



**Instruction Book**

**M-3425A  
Generator Protection**

**BECKWITH**  
**ELECTRIC**  **CO. INC.**

## **TRADEMARKS**

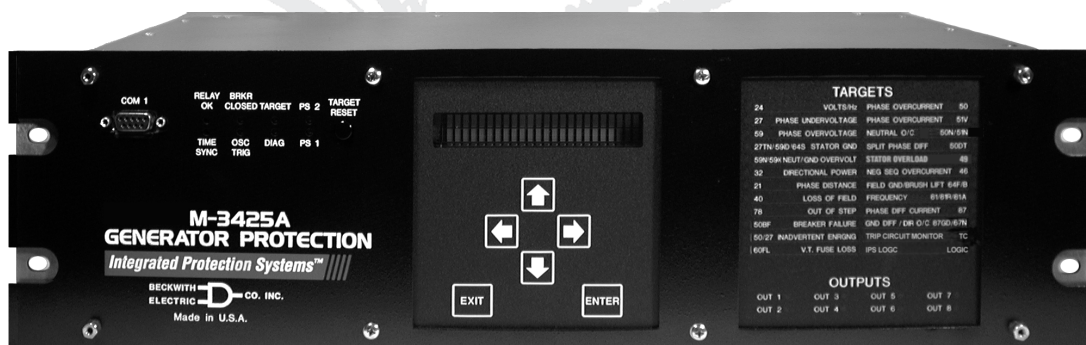
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# Generator Protection M-3425A

**Integrated Protection System® for Generators of All Sizes**



*Unit shown with optional M-3925A Target Module and M-3931 HMI (Human-Machine Interface) Module*

- **Exceeds IEEE C37.102 and Standard 242 requirements for generator protection**
- **Protects generators of any prime mover, grounding and connection type**
- **Provides all major protective functions for generator protection including Out-of-Step (78), Split-Phase Differential (50DT), Under Frequency Time Accumulation (81A), Inadvertent Energizing (50/27) and Turn-to-Turn Fault (59X)**
- **Expanded IPScom® Communications Software provides simple and logical setting and programming, including logic schemes**
- **Simple application with Base and Comprehensive protection packages**
- **Load encroachment blinders and power swing blocking for system backup protection (21) to enhance security during system abnormal conditions**
- **Options: Ethernet Connection, Field Ground/Brush Lift-Off Protection (64F/B), 100% Stator Ground Fault Protection by low frequency injection (64S) and Expanded I/O (15 additional Output Contacts and 8 additional Control/Status Inputs)**

## Protective Functions

### *Base Package*

- Overexcitation (V/Hz) (24)
- Phase Undervoltage (27)
- Directional power sensitive triple-setpoint Reverse Power, Low Forward Power or Overpower detection, one of which can be used for sequential tripping (32)
- Dual-zone, offset-mho Loss of Field (40), which may be applied with undervoltage controlled accelerated tripping
- Sensitive Negative Sequence Overcurrent protection and alarm (46)
- Instantaneous Phase Overcurrent (50)
- Inadvertent Energizing (50/27)
- Generator Breaker Failure (50BF)
- Instantaneous Neutral Overcurrent (50N)
- Inverse Time Neutral Overcurrent (51N)
- Three-phase Inverse Time Overcurrent (51V) with voltage control and voltage restraint.
- Phase Overvoltage (59)
- Neutral Overvoltage (59N)
- Multi-purpose Overvoltage (59X)
- VT Fuse-Loss Detection and blocking (60FL)
- Residual Directional Overcurrent (67N)
- Four-step Over/Underfrequency (81)
- Phase Differential Current (87)
- Ground (zero sequence) Differential Current (87GD)
- IPSlogic takes the contact input status and function status and generates outputs by employing (OR, AND, and NOT) boolean logic and a timer.

## Protective Functions

### *Comprehensive Package*

The Comprehensive Package includes all Base Package functions, as well as the following:

- Three-zone Phase Distance protection for phase fault backup protection (21). Zone three can be used for Out-of-Step Blocking. Load encroachment blinders can be applied.
- Sync Check with Phase Angle,  $\Delta V$  and  $\Delta F$  with dead line/dead bus options (25)
- 100% Stator Ground Fault protection using Third Harmonic Neutral Undervoltage (27TN) or (59D) Third Harmonic Voltage Differential (ratio)
- Stator Overload (49) (Positive Sequence Overcurrent)
- Definite Time Overcurrent (50DT) can be used for split phase differential
- Out-of-Step (78)
- UnderFrequency Accumulation (81A)
- Rate of Change of Frequency (81R)

## Optional Protective Functions

- Field Ground (64F) and Brush Lift Off (64B) (Includes M-3921 Field Ground Coupler)
- 100% Stator Ground protection by low frequency injection (64S). The following equipment is required with the 64S option:
  - 20 Hz signal generator (430-00426)
  - Band Pass Filter (430-00427)
  - 400/5 A 20 Hz CT (430-00428)



## Standard Features

- Eight programmable outputs and six programmable inputs
- Oscillographic recording with COMTRADE or BECO format
- Time-stamped target storage for 32 events
- Metering of all measured parameters and calculated values
- Three communications ports (two RS-232 and one RS-485)
- S-3400 IPScom® Communications Software
- Includes MODBUS and BECO 2200 protocols
- Standard 19" rack-mount design (vertical mounting available)
- Removable printed circuit board and power supply
- 50 and 60 Hz models available
- Both 1A and 5 A rated CT inputs available
- Additional trip inputs for externally connected devices
- IRIG-B time synchronization
- Operating Temperature: -20° C to +70° C
- Sequence of Events Log
- Trip Circuit Monitoring
- Breaker Monitoring
- Four Setpoint Profiles (Groups)
- IPScom Profile File Manager

## Comprehensive Package

- M-3925A Target Module
- M-3931 Human-Machine Interface (HMI) Module

## Optional Features

- Redundant power supply
- RJ45 Ethernet port utilizing MODBUS over TCP/IP and BECO2200 over TCP/IP protocols
- RJ45 Ethernet port utilizing DNP over TCP/IP Protocol
- RJ45 Ethernet port utilizing IEC 61850 Protocol
- RJ45 port RS-485 utilizing DNP over TCP/IP Protocol
- M-3801D IPSplot® *PLUS* Oscillograph Analysis Software
- Expanded I/O (15 additional outputs and 8 additional inputs)
- Standard and Expanded I/O Models available in vertical panel mount

**PROTECTIVE FUNCTIONS**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Phase Distance (three-zone mho characteristic)</b>				
<b>21</b>	Circle Diameter #1,#2,#3	0.1 to 100.0 $\Omega$ (0.5 to 500.0 $\Omega$ )	0.1 $\Omega$	$\pm 0.1 \Omega$ or 5% ( $\pm 0.5 \Omega$ or 5%)
	Offset #1,#2,#3	-100.0 to 100.0 $\Omega$ (-500.0 to 500.0 $\Omega$ )	0.1 $\Omega$	$\pm 0.1 \Omega$ or 5% ( $\pm 0.5 \Omega$ or 5%)
	Impedance Angle #1,#2,#3	0° to 90°	1°	$\pm 1^\circ$
	<b>Load Encroachment Blinder #1,#2,#3</b>			
	Angle	1° to 90°	1°	$\pm 1^\circ$
	R Reach	0.1 to 100 $\Omega$		
	Time Delay #1,#2,#3	1 to 8160 Cycles	1 Cycle	$\pm 1$ Cycle or $\pm 1\%$
	Out-of-Step Delay	1 to 8160 Cycles	1 Cycle	$\pm 1$ Cycle or $\pm 1\%$
	Overcurrent Supervision	0.1 to 20 A (0.02 to 4 A)	0.1 A 0.01 A	$\pm 0.1$ A or $\pm 2\%$ $\pm 0.02$ A or $\pm 2\%$

When out-of-step blocking on Zone 1 or Zone 2 is enabled, Zone 3 will not trip and it will be used to detect the out-of-step condition for blocking Function 21 #1 and/or 21 #2.

<b>Volts / Hz</b>				
<b>24</b>	<b>Definite Time</b>			
	Pickup #1, #2	100 to 200%	1%	$\pm 1\%$
	Time Delay #1, #2	30 to 8160 Cycles	1 Cycle	$\pm 25$ Cycles
	<b>Inverse Time</b>			
	Pickup	100 to 200%	1%	$\pm 1\%$
	Characteristic Curves	Inverse Time #1–#4	—	—
	Time Dial: Curve #1	1 to 100	1	$\pm 1\%$
	Time Dial: Curves #2–#4	0.0 to 9.0	0.1	$\pm 1\%$
	Reset Rate	1 to 999 Sec. (from threshold of trip)	1 Sec.	$\pm 1$ Second or $\pm 1\%$

The percent pickup is based on nominal VT secondary voltage and nominal system frequency settings. The pickup accuracy stated is only applicable from 10 to 80 Hz, 0 to 180 V, 100 to 150% V/Hz and a nominal voltage setting of 120V.

<b>Sync Check</b>				
<b>25</b>	<b>25D Dead Check</b>			
	Dead Voltage Limit	0 to 60 V	1 V	$\pm 0.5$ V or $\pm 0.5\%$
	Dead Time Delay	1 to 8160 Cycles	1 Cycle	-1 to +3 Cycles or 1%
	<b>25S Sync Check</b>			
	Phase Angle Limit	0° to 90°	1°	$\pm 1^\circ$
	Upper Voltage Limit	60 to 140 V	1 V	$\pm 0.5$ V or $\pm 0.5\%$
	Lower Voltage Limit	40 to 120 V	1 V	$\pm 0.5$ V or $\pm 0.5\%$
	Delta Voltage Limit	1.0 to 50.0 V	0.1 V	$\pm 0.5$ V or $\pm 0.5\%$
	Delta Frequency Limit	0.001 to 0.500 Hz	0.001 Hz	$\pm 0.0007$ Hz or $\pm 5\%$
	Sync Check Time Delay	1 to 8160 Cycles	1 Cycle	-1 to +3 Cycles or $\pm 1\%$

Various combinations of input supervised hot/dead closing schemes may be selected. The 25 function cannot be enabled if the 59D function with  $V_X$  or 67N function with  $V_X$  is enabled.

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Phase Undervoltage</b>				
27	Pickup #1, #2, #3	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$ $\pm 0.8 \text{ V}$ or $\pm 0.75\%^*$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 0.5\%^{**}$

\* When both RMS and Line-Ground to Line-Line VT connection is selected.

\*\*When RMS (total waveform) is selected, timing accuracy is  $\leq 20$  cycles or  $\pm 1\%$ .

<b>Third-Harmonic Undervoltage, Neutral</b>				
27 TN	Pickup #1, #2	0.10 to 14.00 V	0.01 V	$\pm 0.1 \text{ V}$ or $\pm 1\%$
	Positive Sequence Voltage Block	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Forward Under Power Block	0.01 to 1.00 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Reverse Under Power Block	-1.00 to -0.01 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Lead Under VAr Block	-1.00 to -0.01 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Lag Under VAr Block	0.01 to 1.00 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Lead Power Factor Block	0.01 to 1.00	0.01	$\pm 0.03 \text{ PU}$ or $\pm 3\%$
	Lag Power Factor Block	0.01 to 1.00	0.01	$\pm 0.03 \text{ PU}$ or $\pm 3\%$
	High Band Forward Power Block	0.01 to 1.00 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Low Band Forward Power Block	0.01 to 1.00 PU	0.01 PU	$\pm 0.01 \text{ PU}$ or $\pm 2\%$
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	-1 to +5 Cycles or $\pm 1\%$

<b>Directional Power</b>				
32	Pickup #1, #2, #3	-3.000 to +3.000 PU	0.001 PU	$\pm 0.002 \text{ PU}$ or $\pm 2\%$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	+16 Cycles or $\pm 1\%$

The minimum Pickup limits are  $-.002$  and  $+.002$  respectively.

The per-unit pickup is based on nominal VT secondary voltage and nominal CT secondary current settings. This function can be selected as either overpower or underpower in the forward direction (positive setting) or reverse direction (negative setting). Element #3 can be set as real power or reactive power. This function includes a programmable target LED that may be disabled.

<b>Loss of Field (dual-zone offset-mho characteristic)</b>				
40	Circle Diameter #1, #2	0.1 to 100.0 $\Omega$ (0.5 to 500.0 $\Omega$ )	0.1 $\Omega$	$\pm 0.1 \text{ } \Omega$ or $\pm 5\%$ ( $\pm 0.5 \text{ } \Omega$ or $\pm 5\%$ )
	Offset #1, #2	-50.0 to 50.0 $\Omega$ (-250.0 to 250.0 $\Omega$ )	0.1 $\Omega$	$\pm 0.1 \text{ } \Omega$ or $\pm 5\%$ ( $\pm 0.5 \text{ } \Omega$ or $\pm 5\%$ )
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%$
	Time Delay with Voltage Control #1, #2	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%$
	Voltage Control (positive sequence)	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Directional Element	0° to 20°	1°	—

Time delay with voltage control for each zone can be individually enabled.

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Negative Sequence Overcurrent</b>				
46	<b>Definite Time</b>			
	Pickup	3 to 100%	1%	±0.5% of 5 A (±0.5% of 1 A)
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	<b>Inverse Time</b>			
	Pickup	3 to 100%	1%	±0.5 % of 5 A (±0.5% of 1 A)
	Time Dial Setting ( $K = I_2^2 t$ )	1 to 95	1	±3 Cycles or ±3%
	Definite Maximum Time to Trip	600 to 65,500 Cycles	1 Cycle	±1 Cycle or ±1%
	Definite Minimum Time	12 Cycles	—	fixed
	Reset Time (Linear)	1 to 600 Seconds (from threshold of trip)	1 Second	±1 Second or ±1%

Pickup is based on the generator nominal current setting.

<b>Stator Overload Protection</b>				
49	Time Constant #1, #2	1.0 to 999.9 minutes	0.1 minutes	
	Maximum Overload Current	1.00 to 10.00 A (0.20 to 2.00 A)	0.01 A	±0.1 A or ±2%

<b>Instantaneous Phase Overcurrent</b>				
50	Pickup #1, #2	0.1 to 240.0 A (0.1 to 48.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

When frequency  $f$  is  $< (f_{nom} - 5)$  Hz add an additional time of  $(1.5/f + 0.033)$  sec to the time delay accuracy.

<b>Breaker Failure</b>				
50 BF	<b>Pickup</b>			
	Phase Current	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%)
	Neutral Current	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

50BF can be initiated from designated M-3425A output contacts or programmable control/status inputs.

<b>Definite Time Overcurrent</b>				
50 DT	Pickup Phase A #1, #2	0.20 A to 240.00 A (0.04 A to 48.00 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Pickup Phase B #1, #2	(same as above)		
	Pickup Phase C #1, #2	(same as above)		
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

This function uses generator line-side currents.

When 50DT function is used for split-phase differential protection, 50BF, 87, and 87GD functions should not be used, and the  $I_A$ ,  $I_B$  and  $I_C$  inputs must be connected to the split phase differential currents.

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Instantaneous Neutral Overcurrent</b>				
<b>50N</b>	Pickup	0.1 to 240.0 A (0.1 to 48.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

When the frequency  $f$  is  $< (f_{nom} - 5)$  Hz add an additional time of  $(1.5/f + 0.033)$  sec to the time delay accuracy.

<b>Inadvertent Energizing</b>				
<b>50/27</b>	<b>50 Overcurrent</b> Pickup	0.5 to 15.00 A (0.1 to 3.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	<b>27 Undervoltage</b> Pickup	5 to 130 V	1 V	±0.5 V
	Pick-up Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Drop-out Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

When RMS (total Waveform) is selected, timing accuracy is  $\leq 20$  cycles or  $\pm 1\%$ .

<b>Inverse Time Neutral Overcurrent</b>				
<b>51N</b>	Pickup	0.25 to 12.00 A (0.05 to 2.40 A)	0.01 A	±0.1 A or ±1% (±0.02 A or ±1%)
	Characteristic Curve	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves Moderately Inverse/Very Inverse/Extremely Inverse/IEEE Curves		
	Time Dial	0.5 to 11.0	0.1	±3 Cycles or ±3%*
		0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.01 0.01	

\* For IEC Curves the timing accuracy is  $\pm 5\%$ .

When the frequency  $f$  is  $< (f_{nom} - 5)$  Hz add an additional time of  $(1.5/f + 0.033)$  sec to the time delay accuracy.

<b>Inverse Time Phase Overcurrent, with Voltage Control or Voltage Restraint</b>				
<b>51V</b>	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±1% (±0.02 A or ±1%)
	Characteristic Curve	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves Moderately Inverse/Very Inverse/Extremely Inverse/IEEE Curves		
	Time Dial	0.5 to 11.0	0.1	±3 Cycles or ±3%*
		0.05 to 1.10 (IEC curves)	0.01	
		0.5 to 15.0 (IEEE curves)	0.01	
	Voltage Control (VC) or Voltage Restraint (VR)	5 to 180 V Linear Restraint	1 V —	±0.5 V or ±0.5% —

\* For IEC Curves the timing accuracy is  $\pm 5\%$ .

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Phase Overvoltage</b>				
<b>59</b>	Pickup #1, #2, #3	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$ $\pm 0.8 \text{ V}$ or $\pm 0.75\%^*$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%^{**}$
	Input Voltage Select	Phase, Positive or Negative Sequence***		

\* When both RMS and Line-Ground to Line-Line is selected.

\*\* When RMS (total waveform) is selected, timing accuracy is  $\leq 20$  cycles or  $\pm 1\%$ .

\*\*\* When positive or negative sequence voltage is selected, the 59 Function uses the discrete Fourier transform (DFT) for magnitude calculation, irrespective of the RMS/DFT selection, and timing accuracy is  $\pm 1 \text{ Cycle}$  or  $\pm 1\%$ . Positive and negative sequence voltages are calculated in terms of line-to-line voltage when Line to Line is selected for V.T. Configuration.

<b>Third-Harmonic Voltage Differential Ratio</b>				
<b>59D</b>	Ratio ( $V_X/V_N$ )	0.1 to 5.0	0.1	
	Time Delay	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%$
	Positive Seq Voltage Block	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Line Side Voltage	$V_X$ or $3V_0$ (calculated)		

The 59D function has a cutoff voltage of 0.5 V for 3<sup>rd</sup> harmonic  $V_X$  voltage. If the 180 Hz component of  $V_N$  is expected to be less than 0.5 V the 59D function can not be used.

The 59D function with  $V_X$  cannot be enabled if the 25 function is enabled. The line side voltage can be selected as the third harmonic of  $3V_0$  (equivalent to  $V_A + V_B + V_C$ ) or  $V_X$ .

$3V_0$  selection for line side voltage can only be used with line-ground VT configuration.

<b>Neutral Overvoltage</b>				
<b>59N</b>	Pickup #1, #2, #3	5.0 to 180.0 V	0.1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%$
	Neg. Seq. Voltage Inhibit (>)	1.0 to 100.0 %	0.1 %	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Zero Seq. Voltage Inhibit (<)	1.0 to 100.0 %	0.1 %	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Zero Seq. Voltage Selection	$3V_0$ or $V_X$		
	20 Hz Injection Mode	Enable/Disable		

When 64S is purchased, the 59N Time Delay Accuracy is -1 to +5 cycles.

<b>Multi-purpose Overvoltage</b>				
<b>59X</b>	Pickup #1, #2	5 to 180 V	1 V	$\pm 0.5 \text{ V}$ or $\pm 0.5\%$
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	$\pm 1 \text{ Cycle}$ or $\pm 1\%$

Multi-purpose input that may be used for turn-to-turn stator ground protection, bus ground protection, or as an extra Phase-Phase, or Phase-Ground voltage input.

When 64S is purchased, the 59N Time Delay accuracy is -1 to +5 cycles.

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>VT Fuse-Loss Detection</b>				
<b>60 FL</b>	A VT fuse-loss condition is detected by using the positive and negative sequence components of the voltages and currents. VT fuse-loss output can be initiated from internally generated logic, and/or from input contacts.			
	Alarm Time Delay	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%
	Three Phase VT Fuse Loss Detection	Enable/Disable		

<b>Residual Directional Overcurrent</b>				
<b>67N</b>	<b>Definite Time*</b>			
	Pickup	0.5 to 240.0 A (0.1 to 48.0 A)	0.1 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%
	<b>Inverse Time*</b>			
	Pickup	0.25 to 12.00 A (0.05 to 2.40 A)	0.01 A	± 0.1 A or ± 3% (± 0.02 A or ± 3%)
	Characteristic Curve	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves Moderately Inverse/Very Inverse/Extremely Inverse/IEEE Curves		
	Time Dial	0.5 to 11.0 0.05 to 1.10 (IEC Curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.01	± 3 Cycles or ± 5%
	<b>Directional Element</b>			
	Max Sensitivity Angle (MSA)	0 to 359°	1°	
	Polarizing Quantity	3V <sub>0</sub> (calculated), V <sub>N</sub> or V <sub>X</sub>		

\*Directional control for 67NDT or 67NIT may be disabled.

V<sub>X</sub> polarization cannot be used if 25 function is enabled.

3V<sub>0</sub> polarization can only be used with line-ground VT configuration.

Operating current for 67N can be selected as 3I<sub>0</sub> (calculated) or I<sub>N</sub> (Residual CT).

If 87GD is enabled, 67N with I<sub>N</sub> (Residual CT) operating current will not be available.

<b>Out of Step (mho characteristic)</b>				
<b>78</b>	Circle Diameter	0.1 to 100.0 Ω (0.5 to 500.0 Ω)	0.1 Ω	± 0.1 Ω or 5% (± 0.5 Ω or 5%)
	Offset	-100.0 to 100.0 Ω (-500.0 to 500.0 Ω)	0.1 Ω	± 0.1 Ω or 5% (± 0.5 Ω or 5%)
	Impedance Angle	0° to 90°	1°	± 1°
	Blinder	0.1 to 50.0 Ω (0.5 to 250.0 Ω)	0.1 Ω	± 0.1 Ω or 5% (± 0.5 Ω or 5%)
	Time Delay	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%
	Trip on mho Exit	Enable/Disable		
	Pole Slip Counter	1 to 20	1	
	Pole Slip Reset	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Frequency</b>				
<b>81</b>	Pickup #1,#2,#3,#4	50.00 to 67.00 Hz 40.00 to 57.00 Hz*	0.01 Hz	± 0.02 Hz
	Time Delay #1–#4	3 to 65,500 Cycles	1 Cycle	± 2 Cycles or ± 1%

The pickup 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. Beyond these ranges, the accuracy is ± 0.1 Hz.

\* This range applies to 50 Hz nominal frequency models.

<b>Frequency Accumulation</b>				
<b>81A</b>	Bands #1, #2, #3, #4, #5, #6			
	High Band #1	50.00 to 67.00 Hz 40.00 to 57.00 Hz*	0.01 Hz	± 0.02 Hz
	Low Band #1–#6	50.00 to 67.00 Hz 40.00 to 57.00 Hz*	0.01 Hz	± 0.02 Hz
	Delay #1–#6	3 to 360,000 Cycles	1 Cycle	± 2 Cycles or ± 1%

When using multiple frequency bands, the lower limit of the previous band becomes the upper limit for the next band, i.e., Low Band #2 is the upper limit for Band #3, and so forth. Frequency bands must be used in sequential order, 1 to 6. Band #1 must be enabled to use Bands #2–#6. If any band is disabled, all following bands are disabled.

When frequency is within an enabled band limit, accumulation time starts (there is an internal ten cycle delay prior to accumulation) and allows the underfrequency blade resonance to be established to avoid unnecessary accumulation of time. When duration is greater than set delay, the alarm asserts and a target log entry is made.

The pickup accuracy applies to 60 Hz models at a range of 57 to 63 Hz, and 50 Hz models at a range of 47 to 53 Hz. Beyond these ranges, the accuracy is ± 0.1 Hz.

\* This range applies to 50 Hz nominal frequency models.

<b>Rate of Change of Frequency</b>				
<b>81R</b>	Pickup #1, #2	0.10 to 20.00 Hz/Sec.	0.01 Hz/Sec.	± 0.05 Hz/Sec. or ± 5%
	Time Delay #1, #2	3 to 8160 Cycles	1 Cycle	+ 20 Cycles
	Negative Sequence Voltage Inhibit	0 to 99%	1%	± 0.5%

<b>Phase Differential Current</b>				
<b>87</b>	Pickup #1, #2	0.20 A to 3.00 A (0.04 to 0.60 A)	0.01 A	± 0.1 A or ± 5% (± 0.02 A or ± 5%)
	Percent Slope #1, #2	1 to 100%	1%	± 2%
	Time Delay* #1, #2	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%
	CT Correction**	0.50 to 2.00	0.01	

\*When a time delay of 1 cycle is selected, the response time is less than 1–1/2 cycles.

\*\*The CT Correction factor is multiplied by  $I_A$ ,  $I_B$ ,  $I_C$ .

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.



**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Ground (zero sequence) Differential Current</b>				
<b>87GD</b>	Pickup	0.20 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 to 8160 Cycles*	1 Cycle	+1 to -2 Cycles or ±1%
	CT Ratio Correction (R <sub>c</sub> )	0.10 to 7.99	0.01	

\*The Time Delay Setting should not be less than 2 Cycles.

The 87GD function is provided primarily for low-impedance grounded generator applications. This function operates as a directional differential. If  $3I_0$  or  $I_N$  is extremely small (less than 0.2 secondary Amps), the element becomes non-directional.

If 67N function with  $I_N$  (Residual) operating current is enabled, 87GD will not be available. Also, if 50DT is used for split-phase differential, 87GD function will not be available.

<b>IPSlogic™</b>				
<b>IPS</b>	<b>IPSlogic uses element pickups, element trip commands, control/status input state changes, output contact close signals to develop 6 programmable logic schemes.</b>			
	Time Delay #1–#6	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%

<b>Breaker Monitoring</b>				
<b>BM</b>	Pickup	0 to 50,000 kA Cycles or kA <sup>2</sup> Cycles	1 kA Cycles or kA <sup>2</sup> Cycles	± 1 kACycles or kA <sup>2</sup> Cycles
	Time Delay	0.1 to 4095.9 Cycles	0.1 Cycles	± 1 Cycle or ± 1%
	Timing Method	IT or I <sup>2</sup> T		
	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.

**PROTECTIVE FUNCTIONS (cont.)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Trip Circuit Monitoring</b>				



Time Delay	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%
------------	------------------	---------	-------------------

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

<b>Nominal Settings</b>				
Nominal Voltage	50.0 to 140.0 V	0.1 V	—	
Nominal Current	0.50 to 6.00 A	0.01 A	—	
VT Configuration	Line-Line/Line-Ground/ Line-Ground to Line-Line*			
Delta/Wye Unit Transformer	Disable/Delta AB/Delta AC			
Seal-In Delay	2 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%	

\*When Line-Ground to Line-Line is selected, the relay internally calculates the line-line voltages from the line-ground voltages for all voltage-sensitive functions. This Line-Ground to Line-Line selection should only be used for a VT connected Line-Ground with a secondary voltage of 69 V (not 120 V).

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

**OPTIONAL PROTECTIVE FUNCTIONS**

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
<b>Field Ground Protection</b>				
<b>64F</b>	Pickup #1, #2	5 to 100 K $\Omega$	1 K $\Omega$	$\pm 10\%$ or $\pm 1\text{K}\Omega$
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	$\pm (\frac{2}{\text{IF}} + 1)$ Sec.
	Injection Frequency (IF)	0.10 to 1.00 Hz	0.01 Hz	
<b>64B</b>	<b>Brush Lift-Off Detection</b> (measuring control circuit)			
	Pickup	0 to 5000 mV	1 mV	
	Time Delay	1 to 8160 Cycles	1 Cycle	$\pm (\frac{2}{\text{IF}} + 1)$ Sec.

When 64F is purchased, an external Coupler Module (M-3921) is provided for isolation from dc field voltages.

[Figure 11](#), Field Ground Protection Block Diagram, illustrates a typical connection utilizing the M-3921 Field Ground Coupler. Hardware dimensional and mounting information is shown in [Figure 12](#), M-3921 Field Ground Coupler Mounting Dimensions.

<b>100% Stator Ground Protection by low frequency injection</b>				
<b>64S</b>	Total Current Pickup	2 to 75 mA	0.1 mA	$\pm 2$ mA or $\pm 10\%$
	Real Component of Total Current Pickup**	2 to 75 mA	0.1 mA	$\pm 2$ mA or $\pm 10\%$
	Time Delay	1 to 8160 Cycles	1 Cycle	$\pm 1$ Cycle* or $\pm 1\%$

An external Low Frequency Generator, Band Pass Filter and Current Transformer are required for this function. 64S Function Connection Diagrams ([Figure 13](#) and [Figure 14](#)), illustrate a typical 100% Stator Ground Protection by Low Frequency Injection application. Hardware dimensional and mounting information is illustrated in [Figure 15](#), [Figure 16](#) and [Figure 17](#).

59D is automatically disabled when the 64S function is purchased. 59N may be applied when this function is enabled.

\* Time Delay accuracy in cycles is based on 20 Hz frequency.

\*\* Operation of the real component requires voltage applied to  $V_N$  input to be  $> 0.5$  Volts at 20 Hz.

†Select the greater of these accuracy values.

Values in parentheses apply to 1 A CT secondary rating.

## Description

The M-3425A Generator Protection Relay is suitable for all generator ratings and prime movers. Typical connection diagrams are illustrated in [Figure 4](#), M-3425A One-Line Functional Diagram (configured for phase differential), and [Figure 5](#), One-Line Functional Diagram (configured for split-phase differential).

## Configuration Options

The M-3425A Generator Protection Relay is available in either a Base or Comprehensive package of protective functions. This provides the user with flexibility in selecting a protective system to best suit the application. Additional Optional Protective Functions may be added at the time of purchase at per-function pricing.

The Human-Machine Interface (HMI) Module, Target Module, or redundant power supply can be selected at time of purchase.

When the Field Ground (64F) Premium Protective Function is purchased, an external coupler module (M-3921) is provided for isolation from the dc field voltages.

When 100% Stator Ground (64S) protection using low-frequency injection is purchased, an external band pass filter and frequency generator is provided.

## Multiple Setpoint Profiles (Groups)

The relay supports four setpoint profiles. This feature allows multiple setpoint profiles to be defined for different power system configurations or generator operating modes. Profiles can be switched either manually using the Human-Machine Interface (HMI), by communications, programmable logic or by control/status inputs. The IPScom Profile File Manager utility simplifies editing and managing setpoint profile groups.

■**NOTE:** During profile switching, relay operation is disabled for approximately 1 second.

## Metering

The relay provides metering of voltages (phase, neutral and sequence quantities), currents (phase, neutral and sequence quantities), real power, reactive power, power factor and impedance measurements.

Metering accuracies are:

Voltage:	$\pm 0.5$ V or $\pm 0.5\%$ , whichever is greater $\pm 0.8$ V or $\pm 0.75\%$ , whichever is greater (when both RMS and Line-Ground to Line-Line are selected)
Current:	5 A rating, $\pm 0.1$ A or $\pm 3\%$ , whichever is greater 1 A rating, $\pm 0.02$ A or $\pm 3\%$ , whichever is greater
Power:	$\pm 0.01$ PU or $\pm 2\%$ of VA applied, whichever is greater
Frequency:	$\pm 0.02$ Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models) $\pm 0.1$ Hz beyond 63 Hz for 60 Hz models, and beyond 53 Hz for 50 Hz models
Volts/Hz:	$\pm 1\%$

## Oscillographic Recorder

The oscillographic recorder provides comprehensive data recording of all monitored waveforms, storing up to 416 cycles of data. The total record length is user-configurable from 1 to 16 partitions. The sampling rate is 16 times the power system nominal frequency (50 or 60 Hz). The recorder may be triggered using either the designated control/status inputs, trip outputs, 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 data records can be stored in either Beckwith Electric format or COMTRADE format. Oscillograph records are not retained if power to the relay is interrupted.

## Target Storage

Information associated with the last 32 trips is stored. The information includes the function(s) operated, the functions picked up, input/output status, time stamp, and phase and neutral currents at the time of trip.

## Sequence of Events Log

The Sequence of Events Log records relay element status, I/O status, measured values and calculated values time stamped with 1 ms resolution at user-defined 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-3400 IPScom Communications Software. Sequence of Events records are not retained if power to the relay is interrupted.

## Calculations

*Current and Voltage RMS Values:* Uses Discrete Fourier Transform algorithm on sampled voltage and current signals to extract fundamental frequency phasors for relay calculations. RMS calculation for the 50, 51N, 59 and 27 functions, and the 24 function are obtained using the time domain approach to obtain accuracy over a wide frequency band. When the RMS option is selected, the magnitude calculation for 59 and 27 functions is accurate over a wide frequency range (10 to 80 Hz). When the DFT option is selected, the magnitude calculation is accurate near nominal frequency (50 Hz/60 Hz) but will degrade outside the nominal frequency. For 50 and 51N functions the DFT is used when the frequency is 55 Hz to 65 Hz for 60 Hz (nominal) and 45 Hz to 55 Hz for 50 Hz (nominal), outside of this range RMS calculation is used.

## Power Input Options

Nominal 110/120/230/240 Vac, 50/60 Hz, or nominal 110/125/220/250 Vdc. UL/CSA rating 85 Vac to 265 Vac and from 80 Vdc to 288 Vdc. Nominal 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, withstands 65 Vdc for 1 second. Burden 20 VA at 24 Vdc and 20 VA at 48 Vdc.

An optional redundant power supply is available for units that are purchased without the expanded I/O. For those units purchased with the expanded I/O, the unit includes two power supplies which are required to power the relay.

## Sensing Inputs

*Five Voltage Inputs:* Rated for a nominal voltage of 60 Vac to 140 Vac at 60 Hz or 50 Hz. Will withstand 240 V continuous voltage and 360 V for 10 seconds. Source voltages may be line-to-ground or line-to-line connected. Phase sequence ABC or ACB is software selectable. Voltage transformer burden less than 0.2 VA at 120 Vac.

*Seven Current Inputs:* Rated nominal current ( $I_R$ ) of 5.0 A or 1.0 A at 60 Hz or 50 Hz. Will withstand  $3I_R$  continuous current and  $100I_R$  for 1 second. Current transformer burden is less than 0.5 VA at 5 A, or 0.3 VA at 1 A.

## Control/Status Inputs

The control/status inputs, INPUT1 through INPUT6, can be programmed to block any relay protective function, to trigger the oscillograph recorder, to operate one or more outputs or can be an input into IPSlogic. To provide breaker status LED indication on the front panel, the INPUT1 control/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 8 programmable control/status inputs (INPUT7 through INPUT14).

**▲ CAUTION:** The control/status inputs should be connected to dry contacts only, and are internally connected (wetted) with a 24 Vdc power supply.

## 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 expanded I/O includes an additional 15 programmable output contacts (OUTPUT9 through OUTPUT23). These contacts are configurable only using IPScom software.

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 15 expanded I/O output contacts (form 'a') are all rated per IEEE C37.90 (See Tests and Standards section for details).

OUTPUT CONTACTS – TYPICAL OPERATING TIME		
Outputs 1-4: 4 ms	Outputs 5-8: 8 ms	Outputs 9-23 (Extended I/O): 8 ms

## 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 will illuminate when the breaker is closed (when the 52b contact input is open). The **OSC TRIG** LED indicates that oscillographic data has been recorded in the unit's memory. The **TARGET** LED will illuminate when any of the relay functions operate. Pressing and releasing the **TARGET RESET** button resets the target LED if the conditions causing the operation have been removed. Holding the **TARGET RESET** push button displays the present pickup status of the relay functions. The **PS1** and **PS2** LEDs will remain illuminated as long as power is applied to the unit and the power supply is operating properly. **TIME SYNC** LED illuminates when valid IRIG-B signal is applied and time synchronization has been established.

## Communication

Communications ports include rear panel RS-232 and RS-485 ports, a front panel RS-232 port, a rear-panel IRIG-B port, an Ethernet port (optional) and an RJ45 port with RS-485 (optional). The communications protocol implements serial, byte-oriented, asynchronous communication, providing the following functions when used with the S-3400 IPScom® Communications Software. MODBUS, BECO 2200 and DNP3.0 protocols are supported providing:

- Interrogation and modification of setpoints
- Time-stamped information for the 32 most recent trips
- Real-time metering of all quantities measured
- Downloading of recorded oscillographic data and Sequence of Events Recorder data.

The optional Ethernet port can be purchased with MODBUS over TCP/IP and BECO2200 over TCP/IP protocols or with the IEC 61850 protocol.

The optional RJ45 port RS-485 includes the DNP3.0 protocol.

## IRIG-B

The M-3425A Generator Protection Relay can accept either modulated (B-122) using the BNC Port or demodulated (B-002) using the RS-232 Port IRIG-B time clock synchronization signal. The IRIG-B time synchronization information is used to correct the hour, minutes, seconds, and milliseconds information.

## HMI Module\* (Comprehensive Package)

Local access to the relay is provided through an optional M-3931 HMI (Human-Machine Interface) Module, allowing for easy-to-use, menu-driven access to all functions utilizing six pushbuttons and a 2-line by 24 character alphanumeric vacuum florescent display. Features of the HMI Module include :

- User-definable access codes that allow three levels of security
- Interrogation and modification of setpoints
- Time-stamped information for the 32 most recent trips
- Real-time metering of all quantities measured

\* Not available on Base Package

## Target Module\* (Comprehensive Package)

An optional M-3925A Target Module provides 24 target and 8 output LEDs. Appropriate target LEDs will illuminate when the corresponding function operates. The targets can be reset with the **TARGET RESET** pushbutton. The **OUTPUT** LEDs indicate the status of the programmable output relays.

\* Not available on Base Package

## Temperature Controller Monitoring

Any Temperature Controller equipped with a contact output may be connected to the M-3425A and controlled by the relay's programmable IPSlogic function. [Figure 1](#) is an example of a typical Temperature Controller Monitoring application. The Omron E5C2 Temperature Controller is a DIN rail mounted RTD interface to the M-3425A Generator Protection relay. The E5C2 accepts type J or K thermocouples, platinum RTDs or thermistors as its input. Supply voltage for the E5C2 accepts 110/120 Vac 50/60 Hz, or 220/240 Vac 50/60 Hz or 24 Vdc.

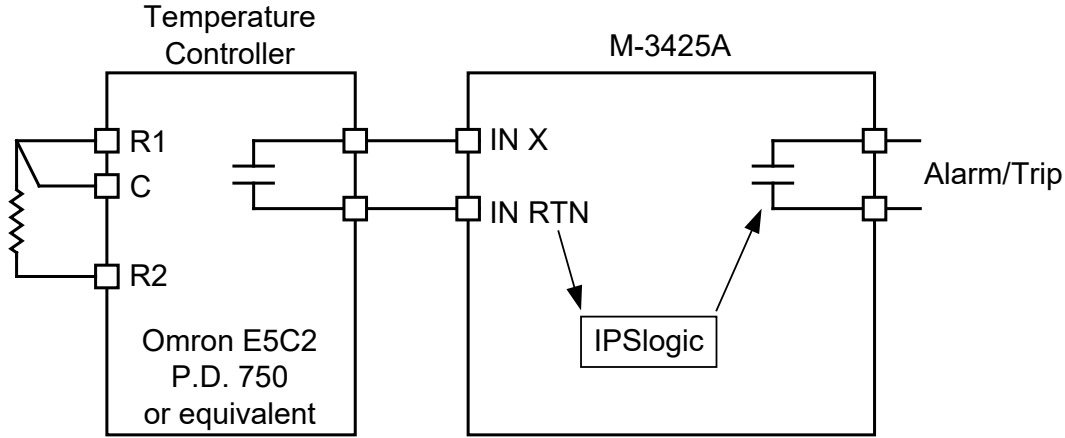


Figure 1 Typical Temperature Controller Monitoring Application

## I/O Expansion (optional)

Optional I/O Expansion provides an additional 15 form 'a' output contacts and an additional 8 control/status inputs. Output LEDs indicate the status of the output relays.

## External Connections

M-3425A external connection points are illustrated in [Figure 2](#) and [Figure 3](#).

## Tests and Standards

The relay complies with the following type tests and standards:

### Voltage Withstand

#### Dielectric Withstand

IEC 60255-5	3,500 Vdc for 1 minute applied to each independent circuit to earth
	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 60255-5	5,000 V pk, +/- polarity applied to each independent circuit to earth
	5,000 V pk, +/- polarity applied between each independent circuit
	1.2 by 50 $\mu$ s, 500 ohms impedance, three surges at 1 every 5 seconds

#### Insulation Resistance

IEC 60255-5	> 100 Megaohms
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## Electrical Environment

### *Electrostatic Discharge Test*

EN 60255-22-2 Class 4 (8 kV) – point contact discharge

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

### *Fast Transient Disturbance Test*

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

### *Surge Withstand Capability*

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

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

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

### *Radiated Susceptibility*

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

### *Output Contacts*

IEEE C37.90	30 A make for 0.2 seconds at 250 Vdc Resistive
UL 508	8 A carry at 120 Vac, 50/60 Hz
CSA C22.2	6 A break at 120 Vac, 50/60 Hz
No. 14	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
IEC 60068-2-2	Dry Heat, +70° C
IEC 60068-2-3	Damp Heat, +40° C @ 93% RH
IEC 60068-2-30	Damp Heat Cycle, +55° C @ 95% RH

## Mechanical Environment

### *Vibration*

IEC 60255-21-1	Vibration response Class 1, 0.5 g
	Vibration endurance Class 1, 1.0 g
IEC 60255-21-2	Shock Response Class 1, 5.0 g
	Shock Withstand Class 1, 15.0 g
	Bump Endurance Class 1, 10.0 g



## Compliance

UL-Listed per 508 – Industrial Control Equipment  
UL-Listed Component per 508A Table SA1.1 Industrial Control Panels  
CSA-Certified per C22.2 No. 14-95 – Industrial Control Equipment  
CE Safety Directive – EN61010-1:2001, CAT II, Pollution Degree 2

## Physical

### Without Optional Expanded I/O

**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:** 17 lbs (7.7 kg)

**Approximate Shipping Weight:** 25 lbs (11.3 kg)

### With Optional Expanded I/O

**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-3425A Instruction Book, Appendix E, Layup and Storage for additional information.*

## Disposal and Recycling

### **Disposal of E-Waste for Beckwith Electric Co. Inc. 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 Co. Inc. for recycling or disposal. The customer is responsible for the shipping cost, and Beckwith Electric Co. Inc. shall cover the recycling cost. Contact Beckwith Electric Co. Inc. for an RMA # to return equipment for recycling.

## Patent & Warranty

The M-3425A Generator Protection Relay is covered by U.S. Patents 5,592,393 and 5,224,011.

The M-3425A 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 Co., Inc. has approved only the English version of this document.*

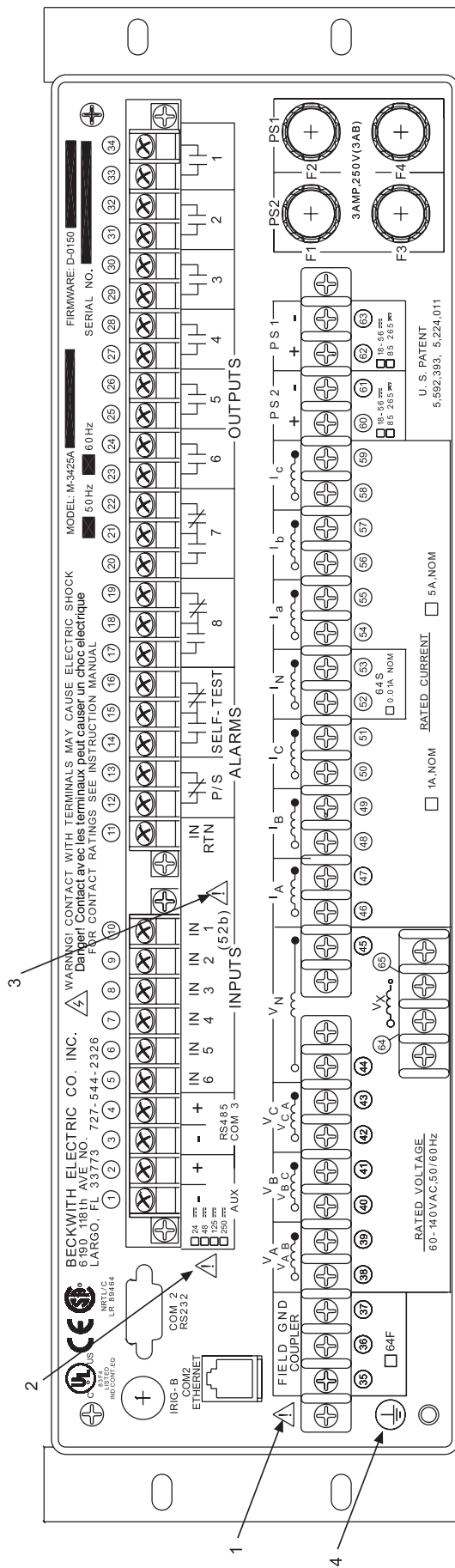


Figure 2 External Connections (Without Optional Expanded I/O)

■ NOTES:

1. See M-3425A Instruction Book Section 4.4, System Setpoints, subsection for 64B/F Field Ground Protection.
2. Before making connections to the Trip Circuit Monitoring input, see M-3425A Instruction Book 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.
3. ▲ **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.
4. ● **WARNING:** The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.

To fulfill requirements for UL and CSA listing, 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.

Torque Requirements:

- Terminals 1–34: 12.0 in-lbs
- Terminals 35–63: 8.0 in-lbs, minimum, and 9.0 in-lbs, maximum.

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

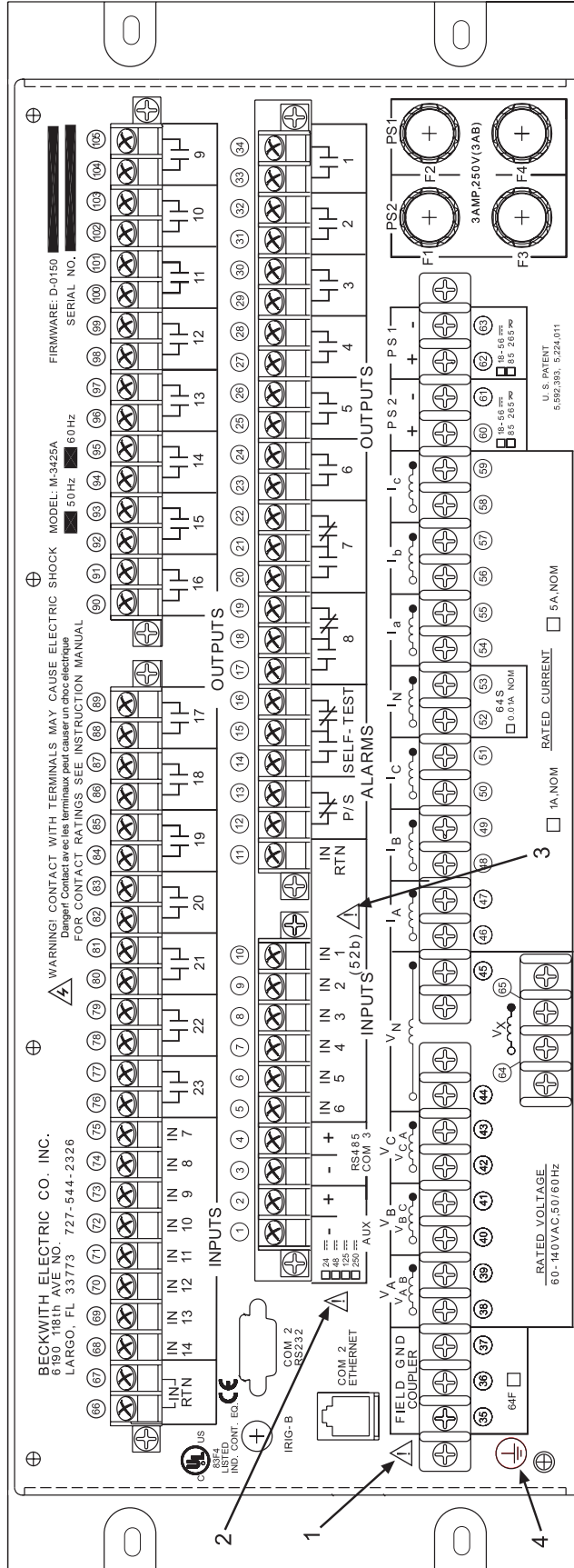


Figure 3 External Connections (With Optional Expanded I/O)

#### NOTES:

1. See M-3425A Instruction Book Section 4.4, System Setpoints, subsection for 64B/F Field Ground Protection.
2. Before making connections to the Trip Circuit Monitoring input, see M-3425A Instruction Book 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.
3. **CAUTION: ONLY DRY CONTACTS** must be connected to inputs (terminals 5 through 10 with 11 common and terminals 68 through 75 with 66 and 67 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
4. **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**

To fulfill requirements for UL and CSA listing, 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.

Torque Requirements:


- Terminals 1–34, 66 –105: 12.0 in-lbs
- Terminals 35–63: 8.0 in-lbs, minimum, and 9.0 in-lbs, maximum.

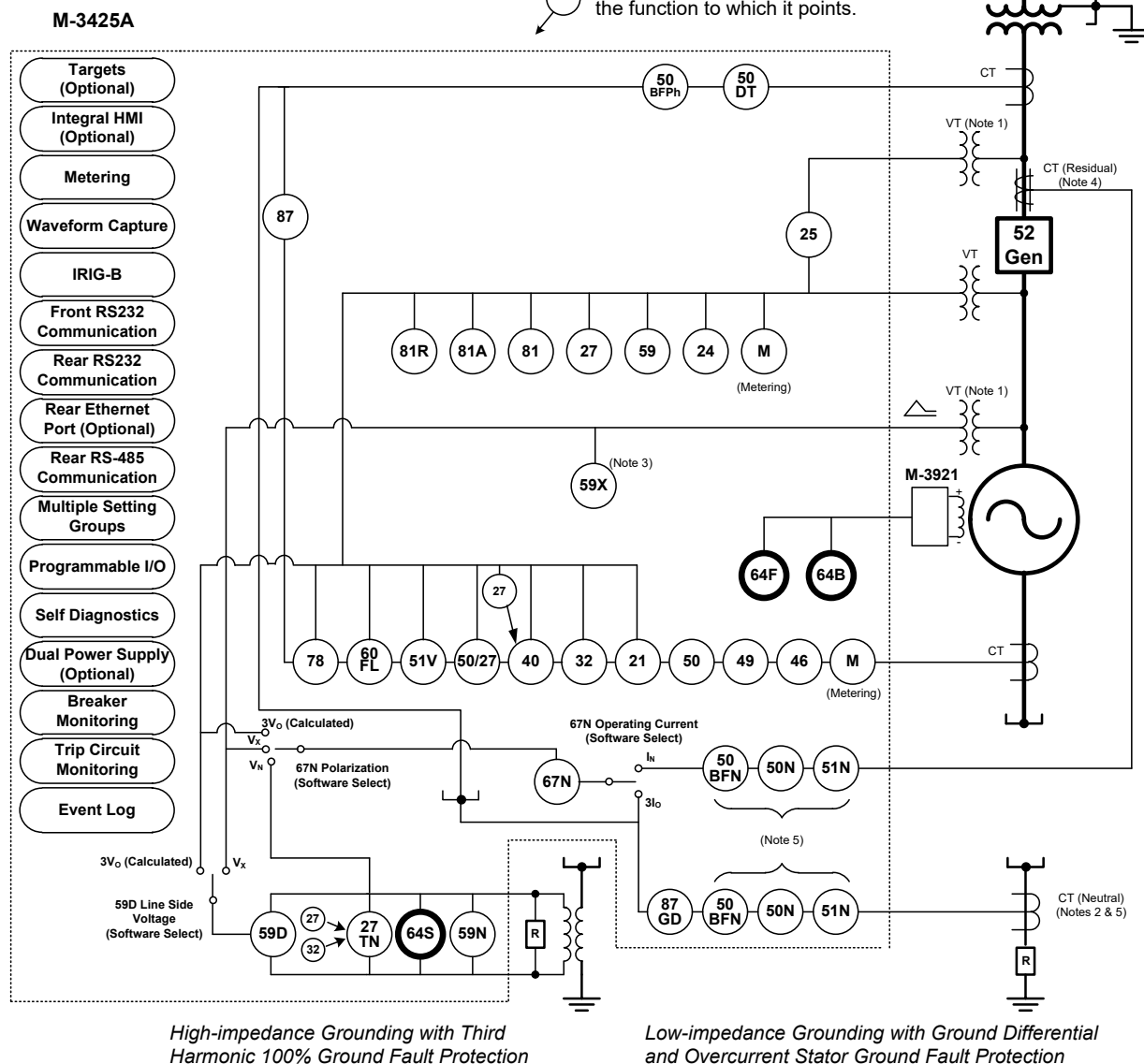
**CAUTION:** Over torquing may result in terminal damage.

### M-3425A Typical Connection Diagram

○ These functions are available in the Comprehensive Package. A subset of these functions are also available in a Base Package.

○ This function is available as a optional protective function.

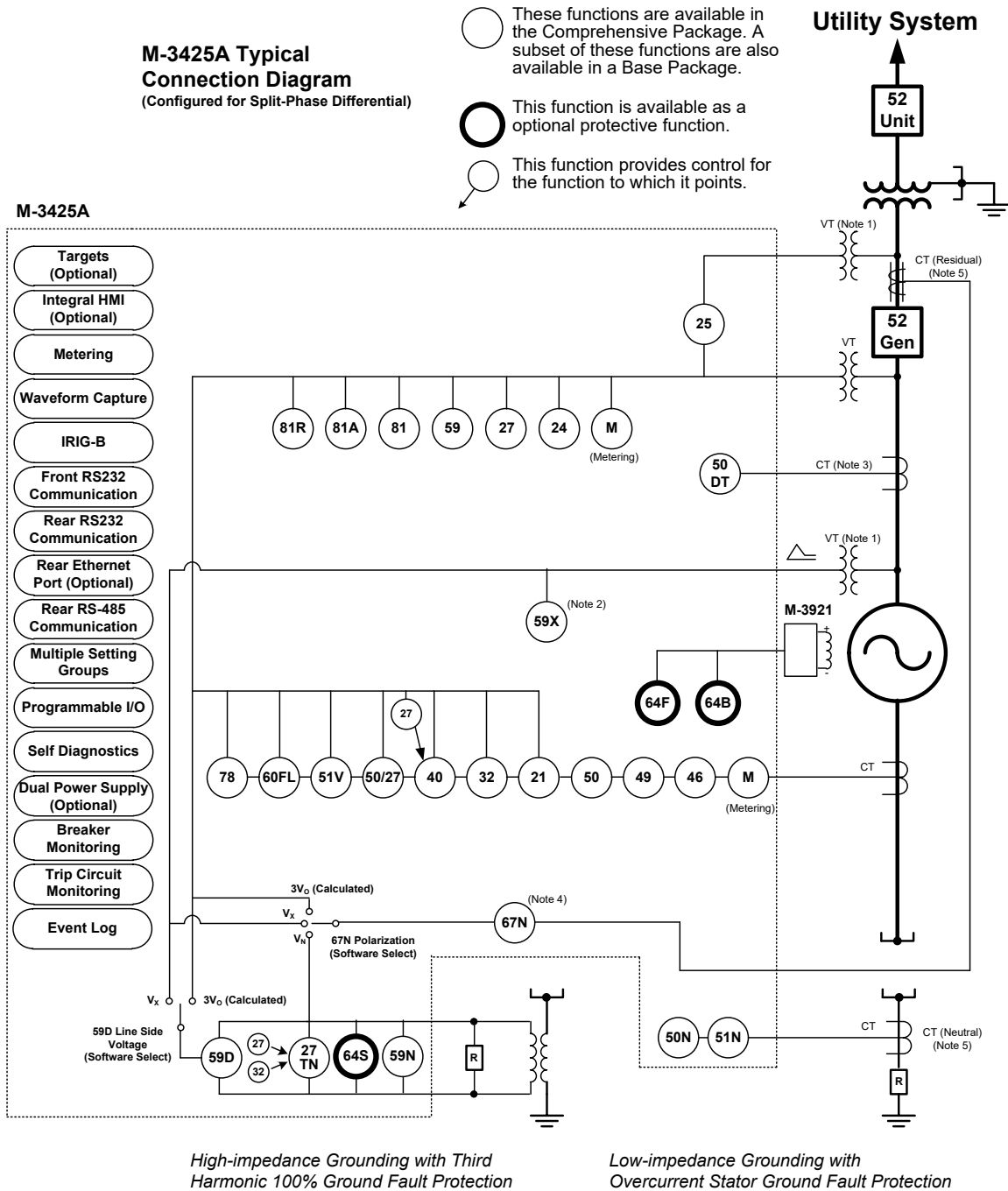
 This function provides control for the function to which it points.



■ **NOTES:**

1. When 25 function is enabled, 59X, 59D with  $V_X$  and 67N with  $V_X$  are not available, and vice versa.
2. When 67N function with  $I_N$  (Residual) operating current is enabled, 87GD is not available, and vice versa.
3. When VT source is used as a turn-to-turn fault protection device (See M-3425A Instruction Book, Chapter 4, System Setup and Setpoints, for additional 59X applications.)
4. The current input  $I_N$  can be connected either from neutral current or residual current.
5. The 50BFN, 50N, 51N, 59D, 67N (with  $I_N$  or  $V_N$ ) and 87GD functions are unavailable when the 64S function has been purchased. See the M-3425A Instruction Book for connection details.

Figure 4 One-Line Functional Diagram (Configured with Phase Differential)

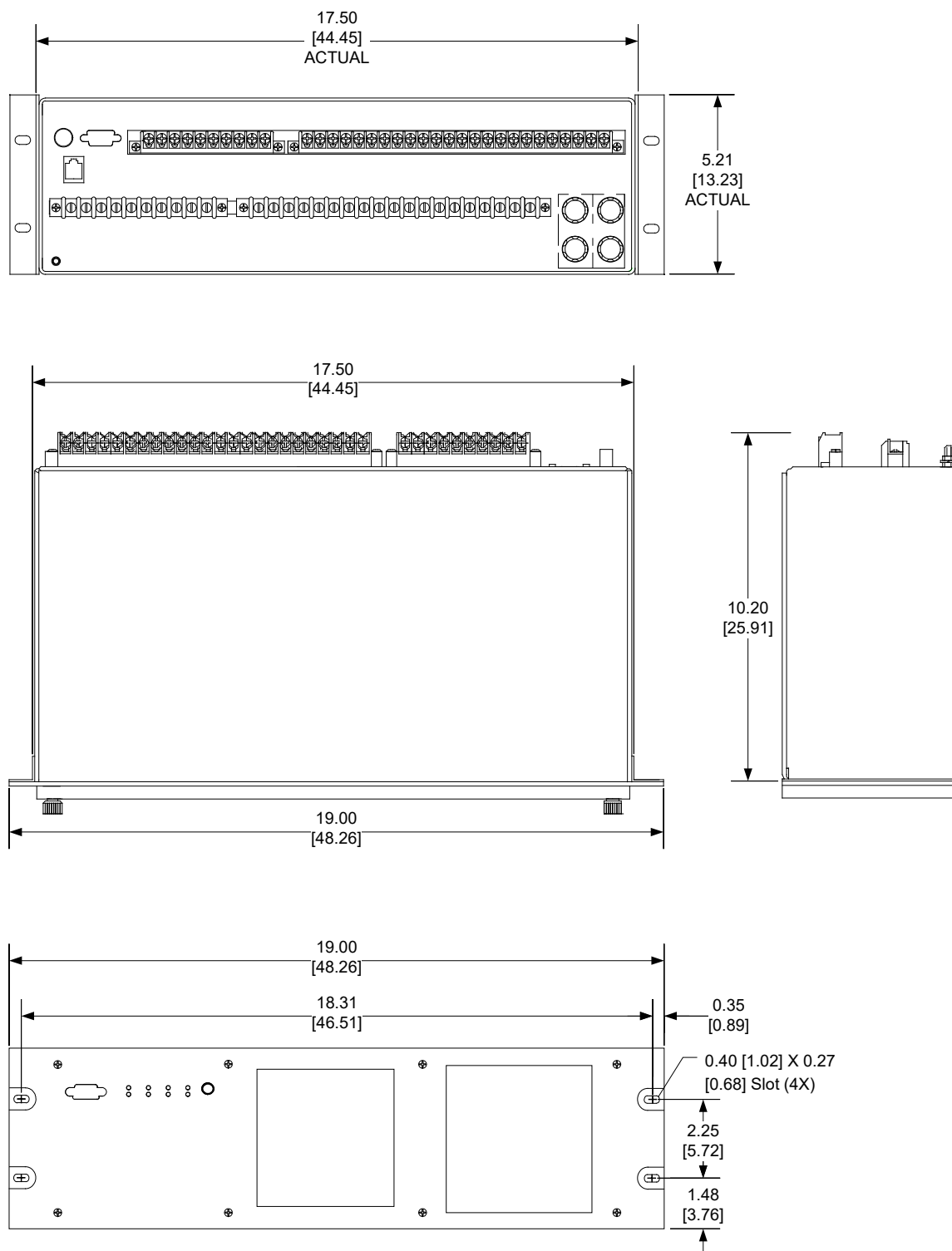


# NOTES:

- When 25 function is enabled, 59X, 59D with V<sub>X</sub> and 67N with V<sub>X</sub> are not available, and vice versa.
- When used as a turn-turn fault protection device.
- CTs are connected for split-phase differential current.
- 67N operating current can only be selected to I<sub>N</sub> (Residual) for this configuration.
- The current input (I<sub>N</sub>) can be connected either from neutral current or residual current.
- The 50BFN, 50N, 51N, 59D, 67N (with I<sub>N</sub> or V<sub>N</sub>) and 87GD functions are unavailable when the 64S function has been purchased. See the M-3425A Instruction Book for connection details.

Figure 5 One-Line Functional Diagram (configured for split-phase differential)

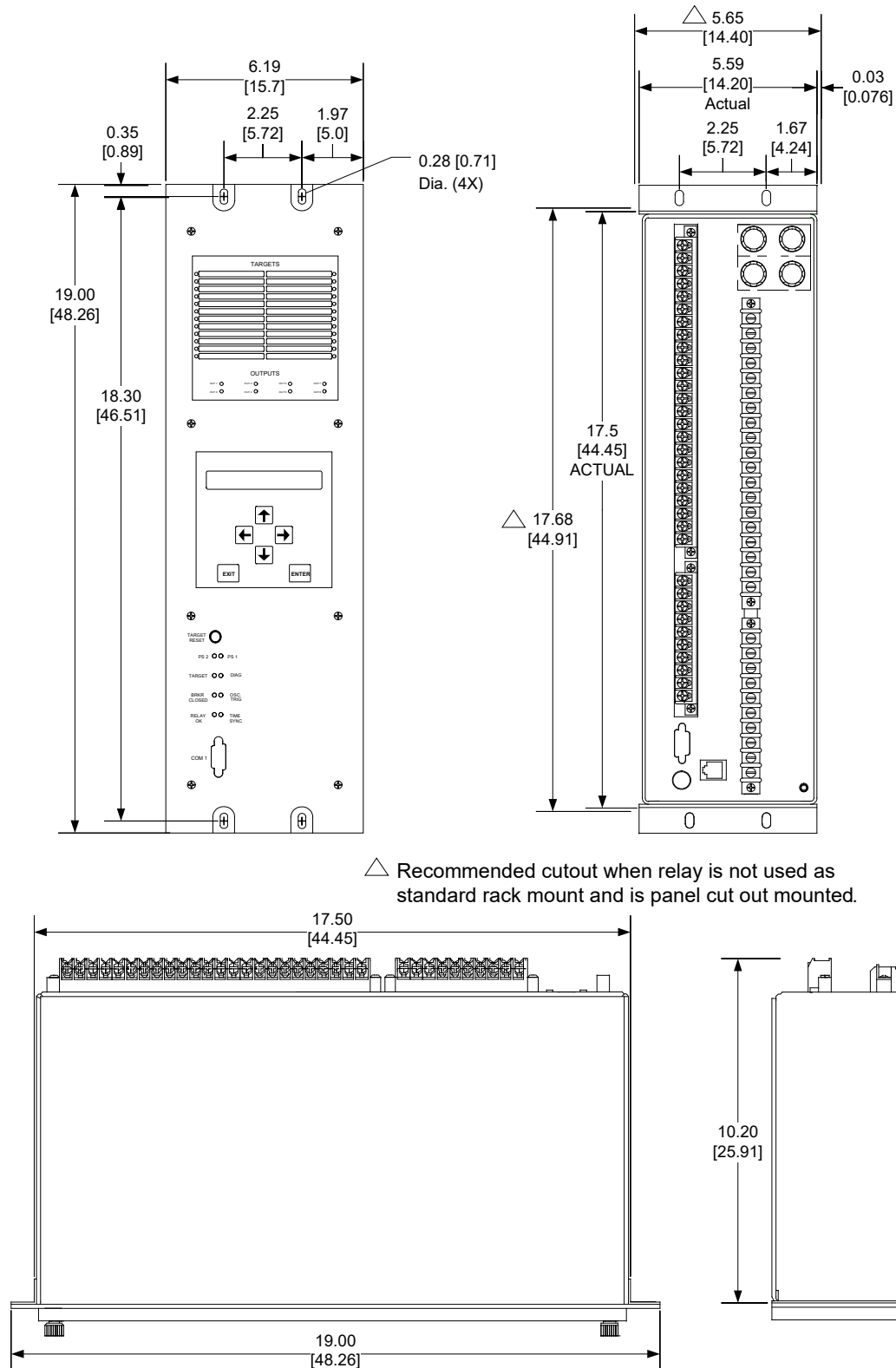
## M-3425A Generator Protection Relay – Specification



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 6 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 7 Vertical Unit Dimensions Without Expanded I/O (H2)



# M-3425A Generator Protection Relay – Specification

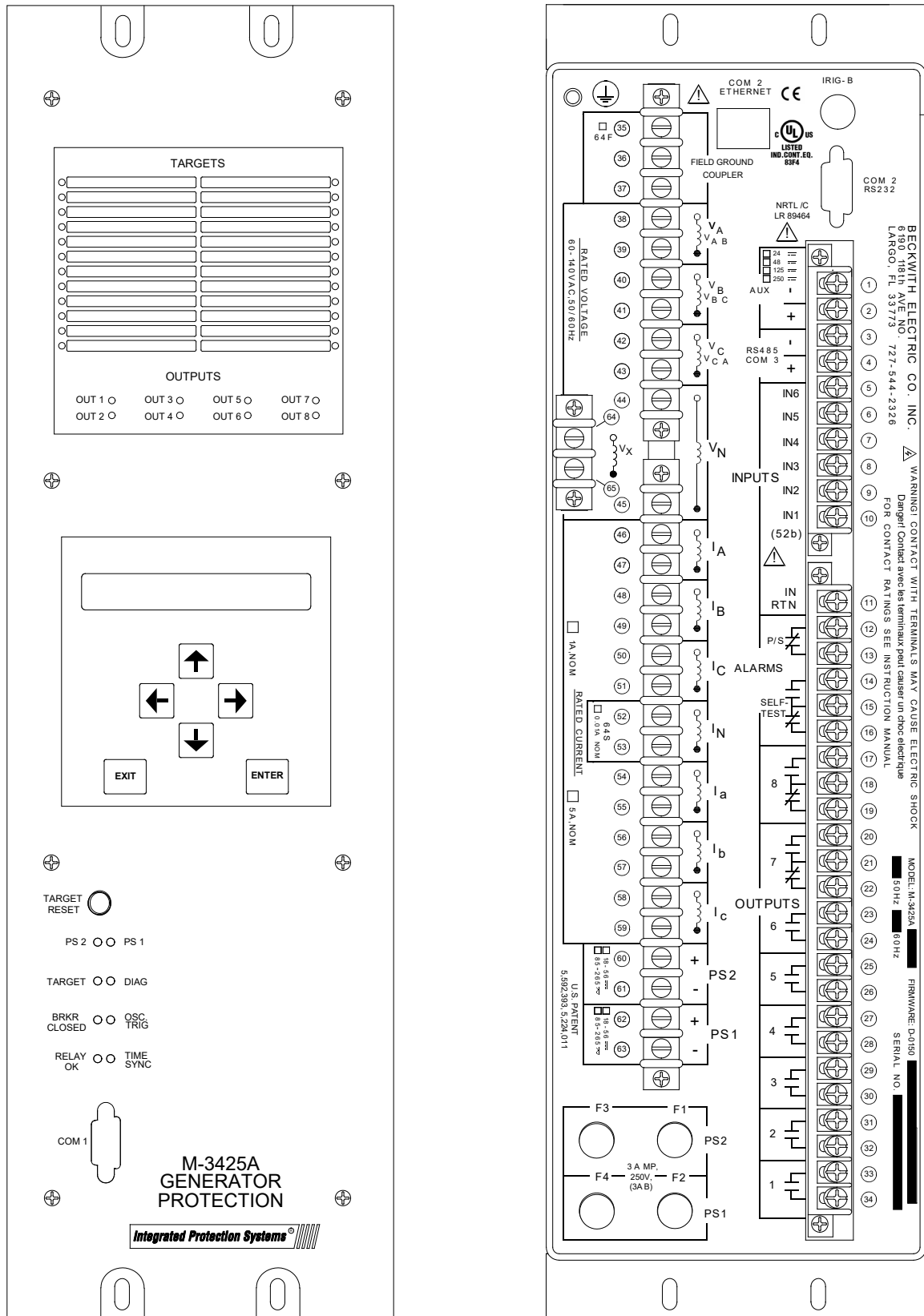
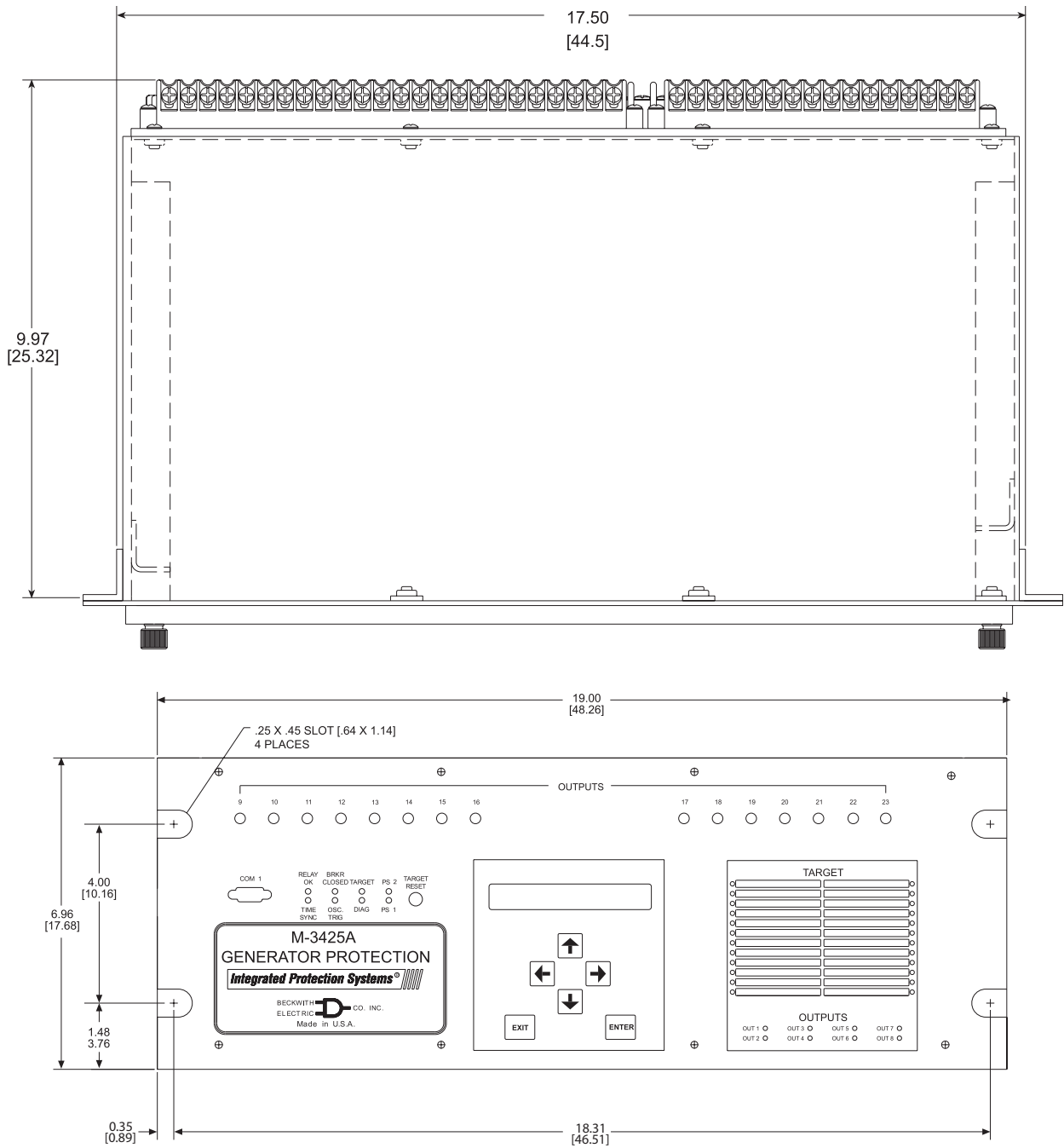


Figure 8 M-3425A Vertical Unit Layout



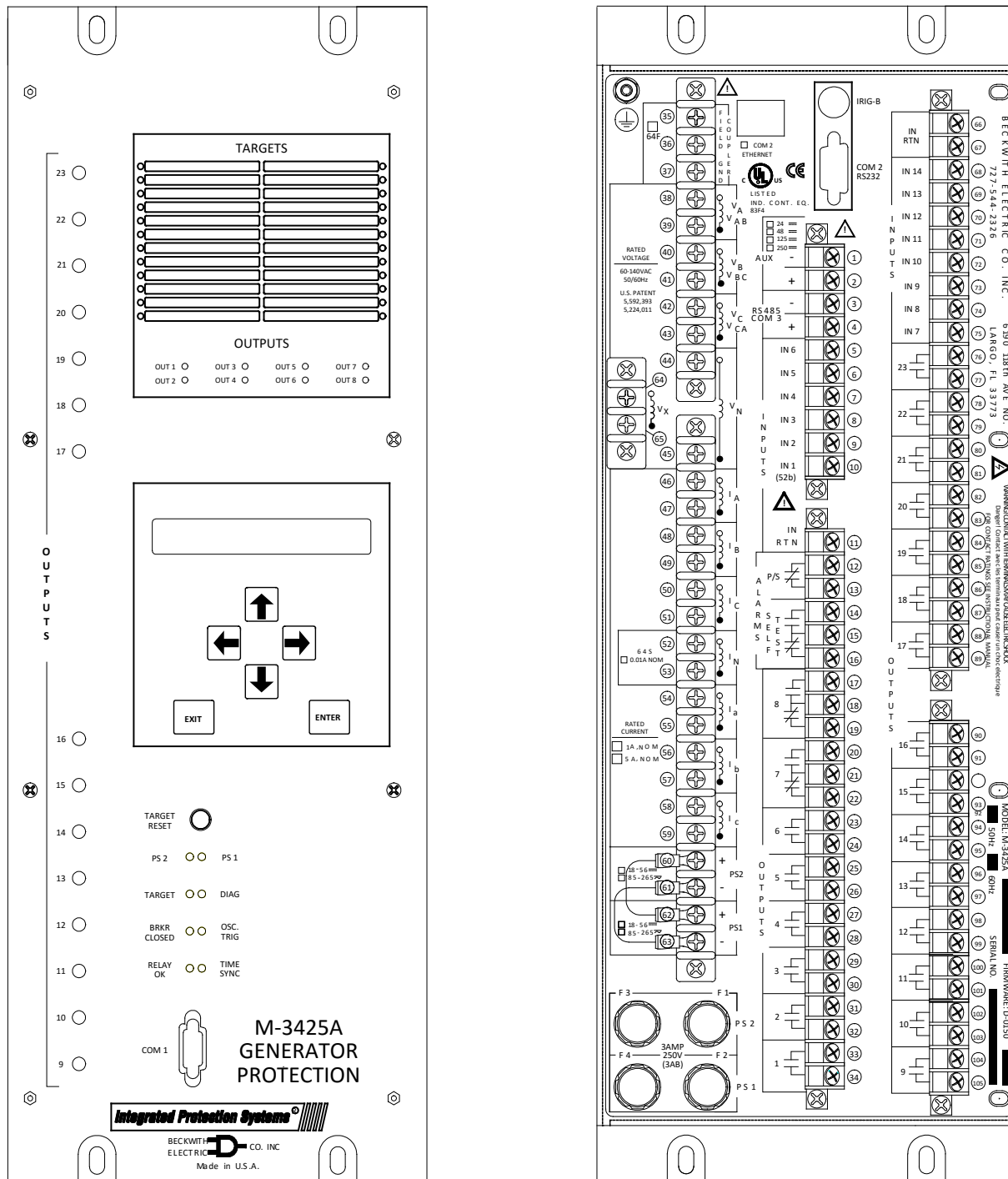
## M-3425A Generator Protection Relay – Specification



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

Figure 9 Horizontal and Vertical Unit Dimensions With Expanded I/O

## M-3425A Generator Protection Relay – Specification



### NOTES:

1. The M-3425A Expanded I/O vertical panel is the same physical size as the M-3425A Expanded I/O horizontal panel. See [Figure 9](#) for dimensions.
2. See Instruction Book Section 5 for Mounting and Cutout information.

Figure 10 M-3425A Expanded I/O Vertical Unit Layout

## M-3921 Field Ground Coupler

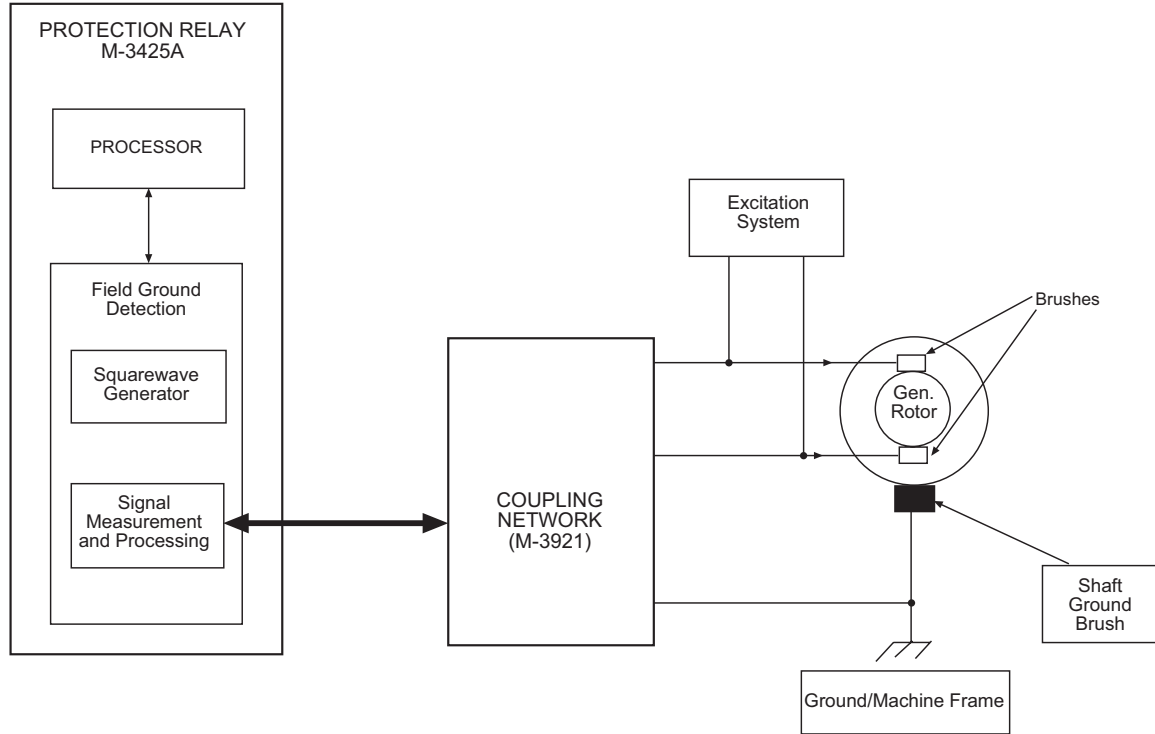


Figure 11 Field Ground Protection Block Diagram

### ■ NOTES:

1. The above circuit measures insulation resistance ( $R_f$ ) between rotor field winding and ground (64F).
2. Relay injects  $\pm 15$  V squarewave ( $V_{out}$ ) and measures return signal ( $V_f$ ) to calculate  $R_f$ .
3. The injection frequency can be set (0.1 to 1.0 Hz) based on the rotor capacitance, in order to improve accuracy.
4. The signal rise time is analyzed to determine if shaft brushes are lifting or open (64B).
5. May also be applied on generators with brushless excitation with a grounding brush and pilot ground fault detection brush.

## Function Specification

**Field/Exciter Supply Voltage Rating** [Terminal (3) to (2)]:

- 60 to 1200 Vdc, continuous
- 1500 Vdc, 1 minute

**Operating Temperature:** -20° to +70°, Centigrade

## Patent & Warranty

The M-3921 Field Ground Coupler is covered by a five-year warranty from date of shipment.

## Tests and Standards

M-3921 Field Ground Coupler complies with the following tests and standards:

### Voltage Withstand

#### *Isolation*

5 kV ac for 1 minute, all terminals to case

#### *Impulse Voltage*

IEC 60255-5      5,000 V pk, 1.2 by 50  $\mu$ s, 0.5 J, 3 positive and 3 negative impulses at 5 second intervals per minute

### Electrical Interference

#### *Electrostatic Discharge Test*

EN 60255-22-2      Class 4 (8 kV) — point contact discharge  
Class 4 (15 kV) — air discharge

#### *Fast Transient Disturbance Tests*

IEC 61000-4-4      Class 4 (4 kV, 2.5 kHz)

#### *Surge Withstand Capability*

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

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

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

#### *Radiated Susceptibility*

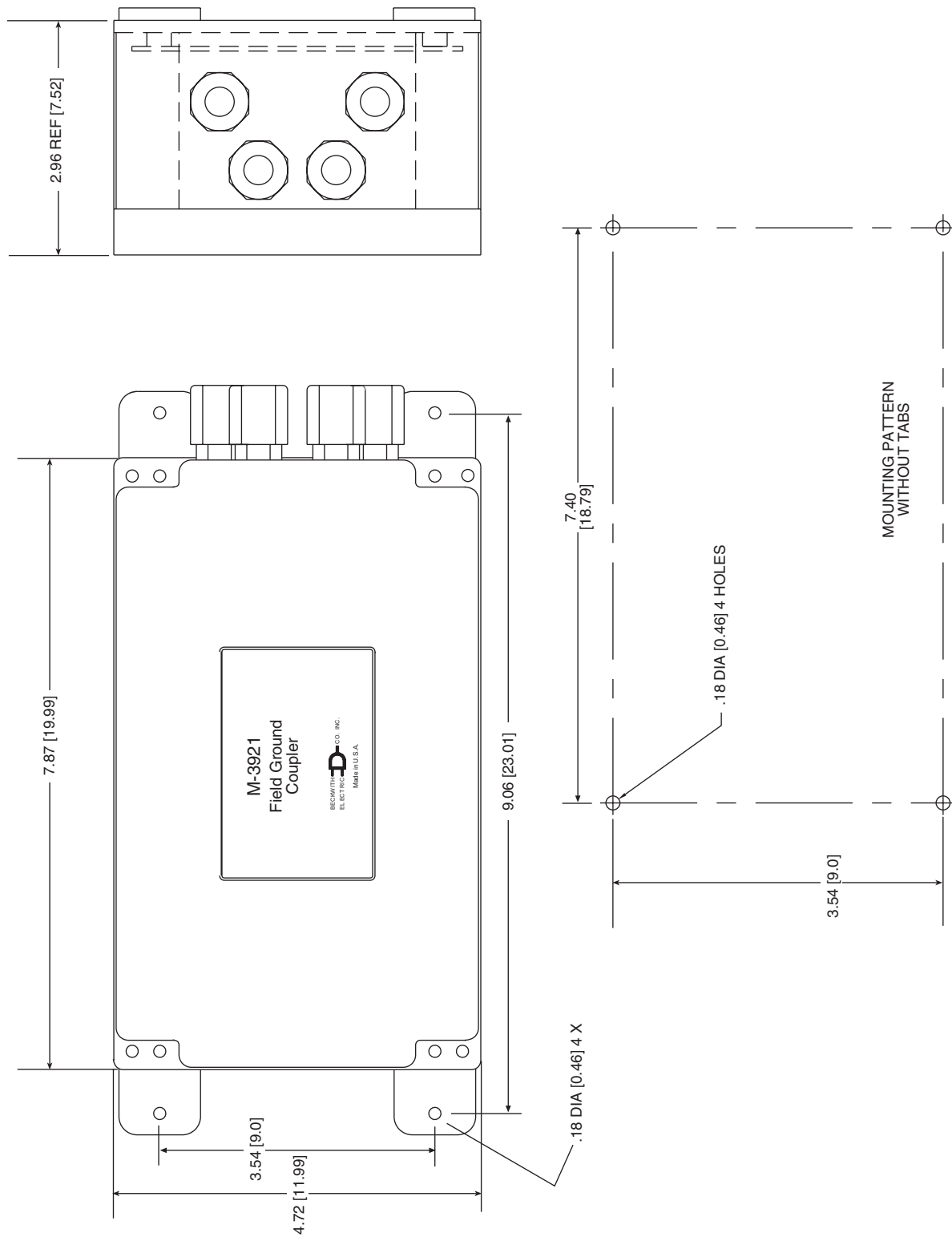
ANSI/IEEE      25-1000 Mhz @ 35 V/m  
C37.90.2

### Atmospheric Environment

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

#### *Enclosure Protection*

NEMA I3, IP65C



■NOTE: Dimensions in brackets are in centimeters.

Figure 12 M-3921 Field Ground Coupler Mounting Dimensions

## **64S 100% Stator Ground Protection by Low Frequency Signal Injection**

■ **NOTE:** The Stator Ground Protection function (64S) must be selected when the M-3425A is initially ordered.

The 100% stator ground fault protection is provided by injecting an external 20 Hz signal into the neutral of the generator. The protection is provided when the machine is on-line as well as off-line (provided that the 20 Hz generator and relay are powered on.) This scheme requires the following external components in addition to M-3425A protection system:

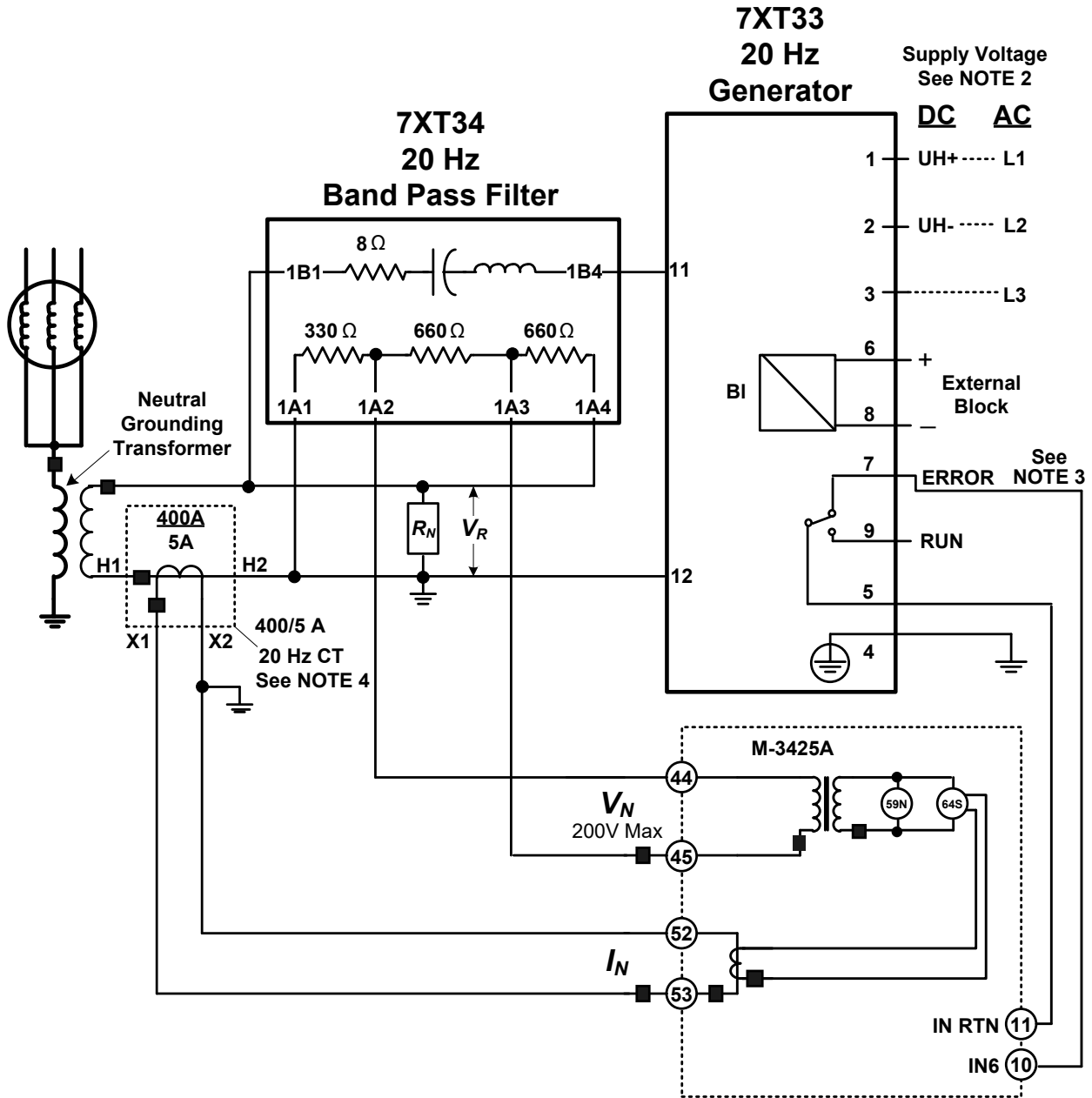
- 20 Hz Signal-generator (BECO Surface Mount/Flush Part No. 430-00426)(Siemens 7XT33)
- Band-pass filter (BECO Surface Mount/Flush Part No. 430-00427)(Siemens 7XT34)
- 20 Hz Measuring Current Transformer, 400/5 A CT (BECO Part No. 430-00428) (ITI-CTW3-60-T50-401)

The voltage signal generated by the 20 Hz signal-generator is injected into the secondary of the generator neutral grounding transformer through a band-pass filter. The band-pass filter passes the 20 Hz signal and rejects out-of-band signals. The output of the 20 Hz band-pass filter is connected to the  $V_N$  input of the M-3425A relay through a suitable voltage divider, that limits the M-3425A to  $\leq 200$  Vac. Use a Straight Through Connection if the maximum 50/60 Hz ground fault voltage measured by  $V_N$  is less than or equal to 200 Volts. The 20 Hz current is also connected to the  $I_N$  input of the M-3425A through the 20 Hz current transformer.

When the generator is operating normally (no ground fault) only a small amount of 20 Hz current will flow as a result of the stator capacitance to ground. The 20 Hz current increases when a ground fault occurs anywhere on the generator stator windings. The 64S function issues a trip signal after a set time delay when the measured 20 Hz current exceeds the pickup current setting.

The Undervoltage Inhibit should not be enabled since the voltage will be small for cases where the Neutral Resistor ( $R_N$ ) is small.

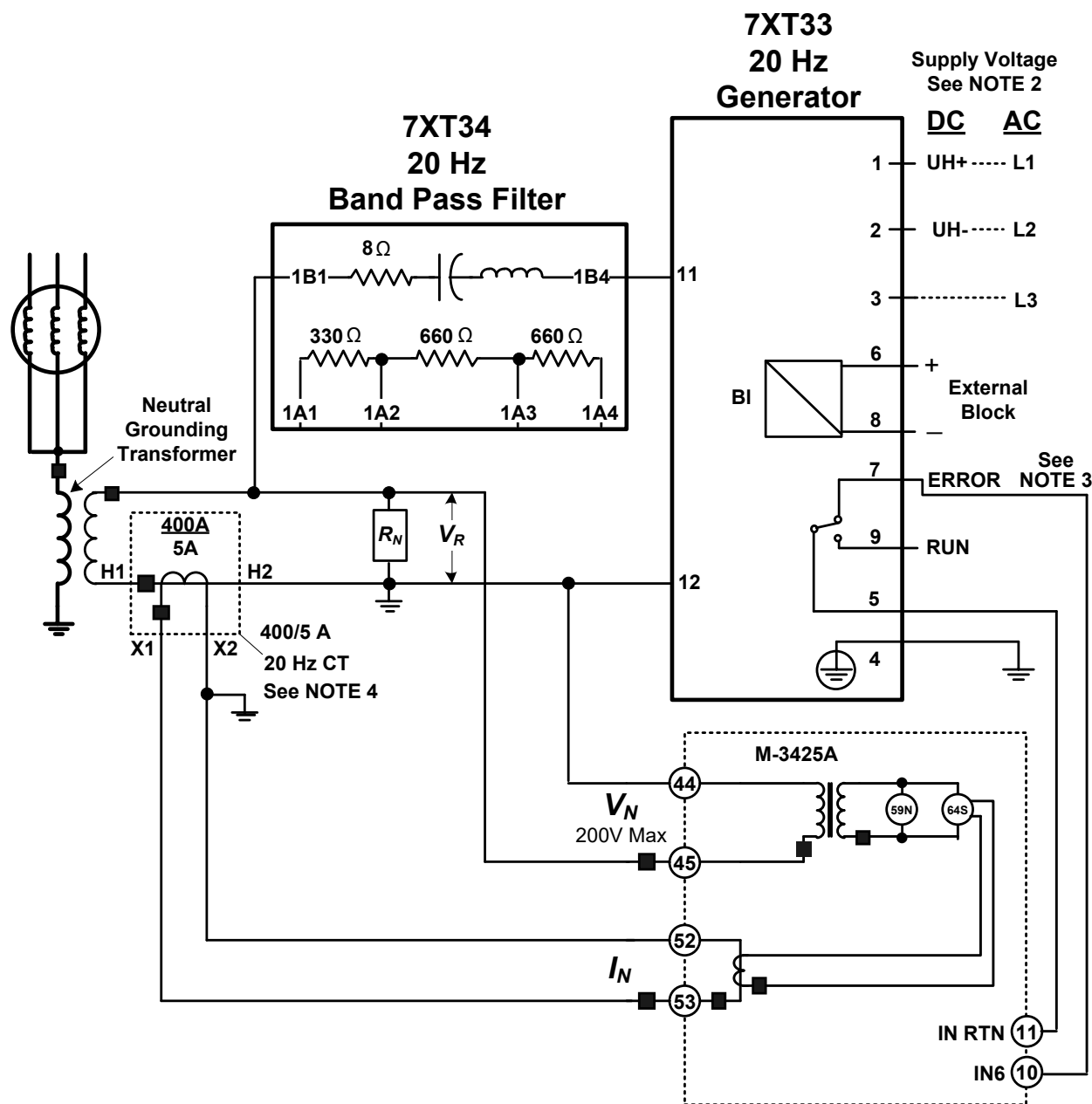
The 59N function (90 to 95%) should also be used in conjunction with 64S protection to provide backup protection.



#### NOTES:

1. Use the Voltage Divider Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage > 200 Vac.
2. See Chapter 4 of the Instruction Book for detailed information.
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.

Figure 13 64S Function Voltage Divider Connection Diagram



■ **NOTES:**

1. Use the Straight Through Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage < 200 Vac.
2. See Chapter 4 of the Instruction Book for detailed information.
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.

Figure 14 64S Function Straight Through Connection Diagram



## 20 Hz Signal Generator Function Specifications

### Auxiliary Voltage

Rated auxiliary voltage  $U_H$  ac      3x (100/120 V ac), 50/60 Hz    1x (100 to 120 V ac), 50/60 Hz  
 Permissible variations ac              88 to 230 V ac

OR

Rated auxiliary voltage  $U_H$  dc          110 to 220 V dc  
 Permissible Variations dc              88 to 250 V dc

Permissible consumption at 8 Ohm impedance  $\leq 100$  VA

■ **NOTE:** 230 VAC is permissible for commissioning only, which is limited in time.

### 20 Hz Output Voltage

Connections (11 and 12)

Output Voltage                              approx. 26 V  $\pm 10$  %, rectangular; 20 Hz  $\pm 0.1$  Hz  
 Power Output, permanently              100 VA over all ranges

■ **NOTE:** Output is not resistant to short-circuits.

### Binary Input for Blocking

Connections (6 and 8)

Switching Threshold                      Adjustable voltage range with jumper  
     – For control voltages    24 V  
    48 V  
    60 V      DC 19 V:  $U_{high} \geq DC 19 V$ ,  $U_{low} \leq DC 10 V$   
     – For control voltages    110 V  
    125 V  
    220 V  
    250 V      DC 88 V:  $U_{high} \geq DC 88 V$ ,  $U_{low} \leq DC 44 V$

Permissible voltage, continuous      300 Vdc

### Life Contact

Connections (5, 7 and 9)

Switching capacity    MAKE    30W/VA  
                                  BREAK    20 VA  
    30 W resistance load  
    25 W @ L/R  $\leq 50$  ms

Switching voltage                          DC 24 V to DC 250 V  
    AC 24 to AC 230 V

Permissible current                        1 A permanent

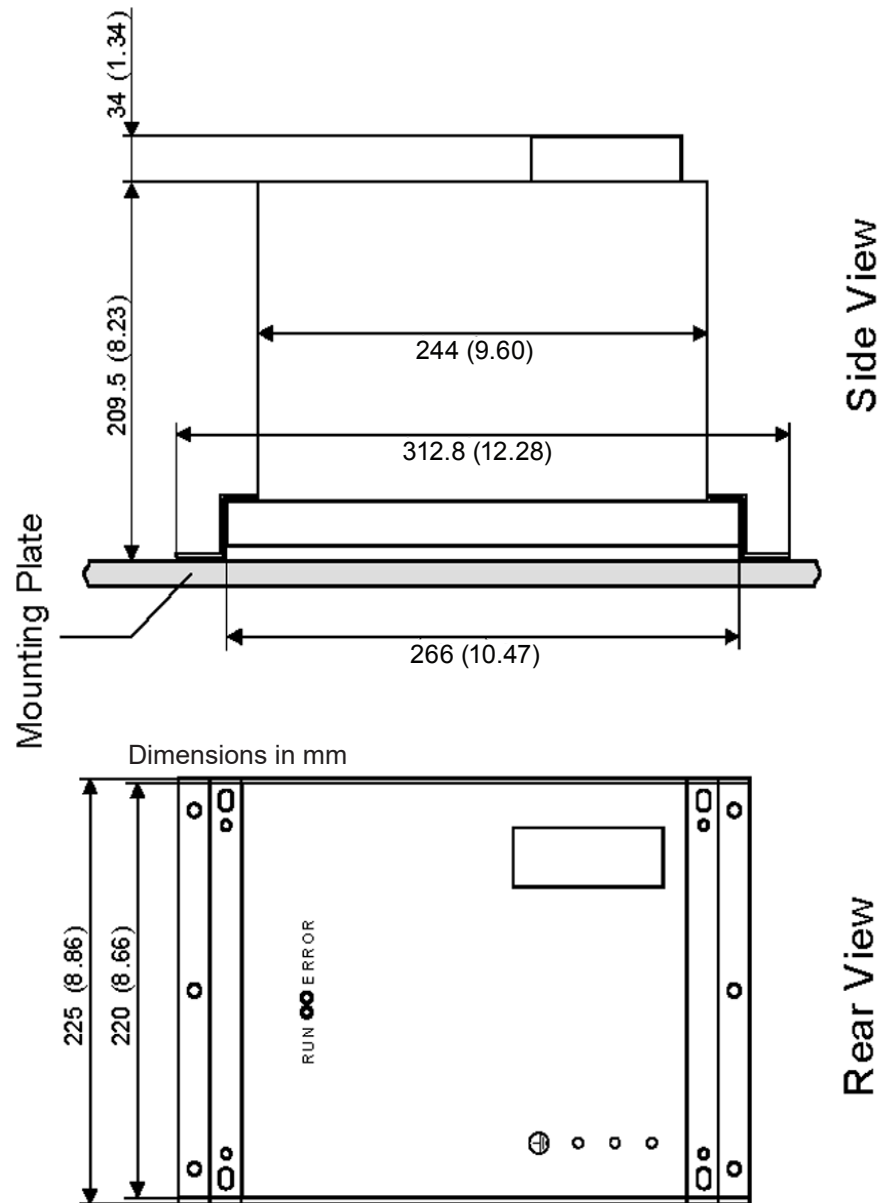
### Permissible Ambient Temperatures

$R_L$  describes the load resistance at the Band Pass output.

with  $R_L < 5$  Ohm       $\leq 55^\circ C$  or  $\leq 131^\circ F$

with  $R_L > 5$  Ohm       $\leq 70^\circ C$  or  $\leq 158^\circ F$

■ **NOTE:** With maximum power output, the device has a power loss of approximately 24 W. To ensure unhindered heat dissipation through the vent holes, the distance to other devices located at the top and bottom must be at least 100 mm. This device must therefore always be mounted in the bottom part of the cabinet.



■ **NOTE:** Detailed Mounting information is contained in the M-3425A Instruction Book Chapter 5, Installation Section 5.6.

*Figure 15 20 Hz Signal Generator Dimensions*

## Band-pass Filter Specifications

### *Load Capacity of the 20 Hz Band-pass Filter*

Connections (1B1-1B4)

Permissible voltage, continuous	55 V ac
Permissible voltage for $\leq 30$ s	550 V ac
Frequency of superimposed ac voltage	$\geq 45$ Hz

Overload capability, continuous	3.25 A ac
---------------------------------	-----------

Test Voltage	2.8 kV dc
--------------	-----------

### *Load Capability of the Voltage Divider Circuit*

Connections (1A1-1A4):

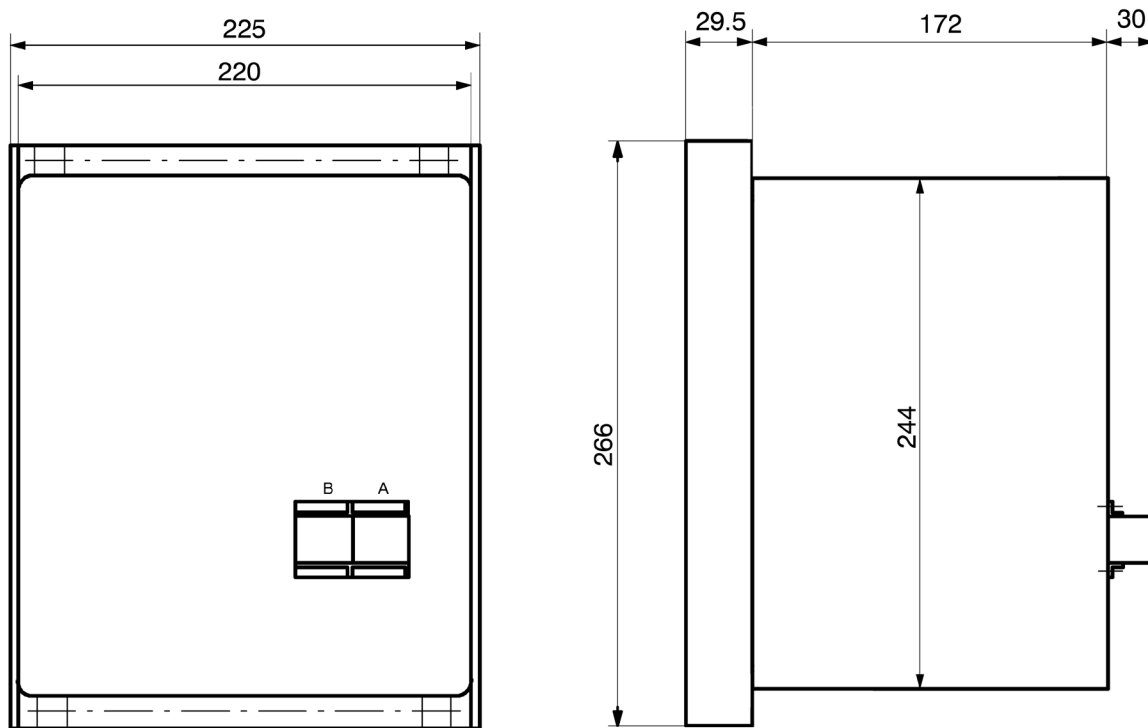
Permissible voltage, continuous	55 V ac
Permissible voltage for $\leq 30$ s	50 V ac

Test Voltage	2.8 kV dc
--------------	-----------

### *Permissible Ambient Temperatures*

with $R_L < 5 \Omega$ burden	$\leq 40^\circ\text{C}$ or $\leq 104^\circ\text{F}$
with $R_L > 5 \Omega$ burden	$\leq 55^\circ\text{C}$ or $\leq 131^\circ\text{F}$

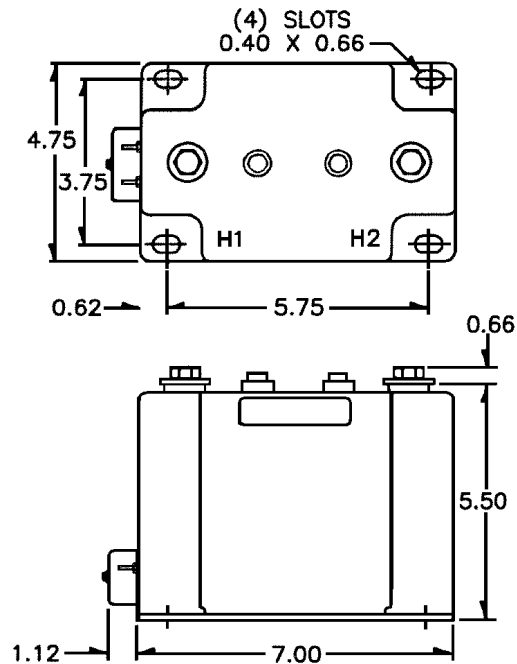
■ **NOTE:** The device may produce up to 75 W power losses during service. In order to prevent heat pockets, the dissipation of the losses must not be restricted. The minimum clearance above and below the device to other units or walls is 100 mm or 4 inches. In cubicles, the device shall be installed in the bottom area.



Dimensions in mm

■ **NOTE:** Detailed Mounting information is contained in the M-3425A Instruction Book Chapter 5, Installation Section 5.

Figure 16 Band-pass Filter Dimensions



Dimensions in inches

Figure 17 20 Hz Measuring Current Transformer 400-5 A CT

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**ISO 9001:2008**

# WARNING

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

## **DANGER! HIGH VOLTAGE**



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

## **PERSONNEL SAFETY PRECAUTIONS**

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



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



### **Always Ground the Equipment**

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

### **Do NOT operate in an explosive environment**

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

### **Keep away from live circuits**

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

### **Exercise care during installation, operation, & maintenance procedures**

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

### **Do not modify equipment**

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

## **PRODUCT CAUTIONS**

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

### **Avoid static charge**

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

### **Use caution when measuring resistances**

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



## **NOTE**

The following features, described in this Instruction Book, are only available for firmware version D-0150-V01.00.34 and later:

59N 20 Hz Injection Mode (Page 2-58)

IEEE curves for 51N, 51V, and 67N functions (Appendix D)

Sequence of Events Recorder (Page 4-18)

Dropout/Reset Time Delay added to IPSlogic (Page 2-91)

Response Time Delay for Communications (Page 4-3)

25 Function (does not produce a target) (Page 2-21)

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## 1.1      Instruction Book Contents

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This instruction book includes six Chapters and eight Appendices.

### Chapter 1: Introduction

Chapter One summarizes the devices’ capabilities, introduces the instruction book contents and describes the application of an M-3425A.

### Chapter 2: Operation

Chapter Two provides the necessary instructions regarding operation of the M-3425A. Manual operation of the M-3425A is accomplished by utilizing either the unit’s front panel controls and indicators, which include the M-3931 Human Machine Interface (HMI) and M-3925A Status Module or through the S-3400 IPScom Communications and Oscillographic Analysis Software.

### Chapter 3: IPScom

Chapter 3 provides a description of each element of the S-3400 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-3425A. 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-3425A, and describes the individual function settings.

### Chapter 5: Installation

The person or group responsible for the installation of the M-3425A 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-3425A.

### 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-3425A HMI Flow diagrams to aide the user in navigating the menu system.

### Appendix G: Index

This Appendix includes the Index for the M-3425A Instruction Book.

### Appendix H: Declaration of Conformity

This Appendix contains the Beckwith Electric Co.'s Declaration of Conformity required by ISO/IEC 17050-1:2004.

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## 1.2 M-3425A Generator Protection Relay

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The M-3425A Generator Protection Relay is a microprocessor-based unit that uses digital signal processing technology to provide up to thirty-four protective relaying functions for generator protection. The relay can protect a generator from internal winding faults, system faults, and other abnormal conditions.

The available M-3425A Generator Protective Functions are listed in [Table 1-1](#). The nomenclature follows the standards of ANSI/IEEE Std. C37.2, Standard Electric Power Systems Device Function Numbers where applicable.

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

The M-3931 Human Machine Interface (HMI) Module allows the user to access the following features and functions from the M-3425A 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-3425A Unit Last Power Up Date and Time
- M-3425A Unit Firmware Version and Serial Number
- Error Codes
- Checksums



FUNCTION	DESCRIPTION
<b>Protective Functions</b>	
21	Phase Distance (three-zone mho characteristic)
24	Volts/Hz (Inverse & Definite Time)
25	Sync Check
27	Phase Undervoltage
27TN	Third Harmonic Undervoltage, Neutral
32	Directional Power
40	Loss of Field (dual-zone offset-mho characteristic)
46	Negative Sequence Overcurrent
49	Stator Overload Protection (Positive Sequence Overcurrent)
50	Instantaneous Phase Overcurrent
50BF	Breaker Failure
50DT	Definite Time Overcurrent
50N	Instantaneous Neutral Overcurrent
50/27	Inadvertent Energizing
51N	Inverse Time Neutral Overcurrent
51V	Inverse Time Overcurrent, with Voltage Control or Restraint
59	Phase Overvoltage
59D	Third-Harmonic Voltage Differential
59N	Neutral Overvoltage
59X	Multi-purpose Overvoltage
60FL	VT Fuse-Loss Detection
67N	Residual Directional Overcurrent
78	Out of Step (mho characteristic)
81	Frequency
81A	Frequency Accumulation
81R	Rate of Change of Frequency
87	Phase Differential Current
87GD	Ground (zero sequence) Differential
IPS	IPSlogic
BM	Breaker Monitor
TC	Trip Circuit Monitoring
<b>Optional Protective Functions</b>	
64F/64B	Field Ground Protection/Brush Lift-Off Detection
64S	100% Stator Ground Protection by Injection

Table 1-1 M-3425A 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 M-3925A Target Module LEDs are used to provide a detailed visual indication of function operation for the most recent event.

The M-3425A retains up to 416 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-3425A 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-3425A 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.

The RJ45 port can also be purchased in a RS-485 configuration. Utilizing a RJ45 Breakout Adapter the RJ45 port supports 2 wire RS-485 and the DNP3.0 protocol.

- COM3, located on the rear terminal block of the relay, is an RS-485 communications port.

■ **NOTE:** COM1, COM2 and COM3 can be disabled for security purposes from the Communications HMI menu. A Level 2 Access Code is required.

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, **IPScm**.

## S-3400 IPScom Communications Software

Each M-3425A unit includes the S-3400 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, **IPScm** for an overview of IPScom features.

## M-3925A Target Module (Comprehensive Package)

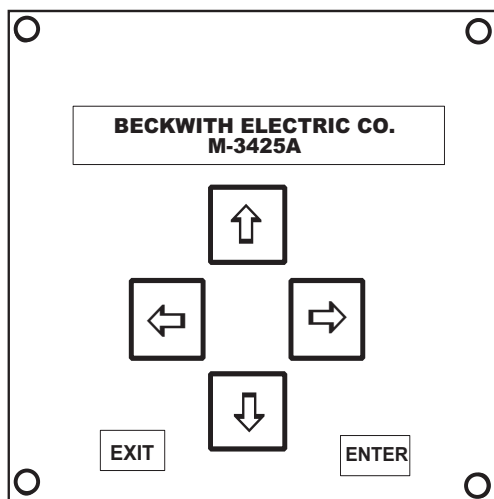
The target module shown in [Figure 1-1](#) includes 24 individually labeled **TARGET** LEDs to target the operation of the functions on the front panel. Eight individually labeled **OUTPUT** LEDs will be illuminated as long as any output is picked up.

TARGETS			
24	VOLTS/Hz	PHASE OVERCURRENT	50
27	PHASE UNDERVOLTAGE	PHASE OVERCURRENT	51V
59	PHASE OVERVOLTAGE	NEUTRAL O/C	50N/51N
27TN/59D/64S	STATOR GND	SPLIT PHASE DIFF	50DT
59N/59X	NEUT/GND OVERVOLT	STATOR OVERLOAD	49
32	DIRECTIONAL POWER	NEG SEQ OVERCURRENT	46
21	PHASE DISTANCE	FIELD GND/BRUSH LIFT	64F/B
40	LOSS OF FIELD	FREQUENCY	81/81R/81A
78	OUT OF STEP	PHASE DIFF CURRENT	87
50BF	BREAKER FAILURE	GND DIFF/DIR O/C	87GD/67N
50/27INADVERTENT ENRGNG		TRIP CIRCUIT MONITOR	TC
60FL	V.T. FUSE LOSS	IPS LOGIC	LOGIC
OUTPUTS			
OUT 1	OUT 3	OUT 5	OUT 7
OUT 2	OUT 4	OUT 6	OUT 8

Figure 1-1 M-3925A Target Module

### M-3931 Human-Machine Interface (HMI) Module (Comprehensive Package)

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



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

## 1.3 Accessories

### M-3801D IPSplot® Plus Oscillograph Analysis Software

The IPSplot® Plus Oscillograph Analysis Software runs in conjunction with IPScom software on any Windows™ compatible computer running Windows 2000 or later, to enable the plotting and printing of waveform data downloaded from the M-3425A Generator 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-3425A 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).

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# 2 Operation

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This chapter contains information that describes the operation of the M-3425A Generator Protection Relay. See Chapter 4 for System Setup, Configuration and Setpoint information. M-3425A operation from either IPScm 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
- 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
- Sequence of Events Recorder
  - Retrieve Records
  - View Records
  - Clear Records

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## 2.1 Front Panel Controls and Indicators

This section describes the operation of the M-3425A as a function of the M-3931 Human Machine Interface Module (HMI) and the M-3925A Target Module.

The M-3425A can be interrogated locally with the HMI panel. An integral part of the design is the layout and function of the front panel indicators and controls, illustrated in [Figure 2-1](#).

### Alphanumeric Display

The HMI module consists of a 2-line 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 the internal clock is synchronized with the IRIG-B time signal. IRIG-B time information is used to accurately tag target and oscillograph events.

### 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.

### Oscillograph Triggered LED

The red **OSC TRIG** LED will illuminate to indicate that oscillograph data has been recorded in the unit's memory and is available for download.

### 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 23 for units with expanded I/O), the **TARGET** LED will illuminate, indicating a relay operation. The **TARGET** LED will remain illuminated until the condition causing the trip is cleared, and the operator presses the **TARGET RESET** pushbutton.

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

### M-3925A Target Module and Target Reset Pushbutton

For units equipped with the optional M-3925A Target Module, additional targeting information is available. The Target module includes an additional 24 target LEDs, and 8 output status LEDs. LEDs corresponding to the particular operated function as well as the present state of the outputs are available.

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



Figure 2-1 M-3425A Front Panel



## 2.2 Operation (HMI/PC)

The purpose of this section is to describe the steps that are necessary to interrogate the M-3425A utilizing either the optional M-3931 HMI or a PC running S-3400 IPScom® Communications software through the COM1 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 5.7, IPScom Communications 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 5.8, Activating Initial Local Communications.

### System Priority

System conflicts will not occur, as local commands initiated from the front panel receive priority recognition. When the unit is in local mode, communication using the serial ports is suspended. IPScom displays an error message to indicate this fact.

### HMI Operation Overview

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

### Default Message Screens

When power is applied to the unit, the relay performs a number of self-tests to ensure that it is operating correctly. During the self-tests, the screen displays an “x” for each test successfully executed.

If all self-tests are executed successfully, the relay will briefly display the word PASS and then a series of status screens that include:

- Model Number
- Software Version Number
- Serial Number
- Date and time as set in the system clock
- User Logo Screen

If a test fails, an error code will be displayed 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, **Self-Test Error Codes**.

When the M-3425A is energized and unattended, the user logo lines are blank.

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

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

[Figure 2-3](#) presents the software menu flow map for HMI-equipped units. This map can be used as a quick reference guide to aid in navigating the relay's menus.

## HMI Security

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

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

**Level 3 Access:** provides access to all M-3425A configuration functions and settings.

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

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

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

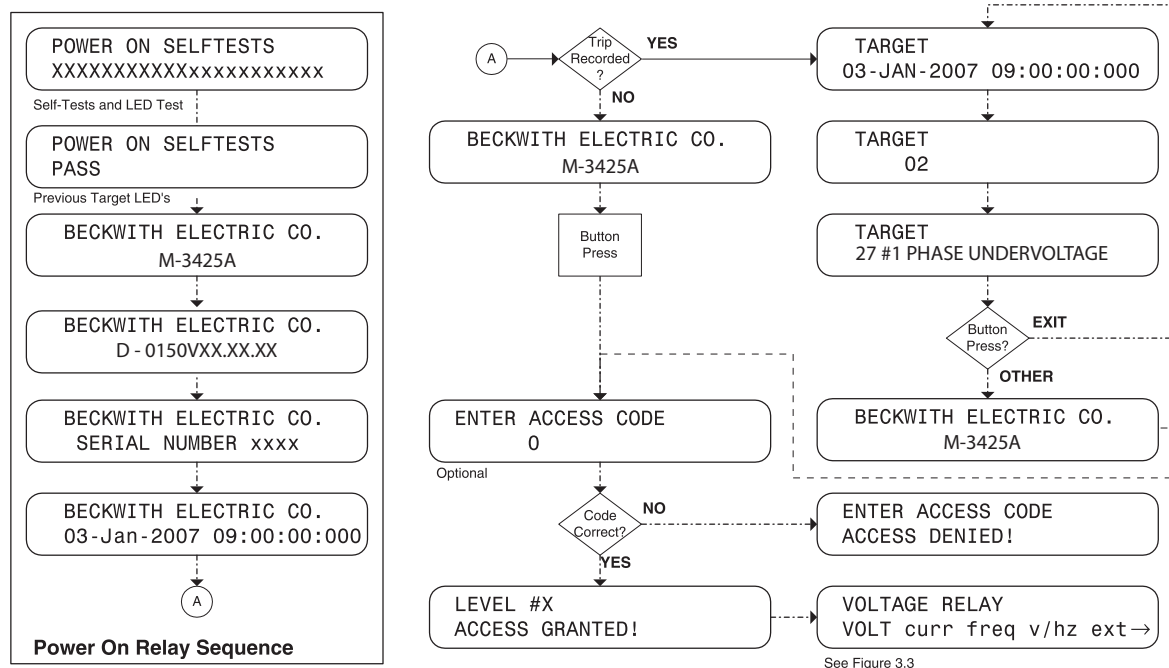
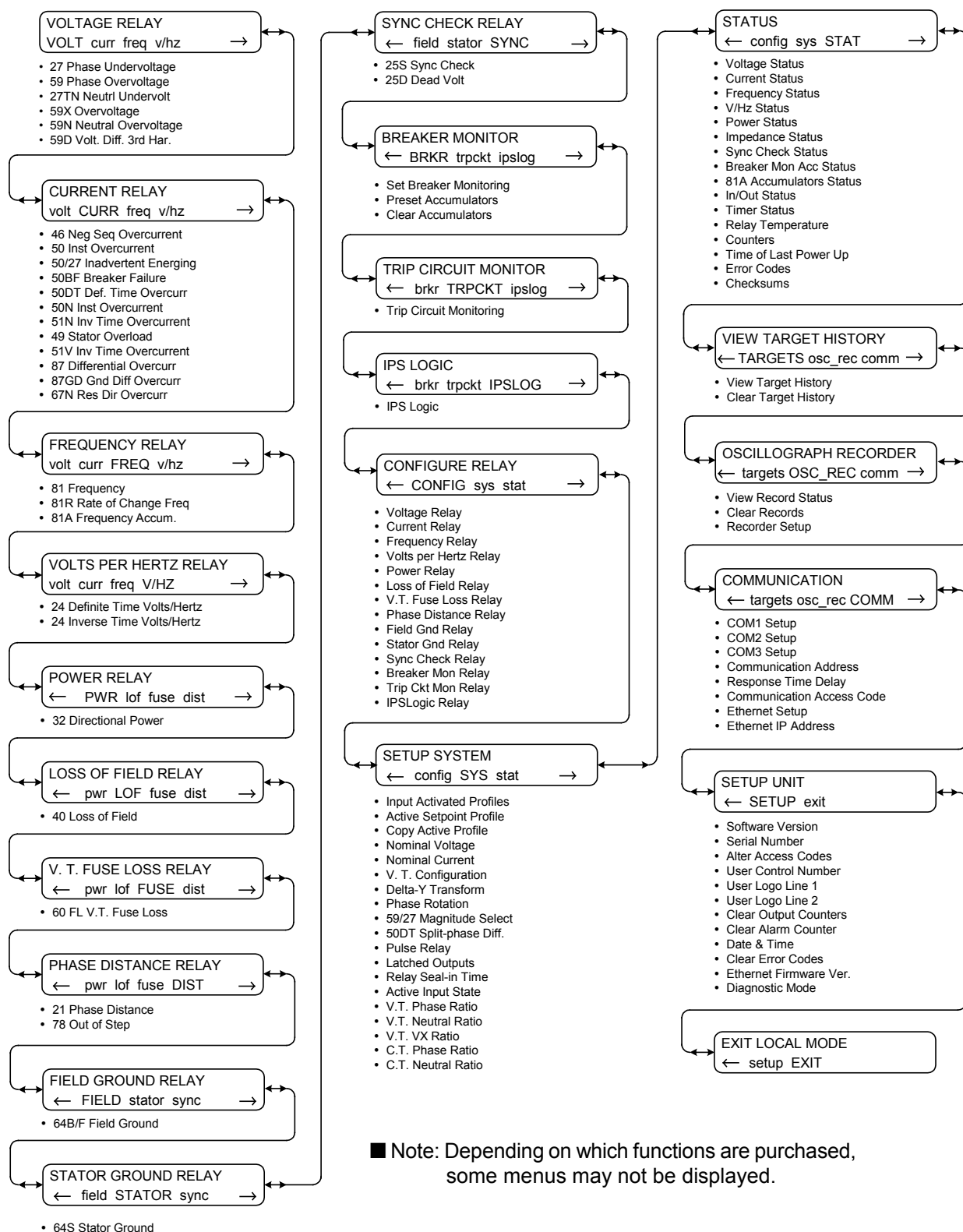


Figure 2-2 Screen Message Menu Flow



■ Note: Depending on which functions are purchased, some menus may not be displayed.

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

Figure 2-3 Main HMI Menu Flow

**Status Monitoring (From Relay Front Panel)**

The menu categories for monitored values are:

- **Voltage Status:** phase voltages, neutral voltage, positive sequence voltage, negative sequence voltage, zero sequence voltage, third harmonic neutral voltage, field ground measurement circuit, stator low frequency injection voltage
- **Current Status:** phase currents (A–B–C/a–b–c), differential current, neutral current, ground differential current, positive sequence current, negative sequence current, zero sequence current, stator low frequency injection current
- **Frequency Status:** frequency, rate of change of frequency
- **Volts/Hz Status:** volts per hertz
- **Power Status:** real power, reactive power, apparent power, power factor
- **Impedance Status:** impedance (Zab, Zbc, Zca), positive sequence impedance, field ground resistance
- **Sync Check Status:** 25S Sync Check and 25D Dead Volt
- **BRKR Monitor**
- **81A Accum. Status**
- **IN/OUT Status:** Status of input and output contacts
- **Timer:** 51V Delay Timer, 51N Delay Timer, 46IT Delay Timer, 24IT Delay Timer
- **Relay Temperature**
- **Counters:** output, alarm counter
- **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

---

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 & STATUS**

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

- Voltage (V)
  - V<sub>AB</sub>
  - V<sub>BC</sub>
  - V<sub>CA</sub>
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - Neutral
  - V<sub>X</sub>
  - 3rd Harmonic V<sub>N</sub>
  - 3rd Harmonic V<sub>X</sub>
- Frequency
  - Hz
  - V/Hz (%)
  - ROCOF (Hz/s)
- Currents (A)
  - Phase A
  - Phase B
  - Phase C
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - Phase a
  - Phase b
  - Phase c
  - Neutral
- Power
  - Real (W)
  - Reactive (Var)
  - Apparent (Va)
  - Power Factor

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- IRIG-B Sync

Primary Metering																																	
<b>Currents (A)</b> Phase A 0.000 Phase B 0.000 Phase C 0.000 Pos. Seq. 0.000 Neg. Seq. 0.000 Zero Seq. 0.000 Phase a 0.000 Phase b 0.000 Phase c 0.000 Neutral 0.000				<b>Voltages (V)</b> AB 0.0 BC 0.0 CA 0.0 Pos. Seq. 0.0 Neg. Seq. 0.0 Zero Seq. 0.0 Neutral 0.0 VX 0.0 3rd Harm. VN 0.00 3rd Harm. VX 0.00				<b>Power</b> Real (W) 0.000 Reactive (var) 0.000 Apparent (va) 0.000 Power Factor 0.00 LAG																									
				<b>Frequency</b> Frequency (Hz) DISABLED V/Hz (%) 0.0 ROCOF (Hz/s) 0.00																													
<b>Inputs</b> <table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td></td><td>FL</td> </tr> </table>								1	2	3	4	5	6	7	8	9	10	11	12	13	14		FL	<b>Status</b> Breaker Closed Osc Triggered Targets IRIGB Sync									
1	2	3	4	5	6	7	8																										
9	10	11	12	13	14		FL																										
<b>Outputs</b> <table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td> </tr> <tr> <td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td></td> </tr> </table>								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			
1	2	3	4	5	6	7	8																										
9	10	11	12	13	14	15	16																										
17	18	19	20	21	22	23																											

Path: Monitor / Primary Metering & Status

Figure 2-4 Primary Metering & Status Screen

**SECONDARY METERING & STATUS**

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

**Monitor/Secondary Metering and Status**

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

- Voltages
  - V<sub>AB</sub>
  - V<sub>BC</sub>
  - V<sub>CA</sub>
  - Neutral
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - V<sub>X</sub>
- Frequency
  - Hz
  - V/Hz (%)
  - ROCOF (Hz/s)
- Currents
  - Phase A
  - Phase B
  - Phase C
  - Neutral
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - 49 #1
  - 49 #2
  - Phase a
  - Phase b
  - Phase c
  - I diff G
  - A-a diff
  - B-b diff
  - C-c diff
- Low Frequency Injection
  - VN (V)
  - IN (mA)
  - Real (mA)
- 3rd Harmonic
  - VN (V)
  - VX (V)
  - VX/VN
- Power (P.U.)
  - Real
  - Reactive
  - Apparent
- Miscellaneous
  - Power Factor
  - Brush V. (mV)
  - Field Insulation (Ohm)
- Impedance
  - AB R
  - AB X
  - BC R
  - BC X
  - CA R
  - CA X
  - Positive Sequence R
  - Positive Sequence X

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- IRIG-B Sync

Secondary Metering																																																			
<b>Currents (A)</b> Phase A 0.000 Phase B 0.000 Phase C 0.000 Neutral 0.000 Pos. Seq. 0.000 Neg. Seq. 0.000 Zero Seq. 0.000 49 #1 0.00						<b>Currents (A)</b> Phase a 0.000 Phase b 0.000 Phase c 0.000 I diff G 0.00 A-a diff 0.00 B-b diff 0.00 C-c diff 0.00 49 #2 0.00																																													
<b>Voltages (V)</b> AB 0.0 BC 0.0 CA 0.0 Neutral 0.0 Pos. Seq. 0.0 Neg. Seq. 0.0 Zero Seq. 0.0 VX 0.0						<b>Impedance (Ohm)</b> AB R 327.67 AB X 327.67 BC R 327.67 BC X 327.67 CA R 327.67 CA X 327.67 Pos. Seq. R 327.67 Pos. Seq. X 327.67																																													
<b>Low Freq. Injection</b> VN (V) <input type="text"/> IN (mA) <input type="text"/> Real (mA) <input type="text"/>				<b>3rd Harmonic</b> VN (V) 0.00 VX (V) 0.00 VX/VN 0.00				<b>Power (p.u.)</b> Real 0.000 Reactive 0.000 Apparent 0.000																																											
<b>Frequency</b> Frequency (Hz) DISABLED V/Hz (%) 0.0 ROCOF (Hz/s) 0.00								<b>Misc</b> Power Factor 0.00 LAG Brush V. (mV) 236 Field Insul. (Ohm) <1K																																											
<b>Inputs</b> <table border="1"> <tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> <tr><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td></td><td>FL</td></tr> </table>								1	2	3	4	5	6	7	8	9	10	11	12	13	14		FL	<b>Outputs</b> <table border="1"> <tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> <tr><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td></tr> <tr><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td></td></tr> </table>				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	2	3	4	5	6	7	8																																												
9	10	11	12	13	14		FL																																												
1	2	3	4	5	6	7	8																																												
9	10	11	12	13	14	15	16																																												
17	18	19	20	21	22	23																																													
<b>Status</b> Breaker Closed Osc Triggered								<b>Targets</b> IRIGB Sync																																											

Path: Monitor / Secondary Metering & Status

Figure 2-5 Secondary Metering & Status Screen



## VIEW TARGET HISTORY

The M-3425A Generator Protection Relay includes the ability to store the last 32 target conditions in a nonvolatile memory. A target is triggered whenever an output is operated. A second function attempting to operate an output (which is already operated) will not trigger a new target, since no new output has been operated or closed. If the second function operation closes a different, unoperated output, a new target will be triggered. A target includes:

- An indication of which function(s) have operated, and timers expired (operated)
- Status information which identifies any function that is timing (picked up)
- Individual phase element information at the time of the trigger, if the operating function was a three phase function
- Phase currents at the time of operation
- Neutral current at the time of operation
- Input and output status, and a date/time tag

## Time and Date Stamping

Time and date stamping of events is only as useful as the validity of the unit's internal clock when no IRIG-B signal is present. Under the **Relay** menu, the **Set Date/Time** command allows the user to manually set the unit's clock.

When a target is triggered, the front panel **TARGET** LED will light, indicating a recent event. If the optional M-3925A Target Module is present, the corresponding function LED will be lit. If the optional M-3931 HMI module is available, a series of screens will be presented, describing the most recent operation. This information is also available remotely by using the IPScom® Communication Software.

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, then the following will be displayed:

---

VOLTAGE RELAY  
VOLT curr freq v/hz →

---

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

---

VIEW TARGET HISTORY  
← TARGETS osc\_rec comm →

---

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

---

VIEW TARGET HISTORY  
TRGT clear

---

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

---

VIEW TARGET HISTORY  
X Target Number

---

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

---

TARGET 1  
01-JAN-2001 12:27:35.125

---

This screen gives the date and time tag of the selected target.

---

TARGET 1  
08 05 01

---

This screen displays operated outputs.

---

Target 1  
I3 I1

---

This screen displays operated inputs at time of trip.

---

TARGET 1  
- OPERATE TARGETS -

---

The following screens display the timed out or “operate” functions.

---

TARGET 1  
27#1 PHASE UNDERVOLTAGE

---

This screen displays the specific function which timed out and triggered the target.

---

TARGET 1  
PHASE A=X B= C=

---

This screen displays the phase information for the displayed function at time out.

---

Target 1  
- PICKUP TARGETS -

---

The following screens display the timing on “picked up” functions when the target was recorded.

---

TARGET 1  
27#1 PHASE UNDERVOLTAGE

---



---

TARGET 1  
PHASE A=X B=X C=X

---

This display gives the phase pickup information for the specific function.

---

TARGET 1  
- CURRENT STATUS -

---



---

TARGET 1  
a=0.02 b=0.03 c=0.04

---

This screen displays the phase current at the time the target operated.

---

TARGET 1  
N=0.50 AMPS

---

This screen displays the neutral current at the time the target operated.

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:

---

CLEAR 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 2-6](#)). The View Targets screen includes the following target information:

- Target Number
- Target Date/Time
- Phase a, b, c and Neutral Currents
- Active Functions
- Function Status (Picked up/Operated)
- Active Inputs and Outputs

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

No.	Date
1	01-Jan-2001 01:01:80.000

Target #1

Current:	Phase a	Phase b	Phase c	Neutral
	0.00 (A)	0.00 (A)	0.00 (A)	0.0 (mA)

Function	Picked Up	Operated
27 #1	Yes (AB BC CA)	Yes (AB BC CA)
27 #2	Yes (AB BC CA)	(AB BC CA)

Inputs

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7  
☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Outputs

☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Path: Relay / Targets / View

Figure 2-6 View Targets Screen

### Clear Targets

To Clear Targets perform the following:

1. Select **Relay/Targets/Clear**. IPScom will display the Clear Targets confirmation dialog screen ([Figure 2-7](#)).

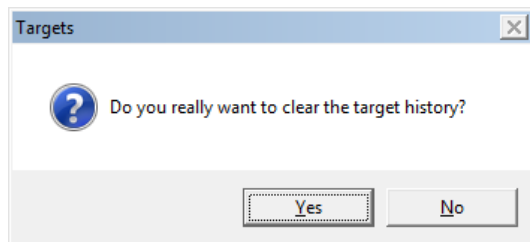


Figure 2-7 Clear Targets Dialog Screen

2. Select **Yes**. IPScom will display the Target History Cleared Successfully confirmation screen ([Figure 2-8](#)).

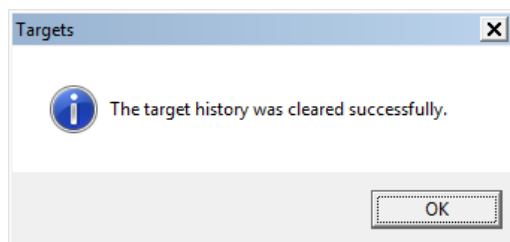


Figure 2-8 Targets Cleared Confirmation Screen

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

### Oscillograph Recorder Data

The Oscillograph Recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded using the communications ports to any IBM compatible personal computer running the S-3400 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 16 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	Number of Cycles per Each Partition
1	416 Cycles
2	280 Cycles
3	208 Cycles
4	168 Cycles
5	136 Cycles
6	120 Cycles
7	104 Cycles
8	88 Cycles
9	80 Cycles
10	72 Cycles
11	64 Cycles
12	64 Cycles
13	56 Cycles
14	56 Cycles
15	48 Cycles
16	48 Cycles

Table 2-1 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-mm-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:

---

CLEAR RECORDS

stat CLEAR setup

---

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

---

CLEAR RECORDS

-RECORDS CLEARED-

---

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

---

CLEAR RECORDERS

stat CLEAR setup

---

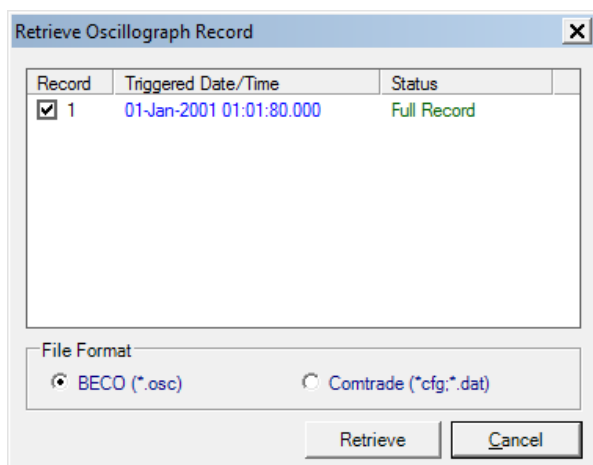
### Oscillograph Recorder (From IPScom)

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

#### Retrieve Oscillograph Records

To retrieve Oscillograph Records perform the following:

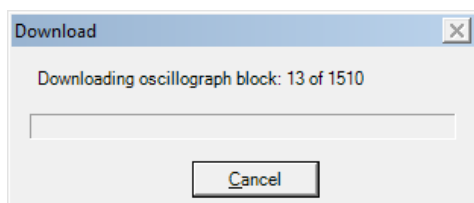
1. Select **Relay/Oscillograph/Retrieve**. IPScom® will display the Retrieve Oscillograph Record dialog screen ([Figure 2-9](#)).



Path: Relay / Oscillograph / Retrieve

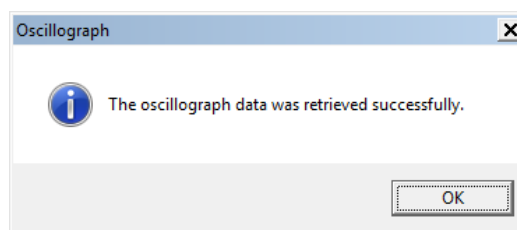
*Figure 2-9 Retrieve Oscillograph Record Dialog Screen*

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 2-10](#)).



*Figure 2-10 Oscillograph Record Download Status Screen*

5. Upon completion of the oscillograph file download, IPScom will display the Download Successful Confirmation screen ([Figure 2-11](#)).



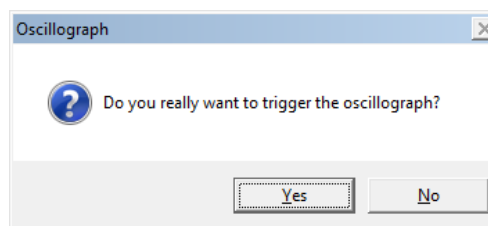
*Figure 2-11 Oscillograph Download Successful Confirmation Screen*

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

#### Trigger Oscillograph

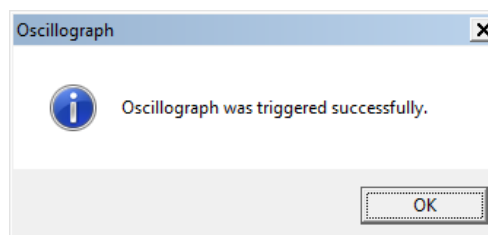
To manually Trigger the Oscillograph perform the following:

1. Select **Relay/Oscillograph/Trigger**. IPScom will display the Trigger Oscillograph confirmation screen ([Figure 2-12](#)).



*Figure 2-12 Trigger the Oscillograph Confirmation Screen*

2. Select **Yes**, IPScom will display the Oscillograph Successfully Triggered dialog screen. ([Figure 2-13](#))



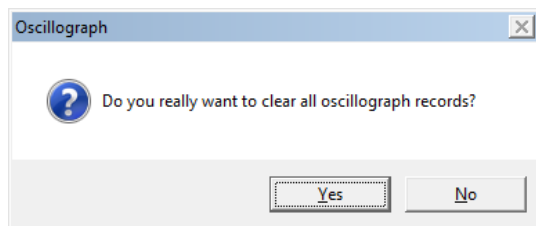
*Figure 2-13 Oscillograph Successfully Triggered Dialog Screen*

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

**Clear Oscillograph Records**

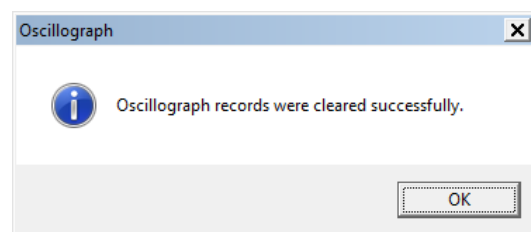
To Clear Oscillograph Records perform the following:

1. Select **Relay/Oscillograph/Clear**. IPScom will display the Clear Oscillograph Records confirmation screen ([Figure 2-14](#)).



*Figure 2-14 Clear Oscillograph Records Confirmation Screen*

2. Select **Yes**, IPScom will display the Oscillograph Records Cleared Successfully dialog screen. ([Figure 2-15](#))



*Figure 2-15 Oscillograph Records Successfully Cleared Dialog Screen*

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

**Software Version (Relay Front Panel only)**

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

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

---

ENTER ACCESS CODE

0

---

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

---

LEVEL #(1,2 or 3)

Access Granted!

---



---

VOLTAGE RELAY

VOLT curr freq v/hz →

---

- c. Go to Step 4.

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

---

VOLTAGE RELAY

VOLT curr freq v/hz →

---

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

---

SETUP UNIT

SETUP exit

---

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

---

SOFTWARE VERSION

VERS sn access number →

---

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

---

SOFTWARE VERSION

D-0150VXX.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 exit

---

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

---

SOFTWARE VERSION

VERS sn access number →

---

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

---

SERIAL NUMBER

vers eth SN access number →

---

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  
SETUP exit

---

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

---

SOFTWARE VERSION  
VERS sn access number →

---

6. 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 number

---

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

---

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

---

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

---

LEVEL #1  
9999

---

9. 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

---

10. 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

---

11. Repeat Step 9 to enter the desired Level #2 User Access Code.

12. 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

---

13. Repeat Step 9 to enter the desired Level #3 User Access Code.

14. Press the **EXIT** pushbutton will return to the previous selection screen:

---

ALTER ACCESS CODES  
vers sn ACCESS number →

---

### Change 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 2-16](#)).

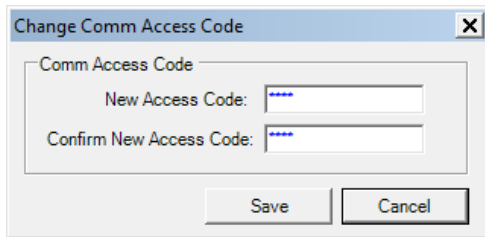


Figure 2-16 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display a Save to Device confirmation screen ([Figure 2-17](#)).

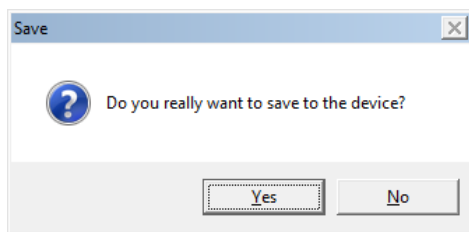


Figure 2-17 Save to Device Confirmation Screen

4. Select **Yes**, IPScom will display the Access Code Changed Successfully confirmation screen ([Figure 2-18](#)).

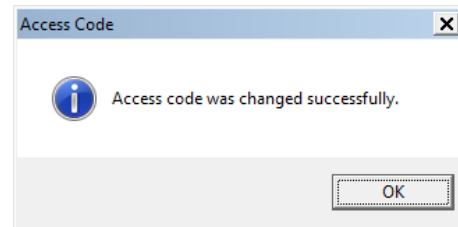


Figure 2-18 Access Code Changed Successfully Confirmation Screen

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.

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

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

### Change 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 2-19](#)).

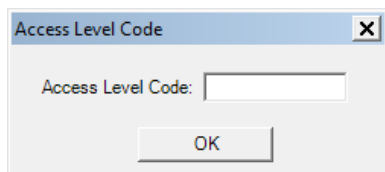


Figure 2-19 Access Level Code Dialog Screen

2. Enter a valid Access Code, then select **OK**. IPScom will display the Change User Access Code dialog screen ([Figure 2-20](#)).

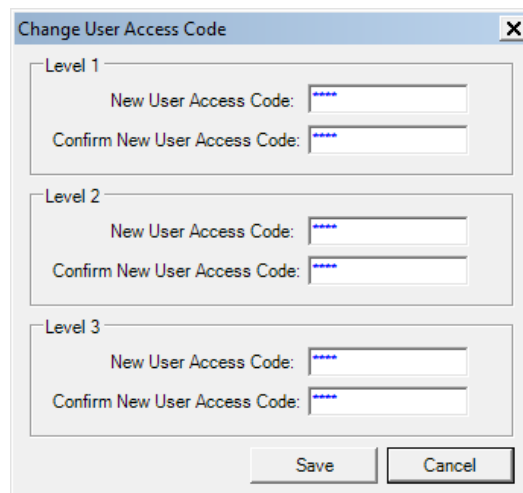


Figure 2-20 Change User Access Code Dialog Screen

3. Enter the desired New User Access Code (1-9999), then re-enter (confirmation) the New User Access Code.
4. Select **Save**, a Save to Device confirmation screen ([Figure 2-17](#)).
5. Select **Yes**, IPScom will display IPScom will display the Access Code Changed Successfully confirmation screen ([Figure 2-18](#)).
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 (IPScm) 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 COUNTERS  
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 OUTPUT COUNTERS  
-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 COUNTERS

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 COUNTER 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 sn access number →

---

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

---

CLEAR ERROR CODES

time ERROR eth\_ver →

---

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 IPScm)

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

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

1. From the IPScm Main Screen menu bar select **Tools/Counters and Error Codes**. IPScm will display the Counters and Error Codes dialog screen ([Figure 2-21](#)).
2. Select the desired Error Code, Alarm Counter, Power Loss Counter to be reset, then select **OK**. IPScm will return to the Main Menu.

Error Codes	
Items	Error Code
<input type="checkbox"/> Last Self Test	27
<input type="checkbox"/> Last Self Test-1	27
<input type="checkbox"/> Last Self Test-2	28
<input type="checkbox"/> Last Self Test-3	0
<input type="checkbox"/> Last Comm	0
<input type="checkbox"/> Received Packet	0

Clear Selected Error Codes

System Counters	
Items	Counter
<input type="checkbox"/> Reset	6
<input type="checkbox"/> Power Loss	2
<input type="checkbox"/> Alarm	0
<input type="checkbox"/> Self Test	4

Clear Selected Counters

Checksums (HEX)

Calibration: 003E

ROM: AF0B

Setpoint: 00CE

Output Counters	
Items	Counter
Output 1	0
Output 2	0
Output 3	0
Output 4	0
Output 5	0
Output 6	0
Output 7	0
Output 8	0
Output 9	0
Output 10	0
Output 11	0
Output 12	0
Output 13	0
Output 14	0
Output 15	0
Output 16	0
Output 17	0
Output 18	0
Output 19	0
Output 20	0
Output 21	0
Output 22	0

Clear All Counters

Figure 2-21 Counters and Error Codes Dialog 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).

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

### Time and Date Stamping

Time and date stamping of events is only as useful as the validity of the unit's internal clock when no IRIG-B signal is present. Under the **Relay** menu, the **Set Date/Time** command allows the user to manually set the unit's clock.

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 2-22) and indicate the number of Sequence of Events Recorder Events being downloaded.

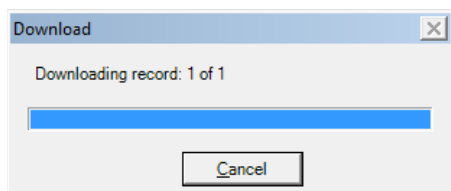


Figure 2-22 Sequence of Events Retrieve Download Screen

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**.

### 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 2-23).
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 2-23).

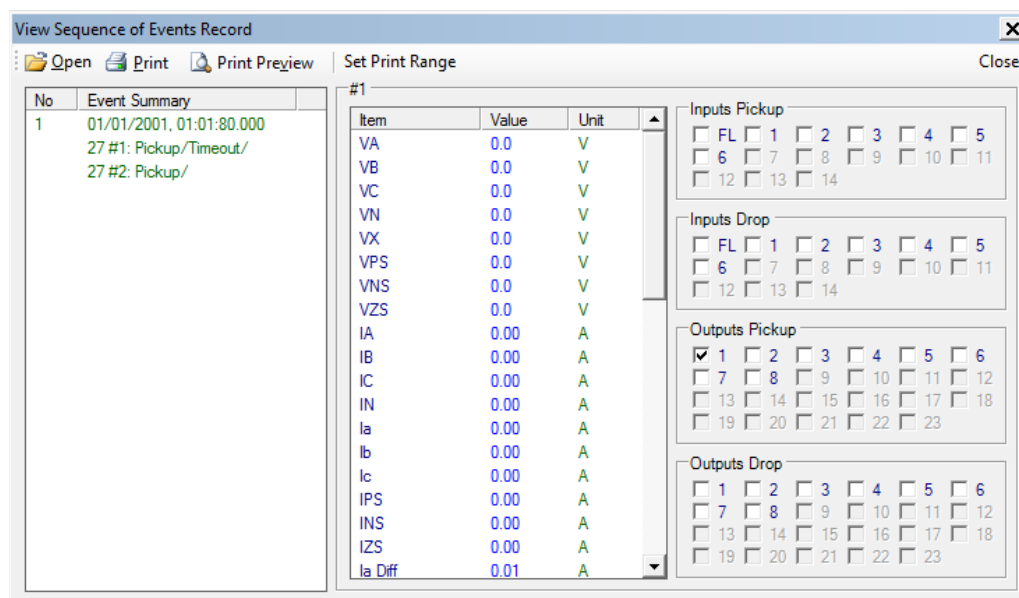


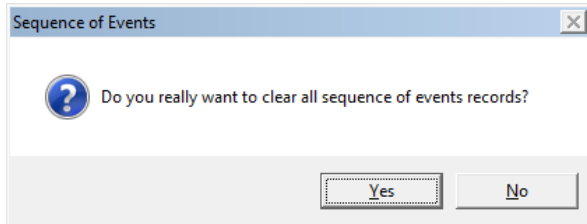
Figure 2-23 View Sequence of Events Record Screen

**Relay/Sequence of Events/Clear**

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

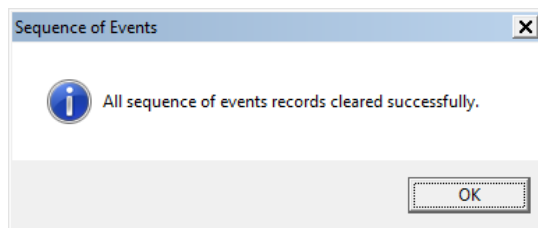
To Clear all Sequence of Events Records perform the following:

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 2-24](#)).



*Figure 2-24 Clear Sequence of Events Record Command Confirmation Screen*

2. Select **YES**, IPScom will respond with the Sequence of Events Records Cleared Successfully screen ([Figure 2-25](#)).



*Figure 2-25 Sequence of Events Record Cleared Successfully Confirmation Screen*

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

# 3 IPScom®

## 3.1 IPScom Functional Description ..... 3-1

This chapter is designed for the person or group responsible for the operation and setup of the M-3425A. The S-3400 IPScom Communications Software can be used to successfully communicate system settings and operational commands to the M-3425A 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 5.7, IPScom Communications Software Installation, and Section 5.8, 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](#)). Existing files can also be dragged and dropped onto the desktop icon, or loaded through a command line prompt.

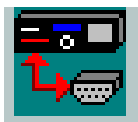


Figure 3-1 IPScom Program Icon

### 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.

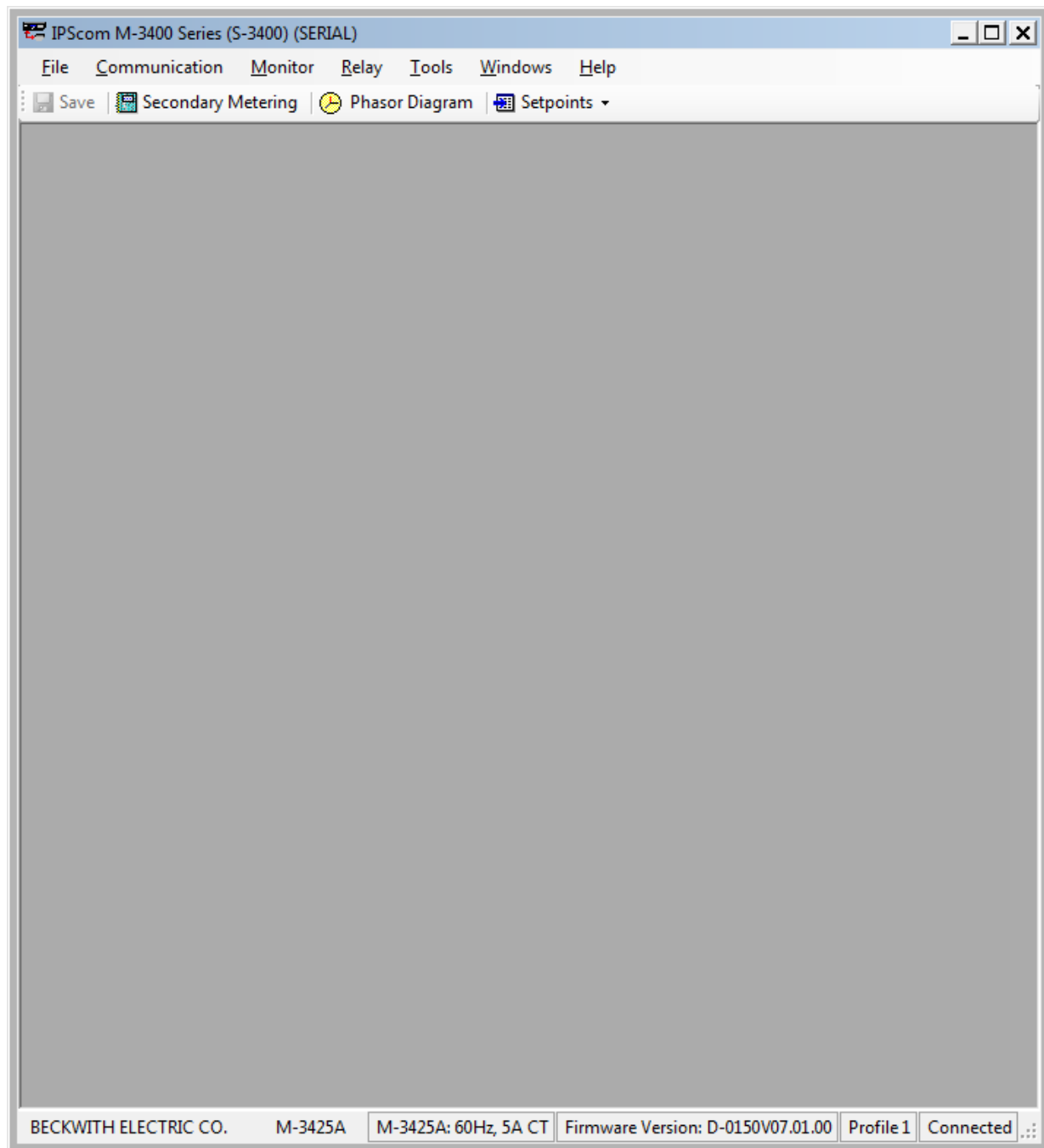


Figure 3-2 IPScom Main Screen

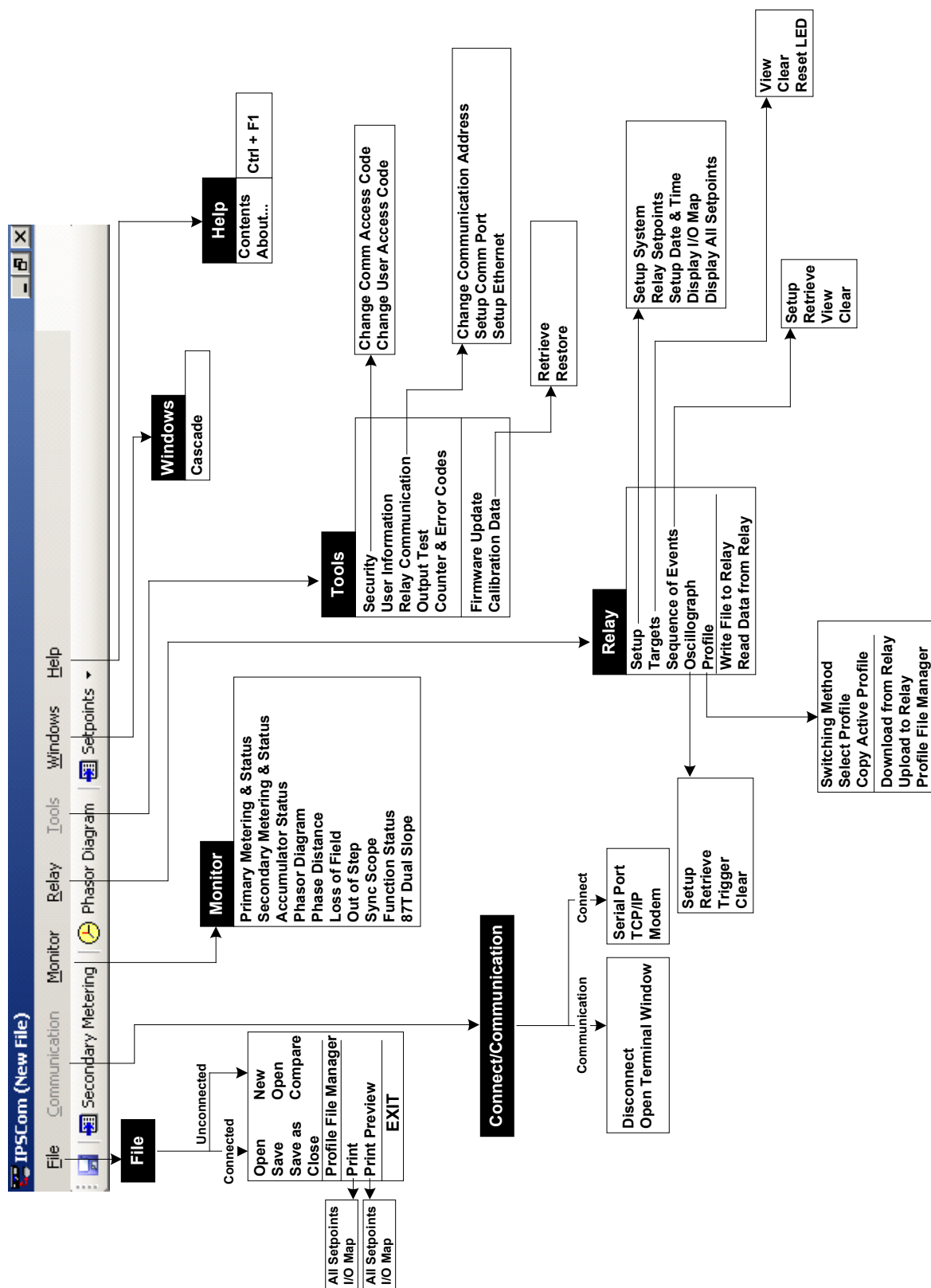
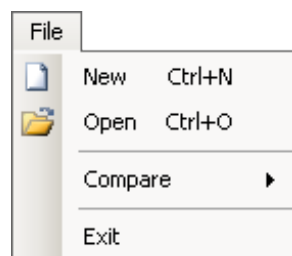
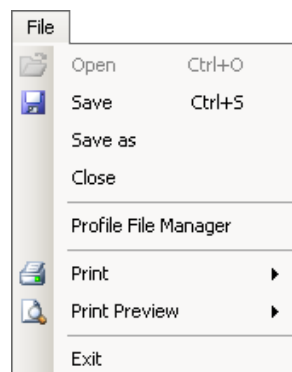


Figure 3-3 S-3400 IPScom Menu Selection

## File Menu



*Initial File Menu*



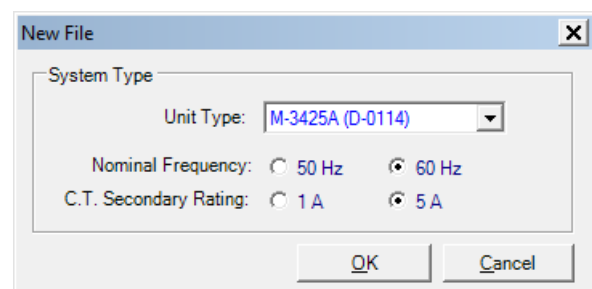
*File Menu When Connected or in File Mode*

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.

### File/New Command

When not connected to a M-3425A, 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 for the selected firmware version.



**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. IPScom will open and automatically convert files created in non S-3400 versions of IPScom. The converted file must be saved before it can be uploaded to the relay. 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 Relay** command in the Relay 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/Profile File Manager

■ **NOTE:** This utility is only available in File mode when IPScom is not connected to a relay, to prevent unintended operation.

The Profile File Manager utility allows the user to manage four setpoint profiles (\*.ips) that are grouped in a Profile File (\*.ipf) that has been created in the Profile File Manager or previously downloaded from a relay.

### 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. To compare two setpoint files proceed as follows:

1. Start IPScom.
2. From the IPScom menu bar select **File/Compare** and select either ".ips Files" or for legacy setpoint files, select ".dat Files".  
IPScom will display an "Open – File to Edit or Newer File" dialog screen with a default file extension of either ".ips" or ".dat".
3. Navigate to the desired "File to Edit or Newer File" location.
4. Select the desired file and then select Open. IPScom will display an "Open – Reference File or Older File" dialog screen with a default file extension of either ".ips" or ".dat".
5. Navigate to the desired Reference File location.
6. 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 IPScom File Compare results dialog screen includes the following features:

- Print/Print Preview
- Edit the newer file settings from the File Compare dialog screen by selecting the feature header which jumps to the feature settings screen and allows the changes to be saved into the newer Setpoint File.
- Save allows any changes to be saved into the newer Control File or legacy Setpoint File.
- "Options/Clone Next Function Clicked" selection will copy all settings in the next user-selected feature header, from the "Reference" file to the "Edit" file in one click.

	Edit	Reference
File:	C:\Program Files (x86)\Becoware\S-3400	C:\Program Files (x86)\Becoware\S-3400
Device:	\Sub1_pimellas.ips	typetestsettings.ips
Version:	M-3425AE	M-3425AE
	V07.02.00	V07.01.00

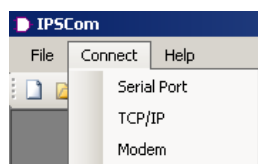
  

Setup System		
<b>Setup</b>		
Phase Rotation:	ACB	ABC
VT Configuration:	Line to Line	Line to Ground
59/27 Magnitude Select:	RMS	DFT
<b>I/O Settings</b>		
<b>Sealm Time</b>		

21: Phase Distance		
<b>21 #1</b>		
Function Enable:	Enable	Enable
Circle Diameter:	10.0	50.0
Impedance Angle:	45	85
Load Encr. Angle:	45	85
Load Encr. R Reach:	10.0	50.0
Time Delay:	30	1
OverCurrent Supervision:	5.00	2.00
Outputs:	8	9, 10, 11, 12, 13, 14, 15, 16
<b>21 #2</b>		
Function Enable:	Disable	Enable
Circle Diameter:	10.0	50.0
Impedance Angle:	45	85

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](#)).

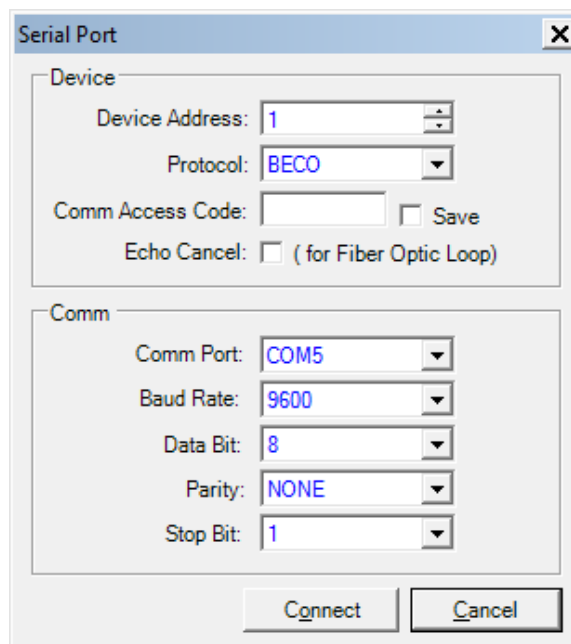
▲ **CAUTION:** The **Echo Cancel** check box should only be used when several relays are connected using a fiber optic loop network. Otherwise, echo cancel must not be selected or communication will be prevented.

▲ **CAUTION:** If the serial port is connected to something other than a modem, and an IPSCOM modem command is executed, the results are unpredictable. In some cases, the computer may have to be reset.

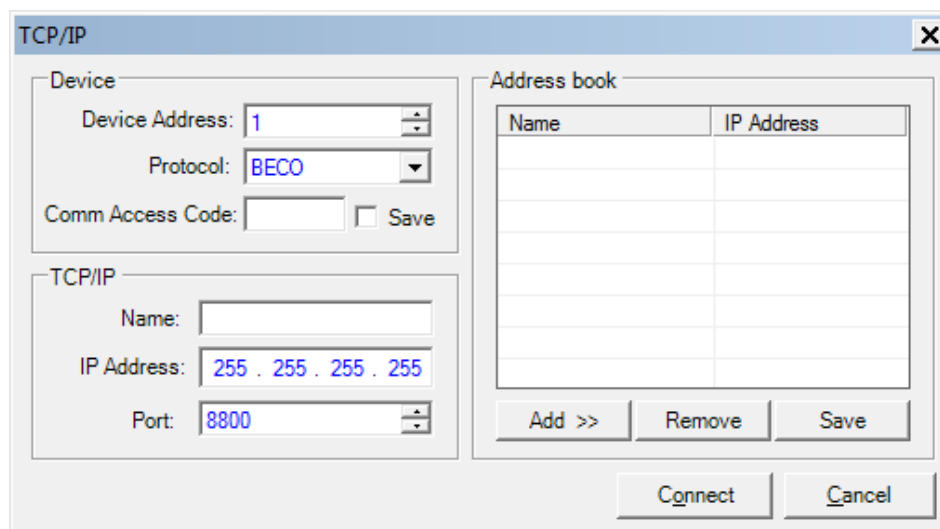
Selecting “TCP/IP” displays the PC TCP/IP and device Settings ([Figure 3-7](#)) for Ethernet communication. Selecting “Modem” displays a modem Dialog screen ([Figure 3-8](#)), to establish contact with remote locations.

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 3-6 IPSCOM Serial Communication Dialog Screen*

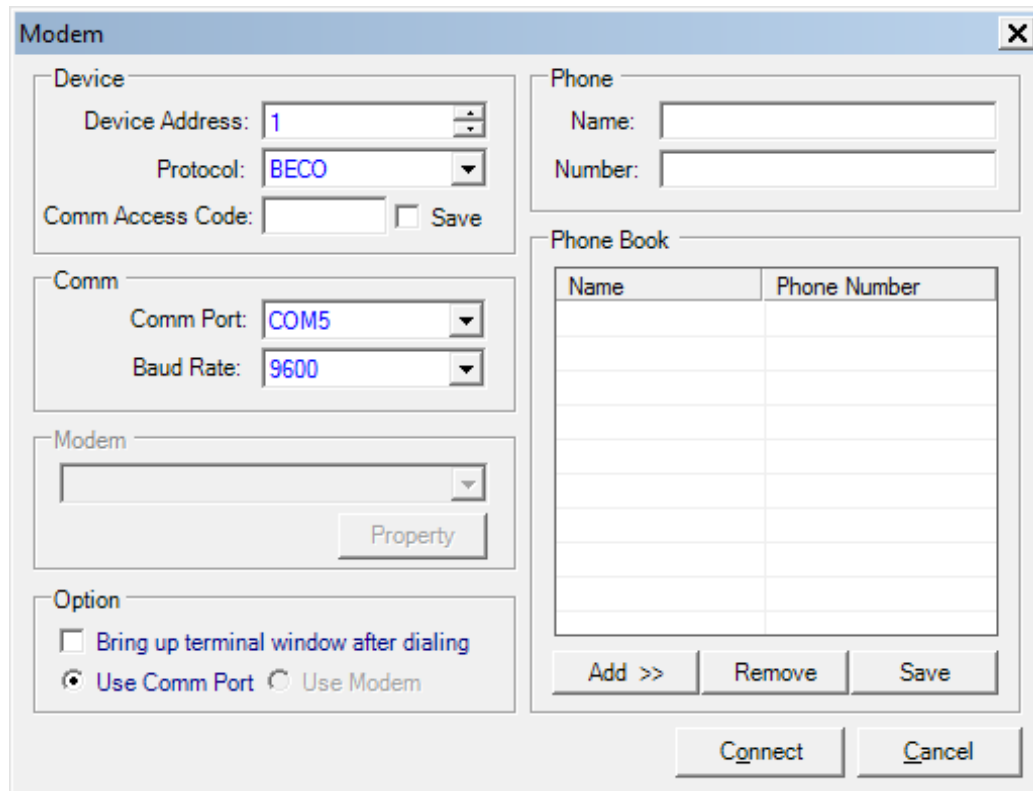


*Figure 3-7 IPSCOM TCP/IP Ethernet Communication Dialog Screen*



**Communication\Open Terminal Window**

Opens the IPScm Terminal Window ([Figure 3-9](#)).



The **Modem** dialog box is used for configuring modem settings. It includes sections for Device, Phone, Comm, Modem, and Option.

**Device**

- Device Address: 1
- Protocol: BECO
- Comm Access Code:  ☐ Save

**Phone**

- Name:
- Number:

**Comm**

- Comm Port: COM5
- Baud Rate: 9600

**Modem**

- 

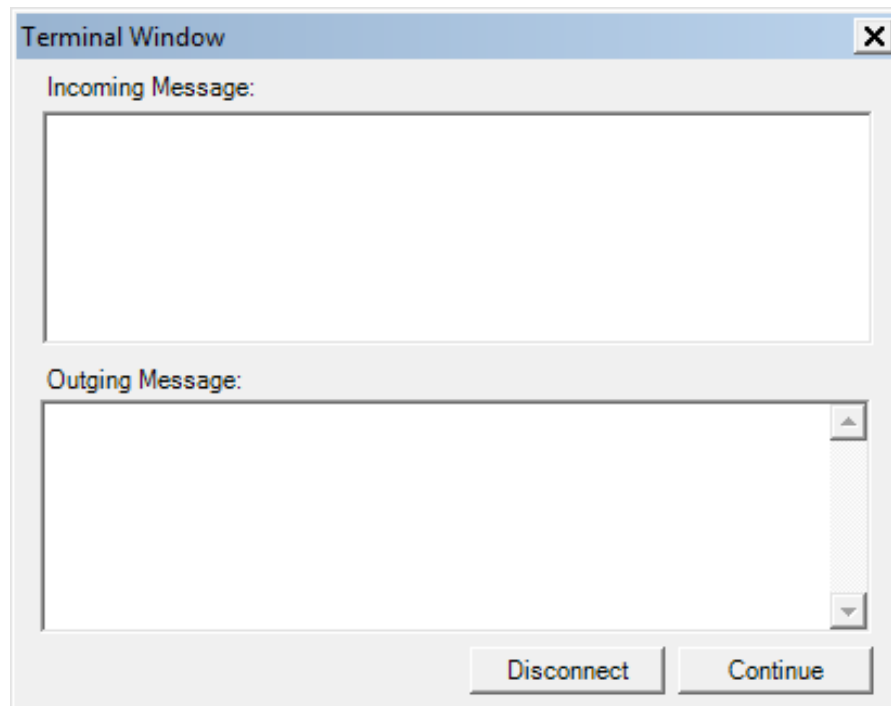
**Option**

- ☐ Bring up terminal window after dialing
- ☒ Use Comm Port ☐ Use Modem

**Phone Book**

Name	Phone Number

*Figure 3-8 IPScm Modem Communication Dialog Screen*



The **Terminal Window** displays incoming and outgoing messages.

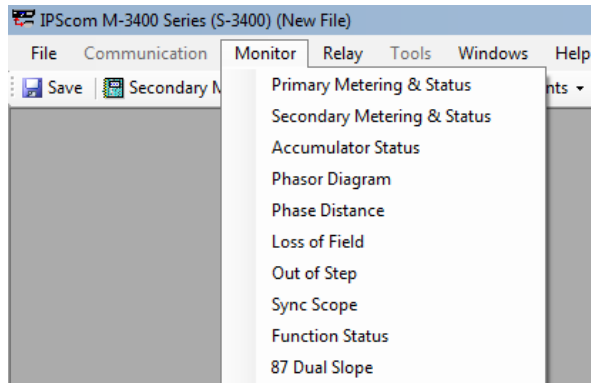
**Incoming Message:**

**Outging Message:**

*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**, **Accumulator Status**, **Phasor Diagram**, **Phase Distance**, **Loss of Field**, **Out of Step**, **Sync Scope**, **Function Status**, and **87T Dual Scope**.



## Monitor/Primary Metering & Status

The Primary Metering screen ([Figure 3-10](#)) allows the user to review the following PRIMARY parameters:

- Voltage (V)
  - $V_{AB}$
  - $V_{BC}$
  - $V_{CA}$
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - Neutral
  - $V_x$
  - 3rd Harmonic  $V_N$
  - 3rd Harmonic  $V_x$

- Frequency
  - Hz
  - V/Hz (%)
  - ROCOF (Hz/s)
- Currents (A)
  - Phase A
  - Phase B
  - Phase C
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - Phase a
  - Phase b
  - Phase c
  - Neutral
- Power
  - Real (W)
  - Reactive (Var)
  - Apparent (Va)
  - Power Factor

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- IRIG-B Sync

Primary Metering

Currents (A)

Phase A	0.000
Phase B	0.000
Phase C	0.000
Pos. Seq.	0.000
Neg. Seq.	0.000
Zero Seq.	0.000
Phase a	0.000
Phase b	0.000
Phase c	0.000
Neutral	0.000

Voltages (V)

AB	0.0
BC	0.0
CA	0.0
Pos. Seq.	0.0
Neg. Seq.	0.0
Zero Seq.	0.0
Neutral	0.0
VX	0.0
3rd Harm. VN	0.00
3rd Harm. VX	0.00

Power

Real (W)	0.000
Reactive (var)	0.000
Apparent (va)	0.000
Power Factor	0.00 LAG

Frequency

Frequency (Hz)	DISABLED
V/Hz (%)	0.0
ROCOF (Hz/s)	0.00

Inputs

1	2	3	4	5	6	7	8
9	10	11	12	13	14		FL

Outputs

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	

Status

Breaker Closed

Osc Triggered

Targets

IRIGB Sync

Path: Monitor / Primary Metering and Status

Figure 3-10 Primary Metering Status Screen

**Monitor/Secondary Metering & Status**

The Secondary Metering and Status screen ([Figure 3-11](#)) allows the user to review the following **SECONDARY** parameters:

- Voltages
  - $V_{AB}$
  - $V_{BC}$
  - $V_{CA}$
  - Neutral
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - $V_x$
- Frequency
  - Hz
  - V/Hz (%)
  - ROCOF (Hz/s)
- Currents
  - Phase A
  - Phase B
  - Phase C
  - Neutral
  - Positive Sequence
  - Negative Sequence
  - Zero Sequence
  - 49 #1
  - 49 #2
  - Phase a
  - Phase b
  - Phase c
  - I diff G
  - A-a diff
  - B-b diff
  - C-c diff
- Low Frequency Injection
  - VN (V)
  - IN (mA)
  - Real (mA)
- 3rd Harmonic
  - VN (V)
  - VX (V)
  - VX/VN
- Power
  - Real
  - Reactive
  - Apparent
- Miscellaneous
  - Power Factor
  - Brush V. (mV)
  - Field Insulation (Ohm)
- Impedance
  - AB R
  - AB X
  - BC R
  - BC X
  - CA R
  - CA X
  - Positive Sequence R
  - Positive Sequence X

Also included on the Secondary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets
- IRIG-B Sync

Secondary Metering																																			
<b>Currents (A)</b> Phase A 0.000 Phase B 0.000 Phase C 0.000 Neutral 0.000 Pos. Seq. 0.000 Neg. Seq. 0.000 Zero Seq. 0.000 49 #1 0.00						<b>Currents (A)</b> Phase a 0.000 Phase b 0.000 Phase c 0.000 I diff G 0.00 A-a diff 0.00 B-b diff 0.00 C-c diff 0.00 49 #2 0.00																													
<b>Low Freq. Injection</b> VN (V) <input type="text"/> IN (mA) <input type="text"/> Real (mA) <input type="text"/>						<b>3rd Harmonic</b> VN (V) 0.00 VX (V) 0.00 VX/VN 0.00																													
<b>Inputs</b> <table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td></td><td>FL</td> </tr> </table>						1	2	3	4	5	6	7	8	9	10	11	12	13	14		FL	<b>Power (p.u.)</b> Real 0.000 Reactive 0.000 Apparent 0.000													
1	2	3	4	5	6	7	8																												
9	10	11	12	13	14		FL																												
<b>Outputs</b> <table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td> </tr> <tr> <td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td></td> </tr> </table>						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		<b>Frequency</b> Frequency (Hz) DISABLED V/Hz (%) 0.0 ROCOF (Hz/s) 0.00					
1	2	3	4	5	6	7	8																												
9	10	11	12	13	14	15	16																												
17	18	19	20	21	22	23																													
						<b>Impedance (Ohm)</b> AB R 327.67 AB X 327.67 BC R 327.67 BC X 327.67 CA R 327.67 CA X 327.67 Pos. Seq. R 327.67 Pos. Seq. X 327.67																													
						<b>Misc</b> Power Factor 0.00 LAG Brush V. (mV) 236 Field Insul. (Ohm) <1K																													
						<b>Status</b> Breaker Closed Targets Osc Triggered IIRGB Sync																													

Path: Monitor / Secondary Metering and Status

Figure 3-11 Secondary Metering Status Screen

### Monitor/Accumulator Status

Frequency Accumulation feature provides an indication of the amount of off frequency operation accumulated.

Turbine blades are designed and tuned to operate at rated frequencies, operating at frequencies different than rated can result in blade resonance and fatigue damage. In 60 Hz machines, the typical operating frequency range for 18 to 25 inch blades is 58.5 to 61.5 Hz and for 25 to 44 inch blades is between 59.5 and 60.5 Hz. Accumulated operation, for the life of the machine, of not more than 10 minutes for frequencies between 56 and 58.5 Hz and not more than 60 minutes for frequencies between 58.5 and 59.5 Hz is acceptable on typical machines.

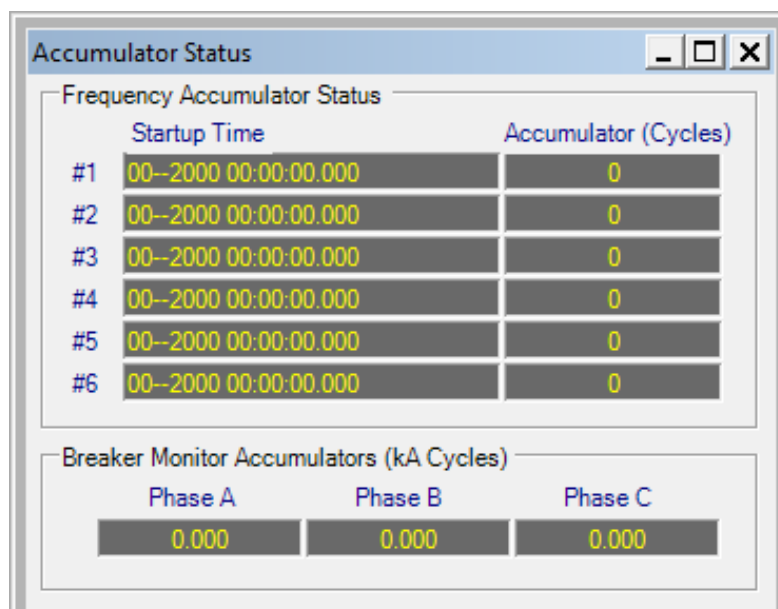
The 81A function can be configured to track off nominal frequency operation by either set point or when the frequency is within a frequency band.

When using multiple frequency bands, the lower limit of the previous band becomes the upper limit

for the next band, i.e., Low Band #2 is the upper limit for Band #3, and so forth. Frequency bands must be used in sequential order, 1 to 6. Band #1 must be enabled to use Bands #2–#6. If any band is disabled, all following bands are disabled.

When frequency is within an enabled band limit, accumulation time starts (there is an internal ten cycle delay prior to accumulation), this allows the underfrequency blade resonance to be established to avoid unnecessary accumulation of time. When accumulated duration is greater than set delay, then the 81A function operated the programmed output contact. The contact can be used to alert the operator or trip the machine.

The accumulator status can be set to preserve the accumulated information from previous devices. This allows the relay to begin accumulating information at a pre-defined value. This setpoint is only available through IPScom® Communications Software.

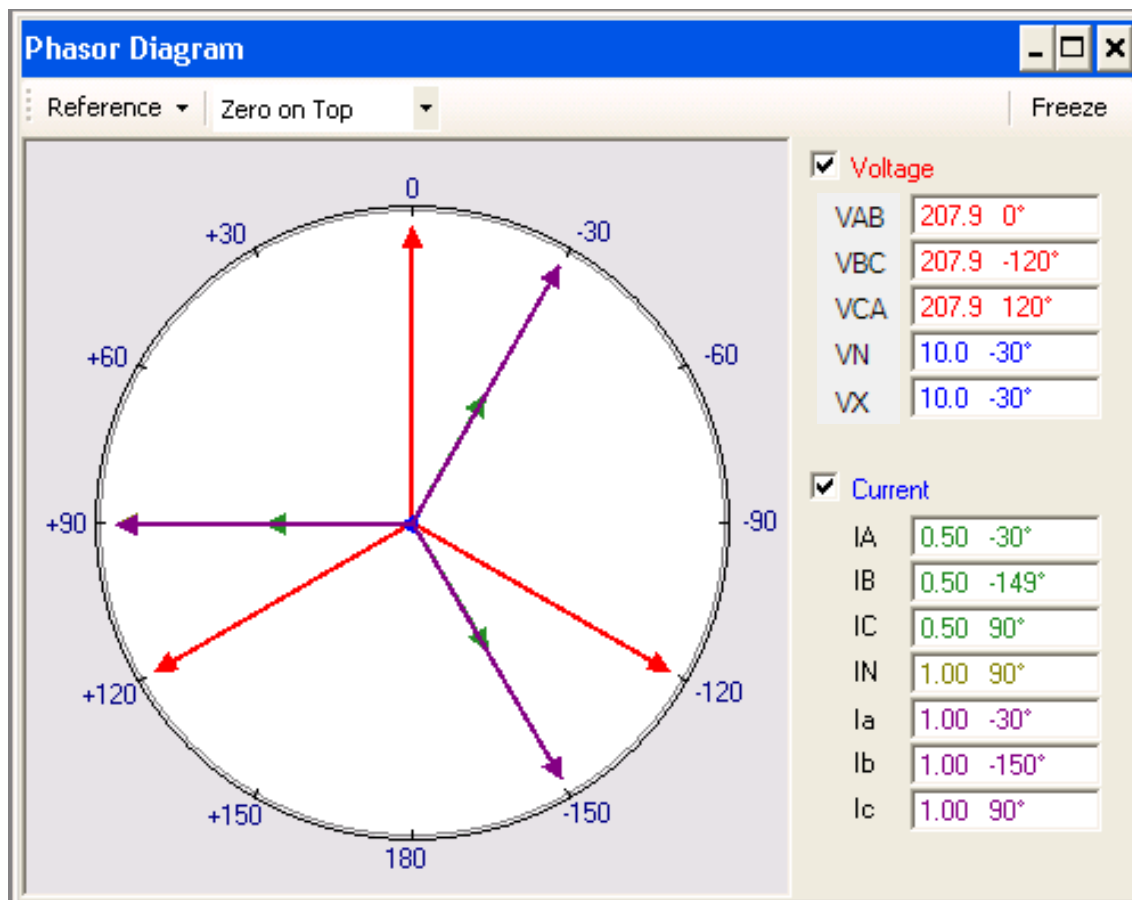


Path: Monitor / Accumulator Status

Figure 3-12 Monitor Frequency Accumulator Status

### Monitor/Phasor Diagram

The Phasor Diagram (Figure 3-13) provides the user with the ability to evaluate a reference Phase Angle to Phase Angle data from other windings. The Phasor Diagram also includes a menu that allows the user to select/deselect sources to be displayed and Freeze capability to freeze the data displayed on the Phasor Diagram.



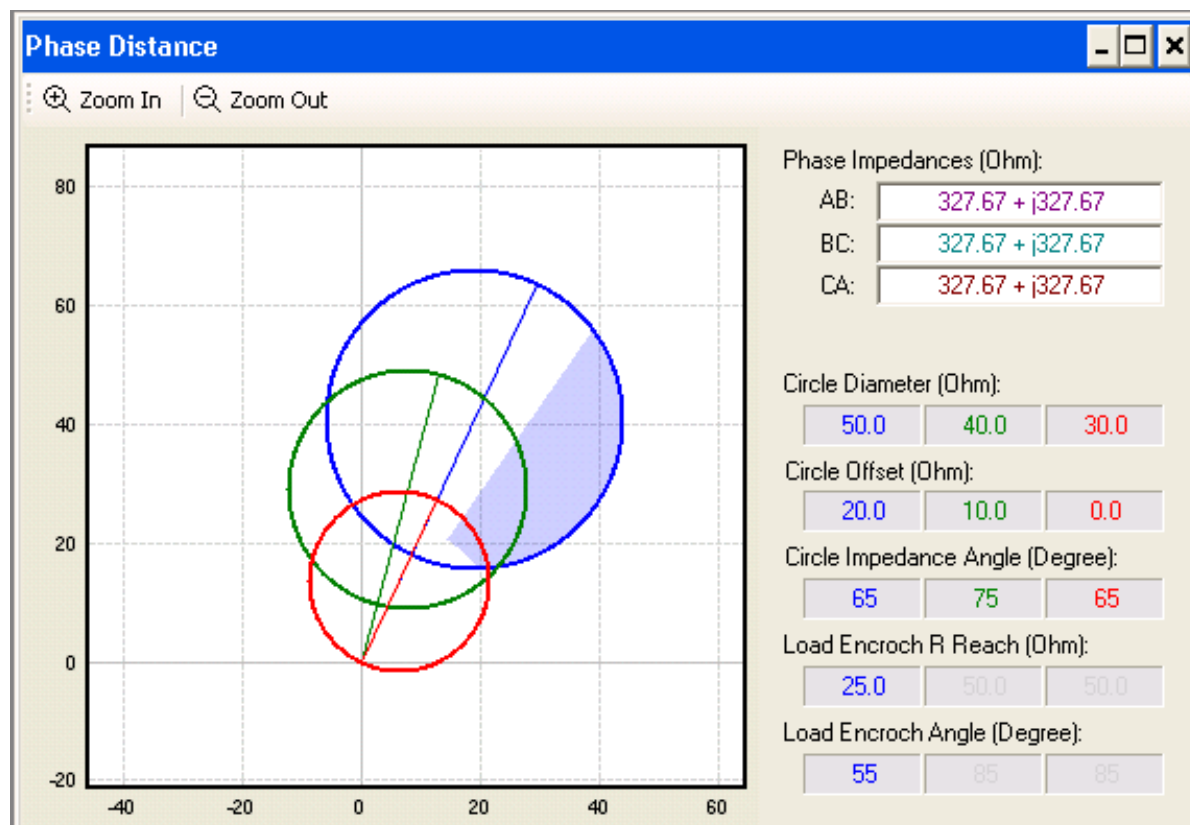
Path: Monitor / Phasor Diagram

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

Figure 3-13 Phasor Diagram

### Monitor/Phase Distance Diagram

The Phase Distance Diagram (Figure 3-14) provides the user with a graphic representation to evaluate Phase Distance settings for all three phases. See Function 21, Phase Distance in Chapter 4 for additional information.



Path: Monitor / Phase Distance Diagram

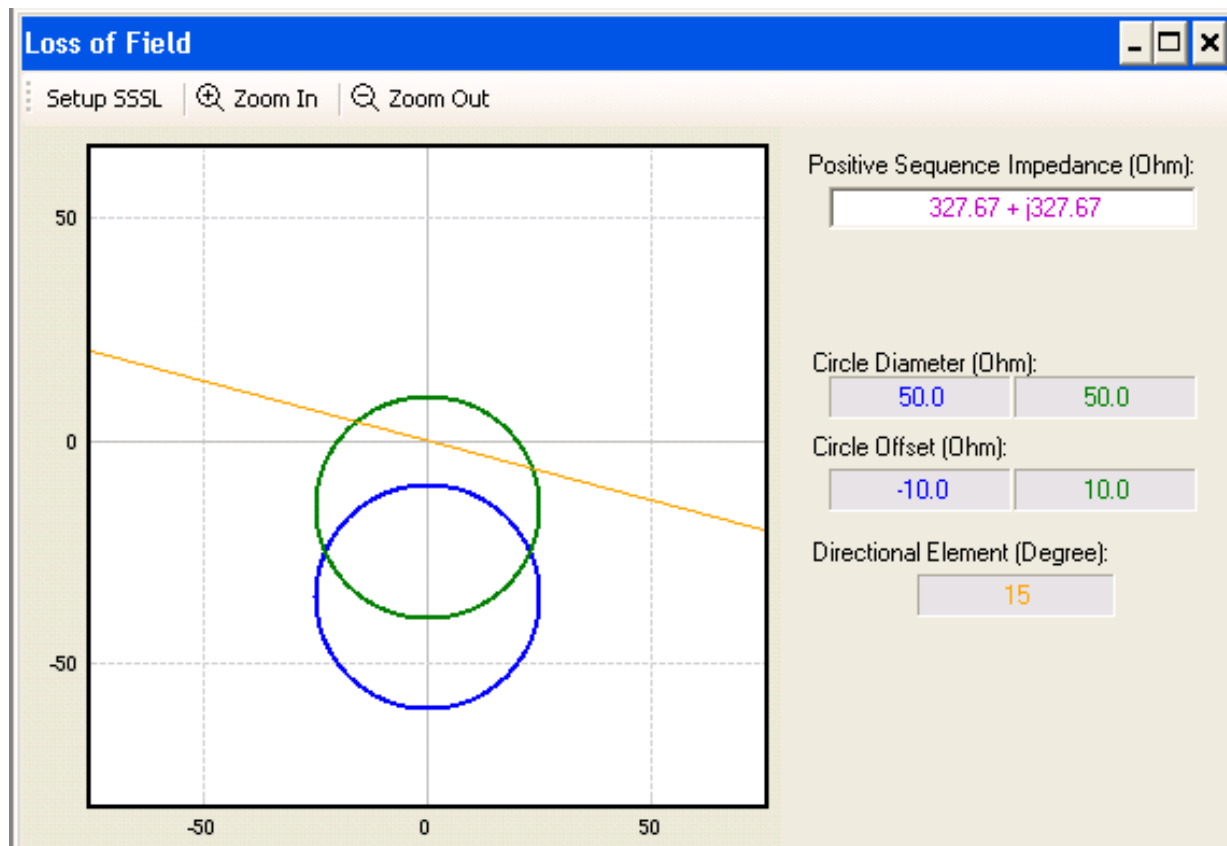
■ **NOTE:** When connections specifying delta-connected CTs are used, Functions 87T and 87H use the Phasor Diagram values (currents actually entering the relay) and not the calculated values displayed on the Secondary Metering and status screen.

Figure 3-14 Phase Distance Diagram



### Monitor/Loss of Field

The Loss of Field Diagram ([Figure 3-15](#)) displays a graphic representation of Loss of settings, and also displays the Positive Sequence Impedance. See Function 40, Loss of Field in Chapter 4 for additional information.

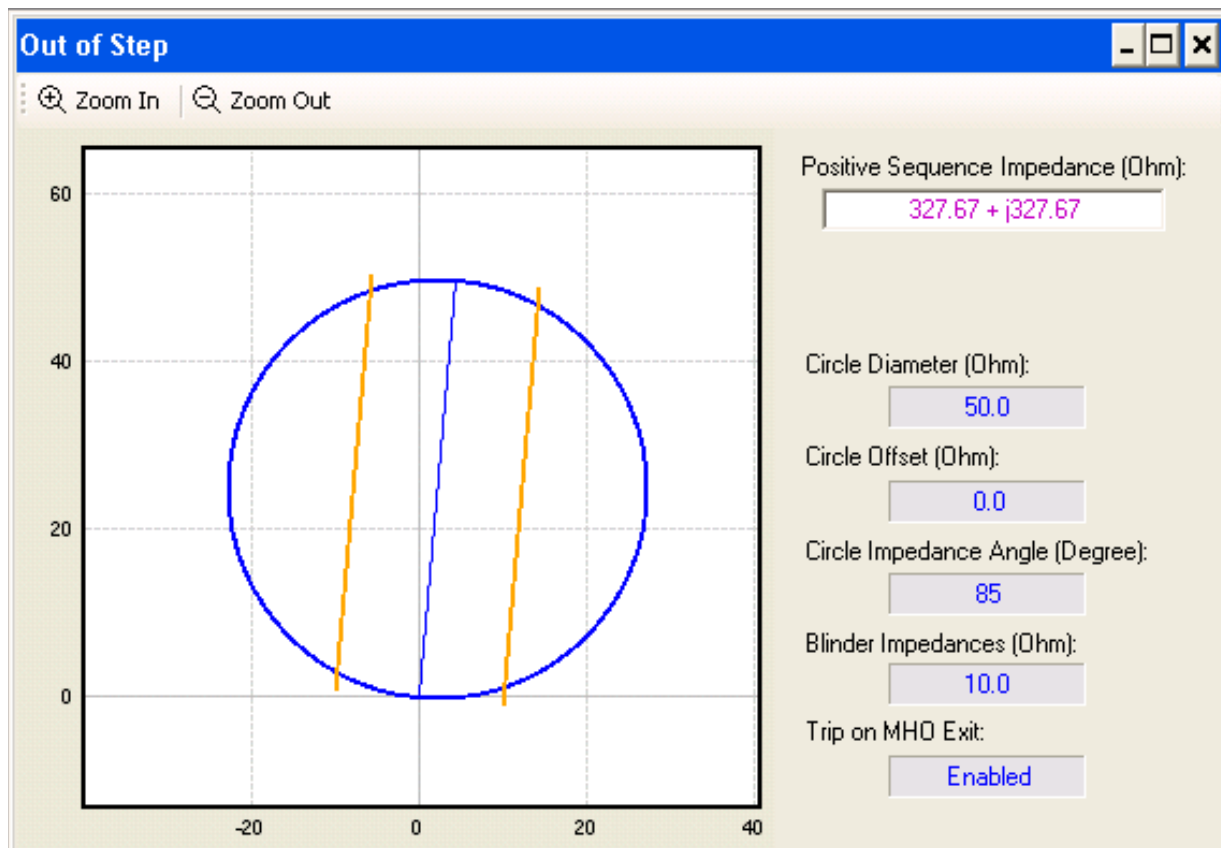


Path: Monitor / Loss of Field

Figure 3-15 Loss of Field Diagram

**Monitor/Out of Step**

The Out of Step graphic representation provides the user with the ability to evaluate Out of Step settings. See Function 78, Out of Step in Chapter 4 for additional information.

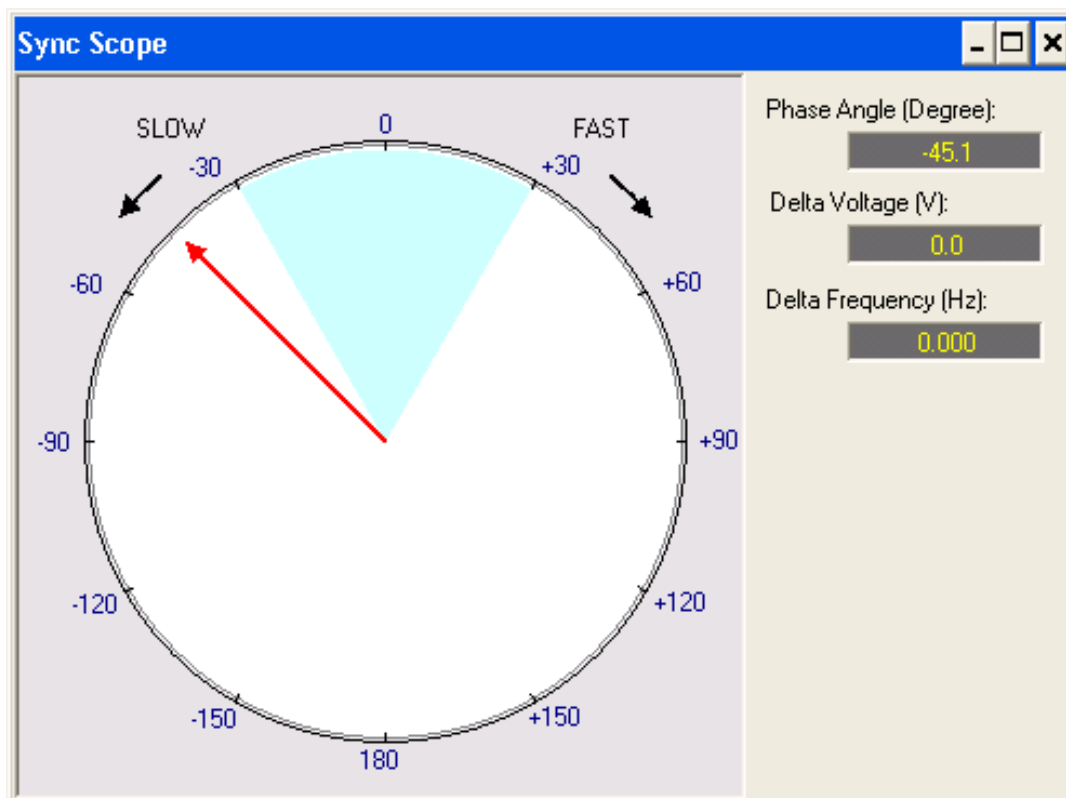


Path: Monitor / Out of Step

Figure 3-16 Out of Step Diagram

### Monitor/Sync Scope

The Sync Scope graphic representation provides the phase difference between the measured quantities. See Function 25, Sync Check in Chapter 4 for additional information.



Path: Monitor / Sync Scope

Figure 3-17 Sync Scope

**▲ CAUTION:** The M-3425A Sync Scope should not be used to determine phase conditions for manual synchronizing because of possible communications time delay.

### Monitor/Function Status

The Function Status screen displays the status of various functions, with a red circle indicating functions that have tripped, and a green circle for those functions that have picked up and are timing. Also displayed are Active Inputs and Outputs.

**Function Status**
\_ □ ×

Function Pickup/Tripped — ● Pickup ● Tripped —

●● 21 #1	●● 32 #3	●● 50/27	●● 64F #2	●● 81R #1
●● 21 #2	●● 40 #1	●● 51N	●● 64S	●● 81R #2
●● 21 #3	●● 40 #2	●● 51V	●● 67N DT	●● 87 #1
●● 24 DT #1	●● 40 VC#1	●● 59 #1	●● 67N IT	●● 87 #2
●● 24 DT #2	●● 40 VC#2	●● 59 #2	●● 78	●● 87GD
●● 24 IT	●● 46 DT	●● 59 #3	●● 81 #1	●● IPSL #1
●● 25 D	●● 46 IT	●● 59D	●● 81 #2	●● IPSL #2
●● 25 S	●● 49 #1	●● 59N #1	●● 81 #3	●● IPSL #3
●● 27 #1	●● 49 #2	●● 59N #2	●● 81 #4	●● IPSL #4
●● 27 #2	●● 50 #1	●● 59N #3	●● 81A #1	●● IPSL #5
●● 27 #3	●● 50 #2	●● 59X #1	●● 81A #2	●● IPSL #6
●● 27TN #1	●● 50BF	●● 59X #2	●● 81A #3	●● BM
●● 27TN #2	●● 50DT #1	●● 60FL	●● 81A #4	●● TC
●● 32 #1	●● 50DT #2	●● 64B	●● 81A #5	
●● 32 #2	●● 50N	●● 64F #1	●● 81A #6	

**Inputs**

1	2	3	4	5	6	7	8
9	10	11	12	13	14		FL

**Outputs**

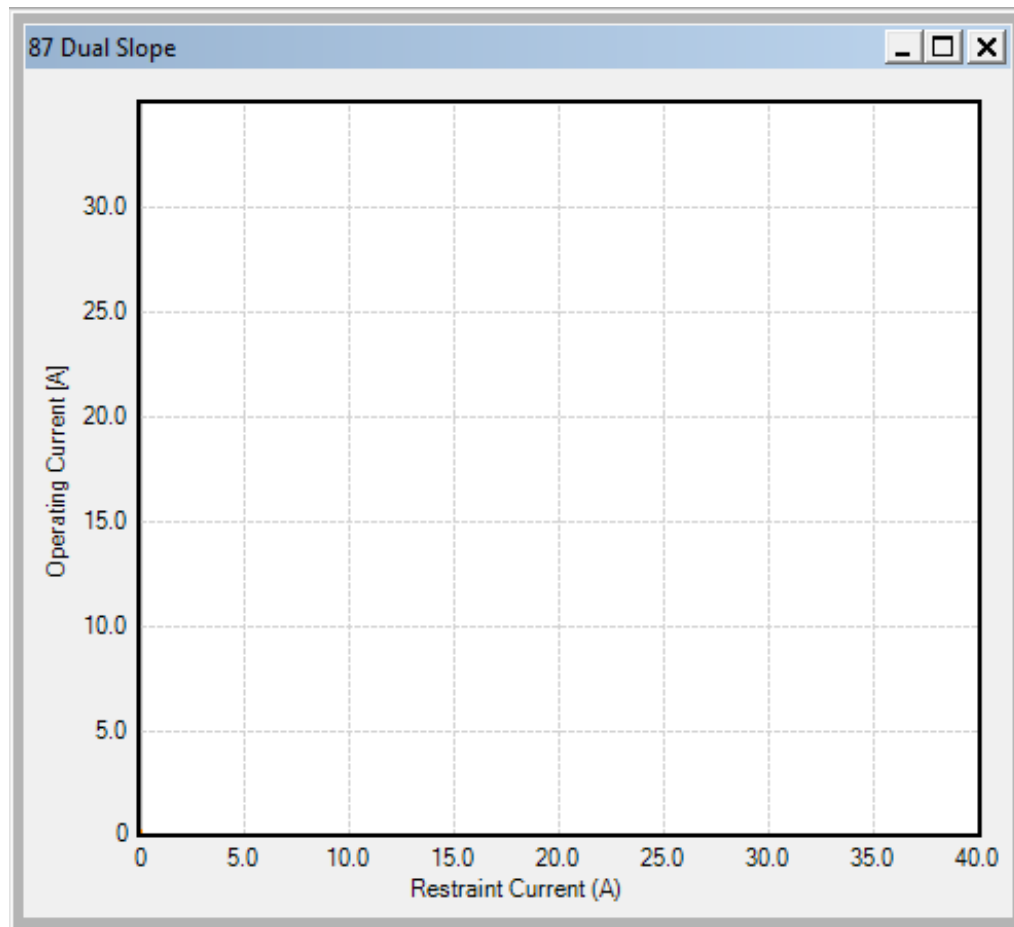
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	

**Path:** Monitor / Function Status

*Figure 3-18 Function Status*

**Monitor/87 Dual Slope**

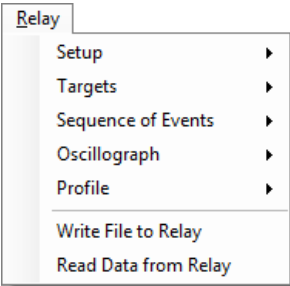
The 87 Dual Slope display allows the user to display a graphical representation of the 87 programmable Dual Slope Percentage Restraint Characteristic. See Function 87, Phase Differential Current in Chapter 4 for additional information.



**Path:** Monitor / 87Dual Slope

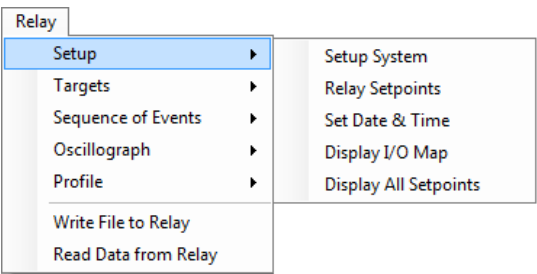
*Figure 3-19 87 Function Dual Slope Display*

Relay Menu



The **Relay** menu provides access to the screens used to set, monitor, or interrogate the relay. Six submenus are provided: **Setup**, **Targets**, **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.

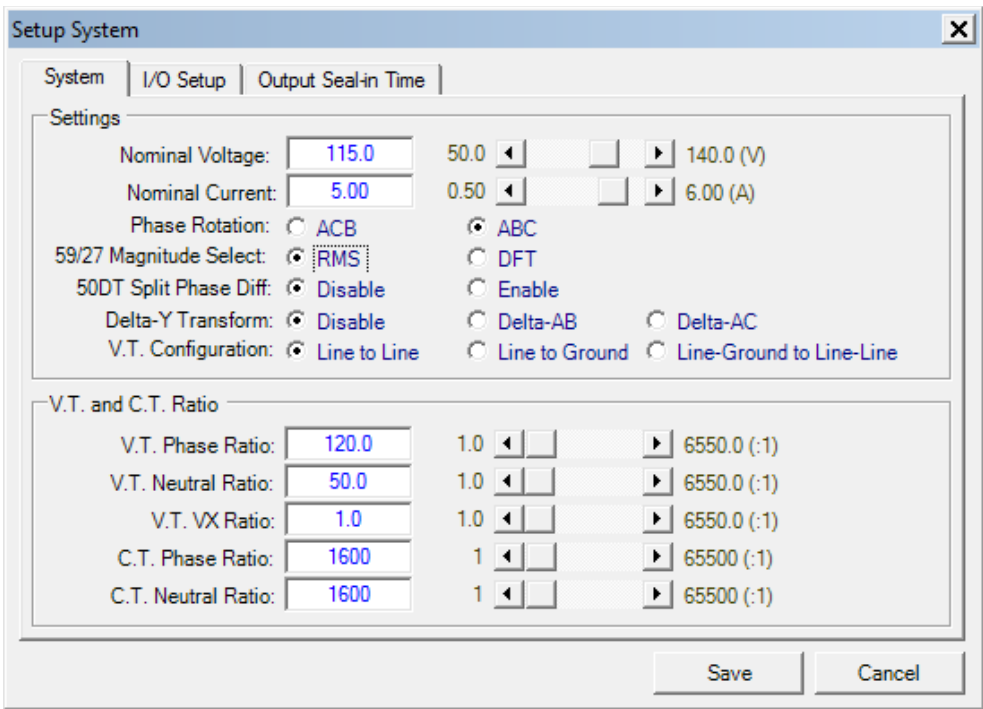
Relay/Setup/Setup System

The **Setup System** selection displays the Setup System dialog screen (Figure 3-20 through Figure 3-22) 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 Input Active State 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.



Path: Relay / Setup / Setup System

Figure 3-20 Setup System/System Dialog Screen

**Setup System**

System | I/O Setup | Output Seal-in Time

**Input Active State (Open)**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14		

**Input Active State (Close)**

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input checked="" type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14		

**Latched Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Pulsed Outputs**

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Save Cancel

Path: Relay / Setup / Setup System

Figure 3-21 Setup System/System/I/O Setup Dialog Screen

**Setup System**

System | I/O Setup | Output Seal-in Time

**Relay Output Seal-in Time (Cycles)**

1:	30	2	◀	▶	8160	13:		0	◀	▶	65535
2:	30	2	◀	▶	8160	14:		0	◀	▶	65535
3:	30	2	◀	▶	8160	15:		0	◀	▶	65535
4:	30	2	◀	▶	8160	16:		0	◀	▶	65535
5:	30	2	◀	▶	8160	17:		0	◀	▶	65535
6:	30	2	◀	▶	8160	18:		0	◀	▶	65535
7:	30	2	◀	▶	8160	19:		0	◀	▶	65535
8:	30	2	◀	▶	8160	20:		0	◀	▶	65535
9:		0	◀	▶	65535	21:		0	◀	▶	65535
10:		0	◀	▶	65535	22:		0	◀	▶	65535
11:		0	◀	▶	65535	23:		0	◀	▶	65535
12:		0	◀	▶	65535						

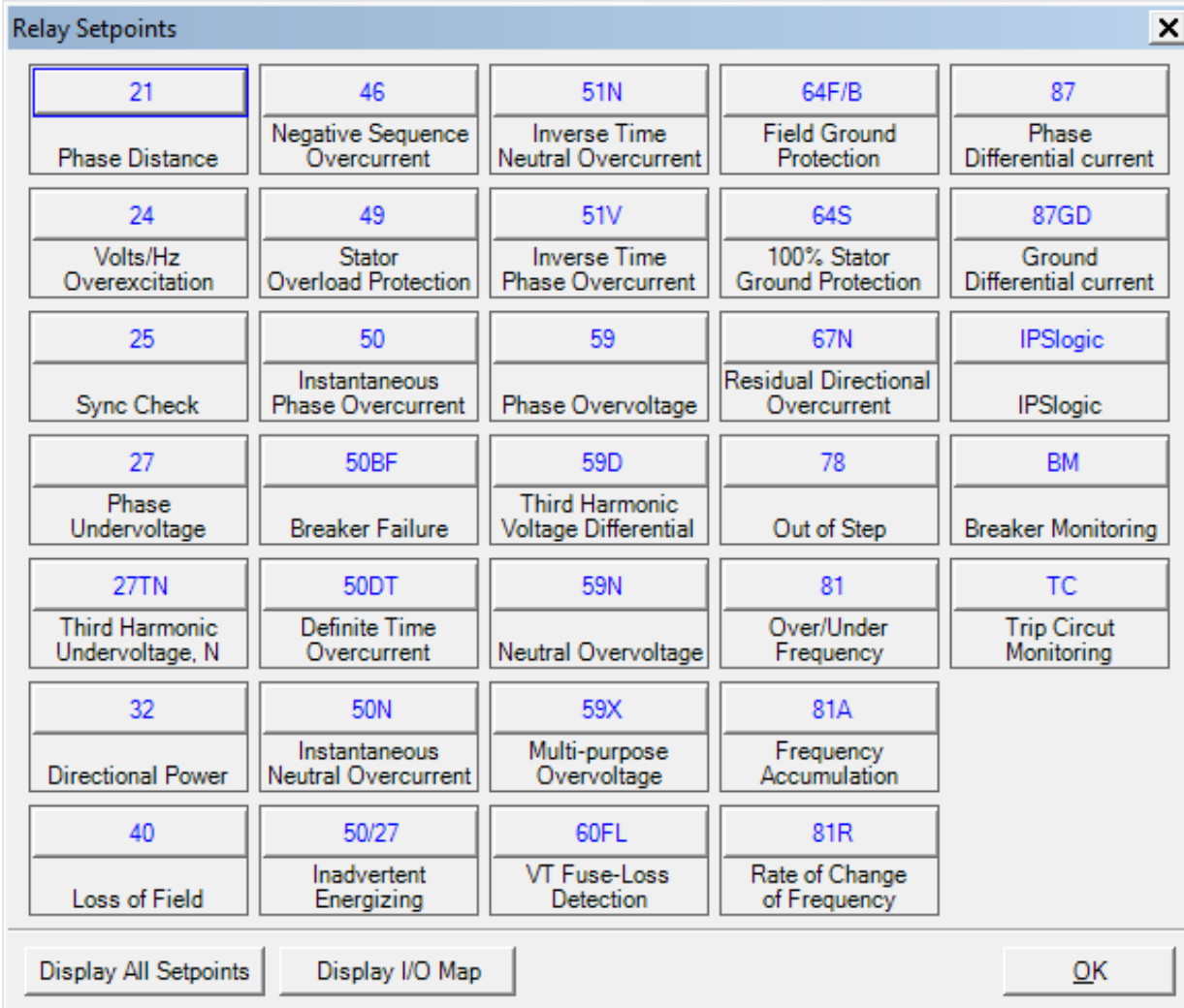
Save Cancel

Path: Relay / Setup / Setup System

Figure 3-22 Setup System/Output Seal-in Time Dialog Screen

### Relay/Setup/Relay Setpoints

The **Relay Setpoints** menu selection displays the Relay Setpoints dialog screen ([Figure 3-23](#)) 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 3-24](#) as an example).



The Relay Setpoints dialog screen is a window titled "Relay Setpoints" with a close button (X) in the top right corner. It contains a grid of 20 buttons arranged in 4 rows and 5 columns. Each button displays a function number and its name. The first button (21) is highlighted with a blue border. At the bottom of the window are three buttons: "Display All Setpoints", "Display I/O Map", and "OK".

21 Phase Distance	46 Negative Sequence Overcurrent	51N Inverse Time Neutral Overcurrent	64F/B Field Ground Protection	87 Phase Differential current
24 Volts/Hz Overexcitation	49 Stator Overload Protection	51V Inverse Time Phase Overcurrent	64S 100% Stator Ground Protection	87GD Ground Differential current
25 Sync Check	50 Instantaneous Phase Overcurrent	59 Phase Overvoltage	67N Residual Directional Overcurrent	IPSlogic IPSlogic
27 Phase Undervoltage	50BF Breaker Failure	59D Third Harmonic Voltage Differential	78 Out of Step	BM Breaker Monitoring
27TN Third Harmonic Undervoltage, N	50DT Definite Time Overcurrent	59N Neutral Overvoltage	81 Over/Under Frequency	TC Trip Circuit Monitoring
32 Directional Power	50N Instantaneous Neutral Overcurrent	59X Multi-purpose Overvoltage	81A Frequency Accumulation	
40 Loss of Field	50/27 Inadvertent Energizing	60FL VT Fuse-Loss Detection	81R Rate of Change of Frequency	

Display All Setpoints    Display I/O Map    OK

Figure 3-23 Relay Setpoints Dialog Screen

#### COMMAND BUTTONS

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

**Display I/O Map** Opens the I/O Map dialog screen ([Figure 3-26](#))

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



**24: Volts/Hz Overexcitation** [X]

**Definite Time #1**

Pickup:  100 ◀ ▶ 200 (%) Disable

Time Delay:  30 ◀ ▶ 8160 (Cycles)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**Definite Time #2**

Pickup:  100 ◀ ▶ 200 (%) Disable

Time Delay:  30 ◀ ▶ 8160 (Cycles)

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**Inverse Time**

Pickup:  100 ◀ ▶ 200 (%) Disable

Time Dial:  1 ◀ ▶ 100

Reset Rate:  1 ◀ ▶ 999 (Sec)

Inverse Time Curves: ☒ #1 ☐ #2 ☐ #3 ☐ #4

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 3-24 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.

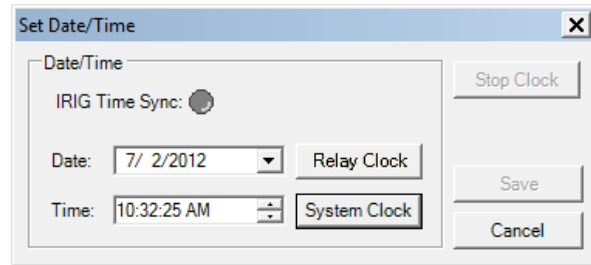
### Relay/Setup/Set Date & Time

The **Setup Date & Time** command (Figure 3-25) allows the system date and time to be set, or system clock to be stopped. The system clock is used for Time and Date Stamping when the Time Sync is not available. 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 3-25 Date/Time Dialog Screen

### SETUP DATE AND TIME COMMAND BUTTONS

<b>Start/Stop Clock</b>	This toggles between start/stop, the relay clock. 'Stop' pauses, 'Start' resumes.
<b>Save</b>	Saves Time and Date settings to the relay when applicable.
<b>Cancel</b>	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 3-26), which contains a chart of programmed input and output contacts, in order to allow scrolling through all relay output and blocking input configurations.

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

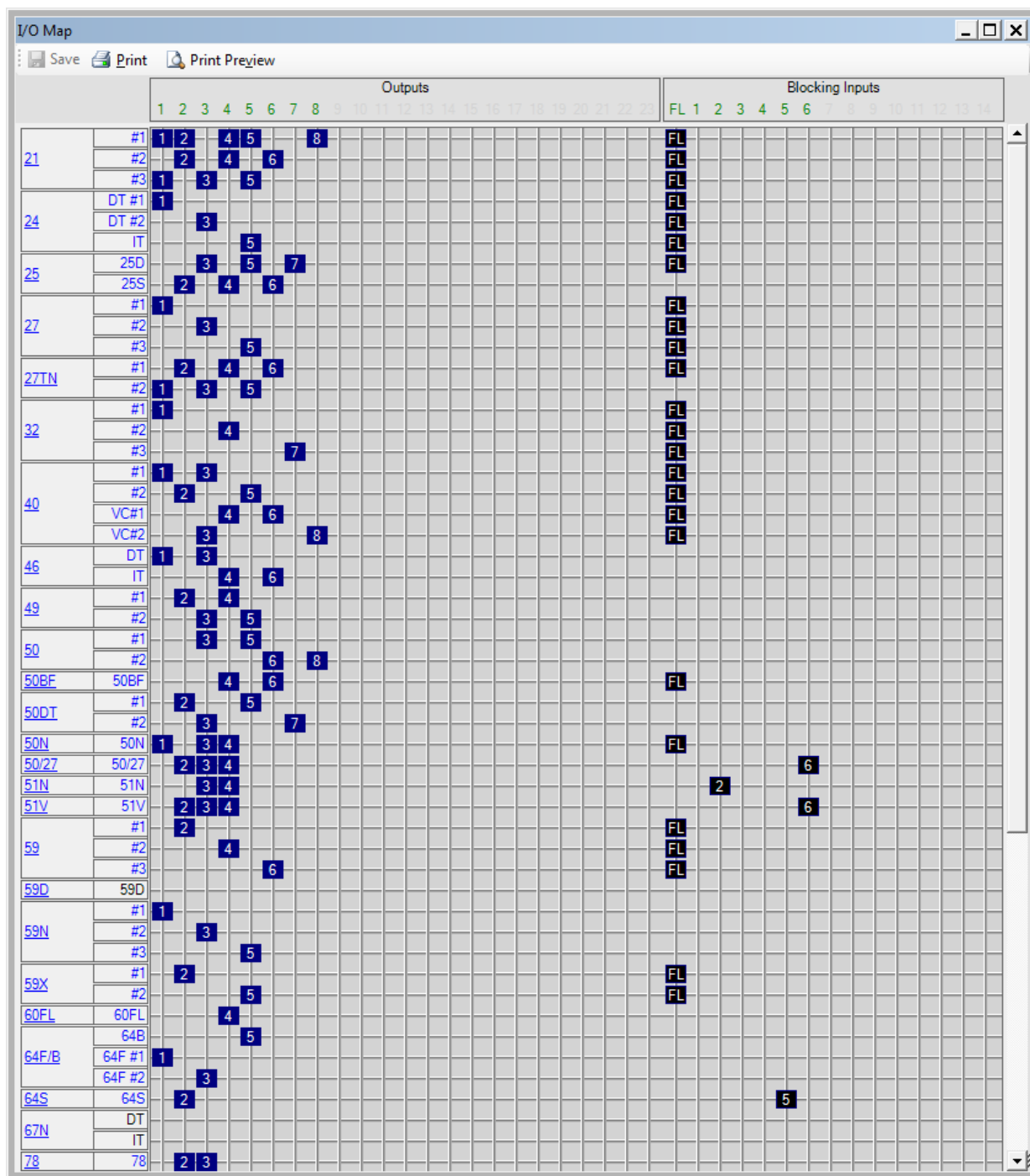


Figure 3-26 I/O Map Screen

### Relay/Setup/Display All Setpoints

Selecting the **Display All Setpoints** button displays the **All Setpoints** dialog screen (Figure 3-27). 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.

**M-3425A All Setpoints**

Software Version: D-0288V01.00.21  
Relay Firmware Version: D-0114V03.00.03  
Serial Number: 0  
BECKWITH ELECTRIC CO.

**Setup System**

CT Type:	5A	Frequency Type:	60Hz
Phase Rotation:	ACB	Expanded I/O:	Disabled
Nominal Voltage:	120.0 (V)	Nominal Current:	5.00 (A)
Delta-Y Transform:	Disable	VT Configuration:	Line to Line
59/27 Magnitude Select:	RMS	50DT Split Phase	Disable
V.T. Phase Ratio:	1.0 (:1)	Differential:	Disable
V.T. VX Ratio:	1.0 (:1)	V.T. Neutral Ratio:	1.0 (:1)
C.T. Neutral Ratio:	10 (:1)	C.T. Phase Ratio:	10 (:1)

**I/O Settings**

Latched Outputs:	Pulsed Outputs:
Active Inputs (Open):	Active Inputs (Close): 1, 2, 3, 4, 5, 6

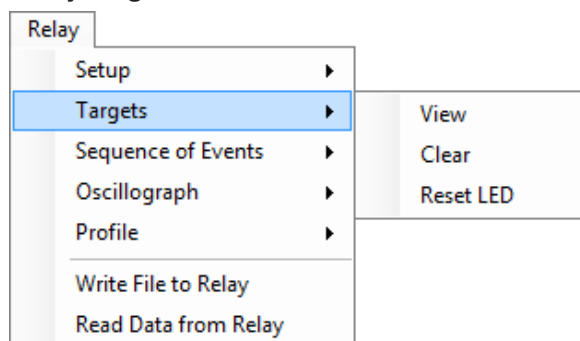
**Sealin Time**

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)

**21: Phase Distance**

<b>21 #1</b>		<b>21 #2</b>	
Blocking Inputs:	FL	Blocking Inputs:	1
Circle Diameter:	10.0 (Ohm)	Circle Diameter:	10.0 (Ohm)
Impedance Angle:	45 (Degree)	Impedance Angle:	45 (Degree)
Load Encroach Angle:	45 (Degree)	Load Encroach Angle:	45 (Degree)
Overcurrent Supervision:	5.00 (A)	Overcurrent Supervision:	5.00 (A)
Outputs:	1, 3, 5	Outputs:	2, 4, 6
Offset:	0.0 (Ohm)	Offset:	0.0 (Ohm)
Time Delay:	30 (Cycles)	Time Delay:	30 (Cycles)
Load Encroach Reach:	10.0 (Ohm)	Load Encroach Reach:	10.0 (Ohm)
Out of Step Block:	Disabled	Out of Step Block:	Disabled
<b>21 #3</b>			
Blocking Inputs:	2	Blocking Inputs:	
Circle Diameter:	10.0 (Ohm)	Circle Diameter:	
Impedance Angle:	45 (Degree)	Impedance Angle:	
Load Encroach Angle:	45 (Degree)	Load Encroach Angle:	
Overcurrent Supervision:	5.00 (A)	Overcurrent Supervision:	
Outputs:	7, 8	Outputs:	
Offset:	0.0 (Ohm)	Offset:	
Time Delay:	30 (Cycles)	Time Delay:	
Load Encroach Reach:	10.0 (Ohm)	Load Encroach Reach:	

Figure 3-27 Display All Setpoints Screen

**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 3-28](#)). 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.

No.	Date
1	01-Jan-2001 01:01:80.000

Target #1

	Phase a	Phase b	Phase c	Neutral
Current:	0.00 (A)	0.00 (A)	0.00 (A)	0.0 (mA)

Function	Picked Up	Operated
27 #1	Yes (AB BC CA)	Yes (AB BC CA)
27 #2	Yes (AB BC CA)	(AB BC CA)

Inputs

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Outputs

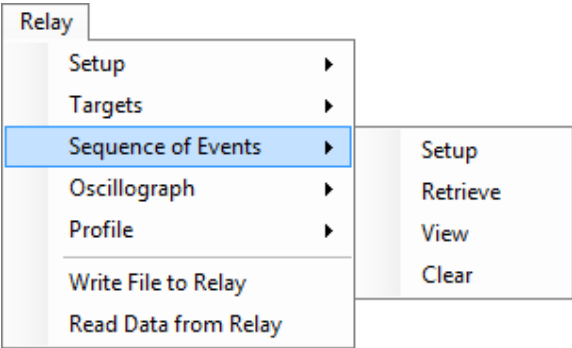
☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Figure 3-28 View Targets Dialog Screen

Relay/Sequence of Events



The Sequence of Events submenu allows the user to **Setup**, **Retrieve**, **View** and **Clear** Sequence of Events records. The **Setup** command displays the **Setup Sequence of Events Recorder** dialog screen (Figure 3-29). 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 3-30). The **View** command displays the View Sequence of Events Record screen (Figure 3-31) 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.

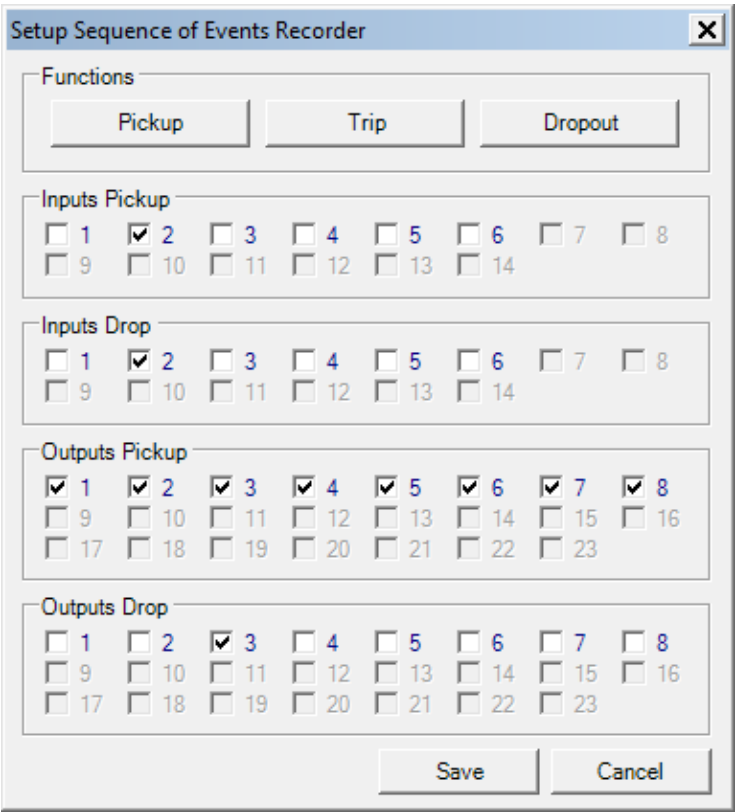


Figure 3-29 Sequence of Events Recorder Setup Screen

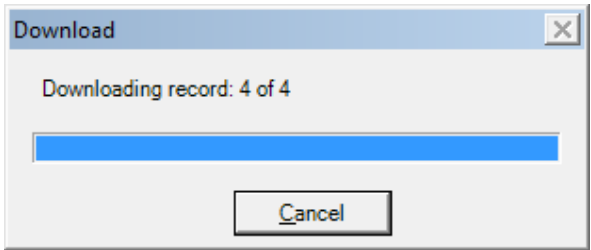


Figure 3-30 Sequence of Events Recorder Retrieve Screen

View Sequence of Events Record X

Open Print Print Preview Set Print Range Close

No	Event Summary
1	01/01/2001, 01:01:80.000 27 #1: Pickup/Timeout/ 27 #2: Pickup/

Item	Value	Unit
VA	0.0	V
VB	0.0	V
VC	0.0	V
VN	0.0	V
VX	0.0	V
VPS	0.0	V
VNS	0.0	V
VZS	0.0	V
IA	0.00	A
IB	0.00	A
IC	0.00	A
IN	0.00	A
Ia	0.00	A
Ib	0.00	A
Ic	0.00	A
IPS	0.00	A
INS	0.00	A
IZS	0.00	A
Ia Diff	0.01	A

**Inputs Pickup**

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5  
☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11  
☐ 12 ☐ 13 ☐ 14

**Inputs Drop**

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5  
☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11  
☐ 12 ☐ 13 ☐ 14

**Outputs Pickup**

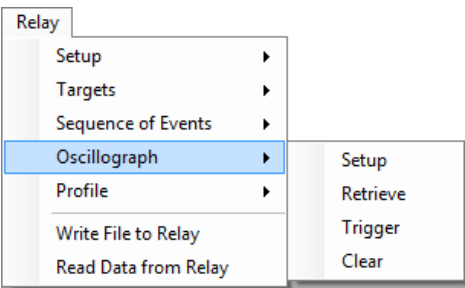
☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6  
☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12  
☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18  
☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Outputs Drop**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6  
☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12  
☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18  
☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Figure 3-31 View Sequence of Events Record Screen

Relay/Oscilloscope



The **Oscilloscope** submenu allows setting and control over the relay's oscilloscope recorder. The **Setup** command allows the user to set the number of partitions and triggering designations to be made (Figure 3-32), **Retrieve** downloads and save data to a file (Figure 3-33). **Trigger** sends a command to the relay to capture a waveform. This is the same as issuing a manual oscilloscope trigger. **Clear** erases all existing records. The optional M-3801D IPSplot®*PLUS* Oscilloscope Analysis Software program is required to view the downloaded oscilloscope files or the files can be converted to ComTrade format.

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

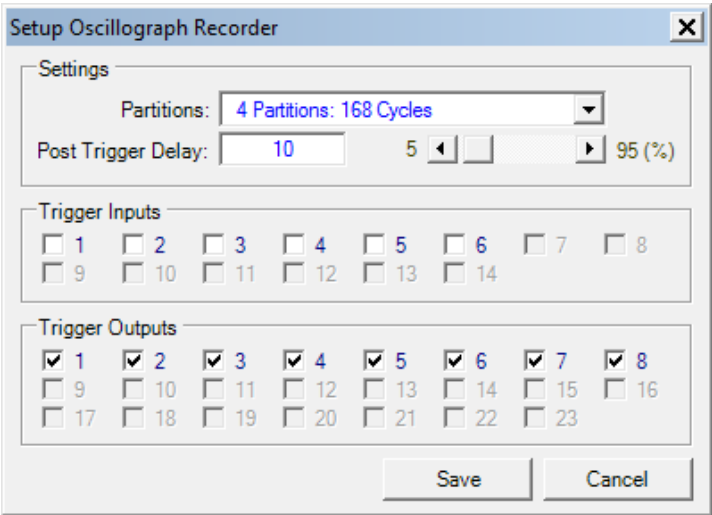


Figure 3-32 Setup Oscilloscope Recorder Dialog Screen

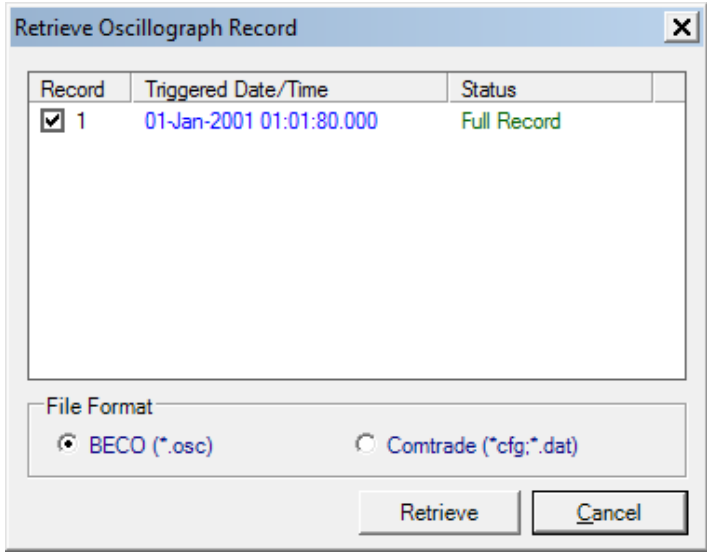
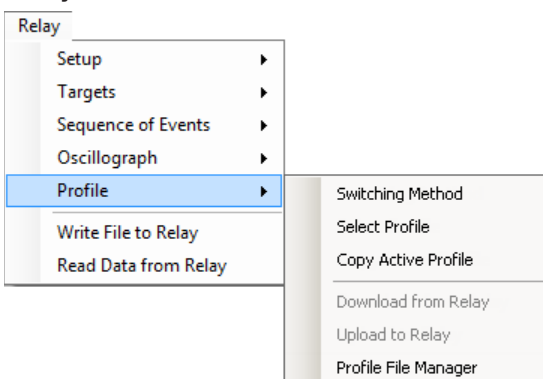


Figure 3-33 Oscilloscope Recorder Retrieve Dialog Screen



**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 3-34). **Select Profile** allows the user to designate the active profile (Figure 3-35). **Copy Active Profile** copies the active profile to one of four profiles (user should allow approximately 15 seconds for copying) (Figure 3-36).

The Profile submenu also provides the means to download and upload to the relay profiles, and access the Profile File Manager utility.

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

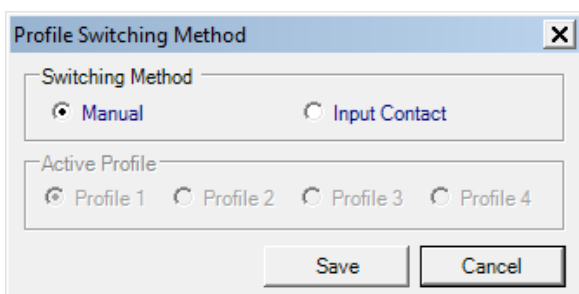


Figure 3-34 Profile Switching Method Dialog Screen

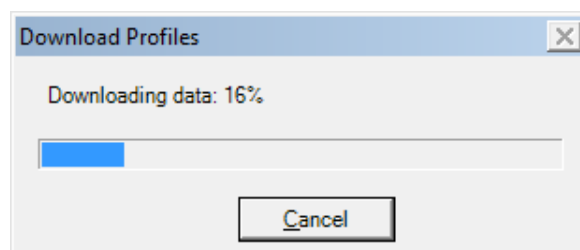


Figure 3-37 Download Profiles Status Dialog Screen

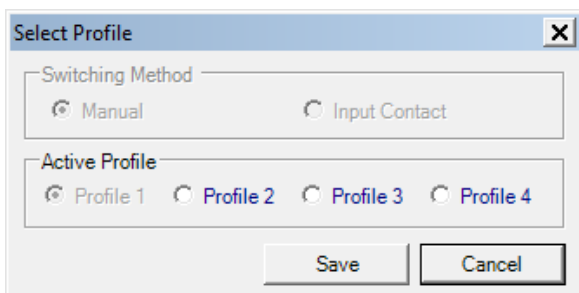


Figure 3-35 Select Profile Dialog Screen

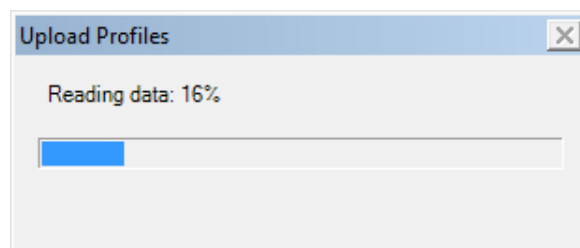


Figure 3-38 Upload Profiles Status Screen

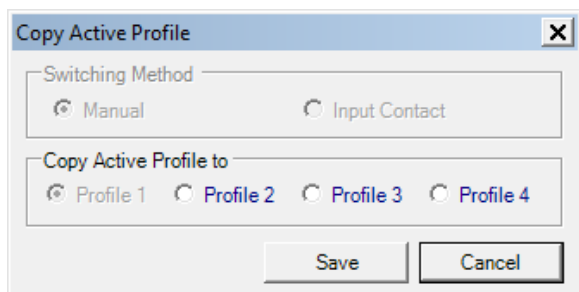


Figure 3-36 Copy Active Profile Dialog Screen

## Profile File Manager

■ **NOTE:** This utility is only available in File mode when IPScom is not connected to a relay, to prevent unintended operation.

The Profile File Manager utility allows the user to manage four setpoint profiles (\*.ips) that are grouped in a Profile File (\*.ipf) that has been created in the Profile File Manager or previously downloaded from a relay.

The Profile File Manager Dialog Screen ([Figure 3-39](#)) displays **New** and **Open** menu selections. The **New** menu selection allows the user to create a new "ipf" profile file with four empty profiles. The **Open** menu selection allows the user to open an existing "ipf" profile file which contains four setting profiles. The four setting profiles are displayed in the "Current Active Profile" section. The selected profile is the active profile. [Figure 3-40](#) represents the Profile File Manager command structure.

The **Operation** section of the dialog screen displays the following commands:

### Copy current active profile to current setting –

This operation is available only with an open profile file. It allows the user to copy the setpoint settings in the selected active profile into the setpoint settings of the open IPScom file.

### Copy current setting to current active profile –

This operation allows the user to copy the current IPScom setpoint settings to the profile that is selected in the "Current Active Profile" section.

### Load a setting file to current active profile –

This operation allows the user to open an "ips" setting file and load the settings into the profile that is selected in the "Current Active Profile" section.

### View current active profile –

This operation allows the user to view and edit the settings in the selected active profile. IPScom will display the "All Setpoints" screen ([Figure 3-27](#)).

### Save current profile to a setting file –

This operation allows the user to save the settings in the selected active profile into an "ips" setting file.

### Save profiles –

This operation allows the user to save all four profiles into an "ipf" profile file that can be saved or uploaded to a relay. This operation is grayed out unless four profiles are created.

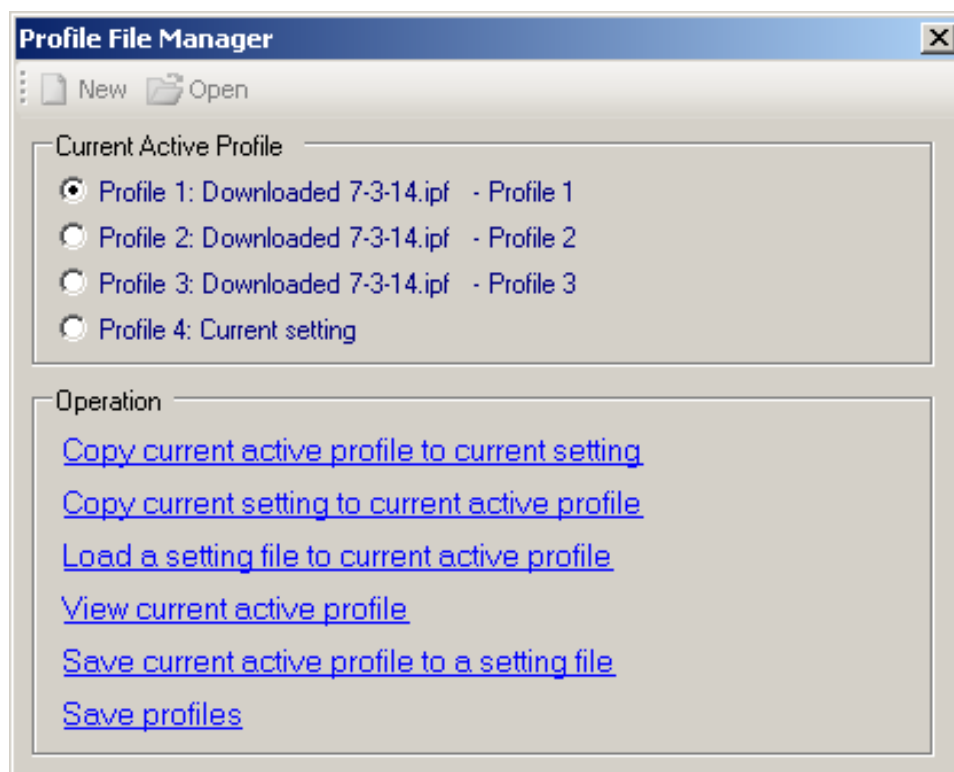


Figure 3-39 Profile File Manager Dialog Screen

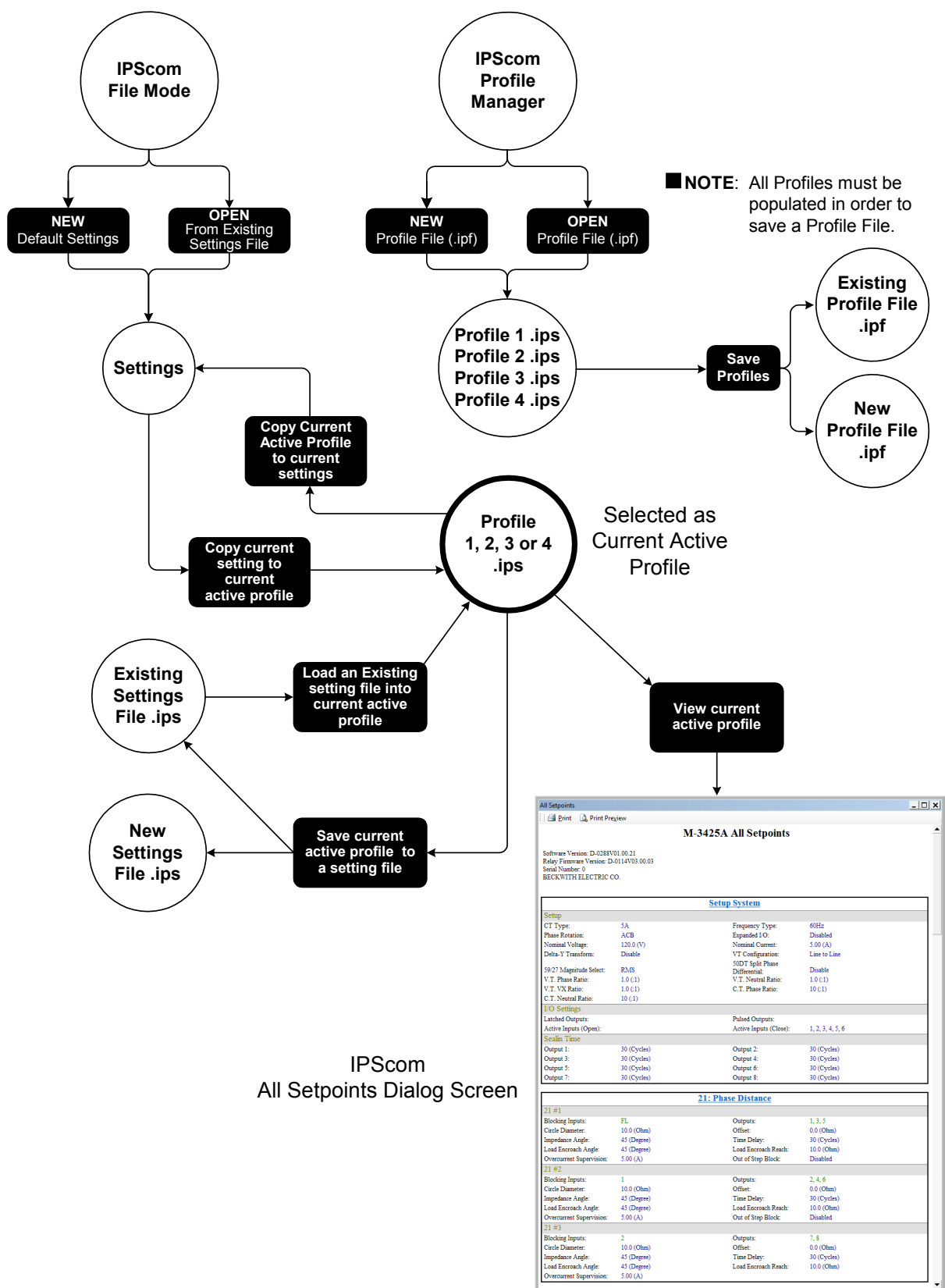
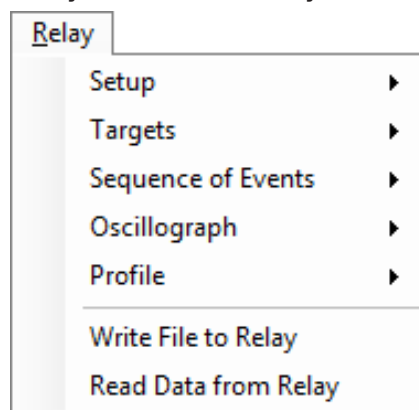


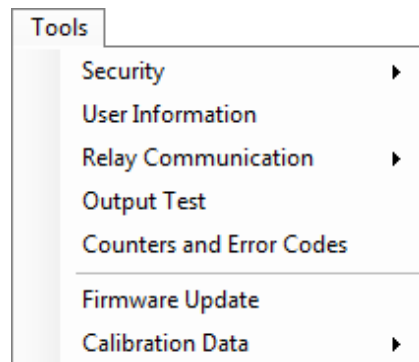
Figure 3-40 Profile File Manager Command Structure

**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 IPScorm® relay support features and functions.

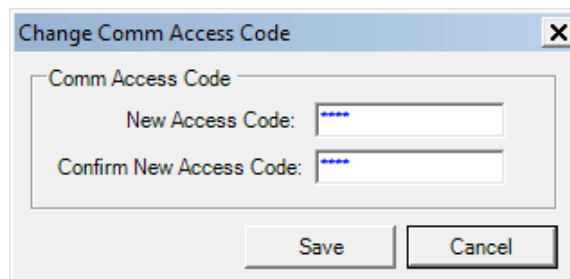
**Tools/Security**

The Security menu item includes the **Change Comm Access Code** 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 3-41](#)) 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 3-41 Change Comm Access Code Dialog Screen*

### Tools/Security/Change User Access Code

The **Change User Access Code** selection displays the Change User Access Code screen (Figure 3-42) which allows the user to change the relay User Access Code. See Section 4.1, **Unit Setup** for detailed setup instructions.

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

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

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

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

Figure 3-42 Change User Access Code Dialog Screen

### Tools/User Information

The User Information menu selection displays the User Information screen (Figure 3-43) 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 3-43 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 IPScm.

### 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 3-44), set the relay's COM Port communication parameters (Figure 3-45) and setup the Ethernet Port (Figure 3-46). See Section 4.1, **Unit Setup** for detailed communication setup instructions.

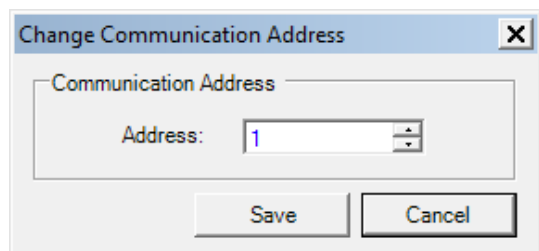


Figure 3-44 Change Relay Communication Address Dialog Screen

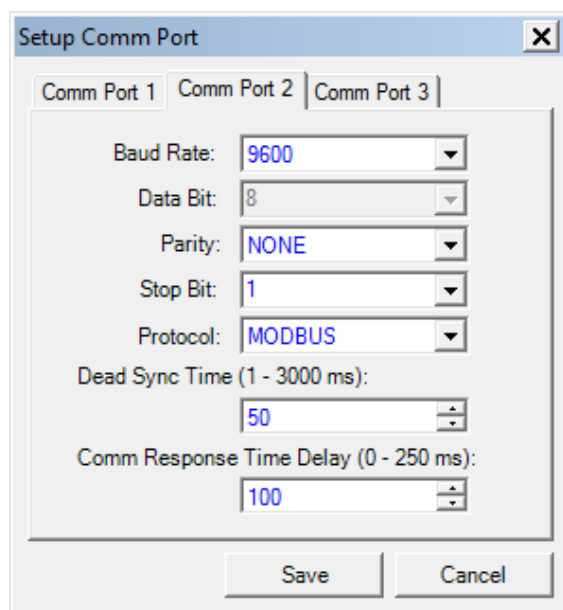


Figure 3-45 Setup Relay Comm Port Dialog Screen

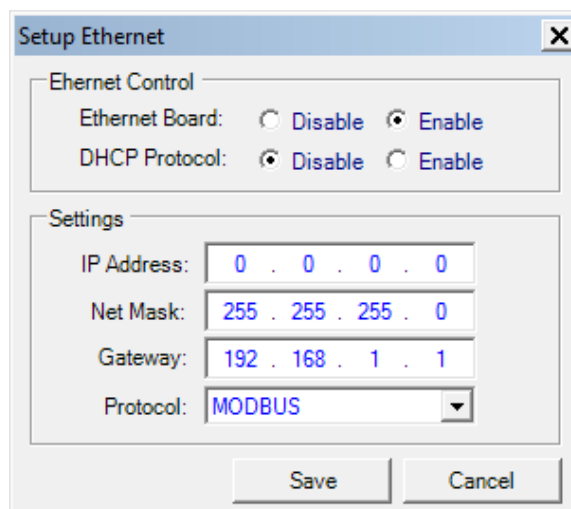


Figure 3-46 Setup Relay Ethernet Port Dialog Screen

### Tools/Output Test

The Output Test menu selection displays the Output Test screens (Figure 3-47 and Figure 3-48) which provides the user with the ability to test each output relay. See Section 6, **Testing** for detailed testing instructions.

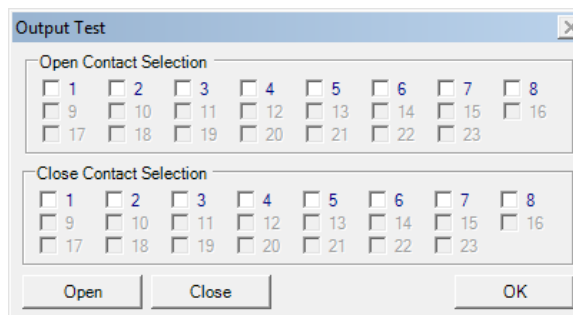


Figure 3-47 Output Test Dialog Screen

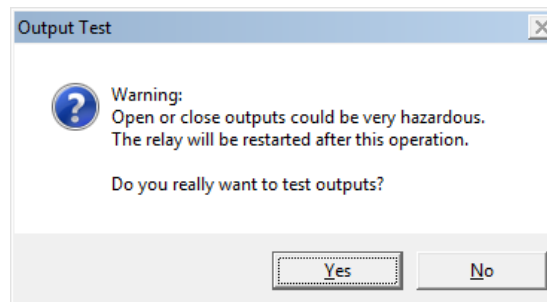


Figure 3-48 Output Test Warning Dialog Screen

### Tools/Counters and Error Codes

The Counters and Error Codes menu selection displays the Counters and Error Codes screen (Figure 3-49) 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.

**Counters and Error Codes**

**Error Codes**

Items	Error Code
<input type="checkbox"/> Last Self Test	27
<input type="checkbox"/> Last Self Test-1	27
<input type="checkbox"/> Last Self Test-2	28
<input type="checkbox"/> Last Self Test-3	0
<input type="checkbox"/> Last Comm	0
<input type="checkbox"/> Received Packet	0

Clear Selected Error Codes

**System Counters**

Items	Counter
<input type="checkbox"/> Reset	6
<input type="checkbox"/> Power Loss	2
<input type="checkbox"/> Alarm	0
<input type="checkbox"/> Self Test	4

Clear Selected Counters

**Checksums (HEX)**

Calibration: 003E

ROM: AF0B

Setpoint: 00CE

**Output Counters**

Items	Counter
Output 1	0
Output 2	0
Output 3	0
Output 4	0
Output 5	0
Output 6	0
Output 7	0
Output 8	0
Output 9	0
Output 10	0
Output 11	0
Output 12	0
Output 13	0
Output 14	0
Output 15	0
Output 16	0
Output 17	0
Output 18	0
Output 19	0
Output 20	0
Output 21	0
Output 22	0

Clear All Counters

Figure 3-49 Counters and Error Codes Dialog Screen

## Tools/Firmware Update

▲ **CAUTION:** M-3425A Firmware Version D0114CXX.XX.XX cannot be updated with this firmware update tool.

The Firmware Update feature allows the user to perform M-3425A Firmware updates. Firmware update files and instructions are provided by Beckwith Electric.

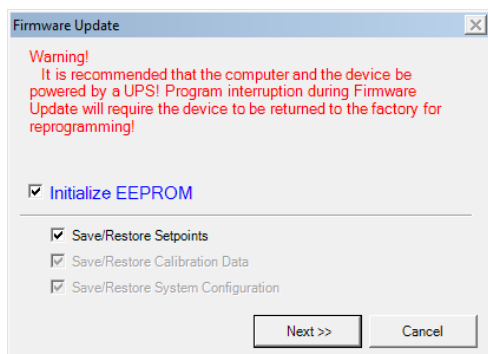


Figure 3-50 Firmware Update Warning Dialog Screen

## Tools/Calibration Data

The Calibration Data feature allows the user to retrieve calibration data from M-3425A relays. It also allows relay calibration data to be restored to the relay.

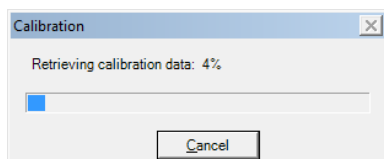
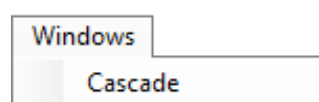


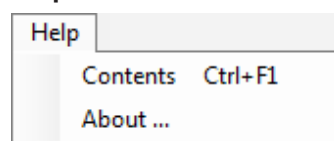
Figure 3-51 Calibration Data Retrieve Dialog Screen

## 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 selections. The **Contents** selection initiates a link to a PDF (Portable Document File) version of this instruction book for easy reference. Adobe Acrobat® reader is required to view this document.

The M-3425A Instruction Book has been indexed to its table of contents. By selecting the 'Bookmarks pane' in Adobe Acrobat Reader, the user can directly access selected topics.

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

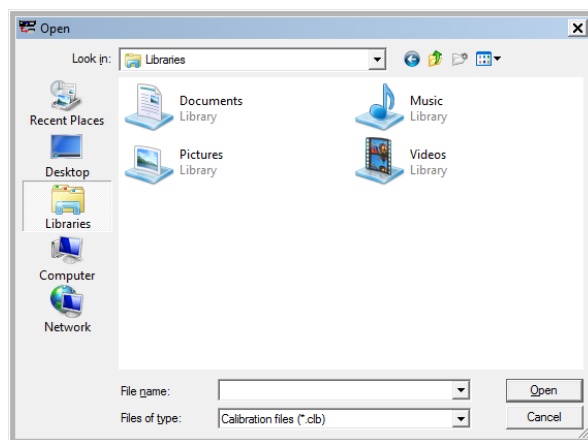


Figure 3-52 Calibration Data Restore Dialog Screen



# 4

## System Setup and Setpoints

4.1	Unit Setup .....	4-4
4.2	Setup System.....	4-28
4.3	System Diagrams.....	4-33
4.4	System Setpoints .....	4-39

Chapter four is designed for the person or group responsible for the Unit Setup, Configuration and System Setpoints of the M-3425A Generator 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 and Sequence of Events 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-3425A System Setup parameters and Setpoints can be performed using either the S-3400 IPScom® Communications Software or from the unit's M-3931 Front Panel Human Machine Interface (HMI), and will be included where applicable.

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## 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.

#### IPScorn 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](#)).

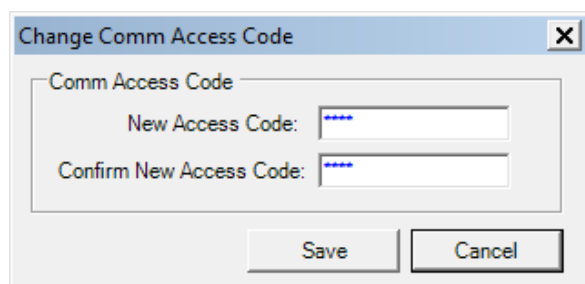


Figure 4-1 Change Comm Access Code Dialog Screen

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.
3. Select **Save**, IPScom will display the Save to Device confirmation screen ([Figure 4-2](#)).

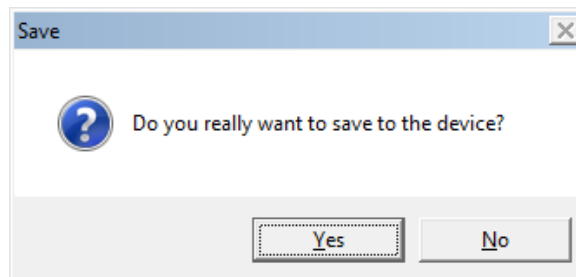


Figure 4-2 Save to Device Confirmation Screen

4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully confirmation screen ([Figure 4-3](#)).

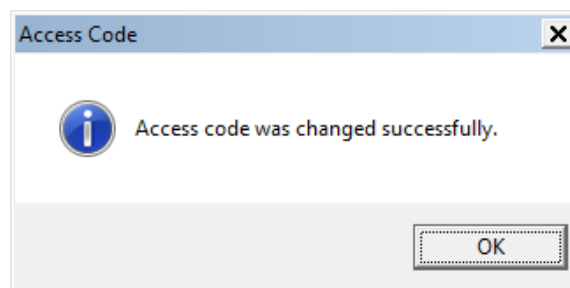


Figure 4-3 Access Code Changed Successfully Confirmation Screen

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.

**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

← targets osc\_rec COMM →

---

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**.

### IPScorn 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.

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

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

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 dialog screen ([Figure 4-4](#)).

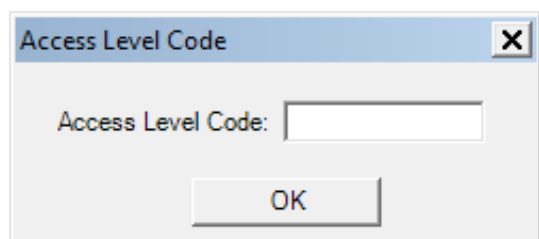


Figure 4-4 Access Level Code Dialog Screen

2. Enter a valid Access Code, then select **OK**. IPScom will display the Change User Access Code dialog screen ([Figure 4-5](#)).

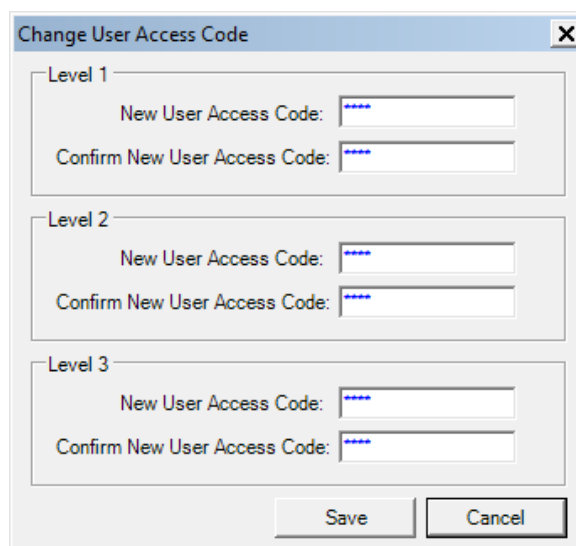


Figure 4-5 Change User Access Code Dialog Screen

3. Enter the desired User Access Code(s) (1-9999), then re-enter (confirmation) the desired User Access Code(s).
4. Select **Save**, IPScom will display the Save to Device Confirmation Screen ([Figure 4-2](#)).
5. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen ([Figure 4-3](#)).
6. 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. Press **ENTER**, the following will be displayed:

---

SOFTWARE VERSION  
VERS sn access number →

---

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

---

ALTER ACCESS CODES  
vers sn ACCESS number →

---

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

---

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

---

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

---

LEVEL #1  
9999

---

9. 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

---

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

---

LEVEL #2 or LEVEL #3  
9999

---

11. Repeat Step 9 to enter the desired Level #2 or Level #3 User Access Code.

14. 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 IPScm®.

## 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.

## IPScm 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 IPScm Main Screen menu select **Tools/User Information**. IPScm will display the User Information dialog screen (Figure 4-6).

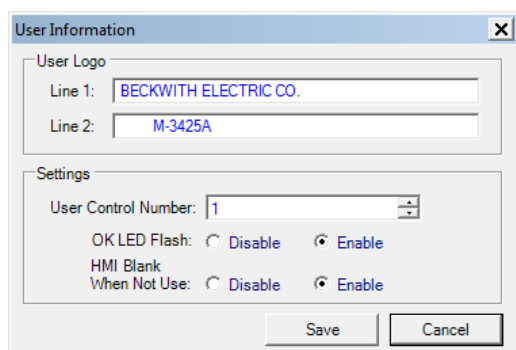


Figure 4-6 User Information Dialog Screen

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**, IPScm 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 sn access number →

---

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

---

USER LOGO LINE 1

LOGO 1 logo 2 alrm →

---



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

---

USER LOGO LINE 1  
\_BECKWITH ELECTRIC CO.

---

8. Input the desired User Logo Line 1 as follows:
- Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
  - Press the Right arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 1.
  - 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-3425A

---

11. Input the desired User Logo Line 2 as follows:
- Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
  - Press the RIGHT arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 2.
  - 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 sn ACCESS number →

---

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

---

USER CONTROL NUMBER

vers sn access NUMBER →

---

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

---

USER CONTROL NUMBER

1

---

8. Input the desired User Control Number as follows:

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

---

USER CONTROL NUMBER

vers sn access NUMBER →

---

9. Press **Exit**.

**HMI System OK LED Setup**

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

---

ENTER ACCESS CODE

0

---

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

---

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

---



---

VOLTAGE RELAY  
VOLT curr freq v/hz →

---

- c. Go to step 4.

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

---

VOLTAGE RELAY  
VOLT curr freq v/hz →

---

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

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

---

SETUP UNIT  
← stat comm SETUP →

---

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

---

SOFTWARE VERSION  
VERS eth sn access →

---

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

---

DIAGNOSTIC MODE  
← 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 4-7](#)). If the IRIG-B interface is used, the hours, minutes, and seconds information in the clock will be synchronized with IRIG-B time information every hour.

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

### IPScom Set Date/Time

To set the relay Date/Time perform the following:

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

1. From the IPScom Main Screen menu select **Relay/Setup/Setup Date & Time**. IPScom will display the Setup Date/Time dialog screen ([Figure 4-7](#)).

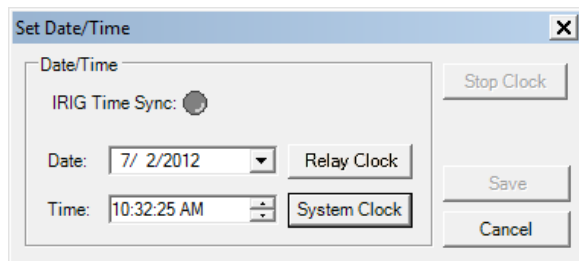


Figure 4-7 Setup Date/Time Dialog Screen

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

## HMI SET DATE and TIME

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

---

ENTER ACCESS CODE

0

---

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

---

LEVEL #(1,2 or 3)

Access Granted!

---

VOLTAGE RELAY

VOLT curr freq v/hz

---

- c. Go to step 4.

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

---

VOLTAGE RELAY

VOLT curr freq v/hz

---

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

---

SETUP UNIT

stat comm SETUP

---

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

---

DATE & TIME

← TIME error eth\_ver 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:

- Utilizing the Up and Down arrow pushbuttons select the desired first digit.
- Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Year.
- 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:

- Utilizing the Right or Left arrow pushbuttons select the desired Month.
- 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:

- Utilizing the Up and Down arrow pushbuttons select the desired Date first digit.
- Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired date.
- 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:

- Utilizing the Right or Left arrow pushbuttons select the desired Day.
- 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:

- Utilizing the Up and Down arrow pushbuttons select the desired first digit.
- Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Hour.
- 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:

- Utilizing the Up and Down arrow pushbuttons select the desired first digit.
- Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Minute(s).
- 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:

- Utilizing the Up and Down arrow pushbuttons select the desired first digit.
- Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Seconds.
- When the desired Seconds have been input, then press **ENTER**. The following will be displayed:

---

DATE & TIME  
← TIME error eth\_ver 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-3425A is an RS-485, 2-wire connection. The COM3 port is for MODBUS communications.

RJ45 port located on the rear of the unit when purchased with the B-1684 RS-485 Adapter Board for DNP communications. Includes RJ45 Breakout Adapter terminal that accepts an RS-485 2-wire connection. This port utilizes the DNP3.0 protocol only over COM2.

**Appendix B**, Figures B-3 and B-4 illustrate 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-3425A 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](http://www.beckwithelectric.com).

▲ **CAUTION:** The **Echo Cancel** check box should only be used when several relays are connected using a fiber optic loop network. Otherwise, echo cancel must not be selected or communication will be prevented.

▲ **CAUTION:** If the serial port is connected to something other than a modem, and an IPSCOM modem command is executed, the results are unpredictable. In some cases, the computer may have to be reset.

### 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 5.7, IPSCOM Communications Software Installation, and Section 5.8, Activating Initial Local Communications.

1. From the IPSCOM Main Screen menu select **Tools/Relay Communication/Setup Comm Port**. IPSCOM will display the Setup Comm Port dialog screen ([Figure 4-8](#)).

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

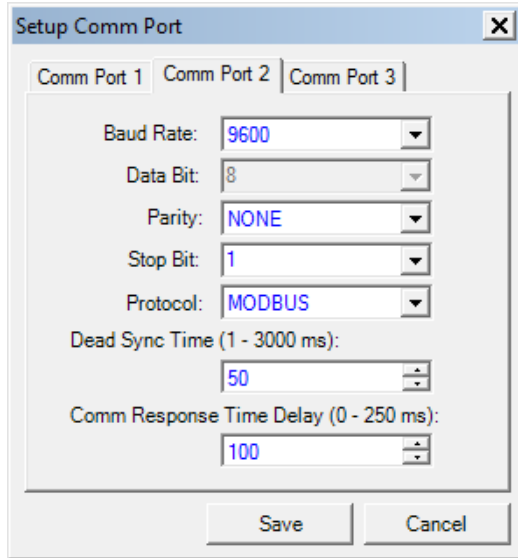


Figure 4-8 Setup Comm Port Dialog Screen

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).
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 IPScorn and the relay allows multiple systems to share a direct or modem connection when connected through COM2 using a communications-line splitter (Figure 4-9). 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.

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

Table 4-1 Dead-Sync Time

9. When the COM Port settings have been entered, then select **Save**. IPScorn will display the Save to Device confirmation screen (Figure 4-2).
10. Select **Yes**, IPScorn will return to the Main Screen.

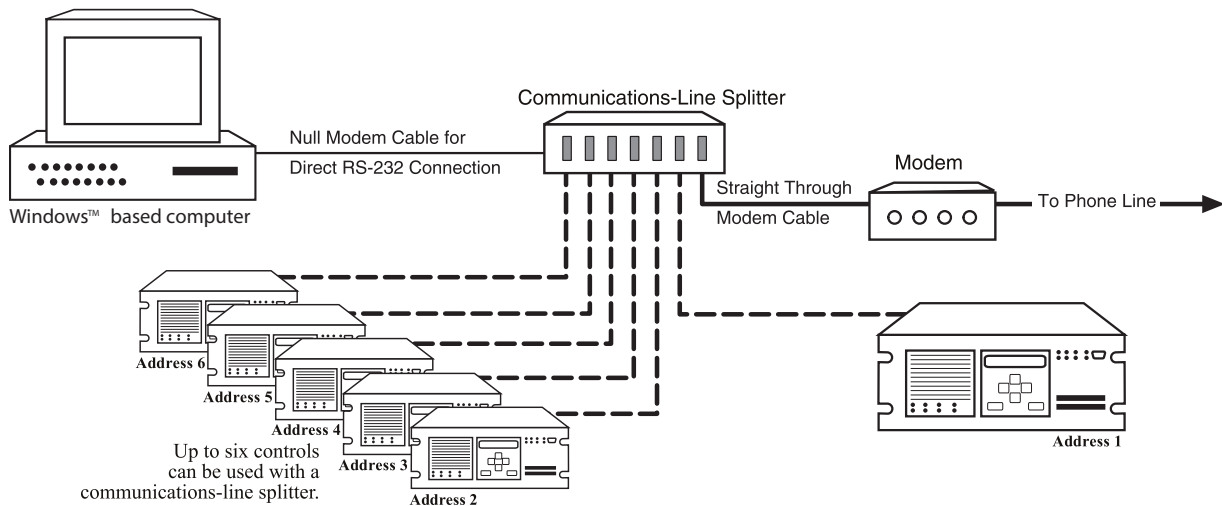


Figure 4-9 Communications-Line Splitter Diagram

**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

---

■ **NOTE:** When the B-1684 RS-485 Adapter Board is present, COM2 protocol is fixed at DNP3.0.

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.

### COM Port Security

COM1, COM2 and COM3 may be disabled for security purposes from the unit HMI. A Level 2 Access Code is required.

### Disabling COM Ports

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!

---



---

INIT TRANSFER  
INIT rmte\_lcal

---

- c. Go to step 4.

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

---

INIT TRANSFER  
INIT rmte\_lcal

---

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

---

Communication  
stat COMM setup

---

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

---

COM1 SETUP  
COM1 com2 com3 com\_adr

---

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

---

PORT ACCESS  
enable DISABLE

---

7. Press the Left or Right Arrow pushbutton as necessary to enable or disable the COM port.

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

---

COM1 BAUD RATE  
baud\_4800 BAUD\_9600

---

9. Repeat Steps 5 through 8 as necessary for additional COM Ports.

## ETHERNET COMMUNICATION SETTINGS

The optional RJ45 Ethernet port can be enabled utilizing either IPScm® 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.

Although the ethernet connection speed is faster than the RS-232 port (can be up to 10 Mbps), the ethernet module connects internally through the COM2 serial connection and is therefore limited to connection speeds up to 9600 bps

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 IPScm 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 IPScm® 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:** When the Ethernet option is purchased with the IEC 61850 protocol, no other protocol may be selected.

Protocol documents are available directly from Beckwith Electric or downloaded from our website [www.beckwithelectric.com](http://www.beckwithelectric.com).

### IPScm Ethernet Port Setup with DHCP

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

1. From the IPScm Main Screen menu select **Tools/Ethernet Setup/Setup Ethernet**. IPScm will display the Setup Ethernet screen ([Figure 4-10](#)).

Figure 4-10 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.

### IPScm® Ethernet Port Setup without DHCP

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

1. From the IPScm Main Screen menu select **Tools/Ethernet Setup**. IPScm will display the Ethernet Setup screen ([Figure 4-10](#)).
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

← dly accss ETH eth\_ip

---

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

---

ETHERNET

DISABLE enable

---

5. Use the Right arrow pushbutton to select ENABLE (Upper Case), then press **ENTER**, the following will be displayed:

---

TCP/IP SETTINGS

TCP prot

---

6. Ensure that TCP is selected (Upper Case).

If TCP is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select TCP.

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

---

DHCP PROTOCOL

DISABLE enable

---

8. If the network does not support the DHCP protocol, then go to Manual Configuration of Ethernet Board (following page) to manually configure the ethernet board.

9. If the DHCP Protocol is to be enabled, then use the Right/Left arrow pushbutton to select ENABLE (Upper Case), then press **ENTER**, the following will be displayed:

---

TCP/IP SETTINGS

TCP prot

---

10. Ensure that PROT is selected (Upper Case).

If PROT is not selected (Upper Case), then use the Right arrow pushbutton to select PROT.

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

---

SELECT PROTOCOL

modbus serconv

---



---

SELECT PROTOCOL

IEC 61850

---

12. Use the Right/Left arrow pushbuttons to select the desired protocol (Upper Case), then press **ENTER**, the following will be displayed:

---

```
ETHERNET PROTOCOL
tcp PROT
```

---

13. Press **EXIT**, the ethernet board will reconfigure and the following will be displayed:

---

```
CONFIGURING ETH...
```

---

If the ethernet board successfully obtains an IP Address the following will be displayed for approximately 2 seconds:

---

```
ETHERNET IP ADDRESS
XX.XX.XX.XX
```

---

The ethernet board is now configured for use and may be accessed through a network.

Then the display will return to the following:

---

```
ETHERNET SETUP
← dly accss 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 IPScm® 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 IPScm installed.

■ **NOTE:** Any compatible modem may be used; however, the unit only communicates at 1200 to 9600 baud.

In order to use IPScm 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 IPScm 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 IPScm.

While IPScm can use any of the 255 serial ports (COM1 through COM255), most computers support only COM1 and COM2.

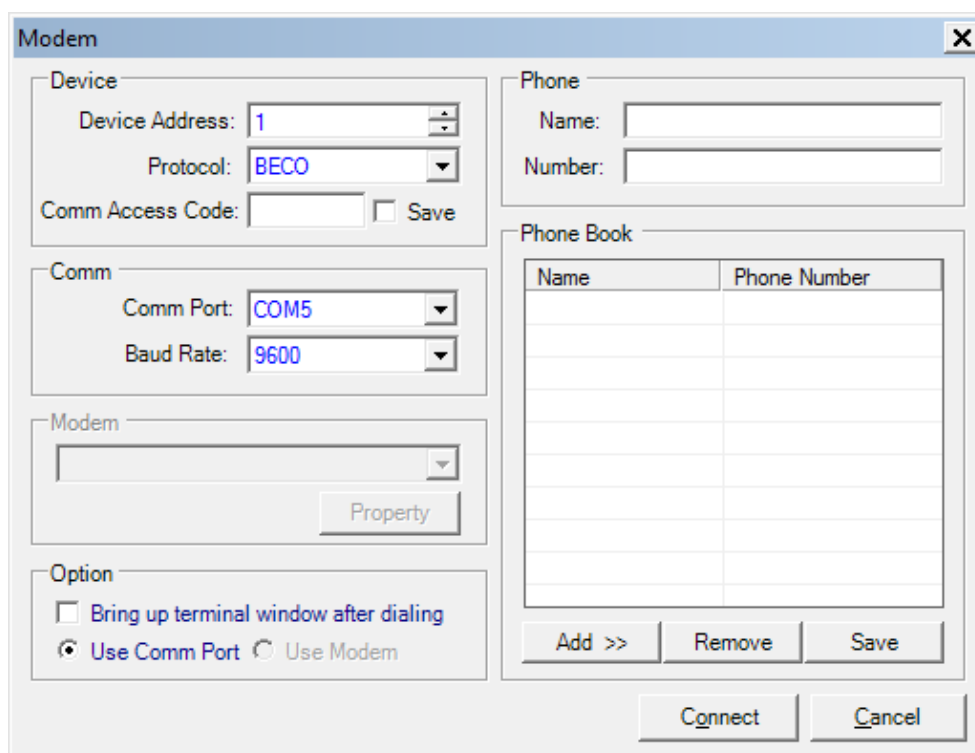
4. Connect the modem to a telephone line, then energize the modem.

**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 4-11](#)).
4. Enter the required information in the Modem Settings section of the screen, then select **Connect**.

**COMMAND BUTTONS**

<b>Add</b>	Allows you to review and change the user lines (unit identifier), phone number, and communication address of a selected entry.
<b>Remove</b>	Deletes a selected entry.
<b>Save</b>	Saves any changes to the displayed information
<b>Connect</b>	Dials the entry selected from the directory.
<b>Cancel</b>	Ends modem communication, allowing the user to dial again.



The image shows a 'Modem' dialog box with several sections:

- Device**: Device Address: 1, Protocol: BECO, Comm Access Code: (empty), Save checkbox (unchecked).
- Comm**: Comm Port: COM5, Baud Rate: 9600.
- Modem**: (empty dropdown), Property button.
- Option**: Bring up terminal window after dialing (unchecked), Use Comm Port (selected), Use Modem (unselected).
- Phone**: Name: (empty), Number: (empty).
- Phone Book**: A table with columns 'Name' and 'Phone Number'.
- Buttons**: Add >>, Remove, Save, Connect, Cancel.

Name	Phone Number

*Figure 4-11 Modem Dialog Screen*

### 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 4-12](#)). Refer to your modem manual for further information.

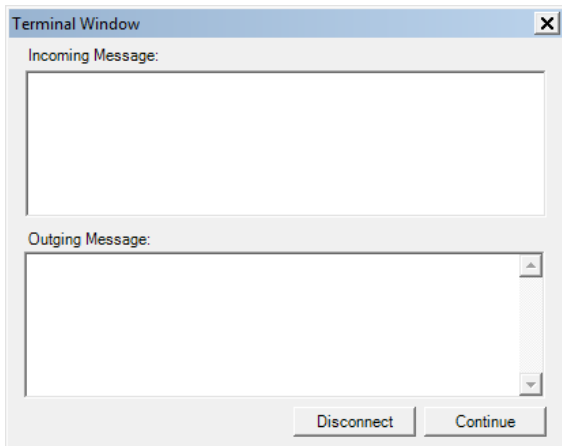


Figure 4-12 Terminal Window

■ **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 personal computer running the S-3400 IPScom® Communications Software. Once downloaded, the waveform data can be examined and printed using the optional M-3801D IPSplot® *PLUS* Oscillograph Data Analysis Software and are also available in COMTRADE file format.

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

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

- **Recorder Partitions:** When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder's memory may be partitioned into 1 to 24 partitions. Table 4-2 illustrates the number of cycles of waveform data per partition with various numbers of windings

When triggered, the time stamp is recorded, and the recorder continues recording for a user-defined period. The snapshot of the waveform is stored in memory for later retrieval using IPScom Communications Software. The **OSC TRIG** LED on the front panel will indicate a recorder operation (data is available for downloading).

- **Trigger Inputs and Outputs:** The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.
- **Post-Trigger Delay:** A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pretrigger data, and 80% post-trigger data.

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

Number of Partitions	Number of Cycles per Each Partition
1	416 Cycles
2	280 Cycles
3	208 Cycles
4	168 Cycles
5	136 Cycles
6	120 Cycles
7	104 Cycles
8	88 Cycles
9	80 Cycles
10	72 Cycles
11	64 Cycles
12	64 Cycles
13	56 Cycles
14	56 Cycles
15	48 Cycles
16	48 Cycles

Table 4-2 Recorder Partitions



### IPScom Setup Oscillograph Recorder

■ **NOTE:** Communication must be established with the target relay for this procedure. When not connected to the relay the 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 4-13](#)).
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.

The screenshot shows the 'Setup Oscillograph Recorder' dialog box. It has a title bar with a close button (X). The dialog is divided into three main sections: 'Settings', 'Trigger Inputs', and 'Trigger Outputs'. In the 'Settings' section, there is a 'Partitions' dropdown menu currently showing '4 Partitions: 168 Cycles', and a 'Post Trigger Delay' slider set to 10, with a range from 5 to 95 (%). The 'Trigger Inputs' section contains checkboxes for inputs 1 through 14, all of which are currently unchecked. The 'Trigger Outputs' section contains checkboxes for outputs 1 through 23, all of which are currently checked. At the bottom of the dialog are two buttons: 'Save' and 'Cancel'.

Figure 4-13 Setup Oscillograph Recorder

**HMI Setup Oscillograph Recorder**

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

---

ENTER ACCESS CODE

0

---

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

---

LEVEL #(1,2 or 3)

Access Granted!

---



---

VOLTAGE RELAY

VOLT curr freq v/hz

---

- c. Go to step 4.

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

---

VOLTAGE RELAY

VOLT curr freq v/hz →

---

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

---

OSCILLOGRAPH RECORDER

← targets OSC\_REC comm →

---

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

---

VIEW RECORD STATUS

STAT clear setup

---

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

---

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:

---

RECORDER SETUP

stat clear SETUP

---

13. Press **Exit**.

**IPScorm Setup Sequence of Events Recorder**

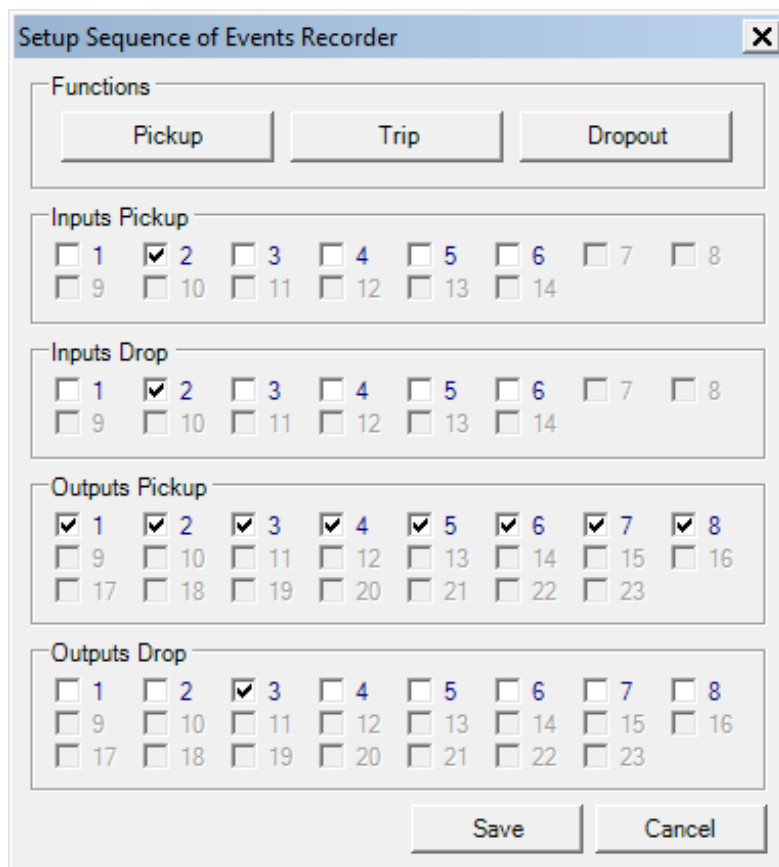
Protective function Pickup, Trip, Dropout and/or Output/Input Pickup or Dropout are selected to trigger the Sequence of Events Recorder.

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

■ **NOTE:** Communication must be established with the target relay for this procedure. When not connected to the relay the Save selection does not save the Sequence of Event settings to the open file.

To setup the Sequence of Events Recorder perform the following:

1. From the IPScorm Main Screen menu select **Relay/Sequence of Events/Setup**. IPScorm will display the Setup Sequence of Events Recorder dialog screen ([Figure 4-14](#)).
2. Select the desired Inputs and Outputs, then select **Save**. IPScorm will display a save to device confirmation ([Figure 4-2](#)).
3. Select **YES**, IPScorm will return to the Main Screen.



The dialog screen is titled "Setup Sequence of Events Recorder" and contains the following sections:

- Functions:** Three buttons labeled "Pickup", "Trip", and "Dropout".
- Inputs Pickup:** A grid of checkboxes for inputs 1 through 14. Input 2 is checked.
- Inputs Drop:** A grid of checkboxes for inputs 1 through 14. Input 2 is checked.
- Outputs Pickup:** A grid of checkboxes for outputs 1 through 23. Outputs 1, 2, 3, 4, 5, 6, 7, and 8 are checked.
- Outputs Drop:** A grid of checkboxes for outputs 1 through 23. Output 3 is checked.
- Buttons:** "Save" and "Cancel" buttons at the bottom right.

Figure 4-14 Setup Sequence of Events Recorder Dialog Screen

## 4.2 Setup System

System setup data is required for proper operation of the relay.

The Setup System consists of defining common information like CT and VT ratios, nominal voltage rating, nominal current rating 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.

■ **NOTE:** Table 4-3 assumes ACTIVE INPUT STATE set to default setting (close circuit = TRUE).

Input 5	Input 6	Selection
Open	Open	Profile 1
Closed	Open	Profile 2
Open	Closed	Profile 3
Closed	Closed	Profile 4

Table 4-3 Input Activated Profile Logic

INPUT ACTIVATED PROFILES
disable      enable
ACTIVE SETPOINT PROFILE
_____
COPY ACTIVE PROFILE
To_Profile_1 →
NOMINAL VOLTAGE
_____ Volts
NOMINAL CURRENT
_____ Amps
VT CONFIGURATION
line-line line-ground→
←line-gnd_to_line-line

When Input Activated Profiles is disabled, the Active Profile can be selected using HMI or remote communication. When enabled, the Active Profile is selected by the state of Input 5 and 6 (see [Table 4-3](#)).

This screen sets the active setpoint profile.

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

The secondary VT voltage when primary voltage is equal to the rated *generator* voltage.  $V_{\text{nominal}} = (V_{\text{gen rated}} \mid \text{VT ratio})$  for L-L VT connections.  $V_{\text{nominal}} = (V_{\text{gen rated}} \mid (\sqrt{3} \text{ VT ratio}))$  for L-G VT connections.

The secondary CT current of the phase CT's with rated *generator* current.  $I_{\text{nom}} = (VA \mid (V_{\text{gen rated}} (\sqrt{3})) (\text{CT ratio}))$

Indicates VT connection. (See [Figure 4-20](#), Three-Line Connection Diagram.) When line-ground voltages are used, functions 24, 27, and 59 may operate for line-ground faults. If this is not desired, the line-gnd-to-line-line selection should be used to prevent operation of these functions for line-ground faults. When line-gnd-to-line-line is selected, the relay internally calculates line-line voltages from line-ground voltages for all voltage-sensitive functions. This line-gnd-to-line-line selection should be used only for a VT line-to-ground nominal secondary voltage of 69V (not for 120 V). For this selection, the nominal voltage setting entered should be line-line nominal voltage, which is  $\sqrt{3}$  times line-ground nominal voltage, and voltage function pickup setpoints calculation should be made using line-to-line voltage.

<hr/> DELTA-Y TRANSFORM dis delta_ab delta_ac <hr/>	<p>When the generator is connected through a Delta-Y (delta ab or delta ac) unit transformer, the relay will internally consider the 30° phase shift for 51V and 21 functions. It defines the connection of the Delta windings of the Delta /Y transformer. If the polarity of the A winding is connected to the non-polarity of the C winding, it is defined as Delta-AC and if the polarity of the A winding is connected to the non-polarity of the B winding, then it is defined as Delta-AB. In the ABC phase rotation, delta lags Y by 30 degrees in Delta-AC and delta leads Y by 30 degrees in Delta-AB.</p>
<hr/> PHASE ROTATION a - c - b      a - b - c <hr/>	<p>This screen allows the user to select the phase rotation of the M-3425A to match the generator.</p>
<hr/> 59/27 MAGNITUDE SELECT rms                      dft <hr/>	<p>This screen allows the selection of RMS or DFT for the 59 and 27 functions. The magnitude can be selected as the RMS of the total waveform (including harmonics) or the RMS of the 60/50 Hz fundamental component of the waveform using the Discrete Fourier Transform (DFT). When the RMS option is selected, the magnitude calculation is accurate over a wide frequency range (10 to 80 Hz) and the accuracy of the time delay is +20 cycles. When the DFT option is selected, the magnitude calculation is accurate near 50 or 60 Hz and the timer accuracy is K1 cycle. When a wider frequency response is needed, select RMS. For generator protection applications, it is recommended to use the RMS selection. RMS is the default when shipped from the factory. For 59 function when positive sequence voltage is selected, the calculation uses DFT irrespective of DFT/RMS selection.</p> <p>■ <b>NOTE:</b> If neither pulsed or latched output is enabled, then the output contact will default to the Normal Mode. Normal Mode maintains the output contact energized as long as the condition that caused it to operate exists. After the actuating condition is cleared, the contact will reset after the programmed seal-in time has elapsed.</p>
<hr/> 50DT SPLIT-PHASE DIFF disable    enable <hr/>	<p>If the 50DT function is to be used for split-phase differential protection, this selection should be enabled. If the 50DT function is to be used as a definite time overcurrent function, or if 50DT is not enabled, this selection should be disabled.</p>
<hr/> PULSE RELAY o8 o7 o6 o5 o4 o3 o2 o1 <hr/>	<p>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. *</p>

<hr/> LATCHED OUTPUTS o8 o7 o6 o5 o4 o3 o2 o1 <hr/>	<p>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.*</p>
<hr/> RELAY SEAL-IN TIME OUT1 _____ Cycles <hr/>	<p>Minimum time the output contact will remain picked up to ensure proper seal-in, regardless of the subsequent state of the initiating function. Individual Seal-In settings are available for all outputs.*</p>
<hr/> ACTIVE INPUT OPEN/close I6 i5 i4 i3 i2 i1 <hr/>	<p>This designates the “active” state for the individual status input. Programming uppercase (see I6) causes the “active” or “operated” condition to be initiated by the external contact opening. Otherwise, external contact closure will activate the input.*</p> <p>*■ <b>NOTE:</b> Settings for expanded I/O must be made through IPScom®.</p>
<hr/> V.T. PHASE RATIO _____ :1 <hr/>	<p>Ratio of the phase VTs.  Example: 13,800 V : 120 V = 13,800/120 = 115:1</p>
<hr/> V.T. NEUTRAL RATIO _____ :1 <hr/>	<p>Ratio of the neutral VT.  Example: 13,800 V : 120 V = 13,800/120 = 115:1</p>
<hr/> V.T. VX RATIO _____ :1 <hr/>	<p>Ratio of auxiliary VT.  Example: 13,800 V : 120 V = 13,800/120 = 115:1</p>
<hr/> C.T. PHASE RATIO _____ :1 <hr/>	<p>Ratio of phase CTs.  Example: 3,000:5 = 3000/5 = 600:1</p>
<hr/> C.T. NEUTRAL RATIO _____ :1 <hr/>	<p>Ratio of neutral CT.  Example: 3,000:5 = 3000/5 = 600:1</p>

**Setup System** [X]

System | I/O Setup | Output Seal-in Time

**Settings**

Nominal Voltage:  50.0 ◀ ▶ 140.0 (V)

Nominal Current:  0.50 ◀ ▶ 6.00 (A)

Phase Rotation: ☐ ACB ☒ ABC

59/27 Magnitude Select: ☒ RMS ☐ DFT

50DT Split Phase Diff: ☒ Disable ☐ Enable

Delta-Y Transform: ☒ Disable ☐ Delta-AB ☐ Delta-AC

V.T. Configuration: ☒ Line to Line ☐ Line to Ground ☐ Line-Ground to Line-Line

**V.T. and C.T. Ratio**

V.T. Phase Ratio:  1.0 ◀ ▶ 6550.0 (:1)

V.T. Neutral Ratio:  1.0 ◀ ▶ 6550.0 (:1)

V.T. VX Ratio:  1.0 ◀ ▶ 6550.0 (:1)

C.T. Phase Ratio:  1 ◀ ▶ 65500 (:1)

C.T. Neutral Ratio:  1 ◀ ▶ 65500 (:1)

[Save] [Cancel]

Figure 4-15 IPScom® Relay Setup System Dialog Screen

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.

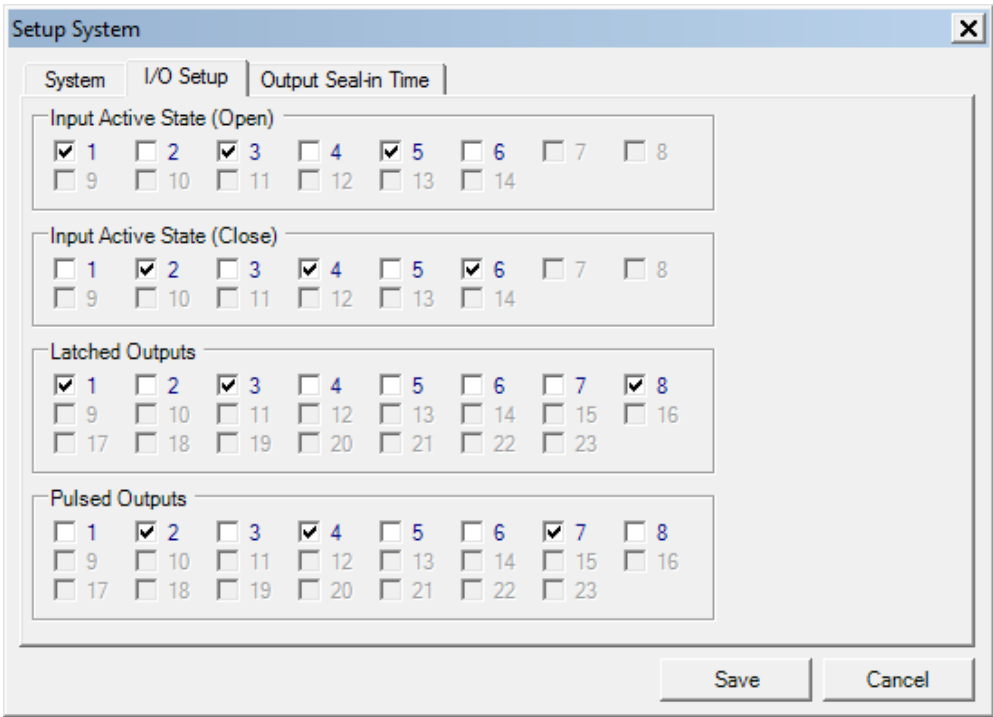


Figure 4-16 IPScom Selection Screen for I/O Setup

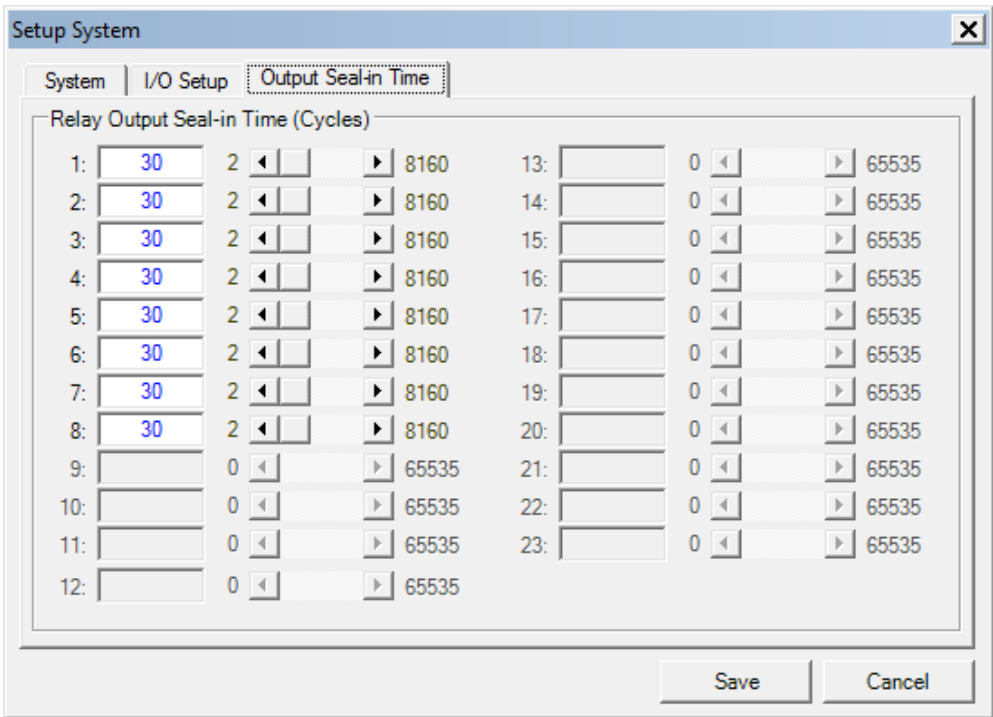
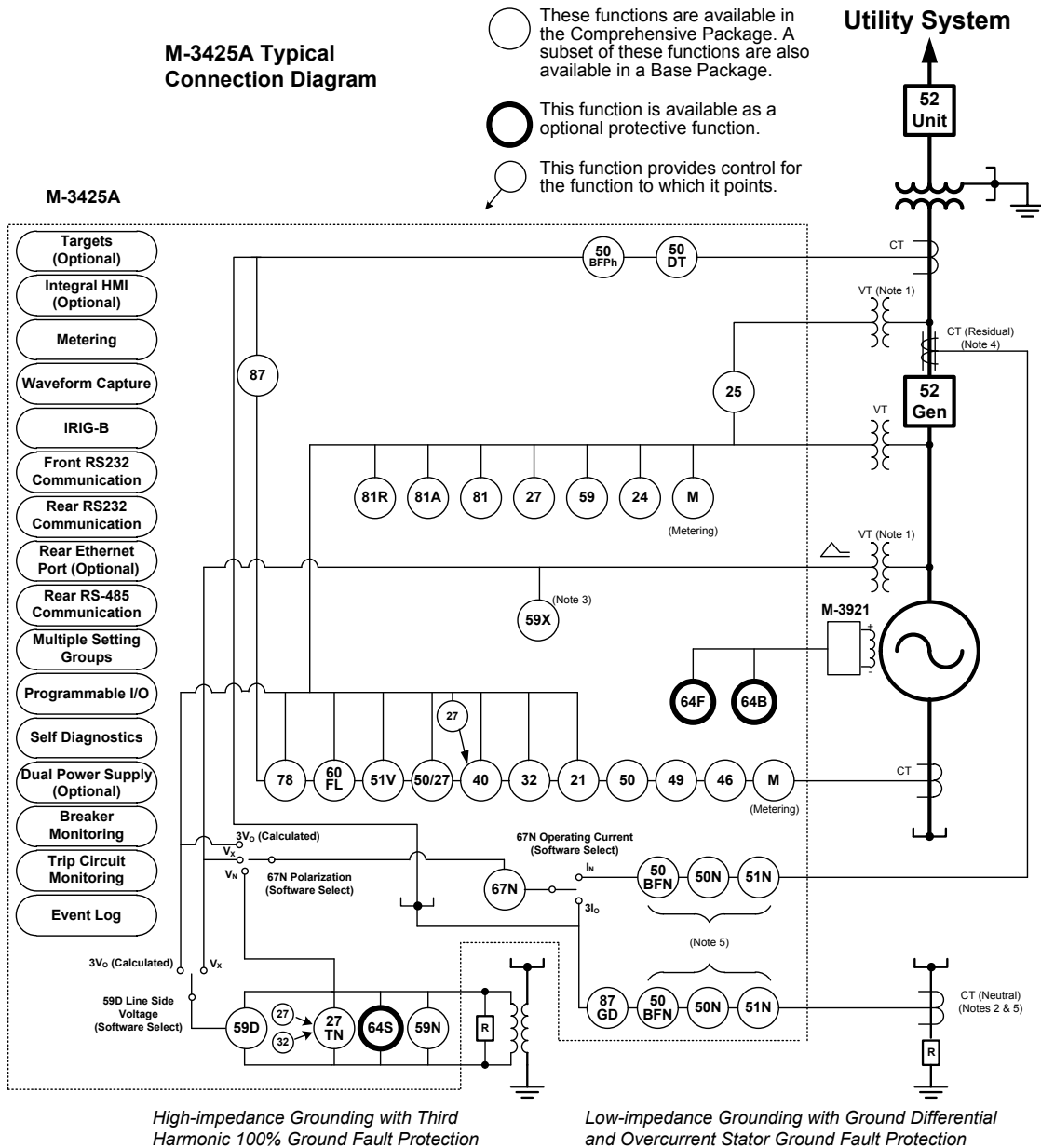


Figure 4-17 IPScom Selection Screen for Output Seal-in Time



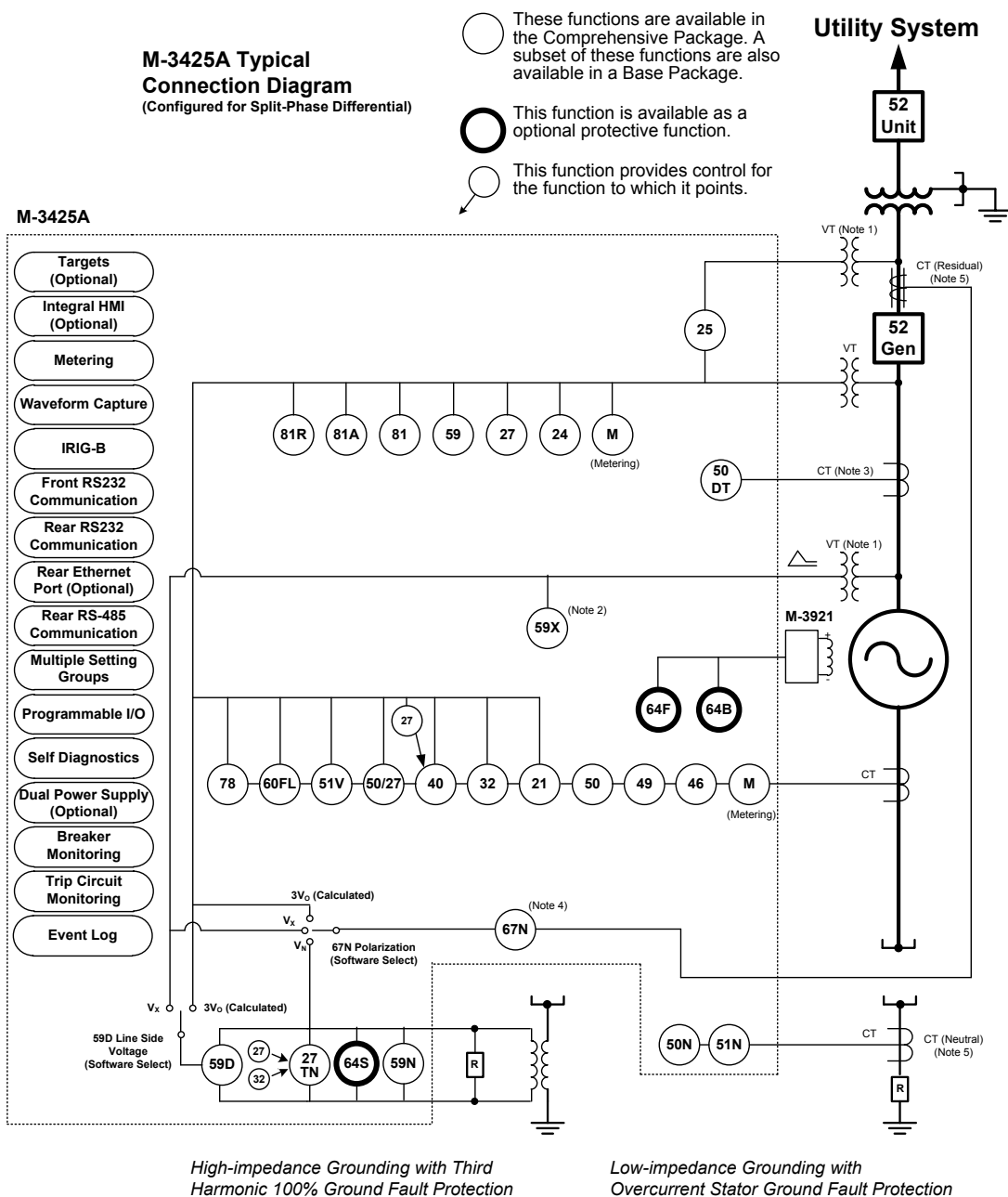
### 4.3 System Diagrams



#### NOTES:

1. When 25 function is enabled, 59X, 59D with V<sub>x</sub> and 67N with V<sub>x</sub> are not available, and vice versa.
2. When 67N function with I<sub>N</sub> (Residual) operating current is enabled, 87GD is not available, and vice versa.
3. The 50BFN, 50N, and 51N may utilize either the neutral current or the residual current.
4. When used as a turn-to-turn fault protection device.
5. The current input I<sub>N</sub> can be either from neutral current or residual current.
6. The 50BFN, 50N, 51N, 59D, 67N (with I<sub>N</sub> or V<sub>N</sub>) and 87GD functions are unavailable when the 64S function has been purchased. See the M-3425A Instruction Book for connection details.

Figure 4-18 One-Line Functional Diagram



#### NOTES:

- When 25 function is enabled, 59, 59X, 59D with  $V_X$  and 67N with  $V_X$  are not available, and vice versa.
- When used as a turn-to-turn fault protection device.
- CTs are connected as split-phase differential current.
- 67N operating current can only be selected to  $I_N$  (Residual) for this configuration.
- The current input ( $I_N$ ) can be either from neutral current or residual current.
- The 50BFN, 50N, 51N, 59D, 67N (with  $I_N$  or  $V_N$ ) and 87GD functions are unavailable when the 64S function has been purchased. See the M-3425A Instruction Book for connection details.

Figure 4-19 Alternative One-Line Functional Diagram (configured for split-phase differential)

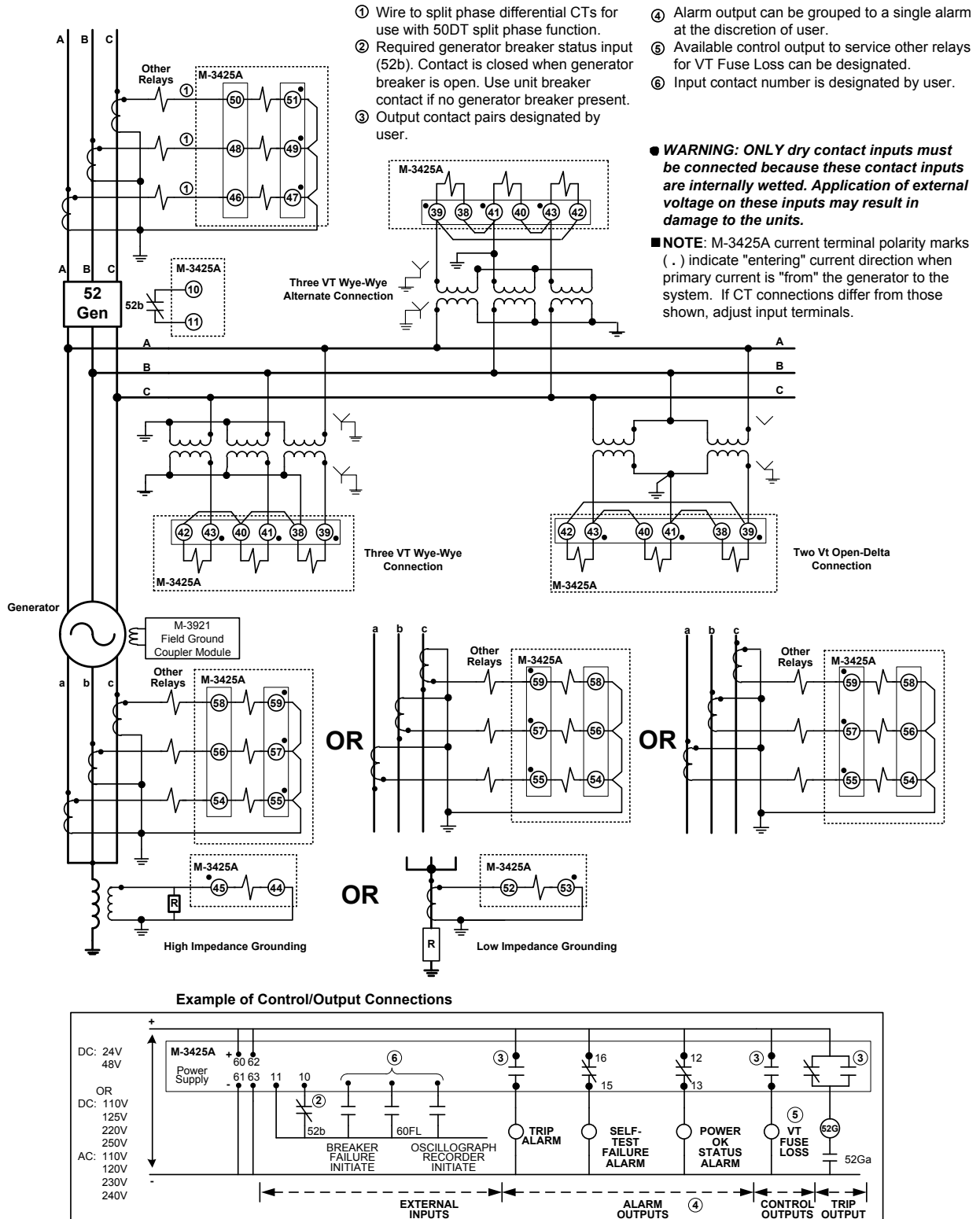
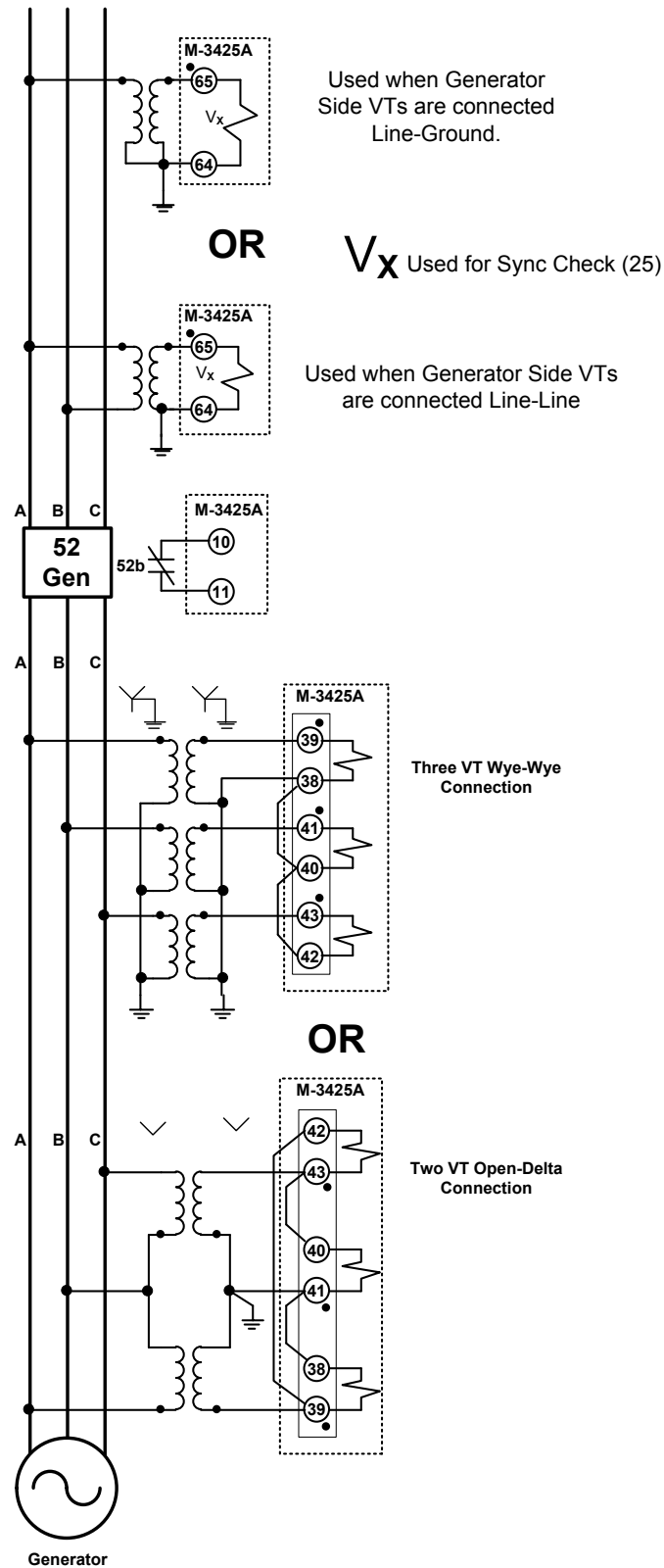
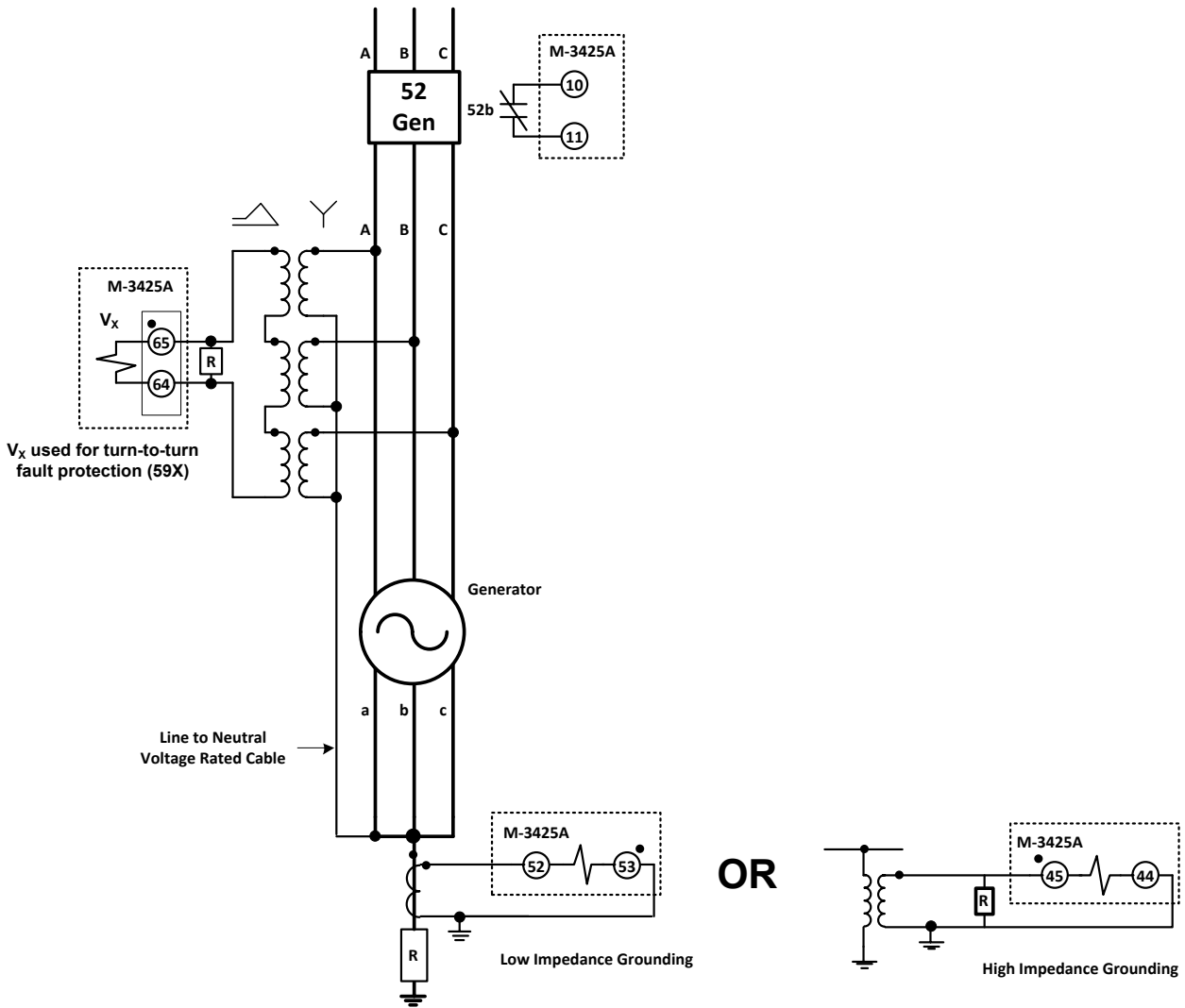


Figure 4-20 Three-Line Connection Diagram



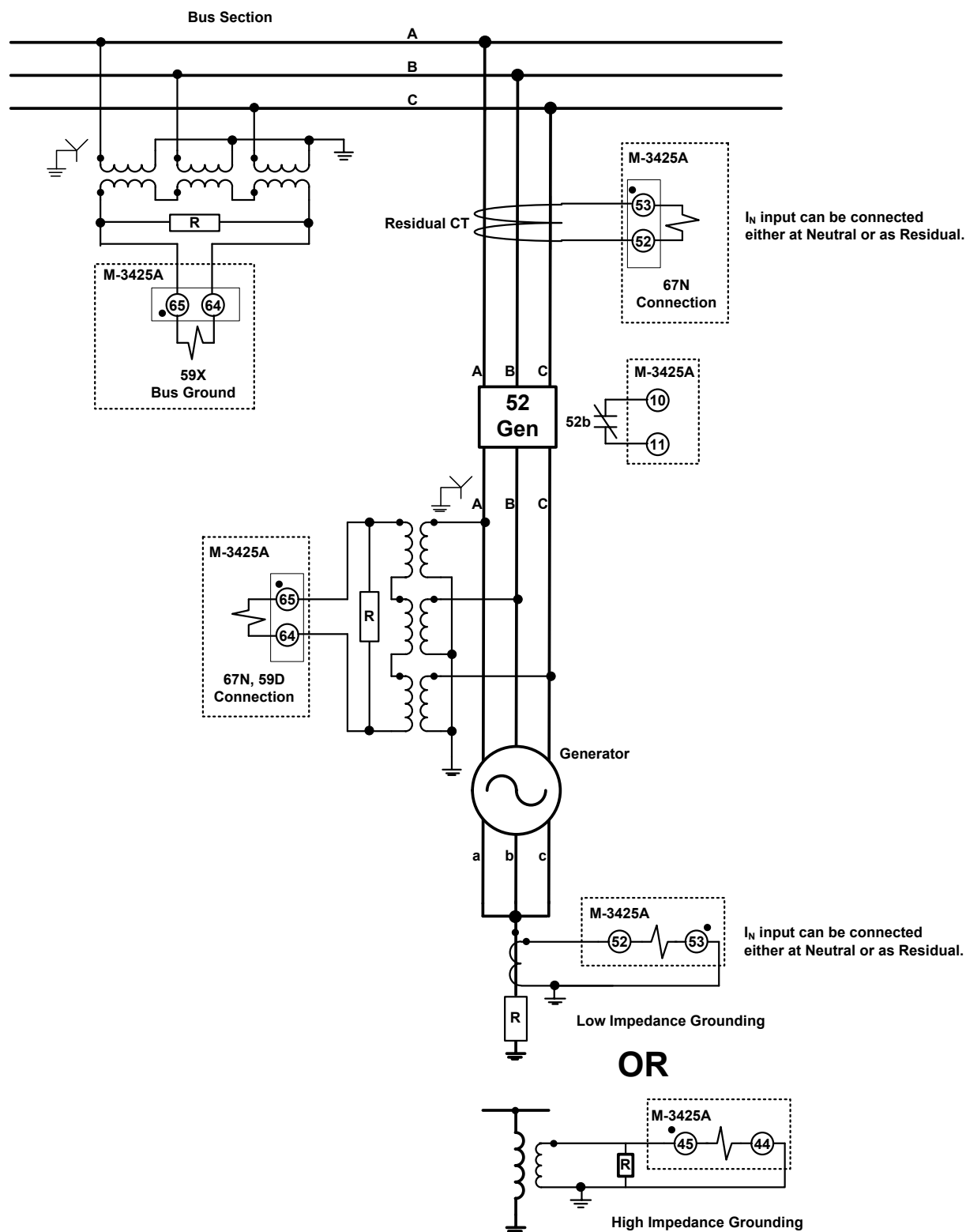
■ **NOTE:** When  $V_X$  is connected for Sync Check function (25), turn-to-turn fault protection (59X) is not available.

Figure 4-21 Function 25 Sync Check Three-Line Connection Diagram



■ **NOTE:** When  $V_x$  is connected for turn-to-turn faults 59X must use 3V0 for the line side voltage (i.e. setting selection) and the V.T. configuration must be Line to Ground. The 25 function is not available.

Figure 4-22 Function 59X Turn to Turn Fault Protection Three-Line Connection Diagram



■ **NOTE:** When  $V_X$  is connected for bus ground protection (59X, 67N, or 59D), 25 function is not available.

Figure 4-23 Function 67N, 59D, 59X (Bus Ground) Three-Line Connection Diagram

## 4.4 System Setpoints

The individual protective functions, along with their magnitude and timing settings are described in the following pages. Settings for disabled functions do not apply. Some menu and setting screens do not appear for functions that are disabled or not purchased. Menu screens are as they would appear on units equipped with the M-3931 HMI Module. The same setting may be entered using M-3400 IPScom Communications Software.

The general information required to complete the input data in this section includes individual relay function:

- pickup settings (converted to relay quantities)
- time delay settings
- frequency settings
- time dials
- power level settings (in percent rated)
- impedance diameter in relay ohms for distance and offset settings

### 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 chosen manually or by contact input. When the profile Switching Method is set to Manual, the HMI, remote communications or one of the IPSlogic elements will select the Active Profile. When the Switching Method is set to Input Contact, the profile is selected by the input contacts. When Input Contact is selected, only the input contacts can switch the relay's profile, and none of the Manual methods will switch the profile.

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.

The IPScom **Profile File Manager** utility allows the user to manage four setpoint profiles (\*.ips) that are grouped in a Profile File (\*.ipf) that has been created in the Profile File Manager or previously downloaded from a relay.

■ **NOTE:** This utility is only available in File mode when IPScom is not connected to a relay, to prevent unintended operation.

### 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
- output choices (OUT1–OUT8; for units with expanded I/O, OUT9–OUT23 may only be set through IPScom®)
- input blocking choices (IN1–IN6; for units with expanded I/O, IN7–IN14 may only be set through IPScom), plus fuse loss blocking

## 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), or OUT9–23 and IN7–14 for units purchased with expanded I/O, plus a block choice for fuse loss logic operation (see 60FL Fuse Loss subsection for details).

The blocking control/status inputs and output contact assignments must be chosen before entering the settings for the individual functions. Both may be recorded on the Relay Configuration Table in **Appendix A, Configuration Record Forms**.

Control/status input IN1 is preassigned to be the 52b breaker status contact. If a multiple breaker scheme is used, the control/status input IN1 must be the series combination of the “52b” breaker contacts. Additional user-chosen control/status inputs may initiate actions such as breaker failure, initiate external fuse loss detection, or trigger the oscillograph recorder.

The relay allows the user to designate up to six logic functions which perform similarly to internal relay functions, using IPSlogic™. These external functions may be enabled or disabled, and output contacts and blocking control/status inputs are chosen the same as for the internal functions. The external functions are described in further detail later in this section.

■ **NOTE:** Uppercase text indicates selection.

27#1 phase undervoltage disable ENABLE
27#1 block input f1 i6 i5 i4 i3 i2 <u>I</u> 1
27#1 relay output o8 o7 o6 o5 o4 o3 o2 <u>O</u> 1

This menu designation is required for each relay function. After enabling the function, the user is presented with the two following screens:

This submenu item assigns the blocking designations (up to six, plus fuse-loss logic) for the enabled function. “OR” logic is used if more than one input is selected.

This submenu item assigns the output contacts (up to eight) for the particular relay function. If no output contacts are assigned, the function will not generate any output or targets even though the function is enabled.

■ **NOTE:** Units with expanded I/O can only set OUT9–OUT23 and IN7–IN14 using IPScom®.



### 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:

FUNCTION	DESCRIPTION
<b>Protective Functions</b>	
21	Phase Distance (three-zone mho characteristic)
24	Volts/Hz (Inverse & Definite Time)
25	Sync Check
27	Phase Undervoltage
27TN	Third Harmonic Undervoltage, Neutral
32	Directional Power
40	Loss of Field (dual-zone offset-mho characteristic)
46	Negative Sequence Overcurrent
49	Stator Overload Protection (Positive Sequence Overcurrent)
50	Instantaneous Phase Overcurrent
50BF	Breaker Failure
50DT	Definite Time Overcurrent
50N	Instantaneous Neutral Overcurrent
50/27	Inadvertent Energizing
51N	Inverse Time Neutral Overcurrent
51V	Inverse Time Overcurrent, with Voltage Control or Restraint
59	Phase Overvoltage
59D	Third-Harmonic Voltage Differential
59N	Neutral Overvoltage
59X	Multi-purpose Overvoltage
60FL	VT Fuse-Loss Detection
67N	Residual Directional Overcurrent
78	Out of Step (mho characteristic)
81	Frequency
81A	Frequency Accumulation
81R	Rate of Change of Frequency
87	Phase Differential Current
87GD	Ground (zero sequence) Differential
IPS	IPSlogic
BM	Breaker Monitor
TC	Trip Circuit Monitoring
<b>Optional Protective Functions</b>	
64F/64B	Field Ground Protection/Brush Lift-Off Detection
64S	100% Stator Ground Protection by Injection

Table 4-4 Available Functions

The **Relay Setpoints** command displays the Relay Setpoints dialog box (see [Figure 4-24](#) from which the individual relay function dialog boxes can be accessed. Choosing a Relay function button will display the corresponding function dialog box (see [Figure 4-25](#) for example).

The Relay Setpoints dialog screen provides access to two additional dialog screens: All Setpoints Table and I/O Map.

Choosing the **Display All** command button displays the All Setpoints Table dialog screen ([Figure 4-26](#)). This screen contains a list of settings for each relay

within a single window to allow scrolling through all relay setpoint configuration values. Choosing the **I/O Map** command button displays the I/O Map dialog screen ([Figure 4-27](#)), which contains a chart of programmed input and output contacts, in order to allow scrolling through all relay output and blocking input configurations. Both dialog screens (All Setpoint Table and I/O Map), feature hotspots 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 again. All available parameters can be reviewed or changed when jumping to a relay configuration dialog screen from either scrolling dialog screen.

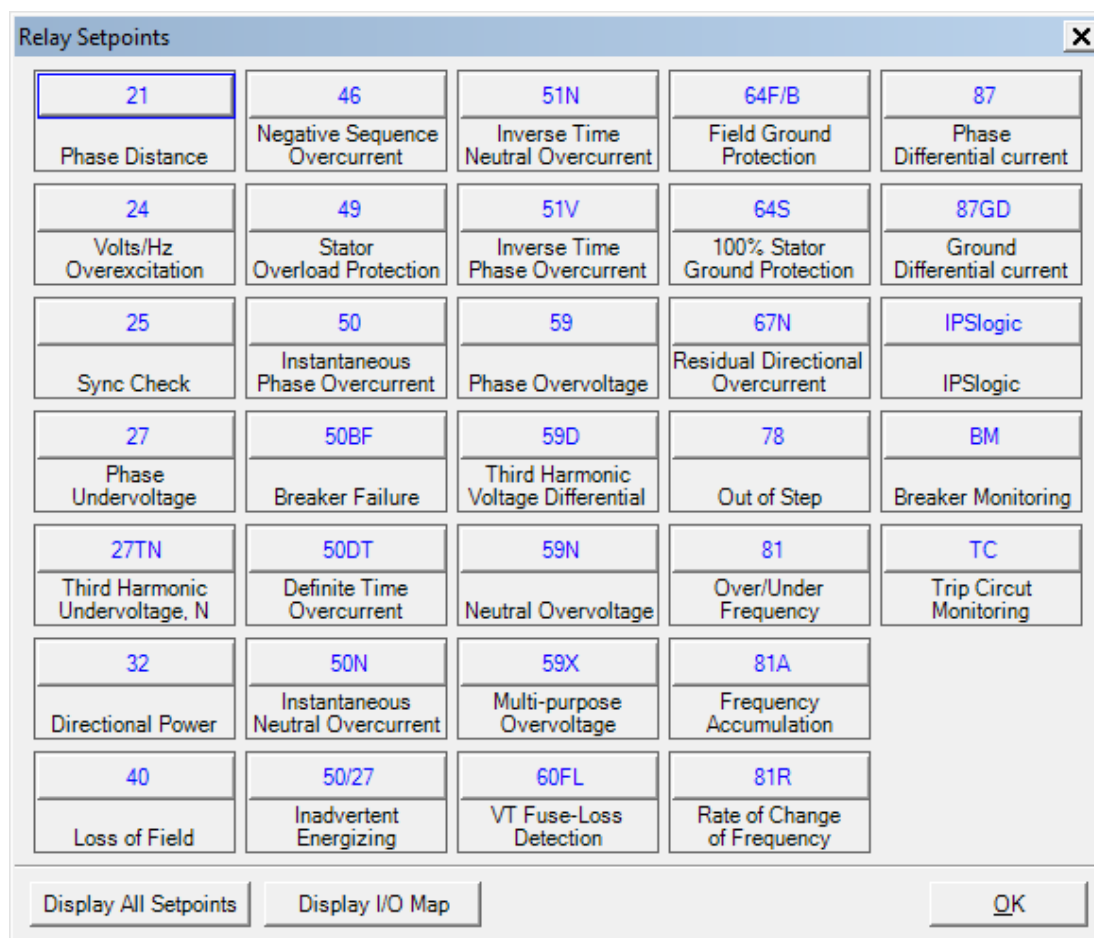


Figure 4-24 Relay Setpoints Dialog Screen

**Path:** Relay menu / Setup submenu / RelaySetpoints

#### COMMAND BUTTONS

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

**Display I/O Map** Opens the I/O Map display.

**Exit** Returns the user to the IPScom® main screen.

**46: Negative Sequence Overcurrent**

**Definite Time**

Pickup:  3 ◀ ▶ 100 (%)

Time Delay:  1 ◀ ▶ 8160 (Cycles)

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**Inverse Time**

Pickup:  3 ◀ ▶ 100 (%)

Time Dial:  1 ◀ ▶ 95

Maximum Time:  600 ◀ ▶ 65500 (Cycles)

Reset Time:  1 ◀ ▶ 600 (Second)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

*Figure 4-25 Negative Sequence Overcurrent Setpoint Dialog Screen*

**Path:** Relay menu / Setup submenu / Setpoints window/ 46 command button OR 46 jump hotspot within All Setpoints Table or Configure dialog screen

#### COMMAND BUTTONS

- Save** When connected to a protection system, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information and returns to the Relay Setpoints, All Setpoints Table, or Configure dialog screen.
- Cancel** Returns the user to the Relay Setpoints, All Setpoints Table, or Configure dialog screen; any changes to the displayed information are lost.

All Setpoints

Print Print Preview

### M-3425A All Setpoints

Software Version: D-0288V01.00.21  
 Relay Firmware Version: D-0114V03.00.03  
 Serial Number: 0  
 BECKWITH ELECTRIC CO.

Setup System			
<b>Setup</b>			
CT Type:	5A	Frequency Type:	60Hz
Phase Rotation:	ACB	Expanded I/O:	Disabled
Nominal Voltage:	120.0 (V)	Nominal Current:	5.00 (A)
Delta-Y Transform:	Disable	VT Configuration:	Line to Line
59/27 Magnitude Select:	RMS	50DT Split Phase Differential:	Disable
V.T. Phase Ratio:	1.0 (:1)	V.T. Neutral Ratio:	1.0 (:1)
V.T. VX Ratio:	1.0 (:1)	C.T. Phase Ratio:	10 (:1)
C.T. Neutral Ratio:	10 (:1)		
<b>I/O Settings</b>			
Latched Outputs:		Pulsed Outputs:	
Active Inputs (Open):		Active Inputs (Close):	1, 2, 3, 4, 5, 6
<b>Sealin Time</b>			
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)

21: Phase Distance			
<b>21 #1</b>			
Blocking Inputs:	FL	Outputs:	1, 3, 5
Circle Diameter:	10.0 (Ohm)	Offset:	0.0 (Ohm)
Impedance Angle:	45 (Degree)	Time Delay:	30 (Cycles)
Load Encroach Angle:	45 (Degree)	Load Encroach Reach:	10.0 (Ohm)
Overcurrent Supervision:	5.00 (A)	Out of Step Block:	Disabled
<b>21 #2</b>			
Blocking Inputs:	1	Outputs:	2, 4, 6
Circle Diameter:	10.0 (Ohm)	Offset:	0.0 (Ohm)
Impedance Angle:	45 (Degree)	Time Delay:	30 (Cycles)
Load Encroach Angle:	45 (Degree)	Load Encroach Reach:	10.0 (Ohm)
Overcurrent Supervision:	5.00 (A)	Out of Step Block:	Disabled
<b>21 #3</b>			
Blocking Inputs:	2	Outputs:	7, 8
Circle Diameter:	10.0 (Ohm)	Offset:	0.0 (Ohm)
Impedance Angle:	45 (Degree)	Time Delay:	30 (Cycles)
Load Encroach Angle:	45 (Degree)	Load Encroach Reach:	10.0 (Ohm)
Overcurrent Supervision:	5.00 (A)		

Figure 4-26 All Setpoints Table Dialog Screen

**Path:** Relay menu / Setup submenu / Setpoints window/ Display All command button



#### JUMP HOTSPOTS

This window provides you with jump hotspots, identified by the hand icon, that take you to each relay dialog screen and the Setup Relay dialog screen. Exiting any of these dialog screens will return the user to the All Setpoints Table dialog screen.

**Print** Prints the All Setpoints dialog screen.

**Print Preview** Provides a pre-display of the All Setpoints dialog screen for printing.

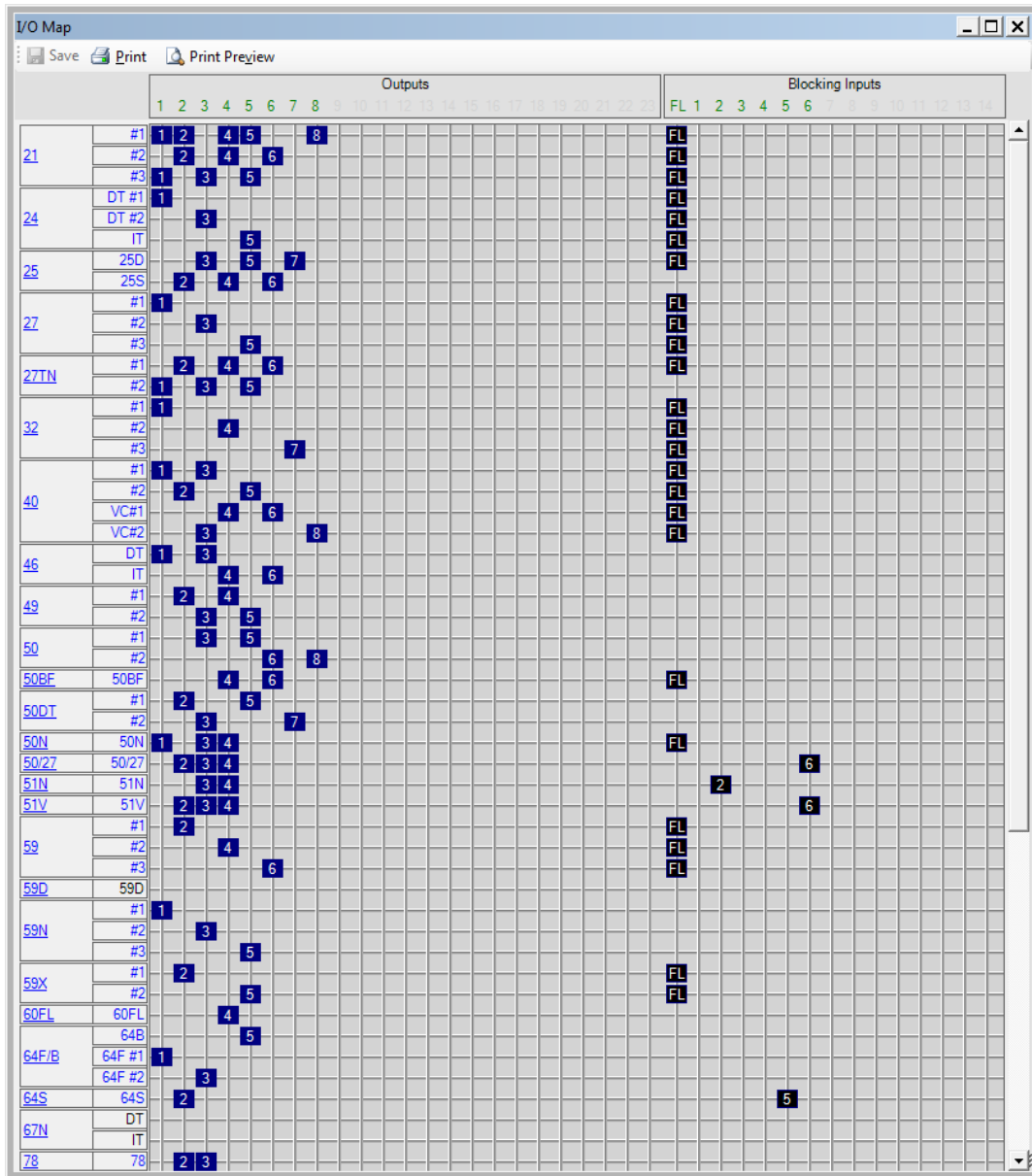


Figure 4-27 I/O Map Screen

**Path:** Relay menu / Setup submenu / Setpoints window/ I/O Map command button



#### JUMP HOTSPOTS

This window provides jump hotspots, identified by the hand icon, that take the user to each relay dialog screen and the Setup Relay dialog screen. Exiting any of these dialog screens will return the user to the I/O Map screen.

**Print** Prints the All Setpoints dialog screen.

**Print Preview** Provides a pre-display of the All Setpoints dialog screen for printing.

## 21 Phase Distance

The Phase Distance function (21) is designed for system phase fault backup protection and is implemented as a three-zone mho characteristic.

Three separate distance elements are used to detect AB, BC, and CA fault types. The ranges and increments are shown in [Figure 4-30](#). The diameter, offset, system impedance angle (relay characteristic angle), and definite time delay need to be selected for each zone for coordination with the system relaying in the specific application.

Zone 1, Zone 2 and Zone 3 may be used for backup protection for unit transformer and transmission faults. Zone 3 in conjunction with Zone 2 can be used to detect an Out of Step condition and it can be programmed to block Function 21 #1 and/or 21 #2. If Zone 3 is being used for out-of-step blocking, it does not trip.

If Zone 1 is not set to see the transmission system, out-of-step blocking is not recommended.

When Zone 3 is used for Out-of-step blocking, the out of step delay is used for the detection of the transit time of the swing between Zone 3 and Zone 2 impedances.

The load encroachment blinder function can be set with a reach and an angle as shown in [Figure 4-29](#). When enabled, this feature will block the 21 Function from misoperating during high load conditions.

When the generator is connected to the system through a delta/wye transformer, proper voltages and currents (equivalent to the high side of the transformer) must be used in order for the relay to see correct impedances for system faults. By enabling the Delta-Y Transform feature (see Section 4.2 Setup System), the relay can internally consider the 30° phase shift (30° lead delta-ab or 30° lag delta-ac) through the delta/wye transformer, saving auxiliary VTs. Impedance calculations for various VT connections are shown in Table 4-5. All impedance settings are secondary relay quantities and can be derived from the following formula:

$$Z_{SEC} = Z_{PRI} \times (R_C \div R_V)$$

where  $Z_{SEC}$  = secondary reflected impedance,  $Z_{PRI}$  = primary impedance,  $R_C$  = current transformer ratio, and  $R_V$  = voltage transformer ratio.

The minimum current sensitivity depends on the programmed reach (diameter and offset). If the current is below the minimum sensitivity current, the impedance calculated will saturate, and not be accurate. This will not cause any relay misoperation.

An overcurrent supervision feature can be enabled, which will block the 21 function when all three phase currents are below the pickup value.

21 #1 DIAMETER _____ Ohms
21 #1 OFFSET _____ Ohms
21 #1 IMPEDANCE ANGLE _____ Degrees
21#1 LOAD ENCROACHMENT disable ENABLE
21 #1 LOAD ENCR ANGLE _____ Degrees
21 #1 LOAD ENCR R REACH _____ Ohms
21 #1 OC SUPERVISION disable enable
21 #1 OC SUPERVISION _____ Amps
21 #1 OUT OF STEP BLOCK disable enable
21 #1 Delay _____ Cycles
21 #3 OUT OF STEP DELAY _____ Cycles

Typically the first zone of protection is set to an impedance value enough in excess of the first external protective section (typically the unit transformer) to assure operation for faults within that protective zone. See [Figure 4-28](#), Phase Distance (21) Coverage.

A negative or positive offset can be specified to offset the mho circle from the origin. This offset is usually set at zero. See [Figure 4-29](#), Phase Distance (21) Function Applied For System Backup.

The impedance angle should be set as closely as possible to the actual impedance angle of the zone being protected.

When enabled the 21 Function is blocked when the impedance falls within the zone but above the R Reach and below the Load Encroachment angle.

**NOTE:** The 21 #2 and #3 zone settings can be set for an additional external section of protection on the system (typically transmission Zone 1 distance relays) plus adequate overreach. #2 and #3 screens are identical to those in #1. Element #3 also includes out-of-step time delay when out-of-step blocking is enabled for Zone #1 and/or Zone #2.

When enabled, the overcurrent supervision blocks the 21 Function when all three phase currents are below the pickup.

When enabled the 21 Function is blocked on the detection of an out-of-step condition.

The time delays are set to coordinate with the primary protection of those overreached zones and, when applicable, with the breaker failure schemes associated with those protective zones.

In Zone #3 when out-of-step blocking is enabled for Zone #1 or #2.

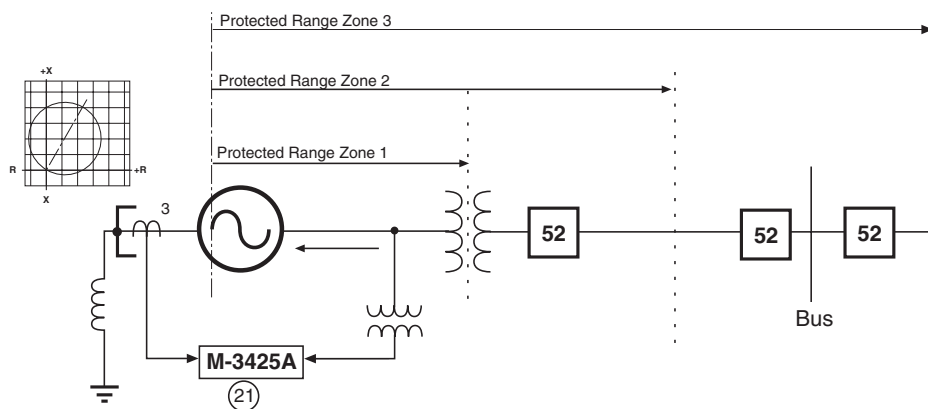
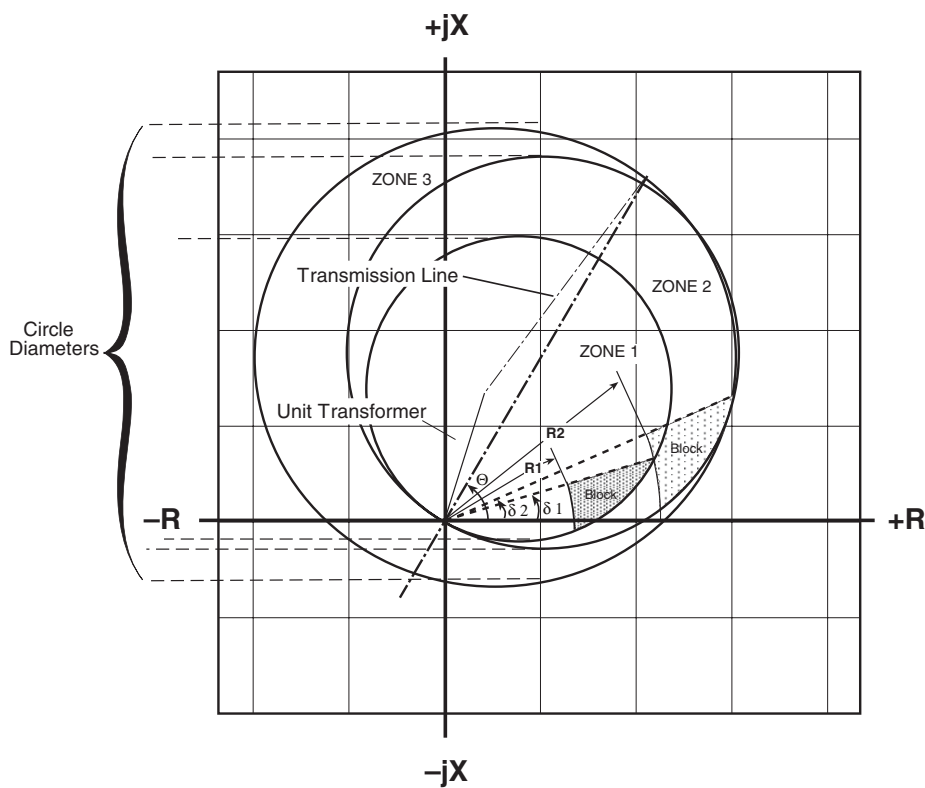


Figure 4-28 Phase Distance (21) Coverage

■ **NOTE:** The reach settings of the distance elements (21) should not include generator impedance since the distance measurement starts at the VT location. However, since the neutral side CTs are used for this function, backup protection for generator Phase-to-Phase faults is also provided.



- |            |  |
|------------|--|
| R1         | Zone 1 Load Encroachment Blinder R Reach |
| R2         | Zone 2 Load Encroachment Blinder R Reach |
| $\delta 1$ | Zone 1 Load Encroachment Blinder Angle   |
| $\delta 2$ | Zone 2 Load Encroachment Blinder Angle   |
| $\theta$   | Impedance Angle Setting                  |

■ **NOTE:** Zone #3 is used for power swing detection in this example.

Figure 4-29 Phase Distance (21) Function Applied for System Backup



**21: Phase Distance**

#1 | #2 | #3

Circle Diameter: 2.3 0.1 100.0 (Ohm) Disable

Offset: 0.0 -100.0 100.0 (Ohm)

Impedance Angle: 89 0 90 (Degree)

Load Encr. Angle: 30 1 90 (Degree) Disable Enable

Load Encr. R Reach: 30.0 0.1 100.0 (Ohm)

Time Delay: 12 1 8160 (Cycles)

OverCurrent SV: 11.6 0.1 20.0 (A) Disable Enable

Out of Step Block Disable Out of Step Block Enable

**Outputs**

☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☒ FL ☒ ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-30 Phase Distance (21) Setpoint Ranges

	Transformer Direct Connected		Transformer Delta-AC Connected		Transformer Delta-AB Connected	
	VT Connection		VT Connection		VT Connection	
	L-L or L-G to L-L	L-G	L-L or L-G to L-L	L-G	L-L or L-G to L-L	L-G
<b>AB Fault</b>	$\frac{V_{AB}}{I_a - I_b}$	$\frac{V_A - V_B}{I_a - I_b}$	$\frac{V_{BC} - V_{AB}}{(3)I_b}$	$\frac{V_B - V_0}{I_b}$	$\frac{V_{AB} - V_{CA}}{(3)I_a}$	$\frac{V_a - V_0}{I_a}$
<b>BC Fault</b>	$\frac{V_{BC}}{I_b - I_c}$	$\frac{V_B - V_C}{I_b - I_c}$	$\frac{V_{CA} - V_{BC}}{(3)I_c}$	$\frac{V_C - V_0}{I_c}$	$\frac{V_{BC} - V_{AB}}{(3)I_b}$	$\frac{V_b - V_0}{I_b}$
<b>CA Fault</b>	$\frac{V_{CA}}{I_c - I_a}$	$\frac{V_C - V_A}{I_c - I_a}$	$\frac{V_{AB} - V_{CA}}{(3)I_a}$	$\frac{V_A - V_0}{I_a}$	$\frac{V_{CA} - V_{BC}}{(3)I_c}$	$\frac{V_c - V_0}{I_c}$

Table 4-5 Impedance Calculation

## 24 Overexcitation Volts/Hz

The Volts-Per-Hertz function (24) provides overexcitation protection for the generator and unit-connected transformers. This function incorporates two definite time elements which can be used to realize traditional two-step overexcitation protection. In addition, the relay includes an inverse time element that provides superior protection by closely approximating the combined generator/unit transformer overexcitation curve. Industry standard inverse time curves may be selected along with a linear reset rate which may be programmed to match specific machine cooling characteristics. The percent pickup is based on the Nominal Voltage setting and the nominal frequency. The V/Hz function provides reliable measurements of V/Hz up to 200% for a frequency range of 2–80 Hz. The ranges and increments are presented in [Figure 4-32](#).

Setting this relay function involves determining the desired protection levels and operating times. The first step is to plot the combined generator and associated unit transformer overexcitation capability limits. This data is typically available from the manufacturer and should be plotted on the same voltage base. Depending on the resulting characteristic, one of the four families of inverse time curves (as shown in Appendix D, **Inverse Time Curves**) can be matched to provide the protection. The two definite time elements can be used to further shape the protection curve or provide an alarm.

[Figure 4-31](#) illustrates a composite graph of generator and transformer limits, a chosen inverse time curve and pickup, and a definite time pickup and delay.

24DT #1 PICKUP _____ %	Definite time setpoint #1 establishes the V/Hz level above which the protection operating time will be fixed at the definite time delay #1.
24DT #1 DELAY _____ 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.
24DT #2 PICKUP _____ %	Definite time setpoint #2 could be programmed to alarm, alerting the operator to take proper control action to possibly avoid tripping.
24DT #2 DELAY _____ Cycles	Time to operation at any V/Hz value exceeding Definite time setting #2.
24IT PICKUP _____ %	The pickup value is the V/Hz value at which the chosen inverse curve begins protective operation. Typical value is 105%.
24IT CURVE crv#1 crv#2 crv#3 crv#4	Allows the user to designate the appropriate curve family for this protection application. These curves are shown in Appendix D, <b>Inverse Time Curves</b> .
24IT TIME DIAL _____	The appropriate curve in the family is designated by the associated “K” value of the curve.
24IT RESET RATE _____ Seconds	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.

### M-3425A Firmware Versions D-0114VXX.XX.XX and Earlier

■ **NOTE:** *When the inverse time element is enabled, the definite time element #1 must be enabled which will provide definite minimum time setting for the inverse time curve.*

The following steps must be followed when setting the inverse time element and definite time element #1:

1. The pickup of the inverse time element must be less than the pickup of the definite time element #1
2. The operating time of the inverse time element at the definite time element #1 pickup should be greater than the definite time element #1 time delay setting ( $A2 > A1$  in [Figure 4-31](#)).
3. When the inverse time element is enabled, definite time element #1 should not be used for alarm. Only definite time element #2 can be used for alarm.

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 Reset Rate setting entered should be time needed for the unit to cool to normal operating temperature if the V/Hz excursion time was just under the trip point.

### M-3425A Firmware Version D-0150V 01.00.34

The inverse time element has a definite minimum time of 30 cycles. Definite Time Element #1 is independent, and has no effect on inverse time elements.

### M-3425A Firmware Version D-0150V 01.04.00

The inverse time element has a definite minimum time of 60 cycles. Definite Time Element #1 is independent, and has no effect on inverse time elements.

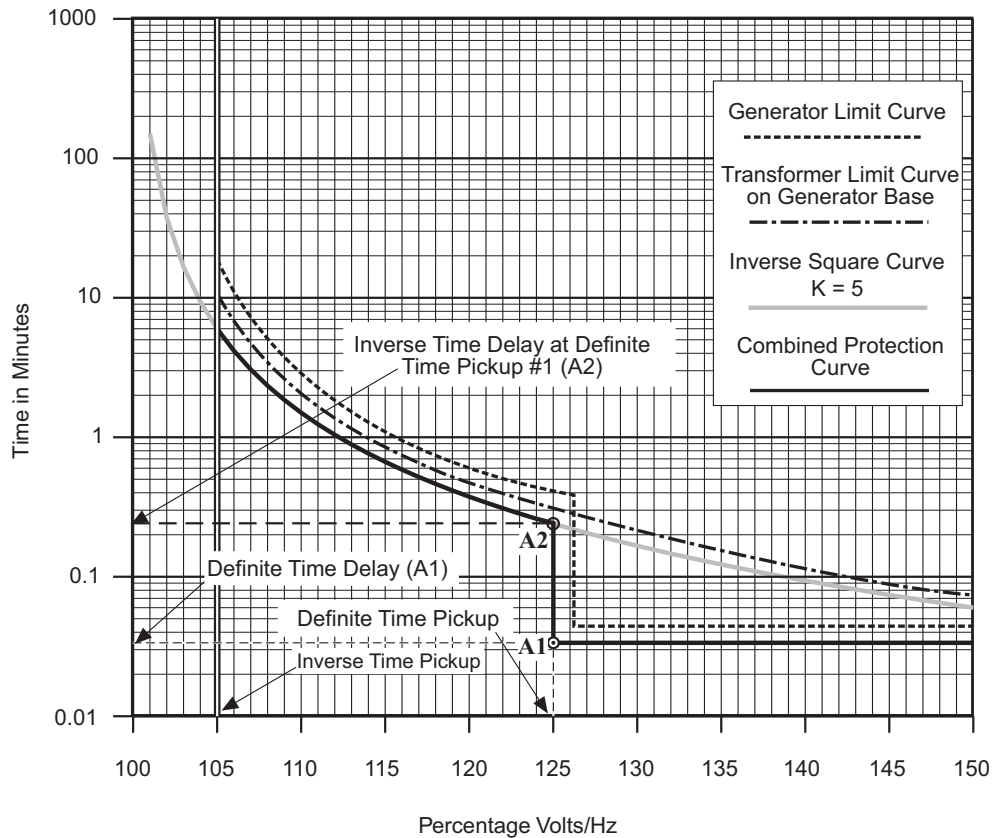


Figure 4-31 Example of Capability and Protection Curves (24)

**24: Volts/Hz Overexcitation** [X]

---

**Definite Time #1**

Pickup:  100 ◀ ▶ 200 (%) [Disable]

Time Delay:  30 ◀ ▶ 8160 (Cycles)

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**Definite Time #2**

Pickup:  100 ◀ ▶ 200 (%) [Disable]

Time Delay:  30 ◀ ▶ 8160 (Cycles)

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**Inverse Time**

Pickup:  100 ◀ ▶ 200 (%) [Disable]

Time Dial:  1 ◀ ▶ 100

Reset Rate:  1 ◀ ▶ 999 (Sec)

Inverse Time Curves: ☒ #1 ☐ #2 ☐ #3 ☐ #4

**Outputs**

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

[Save] [Cancel]

Figure 4-32 Volts-Per-Hertz (24) Setpoint Ranges

## 25 Sync Check

■ **NOTE:** The 25 function cannot be enabled under any one of the following conditions:

- 67N (Residual Directional Overcurrent) is enabled and the polarizing quantity has been set to  $V_X$ .
- 59D is enabled and the line side voltage is set to  $V_X$ .
- 59X is connected for turn-to-turn fault protection or bus ground protection.

The Synchronism (Sync) Check function (25) is used to ensure that the voltage magnitude, phase angle and frequency of the generator ( $V_1$ ) and the utility system ( $V_X$ ) are within acceptable limits before the generator is synchronized with the system. Generator voltage ( $V_1$ ) can be selected as A, B, or C (line-to-ground and line-ground to line-line) or AB, BC, or CA (line-to-line).

The sync check function includes phase angle, delta frequency, and delta voltage checks.

### Phase Angle Check

The phase angle is considered acceptable when the selected sync phase voltage ( $V_1$ ) and system voltage ( $V_X$ ) are within the Upper Volt Limit and Lower Volt Limit window and the measured phase angle is within the phase angle window.

Phase Angle Window is defined as twice the Phase Angle Limit setting. For example, if the Phase Angle Limit is set at 10 degrees, a phase angle window of 20 degrees exists between –10 degrees and +10 degrees. The logic diagram of the phase angle check is shown in [Figure 4-33](#).

### Delta Voltage and Delta Frequency Check

Delta Voltage and Delta Frequency elements may be individually enabled or disabled, as desired. The Delta Voltage check will compare the absolute difference between the selected sync phase voltage ( $V_1$ ) and the measured system voltage ( $V_X$ ) with the Delta Voltage Limit setting. Likewise, the Delta Frequency measures the frequency difference between  $V_1$  and  $V_X$  voltage signals. The Phase Angle Check, Delta Voltage and Delta Frequency Check all combine through an appropriate timer with the output directed to the programmed 25S output contact. A logic diagram representing this logic is presented in [Figure 4-33](#).

## Dead Line/Dead Bus Check

The Dead Volt Limit defines the Hot/Dead voltage level used in Deadline/Dead Bus closing schemes. When the measured  $V_X$  voltage is equal to or below the Dead Volt Limit,  $V_X$  is considered dead. When the measured  $V_X$  is above the Dead Volt Limit,  $V_X$  is considered hot. The opposite side of the breaker uses the positive sequence voltage measurement ( $V_1$ ) for 3-phase consideration in determining hot/dead detection. Different combinations of hot line/dead bus closings may be selected, depending on how the buses are referenced. A logic diagram of the Deadline/Dead Bus scheme is presented in [Figure 4-33](#).

The Dead  $V_1$ , Dead  $V_X$ , and Dead  $V_1$  &  $V_X$  enable are software switches used to enable the dead line/dead bus logic. Further conditioning can be performed on the dead detection logic by selecting one or more input contacts (Dead Input Enable) to control the enabled dead detection element. For example, if INPUT2 (I2) is selected under the Dead Input Enable screen, and both the Dead  $V_1$  and Dead  $V_X$  elements are enabled, the dead check timer will start when INPUT2 is activated, and either  $V_1$  dead/ $V_X$  hot or  $V_1$  hot/ $V_X$  dead. This allows for external control of the desired dead closing scheme. Dead Input Enable selections are common to all dead detection elements. If no inputs are selected under the Dead Input Enable screen, and any dead element is enabled, the dead check timer will start immediately when the dead condition exists.

The 25S and 25D can be programmed to be sent to two different contacts, if desired.

■ **NOTE:** The 25 function does not produce a target or LED and is accompanied by the HMI message “F25 Function Operated”.

If this function is enabled, the following settings are applicable:

25S PHASE LIMIT _____ Degrees	Phase angle setting.
25S UPPER VOLT LIMIT _____ Volts	Upper voltage limit for voltage acceptance.
25S LOWER VOLT LIMIT _____ Volts	Lower voltage limit for voltage acceptance.
25S SYNC CHECK DELAY _____ Cycles	Sync check time delay.
25S DELTA VOLT disable ENABLE	Delta voltage element.
25S DELTA VOLT LIMIT _____ Volts	Delta voltage setting.
25S DELTA FREQUENCY disable ENABLE	Delta frequency element.
25S DELTA FREQ LIMIT _____ Hz	Delta frequency setting.
25S SYNC-CHECK PHASE _____ a b c	Selects the phase voltage on the generator side for SyncCheck functions (A, B, or C for line-to-ground and line-ground to line-line, and AB, BC, CA for line-to-line)
25D DEAD VOLT LIMIT _____ Volts	Voltage less than this setting is defined as “DEAD”; above this setting as “HOT”.
25D DEAD V1 HOT VX disable ENABLE	Enables Dead V1/Hot V <sub>x</sub> setting.
25D DEAD VX HOT V1 disable ENABLE	Enables Hot V1/Dead V <sub>x</sub> setting.
25D DEAD V1 & VX DISABLE enable	Enables Dead V1/Dead V <sub>x</sub> closing.
25D DEAD INPUT ENABLE i6 i5 i4 I3 i2 i1	Externally controlled dead closing. Inputs IN7–IN14 must be set using IPScom.
25D DEAD DELAY _____ Cycles	Dead delay timer setting.

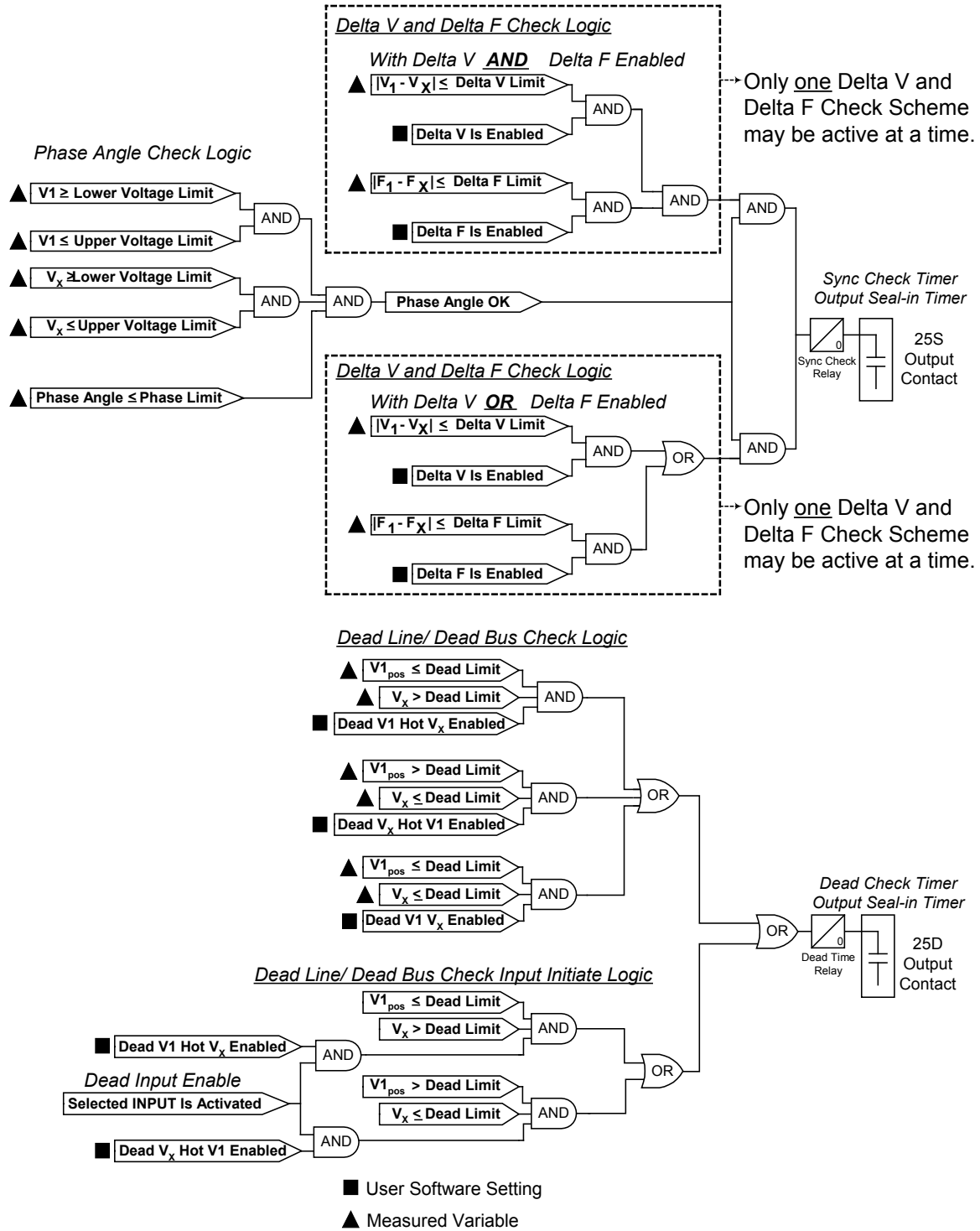


Figure 4-33 Sync Check Logic Diagrams

**25: Sync Check** [X]

**25S**

Phase Angle Window:  0   90 (Degree)

Upper Voltage Limit:  60   140 (V)

Lower Voltage Limit:  40   120 (V)

Sync Check Delay:  1   8160 (Cycles)

Delta Voltage:  1.0   50.0 (V) ☐ Disable ☒ Enable

Delta Frequency:  0.001   0.500 (Hz) ☐ Disable ☒ Enable

Sync Check Phase: ☒ Phase AB ☐ Phase BC ☐ Phase CA

**Outputs**

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input checked="" type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**25D**

Dead Voltage Limit:  0   60 (V)

Dead Time Delay:  1   8160 (Cycles)

Enable: ☐ Dead V1 Hot VX ☒ Hot V1 Dead VX ☒ Dead V1 Dead VX

**Dead Input Enable**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14
----------------------------	----------------------------	---------------------------------------	----------------------------	----------------------------	----------------------------	----------------------------	----------------------------	----------------------------	-----------------------------	-----------------------------	-----------------------------	-----------------------------	-----------------------------

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-34 Sync Check (25) Setpoint Ranges



## 27 Phase Undervoltage

The Phase Undervoltage function (27) may be used to detect any condition causing long- or short-term undervoltage. This is a true three-phase function in that each phase has an independent timing element. The ranges and increments are presented in [Figure 4-35](#).

Magnitude measurement depends on the 59/27 Magnitude Select setting (See Section 4.2, Setup System). When the RMS calculation is selected, the magnitude calculation is accurate over a wide frequency range (10 to 80 Hz) and the accuracy of the time delay is +20 cycles. If DFT calculation is selected, the magnitude calculation is accurate near 50 or 60 Hz, and the timer accuracy is  $\pm 1$  cycle.

27 #1 PICKUP
_____ Volts
27 #1 DELAY
_____ Cycles

27 #2 and 27 #3 Screens are identical to 27 #1.

The screenshot shows a software window titled "27: Phase Undervoltage" with a close button (X). It contains three identical configuration panels labeled #1, #2, and #3. Each panel has the following elements:

- Pickup:** A text box with a value (104 for #1, 180 for #2, 108 for #3) and a range selector (5 to 180 V).
- Time Delay:** A text box with a value (120 for #1, 30 for #2, 30 for #3) and a range selector (1 to 8160 Cycles).
- Disable:** A button to disable the function.
- Outputs:** A grid of checkboxes for 23 outputs. For #1, output 1 is checked. For #2, output 3 is checked. For #3, output 5 is checked.
- Blocking Inputs:** A grid of checkboxes for 15 inputs (FL, 1-14). For all three panels, the FL input is checked.

At the bottom right of the window are "Save" and "Cancel" buttons.

Figure 4-35 Phase Undervoltage (27) Setpoint Ranges

### 27TN Third Harmonic Undervoltage, Neutral

For ground faults near the stator neutral, the Third Harmonic (180/150 Hz) Neutral undervoltage function (27TN) provides stator ground-fault protection for high-impedance-grounded generator applications (See [Figure 4-36](#)). When used in conjunction with the fundamental neutral overvoltage (60/50Hz) function (59N), 100% stator ground-fault protection can be provided. This is illustrated in [Figure 4-36](#).

The 27TN function can be supervised by the positive-sequence undervoltage element. Undervoltage supervision can prevent tripping when the generator field is not energized or the unit is not yet synchronized.

In some generators, the third harmonic voltage can be very low, especially during light load conditions. It is also observed in some generator installations that the third harmonic voltage is considerably reduced for a specific range of power output (band). To prevent mis-operation during these conditions, the 27TN function can be programmed to be supervised (blocked) by low forward power, low reverse power, low Vars (lead and lag), low power factor (lead/lag), and when the forward power is inside a band.

To properly handle pump storage operations, the M-3425A forward power blocking algorithm is enable from “zero per unit” to the forward power setpoint. During plant startup, after the field is flashed and before the unit synchronized, small

current measurement errors cause the measured power to fluctuate (typically <0.2%). This may result in a measured power value that is negative (i.e., -0.001 pu.) If the reverse power blocking is not enabled, the 27TN may be momentarily unblocked, resulting in a relay operation and nuisance generator trip. It is highly recommended that if the Forward Power Blocking is used, both the Forward Power Blocking and Reverse Power Blocking be enabled and set.

In the majority of the cases, these blocking functions will be disabled, except for those operating cases where the third harmonic neutral voltage magnitude is less than 0.5 V. The settings for the blocking functions should be set based on field measurements. Blocking regions are illustrated in [Figure 4-37](#).

The 27TN setting depends on the actual third-harmonic neutral voltage level seen during normal operation of the generator. The setting should be about 50% of the minimum third-harmonic voltage observed during various loading conditions. This can be most conveniently measured during commissioning of the relay. Since the relay measures the third harmonic voltage levels and will display those values directly, no additional equipment is required. The undervoltage inhibit setting should be about 80% to 90% of the nominal voltage. The ranges and increments are presented in [Figure 4-38](#).

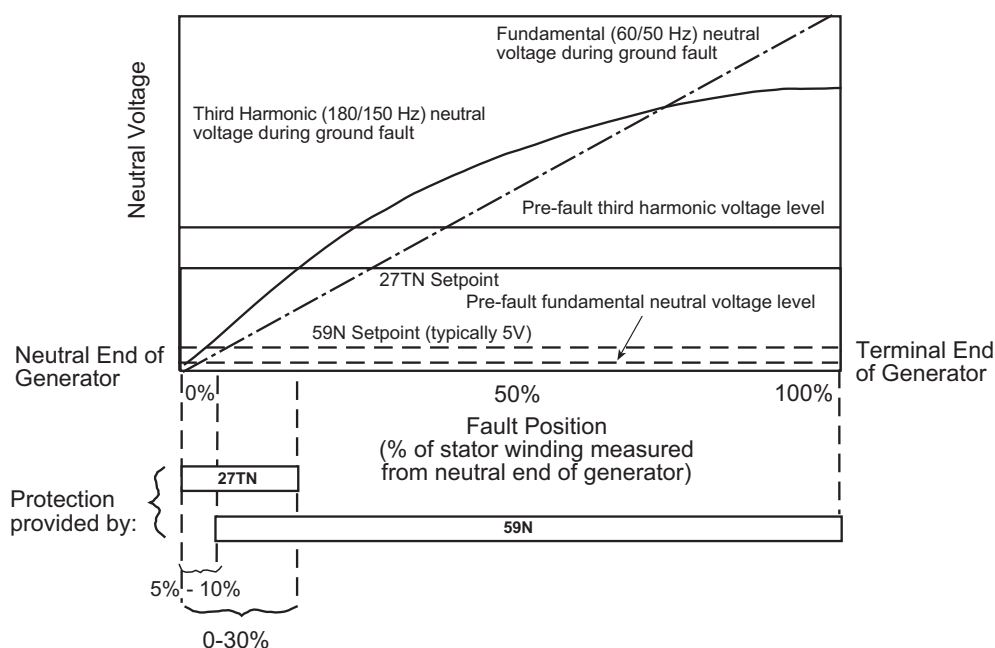


Figure 4-36 Third Harmonic Undervoltage (27TN) Protection Characteristics

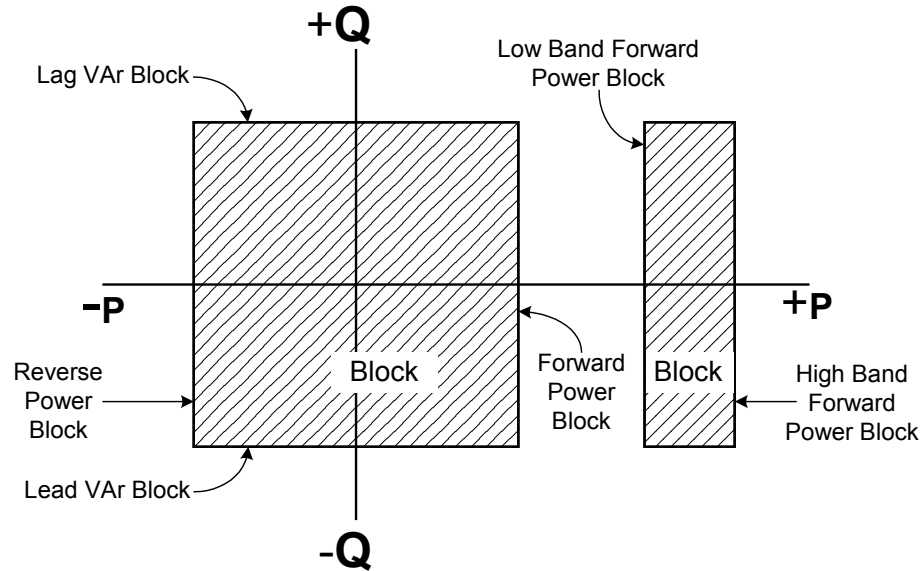


Figure 4-37 27TN Blocking Regions

27TN: Third Harmonic Undervoltage, Neutral

#1 | #2

Pickup: 2.00 0.10 14.00 (V) Disable

Pos. Seq. Voltage Block: 120 5 180 (V) ☐ Disable ☒ Enable

Forward Power Block: 0.05 0.01 1.00 (PU) ☐ Disable ☒ Enable

Reverse Power Block: -0.05 -1.00 -0.01 (PU) ☐ Disable ☒ Enable

Lead var Block: -0.05 -1.00 -0.01 (PU) ☐ Disable ☒ Enable

Lag var Block: 0.05 0.01 1.00 (PU) ☐ Disable ☒ Enable

Lead Power Factor Block: 0.05 0.01 1.00 (Lead) ☐ Disable ☒ Enable

Lag Power Factor Block: 0.05 0.01 1.00 (Lag) ☐ Disable ☒ Enable

Hi Band Forward Power Block: 0.05 0.01 1.00 (PU) ☐ Disable ☒ Enable

Lo Band Forward Power Block: 0.05 0.01 1.00 (PU) ☐ Disable ☒ Enable

Time Delay: 30 1 8160 (Cycles)

Outputs

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-38 Third Harmonic Undervoltage, Neutral Circuit (27TN) Setpoint Ranges

Relay volts are equal to the primary neutral voltage divided by the grounding transformer ratio. Generally set for approximately 50% of the minimum third harmonic voltage observed during various loading conditions.

27TN #2 Screens are identical to 27TN #1.

27TN #1 PICKUP _____ Volts	27TN #1 LAG VAR BLK _____ PU
27TN #1 POS SEQ VOLT BLK disable      ENABLE	27TN #1 LEAD PF BLK disable      enable
27TN #1 POS SEQ VOLT BLK _____ Volts	27TN #1 LEAD PF BLK LEAD
27TN #1 FWD POWER BLK disable      ENABLE	27TN #1 LAG PF BLK disable      enable
27TN #1 FWD POWER BLK _____ PU	27TN #1 LAG PF BLK LAG
27TH #1 REV POWER BLK disable      ENABLE	27TN #1 BAND FWD PWR BLK disable      enable
27TN #1 REV POWER BLK _____ PU	27TN #1 LO B FWD PWR BLK _____ PU
27TN #1 LEAD VAR BLK disable      ENABLE	27TN #1 HI B FWD PWR BLK _____ PU
27TN #1 LEAD VAR BLK _____ PU	27TN #1 DELAY Cycles
27TN #1 LAG VAR BLK disable      ENABLE	

### 32 Directional Power

The Directional Power function (32) can provide protection against both generator motoring and overload. It provides three power setpoints, each with a magnitude setting and a time delay. The Forward Power direction (power flow to system) is automatically chosen when the pickup setting is positive and the Reverse Power direction (power flow to generator) is automatically chosen when the pickup setting is negative. The range, as shown is from  $-3.000$  PU to  $3.000$  PU where  $1.0$  PU is equal to the generator MVA rating. Normalized PU power flow measurements are based on Nominal Voltage and Nominal Current setting, as shown in Section 4.2 Setup System.

#### Protection from Generator Motoring

Protection against motoring is provided by selecting a negative pickup with Over/Under power set to Over. The relay will operate when the measured real power is greater (more negative) than the pickup setting in the reverse direction.

In some steam generator applications it is desirable to trip the generator when the forward power is less than a small value. This is due to the fact that the trapped steam will cause the generator to supply a small amount of power even though the steam valves are closed. In this case the Over/Under

power setting is set to Under and a positive pickup setting is chosen. The relay will trip when the measured forward power is less than the pickup value. The function should be blocked when the generator breaker is open (using contact input blocking) otherwise the function will trip and prevent the generator from being brought online.

#### Protection from Generator Overload

Protection from generator overload is provided by selecting a positive pickup setting with Over/Under Power setting set to Over. The relay will operate when the measured real power is greater than the pickup setting.

#### Protection from Excessive Reactive Power

The directional power element #3 can be set to operate on either real power or reactive power. When protection from excessive reactive power is required the element #3 can be set to operate on reactive power. The relay will operate when the measured reactive power exceeds the pickup setting.

[Figure 4-39](#) through [Figure 4-42](#) show reverse power, low forward power, over power, and over reactive power applications.

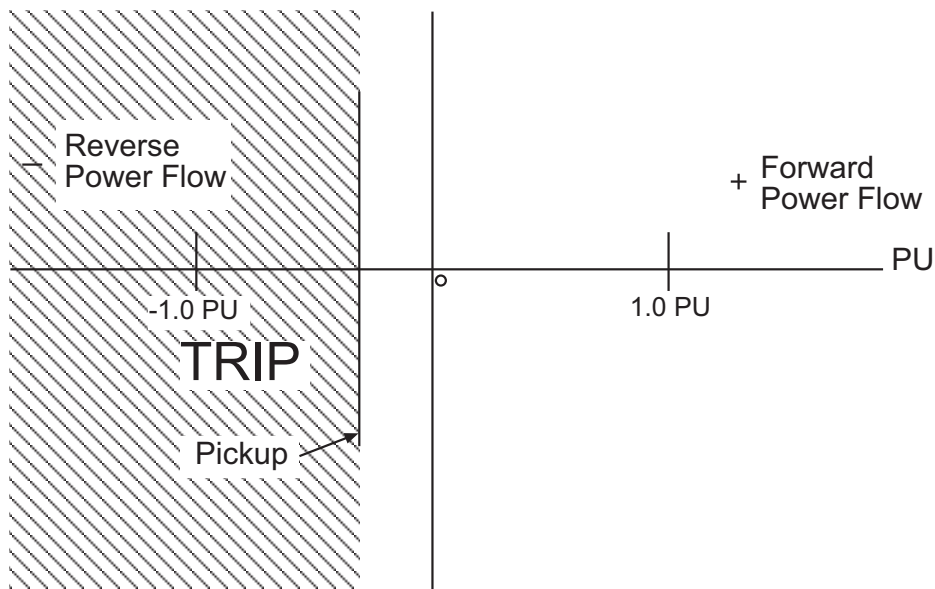


Figure 4-39 Tripping on Reverse Power Flow (Over Power with Negative Pickup)

32 #1 PICKUP _____ PU	The reverse power pickup setting should be based on the type of prime mover and the losses when the generator is motoring.
32 #1 DELAY _____ Cycles	Reverse power relays should always be applied with a time delay in order to prevent mis-operation during power swing conditions. Typical time delay settings are 20 to 30 seconds.
32 #1 TARGET LED disable      enable	Target LED for the 32 Function elements can be individually enabled or disabled.
32 #1 UNDER/OVER POWER over under	When Low Forward Power protection is desired, set this to Under with a positive pickup setting. The relay will trip when the real power measurement is <i>less than or equal to</i> the pickup setpoint.
32 #2 PICKUP _____ PU	If used, positive direction power settings can be used for overload protection, providing either alarm or tripping or both, when power equals or exceeds the setting. The pickup and time delay settings should be based on the capability limit of the generator.  A second reverse power setting can be used for sequential tripping of the generator in which case the associated time delay will be in the range of 2 to 3 seconds.
32 #2 DELAY _____ Cycles	
32 #2 TARGET LED disable      enable	
32 #2 UNDER/OVER POWER over under	
32 #3 PICKUP _____ PU	
32 #3 DELAY _____ Cycles	
32 #3 TARGET LED disable      enable	
32 #3 UNDER/OVER POWER over under	
32 #3 DIR POWER SENSING real      reactive	Directional Power Sensing for Element #3 can be selected as Real or Reactive.

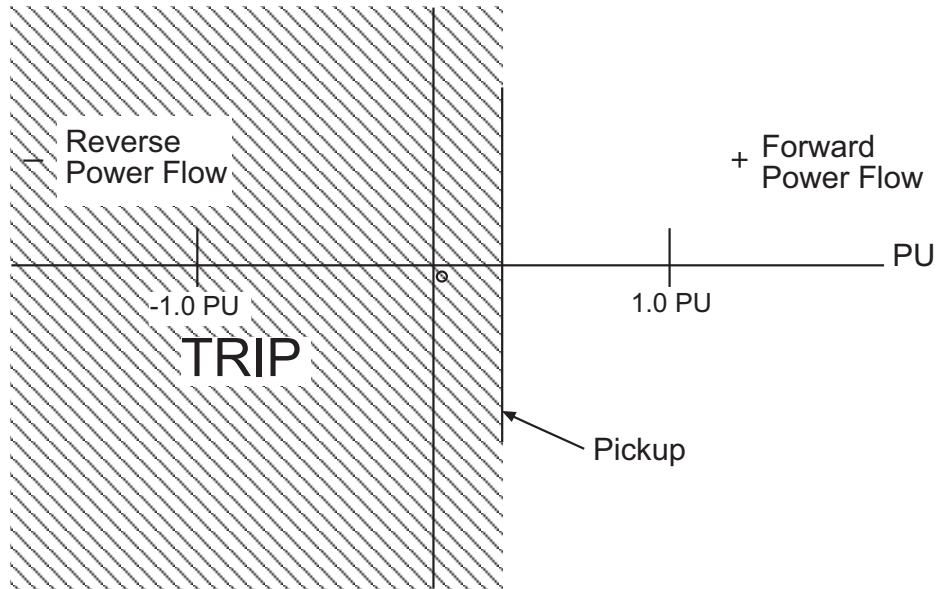


Figure 4-40 Tripping on Low Forward Power (Under Power with Positive Pickup)

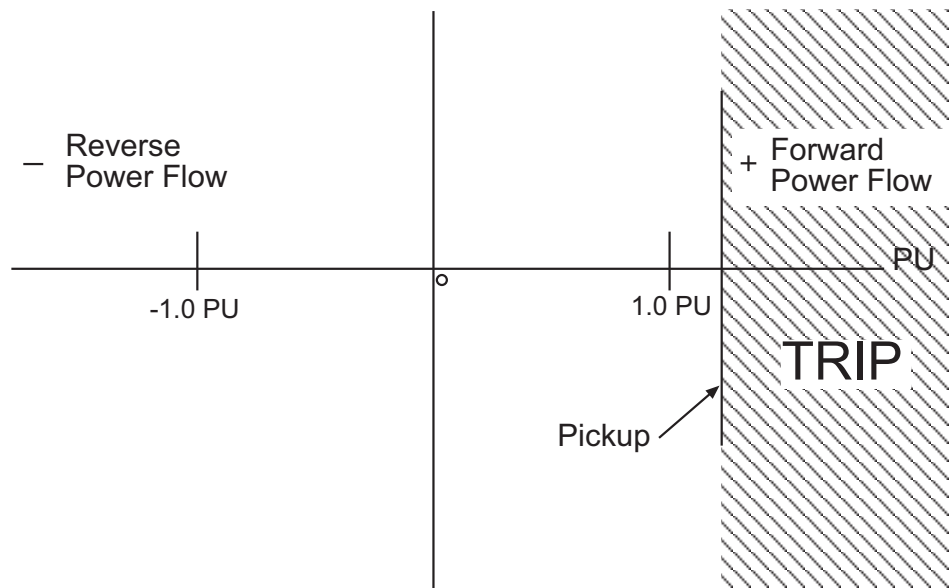


Figure 4-41 Tripping on Overpower (Over Power with Positive Pickup)

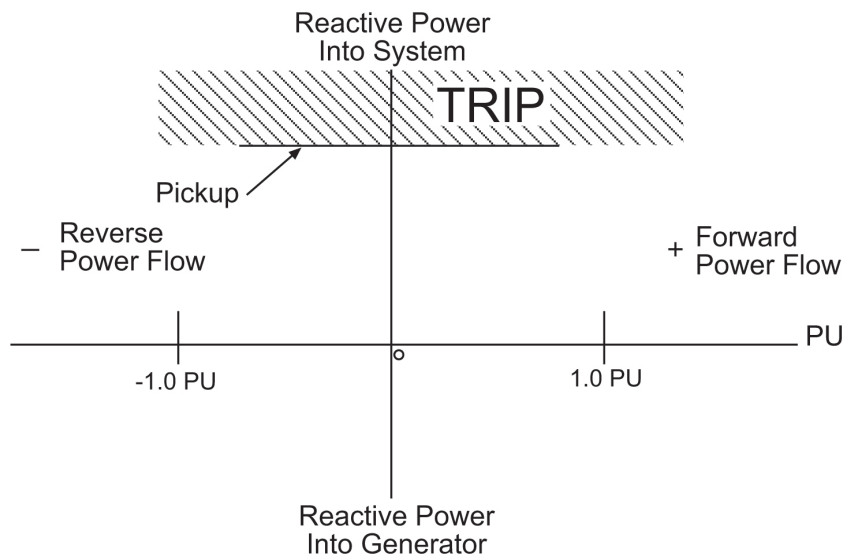


Figure 4-42 Tripping on Over Reactive Power with Element #3  
(Over Power; Positive Pickup and Directional Power Sensing Set to Reactive)

32: Directional Power

#1

Pickup:  -3.000   3.000 (PU)

Time Delay:  1   8160 (Cycles)

Over/Under Power: ☒ Over ☐ Under Target LED: ☒ Disable ☐ Enable

Outputs

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

#2

Pickup:  -3.000   3.000 (PU)

Time Delay:  1   8160 (Cycles)

Over/Under Power: ☒ Over ☐ Under Target LED: ☒ Disable ☐ Enable

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

#3

Pickup:  -3.000   3.000 (PU)

Time Delay:  1   8160 (Cycles)

Over/Under Power: ☒ Over ☐ Under Target LED: ☐ Disable ☒ Enable

Directional Power Sensing: ☐ Real ☒ Reactive

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-43 Directional Power, 3-Phase (32) Setpoint Ranges



#### 40 Loss of Field

The Loss-of-Field function (40) provides protection for a partial or complete loss of field. A variety of possible settings make the M-3425A Generator Protection Relay very flexible when applied to loss-of-field protection. Ranges and increments are presented in [Figure 4-46](#).

The loss-of-field function is implemented with two offset mho elements, an undervoltage element, and a directional element. The setting for each mho element, diameter, offset, and time delay, are adjusted individually. Each element has two time delay settings. The second time delay (delay with VC) is applicable with voltage control, and the timer only starts if the positive sequence voltage is below the voltage control setting. The function with voltage control and without voltage control can be programmed to send to two different output contacts, if desired. The delay with voltage control may be enabled on each element but the voltage level setting is common. The voltage control allows for faster tripping when low voltage may be caused by the VAR intake by the machine with loss of excitation. A common directional unit is provided to block the relay operation during slightly underexcited conditions (since approach #1 with negative offset is inherently directional, the directional element is not required). The directional unit's angle setting ( $Q_D$ ) can be set from  $0^\circ$  to  $20^\circ$ .

The settings of the offset mho elements should be such that the relay detects the loss-of-field condition for any loading while not mis-operating during power swings and fault conditions. Two approaches are widely used in the industry, both of which are supported by the M-3425A relay. Both approaches require knowledge of the reactances and other parameters of the generator. They are described in [Figure 4-44](#), Loss of Field (40)—Protective Approach 1 and [Figure 4-45](#), Loss of Field (40)—Protective Approach 2.

Positive sequence impedance measurements are used for the loss of field functions. All impedance settings are secondary relay quantities and can be derived from the following formula:

$$Z_{SEC} = Z_{PRI} \times (R_C \div R_V)$$

where  $Z_{SEC}$  = secondary reflected impedance,  $Z_{PRI}$  = primary impedance,  $R_C$  = current transformer ratio, and  $R_V$  = voltage transformer ratio.

**The first approach** is shown in [Figure 4-44](#), Loss of Field (40)—Protective Approach 1. Here, both of the offset mho elements (#1 and #2) are set with an offset of  $-X'_d \div 2$ , where  $X'_d$  is the (saturated) direct axis transient reactance of the generator. The diameter of the smaller circle (#1) is set at 1.0 pu impedance on the machine base. This mho element detects loss-of-field from full load to about 30% load. A small time delay provides fast protection.

The diameter of the larger circle (#2) is set equal to  $X_d$ , where  $X_d$  is the (unsaturated) direct axis synchronous reactance of the machine. This mho element can detect a loss-of-field condition from almost no load to full load. A time delay of 30 to 60 cycles (#2) should be used in order to prevent possible incorrect operation on stable swings.

The time delay with voltage control is typically set shorter than the other time delay.

**The second approach** is shown in [Figure 4-45](#), Loss of Field (40)—Protective Approach 2. In this approach, one of the mho elements is set with an offset of  $-X'_d \div 2$ , a diameter of  $1.1 X_d - (X'_d \div 2)$ , and a time delay of 10 to 30 cycles. The second element is set to coordinate with the generator minimum excitation limit and steady-state stability limit.

In order to obtain proper coordination, the offset of this element must be adjusted to be positive. Typically, the offset is set equal to the unit transformer reactance ( $X_T$ ). The diameter is approximately equal to  $(1.1 X_d + X_T)$ . A time delay of 30 to 60 cycles would prevent mis-operation on stable swings.

The following table provides suggested time settings when time delay with VC is used in addition to standard time delay.

Typical setting is  $13^\circ$  (0.974 power factor). This setting is common to both element #1 and #2.

Approach #1 can also be used for Zone #1, and approach #2 for Zone #2, where better coordination with AVR limiters, machine capability limits, and steady state stability limits can be obtained.

40 #1 DIAMETER _____ Ohms	40 #2 OFFSET _____ Ohms
40 #1 OFFSET _____ Ohms	40 #2 DELAY _____ Cycles
40 #1 DELAY _____ Cycles	40VC #2 DELAY WITH VC _____ Cycles
40VC #1 DELAY WITH VC _____ Cycles	40 VOLTAGE CONTROL _____ Volts
40 #2 DIAMETER _____ Ohms	40 DIRECTIONAL ELEMENT _____ Degrees

	Zone 1	Zone 2
Voltage Control Setting	N/A	80 to 90% of Nominal Voltage
Delay	15 Cycles	3,600 Cycles
Delay with VC	Disable	60 Cycles

Table 4-6 Voltage Control Time Settings

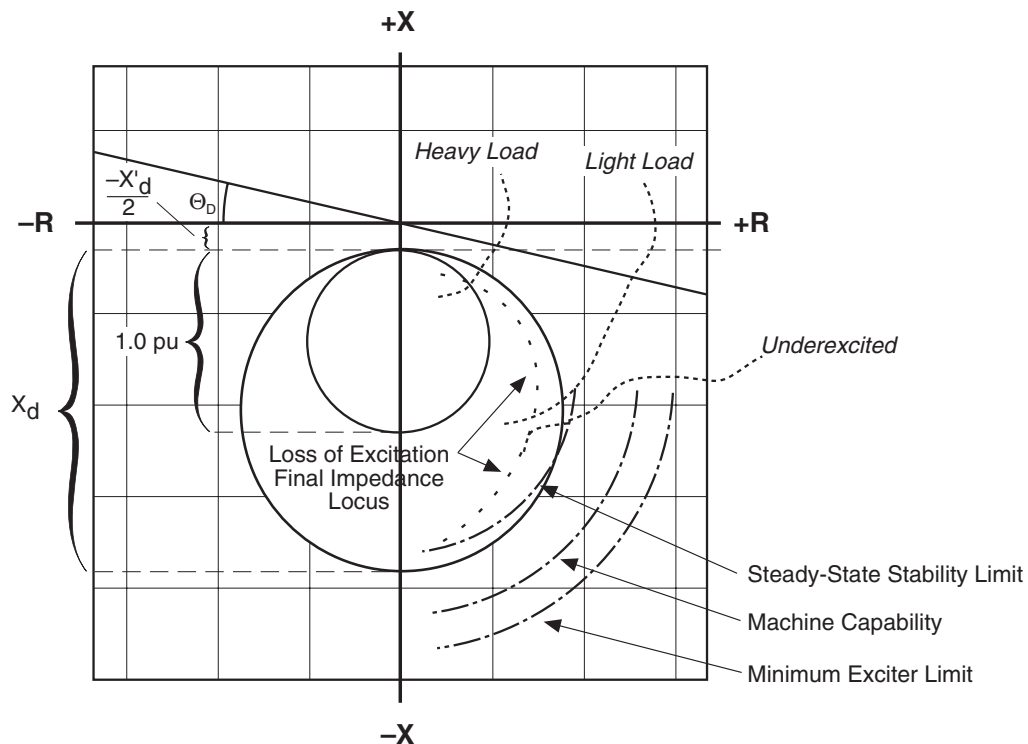


Figure 4-44 Loss of Field (40)—Protective Approach 1

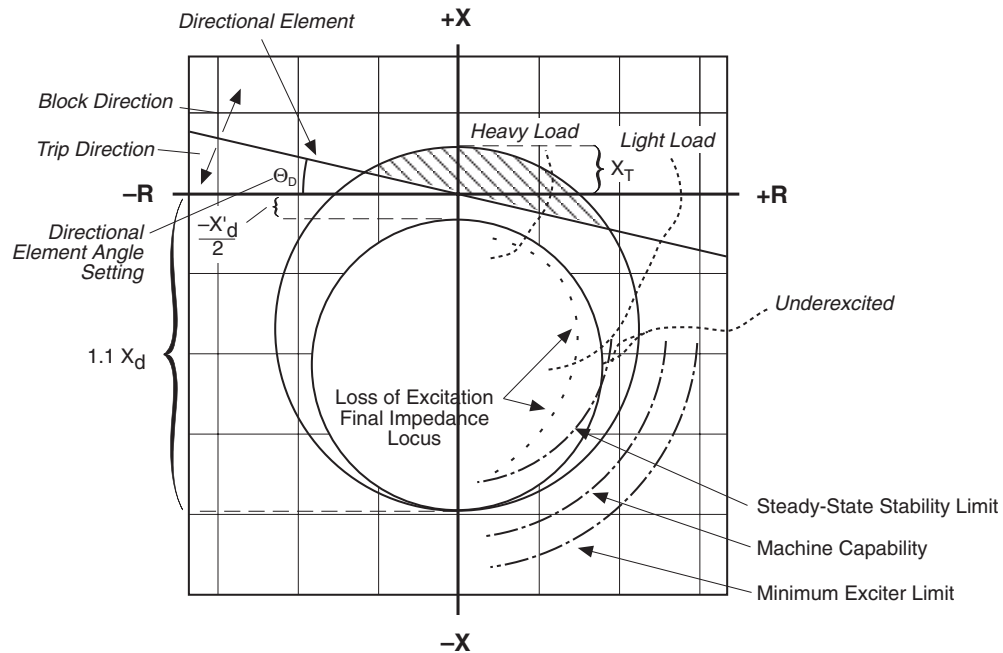


Figure 4-45 Loss of Field (40)—Protective Approach 2

40: Loss of Field

#1 | #2

Circle Diameter: 23.5 0.1 100.0 (Ohm) Disable

Offset: -3.6 -50.0 50.0 (Ohm)

Time Delay: 24 1 8160 (Cycles)

Outputs: ☒ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs: ☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

VC

Delay: 30 1 8160 (Cycles) Disable

Outputs: ☐ 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☒ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs: ☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Setting

Directional Element: 20 0 20 (Degree)

Voltage Control: 108 5 180 (V)

Save Cancel

Figure 4-46 Loss-of-Field (40) Setpoint Ranges

#### 46 Negative Sequence Overcurrent

The Negative Sequence Overcurrent function (46) provides protection against possible rotor overheating and damage due to unbalanced faults or other system conditions which can cause unbalanced three phase currents in the generator. Ranges and increments are presented in [Figure 4-48](#).

This function has a definite time element and an inverse time element. The definite time pickup value and definite operating time are normally associated with an alarm function. The inverse time element is usually associated with a trip function and has a pickup and an operating time defined by an  $(I_2)^2t = K$ , where K is the Time Dial Setting and  $I_2$  is the per unit negative sequence current.

The minimum delay for the inverse time function is factory set at 12 cycles to avoid nuisance tripping. A maximum time to trip can be set to reduce the operating times for modest imbalances. An important feature that helps protect the generator from damage due to recurring imbalances is a linear reset characteristic. When  $I_2$  decreases below the pickup value, the trip timer takes the reset time setting from its 100% trip level. [Figure 4-47](#), Negative Sequence

Overcurrent Inverse Time Curves, illustrates the inverse time characteristic of the negative sequence overcurrent function.

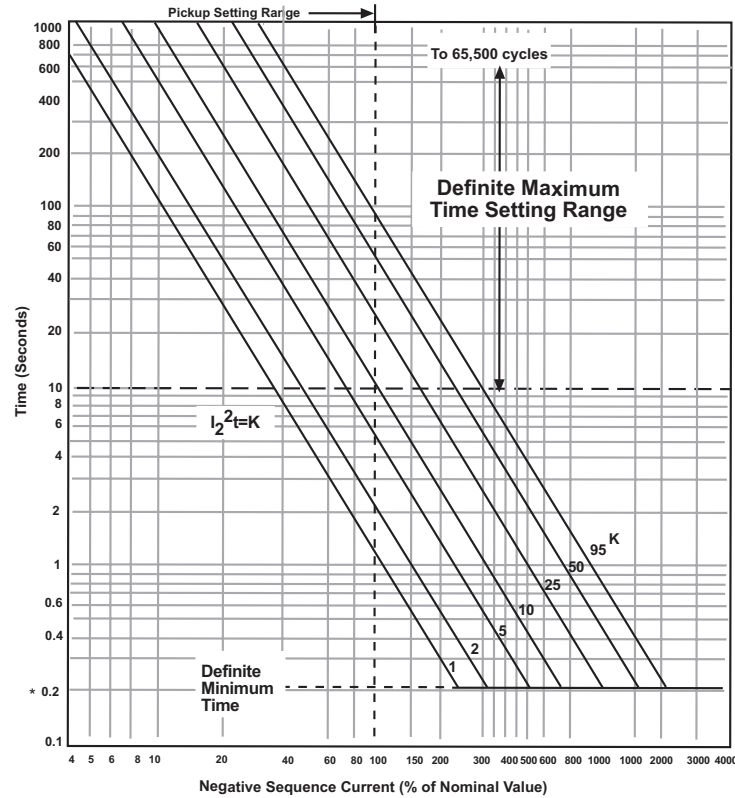
Operating times are slower than shown in [Figure 4-47](#) when measured current values are greater than 15 A (3 A for 1 A rated circuit).

The first task of setting this function is to determine the capabilities of the associated machine. As established by ANSI standards, the machine limits are expressed as  $(I_2)^2t = K$ . The value of K is established by the machine design and is generally provided on test sheets of the machine. The relay can accommodate any generator size because of the wide range of K settings from 1 to 95. Typical values can be found in ANSI C50.13-1977.

The negative sequence pickup range is from 3% to 100% of the Nominal Current value input during system setup (see Section 4.2 Setup System).

This protection must *not* operate for system faults that will be cleared by system relaying. This requires consideration of line protection, bus differential and breaker failure backup protections.

46DT PICKUP _____ %	The pickup setting is usually quite low (3–5%) and the output of this function is usually connected to alarm only.
46DT DELAY _____ Cycles	Time delay should be set high enough to avoid alarms on transients.
46IT PICKUP _____ %	The 46 Inverse Time pickup setting should coincide with the continuous negative sequence current capability of the generator operating at full output.
46IT MAX DELAY _____ Cycles	The maximum trip time is used to reduce the longer trip times associated with low to moderate imbalances to a preset time.
46IT RESET TIME _____ Seconds	Emulates generator cool down time.
46IT TIME DIAL _____	The time dial setting corresponds to the K provided by the generator manufacturer for the specific unit being protected. See <a href="#">Figure 4-47</a> for the negative sequence overcurrent inverse time curves.



■ **NOTE:** When the phase current exceeds 3X I nominal, the operating times will be greater than those shown.

\* 0.24 seconds for 50 Hz units.

Figure 4-47 Negative Sequence Overcurrent Inverse Time Curves

46: Negative Sequence Overcurrent

**Definite Time**

Pickup: 10 3 100 (%) Disable

Time Delay: 120 1 8160 (Cycles)

**Outputs**

☒ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**Inverse Time**

Pickup: 8 3 100 (%) Disable

Time Dial: 10 1 95

Maximum Time: 59400 600 65500 (Cycles)

Reset Time: 1 1 600 (Second)

**Outputs**

☐ 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☒ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-48 Negative Sequence Overcurrent (46) Setpoint Ranges

49 Stator Overload Protection

The Stator Thermal Overload function (49) provides protection against possible damage during overload conditions. The characteristic curves are based on IEC-255-8 standard, and represent both cold and hot curves. The function uses the thermal time constant of the generator and stator maximum allowable continuous overload current ( $I_{max}$ ) in implementing the inverse time characteristic.

$$t = \tau \times I_n \left( \frac{I_L^2 - I_{PL}^2}{I_L^2 - I_{max}^2} \right)$$

Where:  $t$  = time to trip  
 $\tau$  = thermal time constant  
 $I_L$  = load current  
 $I_{PL}$  = pre-load current  
 $I_{max}$  = maximum allowed continuous overload current

*Example:* If we consider that the generator was loaded with 80% of its rating power prior to overload, then the current goes up to 2.0 times the maximum current ( $(I_L/I_{max})=2.0$ ). Selecting the curve  $P=0.8$  (see Figure 2-50), we have  $t/\tau=0.1133$ . If  $\tau=30$  minutes, then the time delay for this condition would be:  $t=0.1133 \times 30=3.3999$  minutes.

The 49 function has two elements, one of which can be used for trip and the other for alarm.

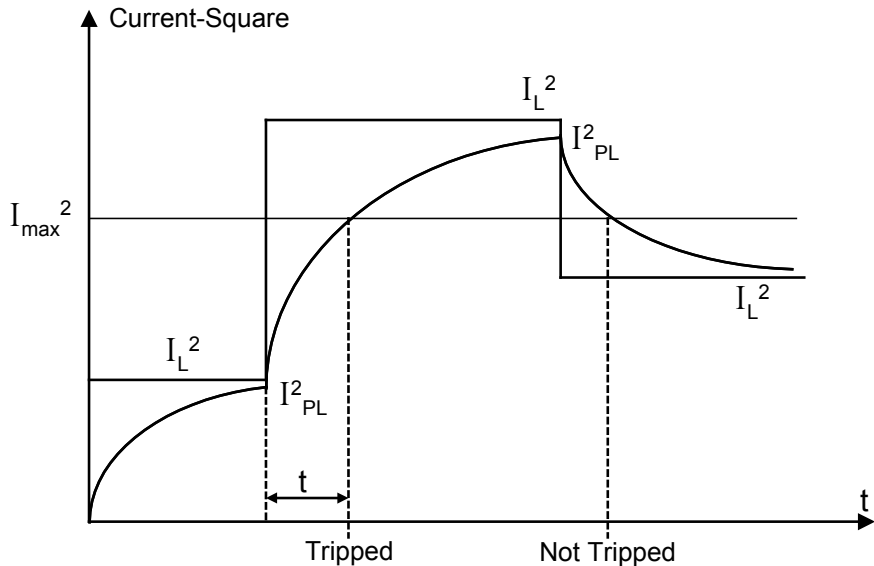
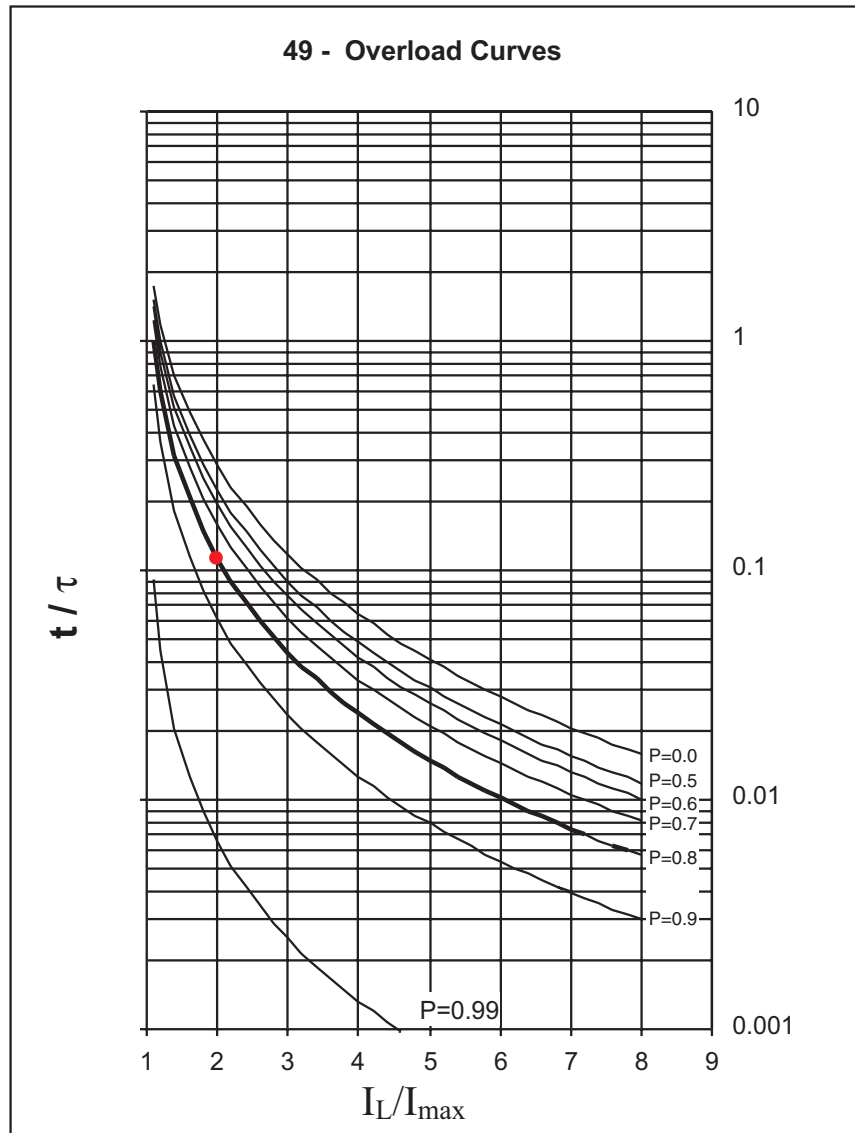


Figure 4-49 Time Constant, Function 49

49 #1 TIME CONSTANT Min	Selects the time constant, 'τ'
49#1 MAX OVERLOAD CURR Amps	Selects the maximum allowed continuous overload current.
	49#2 Screens are identical to those for 49#1.



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

Figure 4-50 49 Function Overload Curves

**49: Stator Overload Protection** ✕

---

**#1**

Time Constant:  1.0 ◀ ▶ 999.9 (min) Disable

Max Overload Current:  1.00 ◀ ▶ 10.00 (A)

**Outputs**

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**#2**

Time Constant:  1.0 ◀ ▶ 999.9 (min) Disable

Max Overload Current:  1.00 ◀ ▶ 10.00 (A)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-51 Stator Thermal Protection (49) Setpoint Ranges



### 50/50N Instantaneous Overcurrent, Phase and Neutral Circuits

The Instantaneous Phase (50) and Instantaneous Neutral (50N) overcurrent functions provide fast tripping for high fault currents. The settings of both functions must be set such that they will not pickup for fault or conditions outside the immediate protective zone. If the neutral current input is connected to a step-up transformer's neutral CT, the 50N function can be used as a breaker flashover protection when used in conjunction with external breaker failure protection. Ranges and Increments are presented in [Figure 4-52](#) and [Figure 4-53](#). The function automatically selects fundamental RMS or total RMS calculation based on the input frequency. When the generator frequency is within  $\pm 5$  Hz from the nominal frequency, it uses fundamental RMS calculation. Outside of this range, it uses total RMS calculation, which will provide protection during offline down to a frequency of 8 Hz.

For providing off-line protection, one of the elements can be supervised by a breaker 'b' contact, and the element blocked when the breaker is closed. This allows the function to be set sensitively (below full load current).

50#1 PICKUP
_____ Amps
50#1 DELAY
_____ Cycles
50N PICKUP
_____ Amps
50N DELAY
_____ Cycles

The relay current ( $I_R$ ) is equal to the primary current ( $I_p$ ) divided by the appropriate CT ratio. These screens are repeated for 50#2 element.

**50: Instantaneous Phase Overcurrent** [X]

#1

Pickup:  0.1   240.0 (A)

Time Delay:  1   8160 (Cycles)

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

#2

Pickup:  0.1   240.0 (A)

Time Delay:  1   8160 (Cycles)

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input checked="" type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-52 Instantaneous Overcurrent (50) Setpoint Ranges

**50N: Instantaneous Neutral Overcurrent** [X]

Pickup:  0.1   240.0 (A)

Time Delay:  1   8160 (Cycles)

Outputs

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-53 Instantaneous Neutral Overcurrent (50N) Setpoint Ranges

### 50BF Generator Breaker Failure/HV Breaker Flashover

The Generator Breaker Failure/HV Breaker Flashover function (50BF) is applicable when a generator breaker is present and line side generator CTs are being used. The 50BF-Ph phase detector element (if enabled) is used for breaker failure and the 50BF-N (if enabled) provides breaker flashover protection by providing an additional breaker failure initiate which is only active when the breaker is open. For high impedance grounded applications, the 50BF-N function is inapplicable and must be disabled. The 50BF-N function is intended to detect an HV breaker flashover by monitoring the ground current flowing into the neutral of the GSU high side wye connected winding (see [Figure 4-54](#)). Ranges and increments are presented in [Figure 4-56](#).

**50BF-Ph Generator Breaker Failure:** When the M-3425A Generator Protection Relay detects an internal fault or an abnormal operating condition, it closes an output contact to trip the generator breaker or the unit HV breaker. When a generator breaker is used, protection is available for the instance where it fails to clear the fault or abnormal condition. Such generator breaker failure protection output contacts must be connected to trip the additional necessary breakers to isolate the generator from the system.

The breaker-failure condition is usually detected by the continued presence of current in any one or more of the phases after a trip has been sent to the breaker. However, the current detector (50BF-Ph) may not always give the correct status of the breaker, especially for generator breakers. This is because faults and abnormal operating conditions such as ground faults, overexcitation, over/under frequency, and reverse power may not produce enough current to operate the current detectors. For this reason, the breaker status input 52b contact must be used, in addition to the 50BF-Ph, to provide adequate breaker status indication.

Implementation of the generator breaker failure function is illustrated in [Figure 4-55](#). The breaker failure timer will be started whenever any one of the designated output contacts or the external programmed breaker failure initiate status input are operated. The timer continues to time if any one of the phase currents are above the 50BF-Ph pickup setting or if the 52b contact indicates the breaker is still closed; otherwise, the timer is reset.

Since current in the generator high side CT which energizes the 50BF protection ( $I_A$ ,  $I_B$ ,  $I_C$ ) might not extinguish concurrently with the breaker opening for faults between the CT location and the generator breaker, a possible area of mis-operation exists. Usually the risk of faults in this limited area is small enough to be ignored but should be considered.

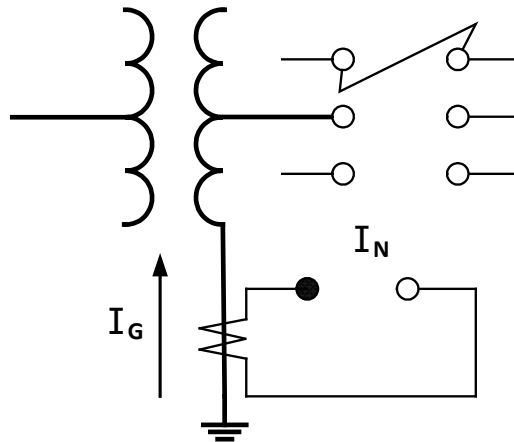


Figure 4-54 50BF-N HV Breaker Flashover

**50BF-Neutral Element:** This instantaneous overcurrent relay is energized from the generator neutral CT (See [Figure 4-18](#), One-Line Functional Diagram). This function is internally in series with a breaker “b” contact (IN1) to provide logic for the breaker flashover protection (see [Figure 4-55](#)). 50BF-Ph must also be enabled and the phase pickup must be set sensitive enough to detect a breaker flashover has occurred.

**HV Breaker Failure (limited)** The breaker failure function may be used for a unit breaker rather than a generator breaker. It is limited in that it has no fault detector associated with the unit breaker. Output contact operation would occur if any of the initiate contacts close and the 52b contact indicated a closed breaker after the set time delay.

This operation is chosen by disabling the neutral element, disabling the phase element, and designating initiating inputs and outputs and a time delay setting.

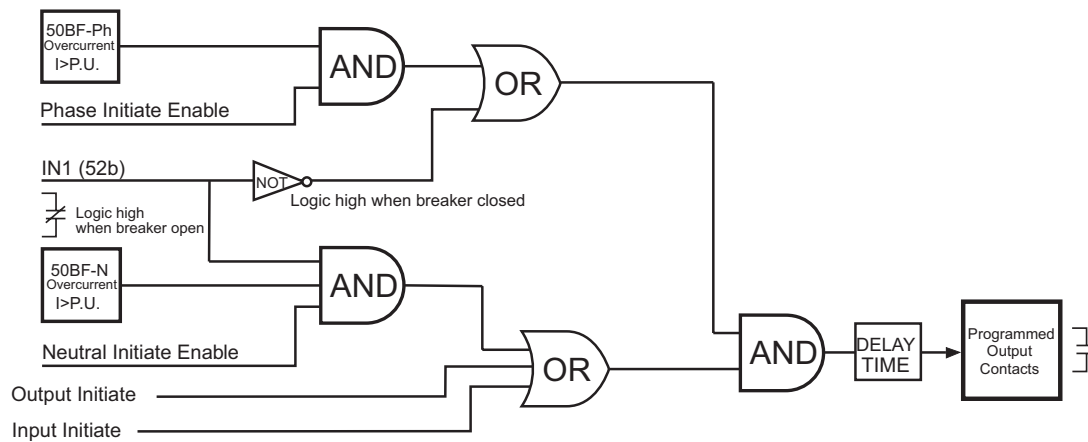


Figure 4-55 Breaker Failure Logic Diagram

50BF PHASE ELEMENT disable enable
50BF PICKUP PHASE _____ Amps
50BF NEUTRAL ELEMENT disable enable
50BF PICKUP NEUTRAL _____ Amps
50BF INPUT INITIATE i6 i5 i4 i3 i2 i1
50BF OUTPUT INITIATE o8 o7 o6 o5 o4 o3 o2 o1
50BF DELAY _____ Cycles

If generator breaker failure function is used in this application, **ENABLE** here.

Set phase pickup amps.

If the breaker flashover protection is to be used with the generator breaker failure function of the relay, set **ENABLE** (enable phase element also for this application.)

Set the neutral pickup amps.

Designate the status inputs which will initiate the breaker failure timer. Inputs IN7–IN14 must be set using IPScom®.

Designate the outputs that will initiate the breaker failure timer. Outputs OUT9–OUT23 must be set using IPScom®.

For generator breaker failure protection, the time delay should be set to allow for breaker operating time plus margin.

50BF: Breaker Failure

Phase Current: 0.15 0.10 10.00 (A) Disable

Phase Current Select: ☐ Disable ☒ Enable

Neutral Current: 1.00 0.10 10.00 (A)

Neutral Current Select: ☐ Disable ☒ Enable

Time Delay: 10 1 8160 (Cycles)

Output Initiate

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Input Initiate

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12
<input type="checkbox"/> 13	<input type="checkbox"/> 14		

Outputs

<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input checked="" type="checkbox"/> 5	<input checked="" type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-56 Breaker Failure (50BF) Setpoint Ranges

**50DT Definite Time Overcurrent (for split-phase differential)**

The Definite Time Overcurrent (50DT) function can be applied in two different configurations based on the CT connections. When CT configuration shown in [Figure 4-18](#), One Line Functional Diagram is used, the 50DT function is used as a definite time phase overcurrent function to provide protection for external and internal faults in the generator. When the CTs are connected to measure the split phase differential current (shown in [Figure 4-19](#), Alternative One Line Functional Diagram), the 50DT function can be used as a split-phase differential relay.

50DT #1 PICKUP PHASE A
_____ Amps
50DT #1 PICKUP PHASE B
_____ Amps
50DT #1 PICKUP PHASE C
_____ Amps
50DT #1 DELAY
_____ Cycles

■ **NOTE:** When 50DT function is used for split-phase differential, 50BF, 87 and 87GD functions must be disabled.

Refer to Section 4.2 Setup System for a description of the 50DT Split-Phase Operate setting, and Section 4.3, System Diagrams.

In some cases, the generators may be run with a faulted turn shorted until the generator winding is repaired. To prevent mis-operation under these conditions, the pickup setting of the faulted phase should be set higher than the other phases. To accommodate this function, individual pickup settings are available for each phase. Ranges and increments are presented in [Figure 4-57](#).

50DT #2 screens are identical to 50DT #1.

The screenshot shows the '50DT: Definite Time Overcurrent' configuration window. It contains two identical sections for #1 and #2. Each section has input fields for Pickup (A), Pickup (B), Pickup (C), and Time Delay, each with a range and increment. There are also checkboxes for Outputs (1-23) and Blocking Inputs (FL, 1-14). A 'Disable' button is present for each section. At the bottom are 'Save' and 'Cancel' buttons.

Section	Parameter	Value	Range/Increment
#1	Pickup (A)	1.20	0.20 to 240.00 (A)
	Pickup (B)	0.40	0.20 to 240.00 (A)
	Pickup (C)	0.60	0.20 to 240.00 (A)
	Time Delay	120	1 to 8160 (Cycles)
#2	Pickup (A)	1.20	0.20 to 240.00 (A)
	Pickup (B)	0.40	0.20 to 240.00 (A)
	Pickup (C)	0.60	0.20 to 240.00 (A)
	Delay	120	1 to 8160 (Cycles)

Figure 4-57 Definite Time Overcurrent (50DT) Setpoint Ranges

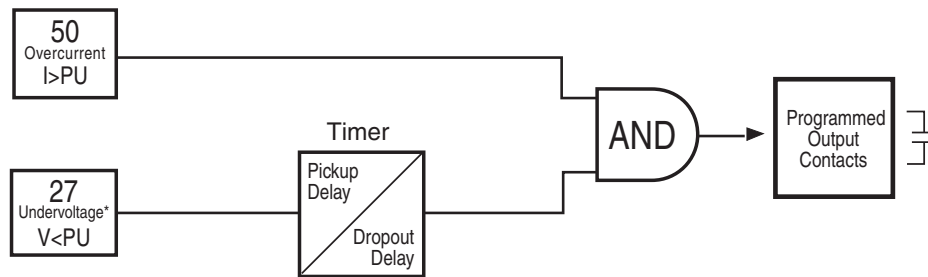
### 50/27 Inadvertent Energizing

The Inadvertent Energizing function (50/27) of the relay is an overcurrent function supervised by generator terminal bus voltage. Inadvertent or accidental energizing of off-line generators has occurred frequently enough to warrant the use of dedicated protection logic to detect this condition. Operating errors, breaker flashovers, control circuit malfunctions or a combination of these causes have resulted in generators being accidentally energized while off-line. The problem is particularly prevalent on large generators connected through a high voltage disconnect switch to either a ring bus or breaker-and-a-half bus configuration. When a generator is accidentally energized from the power system, it will accelerate like an induction

motor. While the machine is accelerating, high currents induced into the rotor can cause significant damage in a matter of seconds. Voltage supervised overcurrent logic is designed to provide this protection. (See [Figure 4-58](#), Inadvertent Energizing Function Logic Diagram)

An undervoltage element (all three phase voltages must be below pickup) with adjustable pickup and dropout time delay supervises instantaneous overcurrent tripping. The undervoltage detectors automatically arm the overcurrent tripping when the generator is taken off-line. This undervoltage detector will disable or disarm the overcurrent operation when the machine is put back in service. Ranges and increments are presented in [Figure 4-59](#).

50/27 PICKUP _____ Amps	Typical pickup setting is 0.5 amps. No coordination is required with other protection since this function is only operational when the generator is off-line.
50/27 VOLTAGE CONTROL _____ Volts	The purpose of the undervoltage detector is to determine whether the unit is connected to the system. The voltage level during this accidental energization depends on the system strength. Typical setting is 50%–70% of rated voltage (in some cases, it may be set as low as 20%.)
50/27 PICKUP DELAY _____ Cycles	The pickup time delay is the time for the undervoltage unit to operate to <i>arm</i> the protection. It must coordinate with other protection for conditions which cause low voltages (typically longer than 21 and 51V time delay settings.)
50/27 DROPOUT DELAY _____ Cycles	The dropout time delay is the time for the unit to operate to <i>disarm</i> the protection when the voltage is increased above the pickup value or the generator is brought on-line.



\* On All Three Phases Simultaneously

Figure 4-58 Inadvertent Energizing Function Logic Diagram

**50/27: Inadvertent Energizing**

(50) - Overcurrent Disable

Pickup:  0.50  ▶

(27) - Undervoltage

Pickup:  5  ▶

Pick-up Delay:  1  ▶

Drop-out Delay:  1  ▶

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-59 Inadvertent Energizing (50/27) Setpoint Ranges



### 51N Inverse Time Neutral Overcurrent

The Inverse Time Neutral Overcurrent function (51N) provides protection against ground faults. Since no zero sequence or ground current is usually present during normal operation, this function can be set for greater sensitivity than the phase overcurrent protection. If the 51N and 50N functions are not used at the generator neutral, they can be used to detect system ground faults by being energized by the step-up transformer neutral CTs. Ranges and increments are presented in [Figure 4-60](#).

The curves available for use are shown in Appendix D, **Inverse Time Curves**. They cover a range from

1.5 to 20 times the pickup setting. An additional one cycle time delay should be added to these curves in order to obtain the relay operating time. Inverse time curves saturate beyond 20 times pickup. For currents in excess of 20 times pickup, operating times are fixed at the 20 times pickup level.

The function automatically selects fundamental RMS or total RMS calculation based on the input frequency. When the generator frequency is within  $\pm 5$  Hz from the nominal frequency, it uses fundamental RMS calculation. Outside of this range, it uses total RMS calculation, which will provide protection during offline down to a frequency of 8 Hz.

51N PICKUP
_____ Amps
51N CURVE
bedefbeinvbeinv →
51N TIME DIAL
_____

The relay current ( $I_R$ ) is equal to the primary current ( $I_P$ ) divided by the appropriate CT ratio.  $I_R = I_P \div \text{CT ratio}$

Select one of the time curves shown in Appendix D, **Inverse Time Curves**. The appropriate curve in the selected family is designated here.

Appropriate Time Dial for coordination with “downstream” relay protection chosen from the time curve above.

**51N: Inverse Time Neutral Overcurrent**

Pickup:  0.25   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 Mod. Inverse  
☐ IEEE Very Inverse  
☐ IEEE Extremely Inverse

**Outputs**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☒ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Figure 4-60 Inverse Time Neutral Overcurrent (51N) Setpoint Ranges

### 51V Inverse Time Phase Overcurrent with Voltage Control/Restraint

Time-overcurrent relays, one per phase, are used to trip circuits selectively and to time-coordinate with other up- or downstream relays. For this function, eight complete series of inverse time tripping characteristics are included. The same descriptions and nomenclature which are traditionally used with electromechanical relays are used in the relay. Thus, user may choose from four BECO curves (BEDEF, BEINV, BEVINV, and BEEINV), four IEC curves (IECI, IECVI, IECEI, and IECLT), and three IEEE curves (MINV, VINV, EINV.) Within each family, the operator selects time dial setting and pickup (tap) setting, just as with electromechanical relays. Ranges and increments are presented in [Figure 4-62](#).

The curves available for use are shown in Appendix D, **Inverse Time Curves**. They cover a range from 1.5 to 20 times the pickup setting. An additional one cycle time delay should be added to these curves in order to obtain the relay operating time. Inverse time curves saturate beyond 20 times pickup. For currents in excess of 20 times pickup, operating times are fixed at the 20 time pickup level. The particular settings will be made by information from short-circuit fault studies and knowledge of the coordination requirements with other devices in the system that respond to time overcurrent.

51V is a true three-phase function, in that the relay incorporates separate integrating timers on each phase.

The inverse time overcurrent function can be voltage controlled (VC), voltage restrained (VR), or neither. For voltage-controlled operation, the function is not active unless the voltage is below the voltage control setpoint. This philosophy is used to confirm that the overcurrent is due to system fault. When applied, most users will set voltage control limits in the range of 0.7 to 0.9 per unit RMS voltage. When voltage restraint is selected (See [Figure 4-61](#), Voltage Restraint (51VR) Characteristic), the pickup setting is continuously modified in proportion to the collapsing terminal voltage. The voltage restraint function is well-suited to small generators with relatively short time constants.

■ **NOTE:** *The 51V function should be blocked by fuse loss if in the voltage control mode only. Fuse loss blocking is not desirable for voltage restraint mode because the pickup is automatically held at 100% pickup during fuse loss conditions, and operation will continue as normal.*

The internally derived voltage used to realize the voltage control or restraint feature depends on the configured VT configuration and the Delta-Y Transform setting (see Section 4.2 Setup System). Table 4-7, Delta/Wye Transformer Voltage-Current Pairs describes the calculation for the various system VT configurations.

51V PICKUP _____ Amps	The pickup of the 51V is set in relay amps. (Relay amps = primary amps ÷ CT ratio)
51V CURVE bedefbeinvbevinv →	Selects one of the time curves as shown in Appendix D, <b>Inverse Time Curves</b> . The appropriate curve in the selected family of curves is designated here.
51V TIME DIAL _____	
51V VOLTAGE CONTROL disable V_CNTL v_rstrnt	Disable if neither voltage control nor voltage restraint is desired. If voltage restraint is designated, the tap setting is modified as shown in <a href="#">Figure 4-61</a> . If voltage control is designated, the 51V will only operate when the voltage is less than the 51V voltage control setting specified below. When applied, the voltage control is usually set in the range of 70% to 90% of the nominal voltage.
51V VOLTAGE CONTROL _____ Volts	

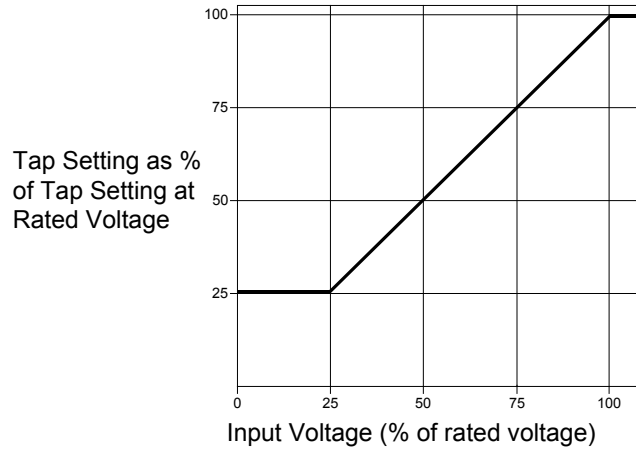


Figure 4-61 Voltage Restraint (51VR) Characteristic

Generator Directly Connected			Generator Connected Through Delta AB/Wye or Delta AC/Wye Transformer		
Current	Voltage Control or Restraint		Current	Voltage Control or Restraint	
	L-G	L-L or L-G to L-L		L-G	L-L or L-G to L-L
$I_a$	$(V_A - V_C)/\sqrt{3}$	$V_{AB}$	$I_a$	$V_A$	$(V_{AB} - V_{CA})/\sqrt{3}$
$I_b$	$(V_B - V_A)/\sqrt{3}$	$V_{BC}$	$I_b$	$V_B$	$(V_{BC} - V_{AB})/\sqrt{3}$
$I_c$	$(V_C - V_B)/\sqrt{3}$	$V_{CA}$	$I_c$	$V_C$	$(V_{CA} - V_{BC})/\sqrt{3}$

Table 4-7 Delta/Wye Transformer Voltage-Current Pairs

**51V: Inverse Time Phase Overcurrent**

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 Mod. Inverse  
☐ IEEE Very Inverse  
☐ IEEE Extremely Inverse

Voltage Control:  5   180 (V)

☐ Disable  
☒ Voltage Control  
☐ Voltage Restraint

**Outputs**

☐ 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☐ FL ☐ 1 ☒ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Figure 4-62 Inverse Time Overcurrent with Voltage Control/Voltage Restraint (51VC/VR) Setpoint Ranges

59 Phase Overvoltage

The Phase Overvoltage function (59) may be used to provide overvoltage protection for the generator. 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 a true 3-phase function in that each phase has an independent timing element.

The 59 function can be programmed to use phase voltage (any one of the three phases) or positive sequence voltage as input.

Positive and negative sequence voltages are calculated in terms of line-to-line voltage when Line to Line is selected for V.T. Configuration.

$$V_1 = 1/3 \cdot (V_{ab} + aV_{bc} + a^2V_{ca})$$
$$V_2 = 1/3 \cdot (V_{ab} + a^2V_{bc} + aV_{ca})$$

Magnitude measurement depends on the 59/27 Magnitude Select setting (See Section 4.2 Setup System). When the RMS option is selected, the magnitude calculation is accurate over a wide frequency range (10 to 80 Hz) and the accuracy of the time delay is +20 cycles. If DFT option is selected, 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, the 59 functions uses DFT to measure the positive sequence voltage, irrespective of DFT/RMS selection. Ranges and increments are presented in [Figure 4-63](#)

59 #1 INPUT VOLTAGE SEL.	
_____	phase_volt pos_seq_volt
59 #1 PICKUP	
_____	Volts
59 #1 DELAY	
_____	Cycles

Generator capability is generally 105% of rated voltage. 59 #2 and 59 #3 screens are identical to 59 #1.

59: Phase Overvoltage X

#1

Input Voltage Selection: ☒ Phase ☐ Positive Sequence Disable

Pickup:  5

Time Delay:  1

**Outputs**  
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**  
☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

#2

Input Voltage Selection: ☒ Phase ☐ Positive Sequence Disable

Pickup:  5

Time Delay:  1

**Outputs**  
☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**  
☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

#3

Input Voltage Selection: ☒ Phase ☐ Positive Sequence Disable

Pickup:  5

Time Delay:  1

**Outputs**  
☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**  
☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Figure 4-63 Phase Overvoltage (59) Setpoint Ranges

59D Third Harmonic Voltage Differential (Ratio)

This scheme, when used in conjunction with 59N function may provide 100% Stator Ground fault protection.

■ **NOTE:** The 59D function has a cutoff voltage of 0.5 V for 3rd harmonic  $V_X$  voltage. If the 180 Hz component of  $V_X$  is expected to be less than 0.5 V the 59D function can not be used.

[Figure 4-64](#) illustrates a third harmonic voltage differential scheme. This scheme compares the third harmonic voltage appearing at the neutral to

that which appears at the generator terminals. The ratio of these third harmonic voltages is relatively constant for all load conditions. A stator phase-to-ground fault will disrupt this balance, causing operation of the differential relay (see [Figure 4-36](#)). The generator terminal voltage (Line Side Voltage) can be selected as  $3V_0$  (Calculated by the relay from  $V_A$ ,  $V_B$  and  $V_C$ ) or  $V_X$  (broken delta VT input connected at the  $V_X$  input.) Positive sequence undervoltage blocking will prevent the function from misoperating when the generator is offline (the terminal voltage is below the set value).

59D RATIO

The ratio (or third harmonic) voltage measured at the generator terminals to the third harmonic voltage measured at neutral.

The 59D Ratio Pickup Setting can be calculated using field measurement of Third Harmonic Voltages as follows:

$$59D \text{ Ratio Pickup} = 1.5 \times \left( \frac{V_X^{3rd}}{V_N^{3rd}} \right) \text{ OR } \left( \frac{3V_0^{3rd}}{V_N^{3rd}} \right)$$

59D LINE SIDE VOLTAGE  
3v0 VX

Where:  $\left( \frac{V_{3XM}}{V_{3NM}} \right) \text{ OR } \left( \frac{3V_{OM}}{V_{3NM}} \right)$

is the maximum measured Ratio of the Third Harmonic Voltages at various loading conditions of the generator.

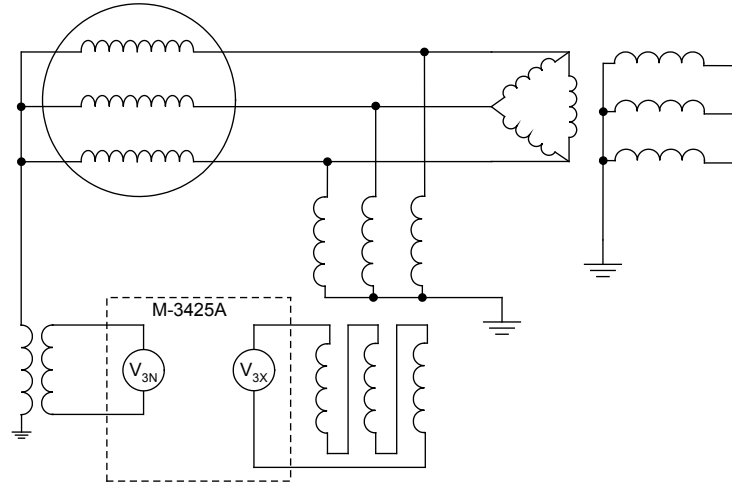
Selection of  $V_X$  will give better accuracy and sensitivity than  $3V_0$ . If  $3V_0$  is selected, VT configuration must be set to Line-Ground. If the nominal third harmonic voltage is <1 V,  $3V_0$  line side voltage selection is not recommended because noise in  $3V_0$  and  $V_N$  can cause 59D misoperation.

59D POS SEQ VOLT BLK  
disable ENABLE

This setting is typically enabled.

59D POS SEQ VOLT BLK  
\_\_\_\_\_ Volts

59D DELAY  
\_\_\_\_\_ Cycles



$$\text{The ratio } \left( \frac{V_{x^{3rd}}}{V_{N^{3rd}}} \right) \text{ OR } \left( \frac{3V_{O^{3rd}}}{V_{N^{3rd}}} \right) > \text{Pickup}$$

Where:  $V_{x^{3rd}}$  is the Third Harmonic Triple Zero Sequence voltage measured at the generator terminals.

$V_{N^{3rd}}$  is the Third Harmonic voltage measure at the neutral.

Figure 4-64 Third Harmonic Voltage Differential (Ratio) Scheme for Generator Ground Fault Protection

59D: Third Harmonic Voltage Differential

Line Side Voltage: ☒ 3V0 ☐ VX Disable

Ratio (VX/VN):  0.1  Disable

Time Delay:  1  Disable

Pos. Seq. Voltage Block:  5  ☐ Disable ☒ Enable

Outputs

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-65 Third Harmonic Voltage Differential (59D) Setpoint Ranges

### 59N Overvoltage, Neutral Circuit or Zero Sequence

The Neutral Overvoltage function (59N) provides stator ground fault protection for high impedance grounded generators. The 59N function can provide ground fault protection for 90–95% of the stator winding (measured from the terminal end).

The 59N function provides three setpoints, and responds only to the fundamental frequency component, rejecting all other harmonic components. Ranges and increments are presented in [Figure 4-67](#).

### Sequence Component Supervision of 59N Element

This scheme provides fast tripping for faults in the generator zone without waiting for the coordination time of the system ground fault relaying or VT fuses. To better cope with issues from capacitive coupling due to ground faults in the system side of the Generator Step UP (GSU) transformer, a 59N accelerated tripping scheme can be employed using sequence component supervision. This method employs the fact that ground faults outside of the unit connection produce some level of negative sequence voltage on the low side of the GSU transformer. The negative sequence voltage ( $V_2$ )

may be used to declare the ground fault is outside of the unit-connected generator, thereby employing a longer time delay on the 59N element to coordinate with system ground fault relaying. If a negative sequence voltage is not detected, the ground fault is presumed to be in the generator zone.

The absence of negative sequence voltage,  $V_2$  (typical negative sequence voltage inhibit setting of 5% of the positive sequence voltage) and the presence of zero sequence  $V_0$  voltage (typical zero sequence voltage inhibit setting of 7% of the positive sequence voltage) along with the pickup of the 59N element (typical 59N pickup setting of 5% of the generator nominal voltage) indicates a fault in the generator protection zone. An example shown in [Figure 4-66](#) illustrates an accelerated tripping scheme. Here 59N#1P (P indicates pickup of the element) is used along with a negative sequence voltage inhibit and zero sequence voltage inhibit settings. The accelerated tripping scheme will not misoperate if VT secondary is faulted as the negative sequence voltage will be high for this condition.

If the negative sequence voltage is above the setpoint or the zero sequence voltage is below the setpoint then 59N#2 will use a normal (longer) time delay.

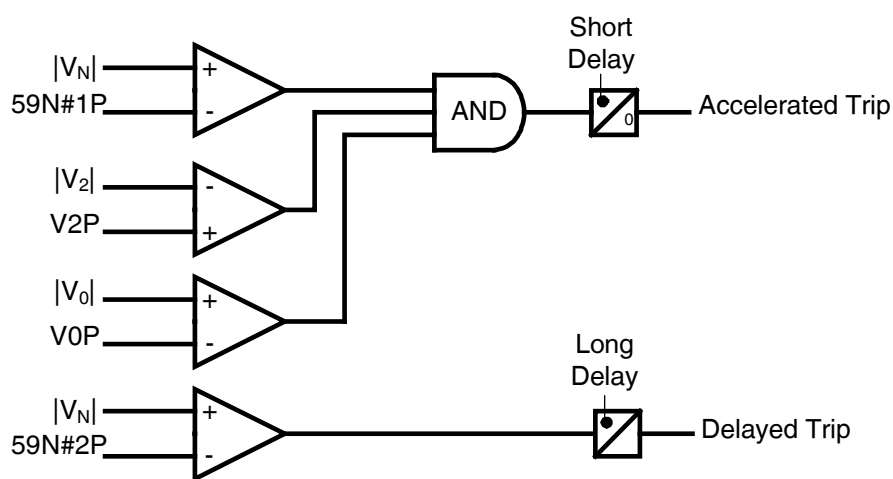


Figure 4-66 Sequence Component Supervision of the 59N Element



Figure 4-67 Overvoltage, Neutral Circuit or Zero Sequence (59N) Setpoint Ranges

59N #1 PICKUP  
\_\_\_\_\_ Volts

59N #1 DELAY  
\_\_\_\_\_ Cycles

59N #1 NEG SEQ VOLT INH  
disable ENABLE

59N #1 NEG SEQ VOLT INH  
\_\_\_\_\_ %

59N #1 ZERO SEQ VOLT INH  
disable ENABLE

59N #1 ZERO SEQ VOLT INH  
\_\_\_\_\_ %

59N #1 ZS VOLT SEL  
3V0 vx

59N 20HZ INJECTION MODE  
disable ENABLE

With typical grounding transformer ratios and a typical minimum setting of 5 volts, this protection is capable of detecting ground faults in about 95% of the generator stator winding from the terminal end.

If grounded-wye/grounded-wye VTs are connected at the machine terminals, the voltage relay must be time coordinated with VT fuses for faults on the transformer secondary winding. If relay time delay for coordination is not acceptable, the coordination problem can be alleviated by grounding one of the secondary phase conductors instead of the secondary neutral. When this technique is used, the coordination problem still exists for ground faults on the secondary neutral conductor. Thus, its usefulness is limited to those applications where the exposure to ground faults on the secondary neutral is small.

Since system ground faults can induce zero sequence voltages at the generator due to transformer capacitance coupling, this relay must coordinate with the system ground fault relaying. It is possible to set 59N#1, 59N#2, and 59N#3 to coordinate with the PT secondary fuses, and also coordinate with worst case capacitive coupling interference voltage from system ground faults (high side of the GSU).

59N #2 and 59N #3 screens are identical to 59N #1.

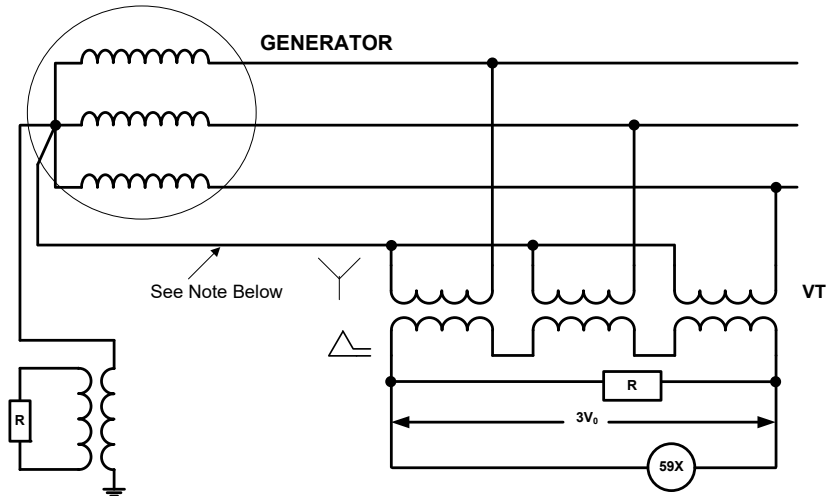
For applications where the M-3425A relay (where the 64S function is purchased or not) is used with 100% Stator Ground protection with 20 Hz injection schemes, the 59N 20 Hz injection mode must be enabled in order to calculate the voltage magnitude accurately for the 59N function, due to the 20 Hz injection voltage. The time delay accuracy of the function is -1 to +5 cycles when the 20 Hz injection mode is enabled.

### 59X Multipurpose Overvoltage (Turn-to-Turn Stator Fault Protection or Bus Ground Protection)

For generators where the stator-winding configuration does not allow the application of split-phase differential, a neutral voltage method can be used to detect turn-to-turn stator winding faults. [Figure 4-68](#) illustrates this method. Three VTs are connected in wye and the primary ground lead is tied to the generator neutral. The secondary is connected in a “broken delta” with an overvoltage relay connected across its open delta to measure  $3V_0$  voltage. In High Impedance grounded generators, connecting the primary ground lead to the generator neutral, makes this element insensitive to stator ground faults. The relay will, however, operate for turn-to-turn faults, which increase the  $3V_0$  voltage above low normal levels. Installation requires the cable from the neutral of the VT to generator neutral be insulated for the system line-to-ground voltage and the relay to be tuned to fundamental (60/50 Hz) frequency components of the voltage since some third-harmonic frequency component of the voltage will be present across the broken delta VT input.

Alternatively, this function can be used to detect bus ground faults, when connected as shown in [Figure 4-23](#).

<hr/> 59X #1 PICKUP <hr/> Volts <hr/>	When used for Turn-to-Turn fault protection the pickup should be set above the normal zero sequence voltage level. Typically the pickup is set to 5 V.
	When used for Bus Ground protection it is again set above the normal zero sequence voltage seen at the bus. Typical setting is between 10 and 20 Volts to provide sensitive protection.
<hr/> 59X #1 DELAY <hr/> Cycles <hr/>	The Time Delay for Turn-to-Turn faults should be set to approximately 5 cycles. For bus ground fault protection application the time delay should coordinate with other ground fault relaying and VT fuses.
	59X #2 screens are identical to 59X #1.



- **NOTE:** Installation requires the cable from the neutral of the VT to generator neutral be insulated for the system line-to-ground voltage.

Figure 4-68 Turn-to-Turn Stator Winding Fault Protection

**59X: Multi-purpose Overvoltage**

#1

Pickup:  5

Time Delay:  1

Outputs

<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

#2

Pickup:  5

Time Delay:  1

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-69 (59X) Multi-purpose Overvoltage Setpoint Ranges

## 60FL VT Fuse Loss

Some functions may operate inadvertently when a VT fuse is blown or an event causes a loss of one, two, or all three potentials to the relay. Provisions are incorporated for both internal and external potential loss detection and blocking of user defined functions. The logic scheme and options are illustrated in [Figure 4-70](#).

### Internal Fuse Loss Detection Logic

The internal logic scheme available will detect a loss of one, two, and all three potentials.

For the loss of one or two potentials, positive and negative sequence quantities are compared. The presence of negative sequence voltage in the absence of negative sequence current is considered to be a fuse loss condition. An additional supervising condition includes a minimum positive sequence voltage to assure voltage is being applied to the relay.

For the loss of all three phase potentials, a comparison of the three phase voltages is made to the three phase currents. If all three potentials are under  $0.05 V_{nom}$ , and all three currents are below  $1.25 I_{nom}$  combined with  $I_1 > 0.33A$ , a three phase potential loss is declared. A seal in circuit is provided to ensure a three phase fuse loss condition is not declared during a three phase fault if the fault current decays below the  $1.25 I_{nom}$  pickup setting.

Protection functions in the relay may be blocked by an assertion of the fuse failure logic (FL), in each function's respective setting screen. Typical functions to block on a loss of potential event are 21, 27, 32, 40, 51V (for Voltage Control only), 67, 67N, 78 and 81.

The 60FL function does not have to be enabled in order to use the FL as a blocking input in the relay configuration menu.

Frequency supervision is applied to the 60FL to avoid nuisance alarms during start up and allow functionality in an overspeed condition.

Depending on the generator rated frequency:

- For a 50Hz system: The 60FL alarm and element blocking will be **inhibited** if the measured frequency is less than 44.88 Hz  $F_L$  or greater than 55.12 Hz  $F_U$  (60FL is **active** from 44.88 Hz to 55.12 Hz).
- For a 60 Hz system: The 60FL alarm and element blocking will be **inhibited** if the measured frequency is less than 54.88 Hz  $F_L$  or greater than 65.12 Hz  $F_U$  (60FL is **active** from 54.88 Hz to 65.12 Hz)

Regarding a fuse failure during overspeed, if a fuse failure existed it would be detected while the generator was operating near rated before the overspeed excursion occurs.

The frequency supervision does not inhibit the 60FL three-phase loss of potential logic.

### External Fuse-Loss Function

For the specific application where the preceding logic cannot be considered reliable (such as when current inputs to the relay are not connected, or sustained positive sequence current during fault conditions is minimal), an external fuse failure function can be used as an input to the relay. The external 60 FL Function contact is connected across any control/status input. The relay protection functions are then blocked by an assertion of the control/status input (INx), as a blocking function in each function's respective setting screen.

### 60FL VT Fuse Loss Alarm Function

The 60FL alarm function is enabled by the internal logic by selecting the "FL" option in the 60 FL function setup screen. It is enable by the external logic by selecting the appropriate control/status input (INx) in the 60FL function setup screen.

A timer associated with the fuse loss alarm logic is available. This timer is to assure proper coordination for conditions that may appear as a fuse loss, such as secondary VT circuit faults that will be cleared by local low voltage circuit action (fuses or circuit breakers). Ranges and increments are presented in [Figure 4-71](#).

60FL INPUT INITIATE
FL i6 i5 i4 i3 i2 i1
60FL 3 PHASE DETECT
disable enable
60FL DELAY
Cycles

The initiating control/status inputs are user-designated. The closing of any of the externally connected contacts (across these inputs) will start the associated time delay to the 60FL function operation. In order to use internal fuse loss logic for 60FL function, "FL" must be checked. Externally initiated fuse loss detection may be input to other status inputs. Inputs IN7–IN14 must be set using IPScom®.

The time delay is set to coordinate for conditions which may appear as a fuse loss but will be corrected by other protection (such as a secondary VT circuit fault which will be cleared by local low voltage circuit action). This delay does not affect internal FL blocking option.

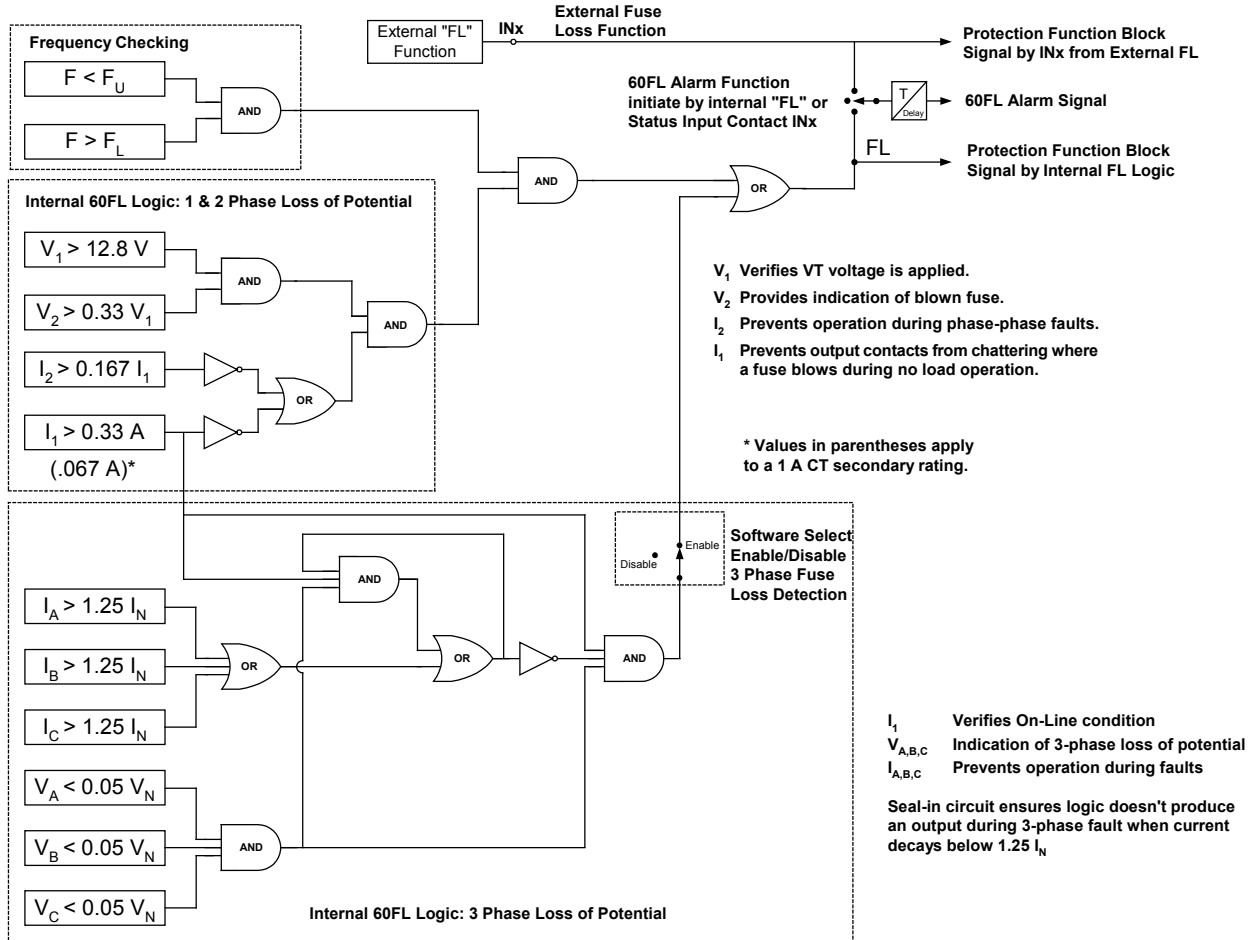


Figure 4-70 Fuse Loss (60FL) Function Logic

**60FL: VT Fuse Loss Detection**

Time Delay: 10 1 8160 (Cycles) Disable

Three Phase Fuse Loss Detection: ☐ Disable ☒ Enable

**Input Initiate**

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**Outputs**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☐ FL ☒ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-71 Fuse Loss (60FL) Setpoint Ranges

**64B/F Field Ground Protection****64F Field Ground Detection**

Typical connections for Field Ground Protection applications (including hydro turbine-generator and brushless generators) is given in [Figure 4-72](#). This function requires the connection of an external coupler (M-3921). To improve accuracy and minimize the effects of stray capacitance, the M-3921 Field Ground Coupler should be mounted close to the exciter. Connections from the coupler to the relay should use low capacitance shielded cable, and be as short as possible. Cable shield should be terminated at the relay end to the Relay Ground Stud (See Figure 5-9, External Connections). If cabling between the coupler and relay exceeds 100 feet, provisions should be made for in circuit calibration to nullify the effects of cabling capacitance. See Section 6.4, Auto Calibration, for calibration procedure.

The Field Ground function provides detection of insulation breakdown between the excitation field winding and the ground. There are two pickup and time delay settings, and one adjustable injection frequency setting for the 64F function. The adjustable frequency is provided to compensate for the amount of capacitance across the field winding and the ground so that the function accuracy is improved. The minimum time delays are calculated as follows:

- Alarm:  $t(\text{sec}) = \frac{2}{f_I} + 1$
- Trip:  $t(\text{sec}) = \frac{2}{f_I} + 7$

Field winding to ground capacitance values and associated time delays are presented in Table 4-8.

Table 4-8 gives typical frequency settings based on the rotor capacitance. The rotor capacitance can be measured with a capacitance meter by connecting the meter across the field winding to ground.

■ **NOTE:** Time delay is dependent on the injection frequency which is a fraction of a Hertz. The time delay must be long enough to ensure multiple measurements to confirm either Alarm or Trip for security.

**Factors Affecting 64F Performance**

Some excitation systems include shaft voltage suppressors which include capacitors that are installed between the +/- field and ground. The effect of these capacitors is given by the following equation:

$$R = \frac{1}{(2\pi f_I C)}$$

where:

R = Parallel winding-ground resistance

$f_I$  = Injection frequency setting

C = Capacitance value

To minimize this effect the following may be implemented:

- The injection frequency setting can be reduced, however accuracy decreases as a result.
- With the concurrence of the exciter manufacturer, surge capacitors rated at a lower value may be installed.

64F #1 PICKUP _____ kOhm	This setting should not exceed 80% of the ungrounded resistance value to prevent nuisance tripping. Typical setting for the 64F #1 pickup element for alarming is 20 Kohms.
64F #1 DELAY _____ Cycles	Refer to Table 4-8.
64F #2 PICKUP _____ kOhm	Typical setting for 64F #2 pickup element for tripping is 5 Kohms.
64F #2 DELAY _____ Cycles	Refer to Table 4-8.

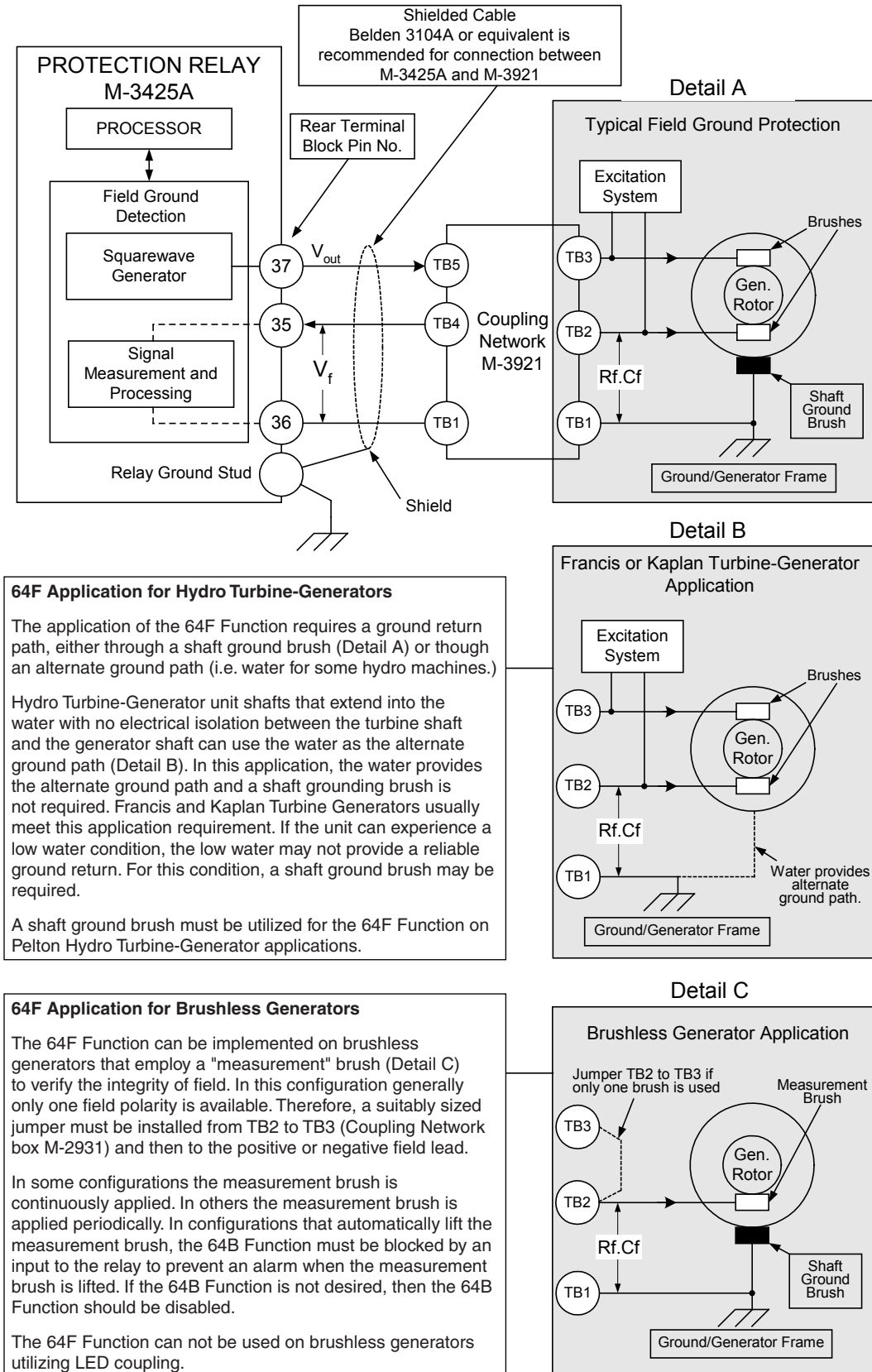


Figure 4-72 M-3921 Field Ground Coupler



● **WARNING:** Machine should be off-line and field excitation should be off during the capacitance measurement.

■ **NOTE:** Field breaker should be closed for the capacitance measurements.

### 64B Brush Lift-Off Detection

Brush Lift-Off Detection (64B) provides detection of open brushes of the rotor shaft. This function works in conjunction with the 64F Field Ground Detection function, and requires the M-3921 Field Ground Coupler.

Field Winding to Ground Capacitance (uF)	Typical Frequency Setting (Hz)	Minimum ALARM Time Delay (sec)	Minimum ALARM Time Delay (cyc)	Minimum TRIP Time Delay (sec)	Minimum TRIP Time Delay (cyc)
1 to 2	0.52	4.85	291	11.85	711
2 to 3	0.49	5.08	305	12.08	725
3 to 4	0.46	5.35	321	12.35	741
4 to 5	0.43	5.65	339	12.65	759
5 to 6	0.39	6.13	368	13.13	788
6 to 7	0.35	6.71	403	13.71	823
7 to 8	0.32	7.25	435	14.25	855
8 to 9	0.3	7.67	460	14.67	880
9 to 10	0.28	8.14	489	15.14	909
>10	0.26	8.69	522	15.69	942
		$T_{min} \text{ (sec)} = 2/f_1 + 1$ for each Typical Frequency Setting		$T_{min} \text{ (sec)} = 2/f_1 + 1 + 7$ for each Typical Frequency Setting	

Table 4-8 Typical Frequency Settings

**64F/B: Field Ground Protection**

**64F #1**  
 Pickup: 20 5 100 (KOhm) Disable  
 Time Delay: 699 1 8160 (Cycles)  
 Outputs: ☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23  
 Blocking Inputs: ☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**64F #2**  
 Pickup: 5 5 100 (KOhm) Disable  
 Time Delay: 339 1 8160 (Cycles)  
 Outputs: ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23  
 Blocking Inputs: ☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**64B**  
 Pickup: 2500 0 5000 (mV) Disable  
 Time Delay: 600 1 8160 (Cycles)  
 Outputs: ☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23  
 Blocking Inputs: ☐ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**Injection**  
 Frequency: 0.43 0.10 1.00 (Hz)

Save Cancel

Figure 4-73 Field Ground Protection (64B/F) Setpoint Ranges



When 64B operates, indicating open brush conditions, the 64F Function cannot detect a field ground. For most generators, when the brushes of the rotor shaft are lifted, the capacitance across the field winding and the ground significantly reduces to less than 0.15  $\mu\text{F}$ . The 64B Function analyzes this capacitance-related signal, and initiates an output contact when it detects an open brush condition. Typically, this output is used to alert operating personnel of an open brush condition. Ranges and increments are presented in [Figure 4-73](#). The typical pickup setting is listed in Table 4-9, Typical Brush Lift-Off Pickup Settings.

In order to assure correct setting, it is recommended that the actual operating value be predetermined during the final stage of the relay installation. By introducing a brush-open condition, the actual value can be easily obtained from the relay. The following procedure can be used to obtain the actual operating value of the 64B during an open brush condition:

**● WARNING: Machine should be off-line and field excitation should be off during the capacitance measurement.**

■ **NOTE:** Field breaker should be closed for the capacitance measurements.

1. After installation has been completed, determine the rotor capacitance, as outlined for the 64F function.
2. With the machine still off-line, apply power to the relay and set the 64B/F operating frequency in accordance with the value listed in Table 4-8, Typical Frequency Settings.
3. Introduce a brush-open condition by disconnecting the rotor brushes or lifting the brushes from their ground. Observe the 64B voltage value displayed by IPScom or the relay. The displayed value is the actual measured operating value of the 64B function.
4. To ensure correct operation and prevent erroneous trips, the Pickup Setting for the 64B Lift-off condition should be set at 80–90% of the actual operating value.

64B PICKUP
_____ mV
64B DELAY
_____ cycles
64B/F FREQUENCY
_____ Hz

The 64B/F Frequency is a shared setting common to both the 64B and 64F Functions. If either function is enabled, this setpoint is available, and should be set to compensate for the amount of capacitance across the field winding and ground, so that the measurement accuracy is improved.

To minimize measurement errors, the 64B/F frequency should be set according to the amount of capacitance across the field winding and the ground. Table 4-8 includes typical settings of the frequency for capacitance, ranging from 1  $\mu\text{F}$  to 10  $\mu\text{F}$ .

Equivalent Brush Lift-Off Capacitance	Typical Brush Lift-Off Pickup Setting
0.05~0.25 $\mu\text{F}$	2500 mV

Table 4-9 Typical Brush Lift-Off Pickup Setting

### 64S 100% Stator Ground Protection by Low Frequency Signal Injection

■ **NOTE:** The Stator Ground Protection function (64S) must be selected when the M-3425A is initially ordered.

The 100% stator ground fault protection is provided by injecting an external 20 Hz signal into the neutral of the generator. The protection is provided when the machine is on-line as well as off-line (provided that the 20 Hz generator and relay are powered on). The injected 20 Hz signal will produce a voltage that appears on the primary side of the grounding transformer when the machine is online as well as offline. This scheme requires the following external components in addition to M-3425A protection system:

- 20 Hz Signal-generator (BECO Part No. 430-00426) (Siemens 7XT33)
- Band Pass filter (BECO Part No. 430-00427) (Siemens 7XT34)
- 20 Hz Measuring Current Transformer, 400/5 A CT (BECO Part No. 430-00428) (ITI CTW3-60-T50-401)

■ **NOTE:** Chapter 5, Installation contains low frequency signal injection equipment installation information.

The voltage signal generated by the 20 Hz signal-generator is injected into the secondary of the generator neutral grounding transformer through a band-pass filter. The band pass filter passes the 20 Hz signal and rejects out-of-band signals. The application of a voltage divider to limit 50/60 Hz voltage on a generator ground fault is dependent on the worst-case secondary voltage presented to the M-3425A  $V_N$  input for a 100% stator phase-to-ground fault. If the worst-case secondary voltage presented to the M-3425A  $V_N$  is >200 Vac, the voltage divider should be used (See [Figure 4-74](#)). If the worst-case secondary voltage presented to the M-3425A  $V_N$  is equal to or less than 200 Vac, the voltage divider should **not** be used and a straight-through connection applied ([Figure 4-75](#)). The 20 Hz current is also connected to the  $I_N$  input of the M-3425A, through the 20 Hz current transformer.

The expected 20 Hz current during no fault condition is given by:

$$I_{NF} = \frac{V_{20}}{X_{CS}}$$

$$X_{CS} = \frac{X_C (\text{Primary})}{N^2}$$

Where  $V_{20}$  is the 20 Hz voltage measured across the neutral resistor  $R_N$  and  $X_{CS}$  is the capacitive reactance of the generator stator winding and unit transformer referred to the grounding transformer secondary.  $N$  is the turn ratio of the grounding transformer. There are two overcurrent pickup settings. One operates on the magnitude of total 20 Hz neutral current measured by the relay. The other pickup setting operates on the real component of the 20 Hz neutral current where  $V_{20}$  is the reference.  $V_{20}$  is the 20 Hz voltage measured across the neutral resistor  $R_N$ . **The real component of the 20 Hz current increases in magnitude during a ground fault on the generator stator since the insulation resistance decreases. The real component of current pickup is disabled when  $V_N$  is less than 0.1 V @ 20 Hz, therefore use the total neutral current element to provide backup for bolted ground faults at the machine neutral. Set the two pickups utilizing the equations illustrated in [Figure 4-77](#).**

The 20 Hz signal generator has an output of 25 volts and the band pass filter output resistance is eight ohms.

Only a small amount of 20 Hz current flows when the generator is operating normally (that is, no ground fault) as a result of the stator capacitance to ground. The magnitude of 20 Hz current increases when there is a ground fault anywhere along the stator windings. The 64S function issues a trip signal after a set time delay when the measured 20 Hz current exceeds a pickup as illustrated in [Figure 4-77](#).

The 59N Function (90 to 95%) should also be used in conjunction with 64S protection to provide backup.

■ **NOTE:** The reach of 59N is reduced when the voltage divider connection is used.

● **WARNING:** When the 64S 20 Hz Injection Method is energized and connected to the secondary of the Generator Neutral Grounding Transformer the low voltage 20 Hz signal is stepped up by the turns ratio of this transformer and appears as a dangerous voltage on the primary of the Generator Neutral Grounding Transformer. Since this element is commonly applied to check for stator grounds, not only when the machine is running, but also on a machine at standstill, personnel must not be working on the generator while this 20 Hz Injection Method is energized and connected to the secondary of the Generator Neutral Grounding Transformer.

If the 20 Hz injection voltage generator receives power from the generator terminal voltage, then the 20 Hz injection voltage generator is automatically switched off whenever the generator terminal voltage is not present.

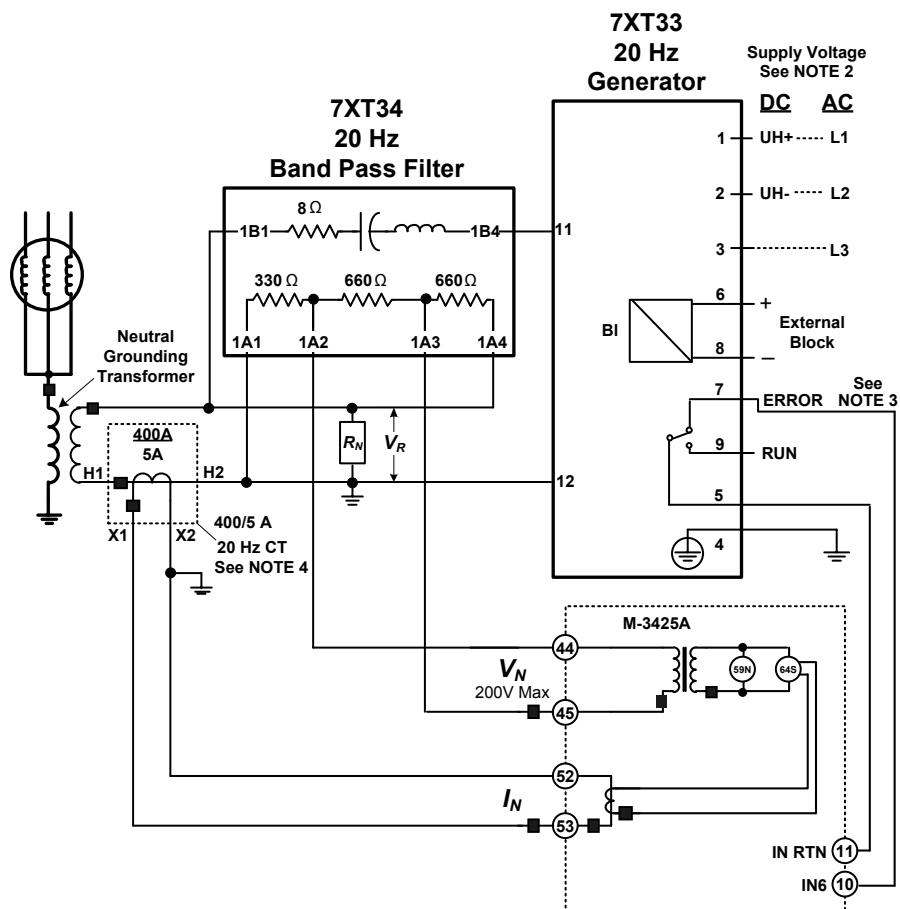
### Backup M-3425A/20 Hz Generator Connections

[Figure 4-76](#) shows methods to connect two M-3425A relays and two 20 Hz Generators for switchover in case any of the devices need to be removed from service without disrupting Machine protection.

The two methods are unrelated and can be performed independently. The 20 Hz Generator switchover or M-3425A isolation can be performed while the Machine is on-line.

These methods can be implemented with either manually operated test switches or with electromechanical relays. Using electromechanical relays allows for automatic change-over of the devices using the self-test outputs of the devices. The actual design of the automatic change-over is left to the user. For additional assistance in implementing this method contact Beckwith Electric. All other connections to the devices are omitted from the figure for clarity, but must be considered in implementation.

**Figure 4-74** illustrates the Voltage Divider connection for the Neutral Voltage input  $V_N$ . The maximum continuous rating for  $V_N$  is 200 volts.



*Figure 4-74 Voltage Divider Connection Diagram*

■ **NOTES:**

1. Use the Voltage Divider Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage > 200 Vac.
2. Refer to [Table 4-10](#) and [Table 4-11 on page 4-102](#).
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.

$V_R$  is the voltage drop across the neutral resistor  $R_N$ .  $V_N$  is determined as follows for the Voltage Divider connection:

$$V_N = \frac{V_R \cdot (660 \, \Omega)}{(660 \, \Omega + 660 \, \Omega + 330 \, \Omega)}$$

$$V_N = \frac{2 \cdot V_R}{5}$$

$$V_N = 0.4 \cdot V_R$$

Figure 4-75 illustrates the High Voltage connection for the Neutral Voltage input  $V_N$ .

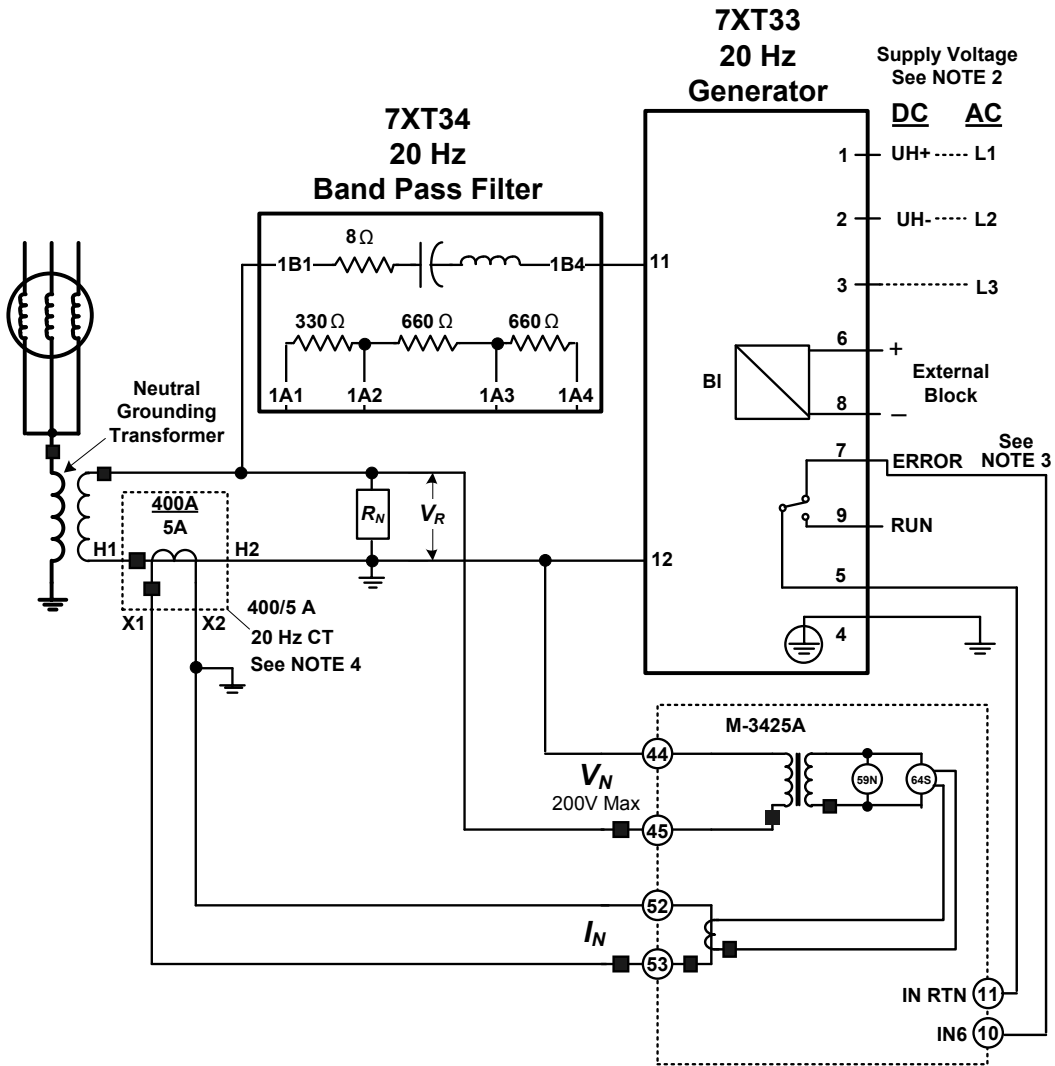


Figure 4-75 Straight Through Connection Diagram

■NOTES:

1. Use the Straight Through Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage < 200 Vac.
2. Refer to [Table 4-10](#) and [Table 4-11 on page 4-102](#).
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.

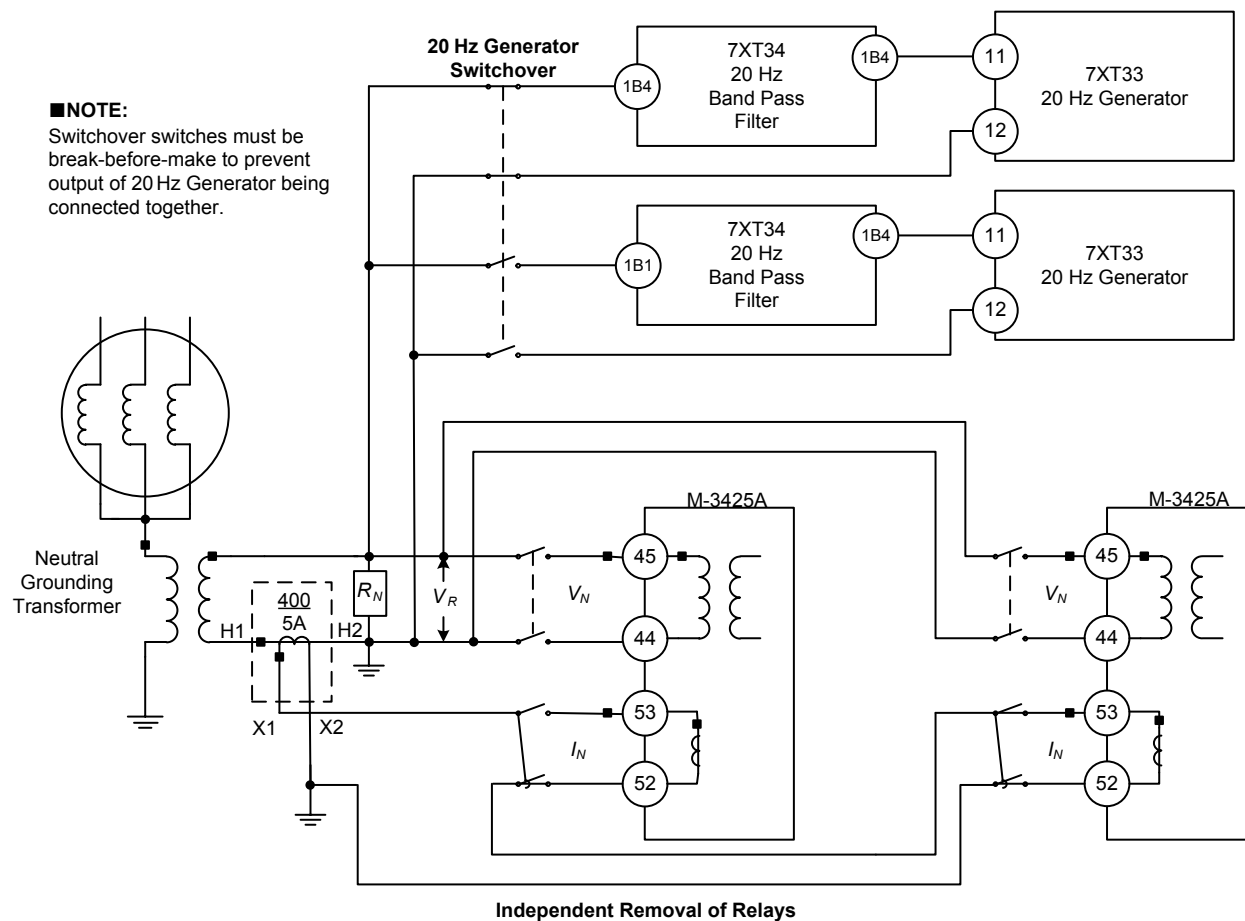
7XT33 Version Variations (listed latest to earliest)		
7XT33 Version	Connections	Supply Voltage Range
7XT3300-0*A00/FF	See Figures 4-74 and 4-75	88 to 250 Vdc / 88 to 230 Vac
7XT3300-0*A00/EE	See Figures 4-74 and 4-75	88 to 250 Vdc / 88 to 230 Vac
7XT3300-0*A00/DE	See Figures 4-74 and 4-75	88 to 253 Vdc / 80 to 130 Vac
7XT3300-0*A00/DD	See Figures 4-74 and 4-75	88 to 253 Vdc / 80 to 130 Vac
7XT3300-0*A00/BB	<b>See Cross Reference Table 4-11</b>	88 to 253 Vdc / 80 to 130 Vac

\* Indicates mounting option B Surface-mounted housing or C Panel Flush mounted

Table 4-10 7XT33 Version Variations

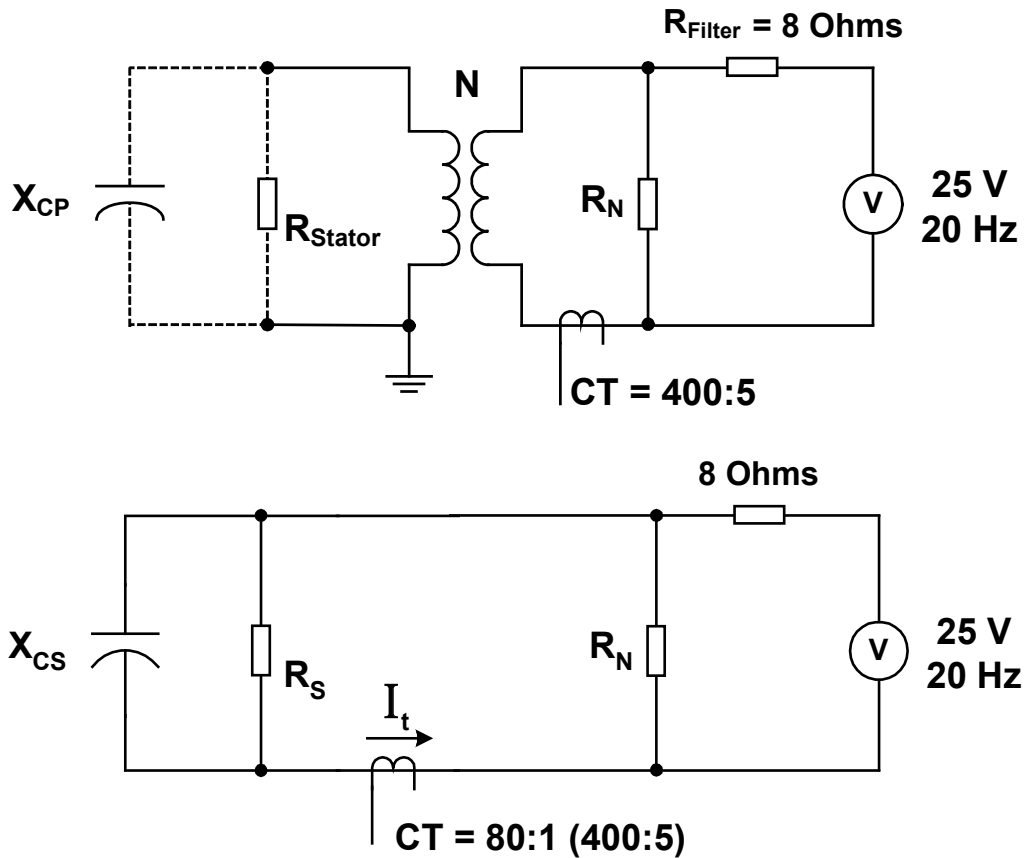
Connection Cross Reference											
Later Versions	1	2	3	4	5	6	7	8	9	11	12
Initial BB Version	1A1	1A2	1A3	1A4	3A1	2A1	3A2	2A3	3A3	4A1	4A3

*Table 4-11 7XT33 Connection Cross Reference – Initial BB to Later Versions*



*Figure 4-76 Simplified Redundant 64S Stator Ground Protection*

64S TOTAL CURRENT disable ENABLE	
64S TOTAL CURR PU _____ mAmps	Pickup setting for the overcurrent element that operates on the 20 Hz neutral current measured by the relay ( $I_N$ ). This setting ranges from 2 to 75 mA and is for the total current, which includes both the real and imaginary components.
64S REAL COMP CURRENT disable ENABLE	
64S REAL COMP CURR PU _____ mAmps	This is the pickup setting for the overcurrent element that operates on the real component of the 20 Hz neutral current measured by the relay ( $Re(I_N)$ ). The 20 Hz neutral voltage measured by the relay is the reference used to calculate the real component. This setting is in milli-amps and ranges from 2 to 75 mA.
64S DELAY _____ Cycles	This is the time delay on pickup for both overcurrent elements described above.
64S VOLT RESTRAINT disable ENABLE	If voltage restraint is enabled the overcurrent pickup settings described above are varied depending on the magnitude of 20 Hz neutral voltage measured by the relay. The pickup settings are more sensitive for neutral voltage less than or equal to 25 volts. The pickup settings are de-sensitized for neutral voltage greater than 25 volts. Refer to <a href="#">Figure 4-78</a> . Voltage restraint is typically disabled since the measured neutral voltage is most often approximately one volt, or less. If 64S is purchased without Real Component, then Voltage Restraint is always enabled and cannot be disabled.
64S UNDERFREQ INHIBIT disable ENABLE	Enable this setting to block F64S when the system voltage measured by the relay is 40 Hz or less such as during startup. This can prevent nuisance tripping during startup and shutdown when the generator is transitioning through the lower frequencies.



$$X_{CS} = \frac{X_{CP}}{N^2} \quad \text{Capacitive reactance of stator windings and unit transformer (secondary)}$$

$$R_S = \frac{R_{Stator}}{N^2} \quad \text{Insulation resistance (secondary)}$$

Where:

$X_{CP}$  = Capacitive reactance of stator windings and unit transformer (primary)

$R_{Stator}$  = Insulation resistance (primary)

$N$  = Turns ratio of grounding transformer

$R_N$  = Neutral grounding resistance (secondary)

Figure 4-77 Primary Transferred To Transformer Secondary



Calculate the total current measured by the current input  $I_N$  as follows:

$$I_T = \frac{25}{8 + \left(1 + \frac{8}{R_N}\right) \cdot \bar{Z}_S}$$

$$\bar{Z}_S = \left( \frac{R_S \cdot X_{CS}}{\sqrt{R_S^2 + X_{CS}^2}} \right) \angle \theta$$

$$\theta = -90^\circ - \tan^{-1} \left( \frac{-X_{CS}}{R} \right)$$

$$I_N = \frac{I_T}{80}$$

Calculate the real component of the current measured by the current input  $I_N$  with respect to the neutral voltage input as follows:

$$\text{Re}(I_T) = I_T \cdot \cos(\phi)$$

$$\text{Re}(I_N) = \frac{I_T \cdot \cos(\phi)}{80}$$

Where:

$$\phi = \text{ArcTAN} \left[ \frac{\left(1 + \frac{8}{R_N}\right) \cdot (Z_S) \sin \theta}{8 + \left(1 + \frac{8}{R_N}\right) \cdot (Z_S) \cos \theta} \right]$$

$\text{Re}(Z_S)$  is the real component of  $Z_S$  and  $\text{Im}(Z_S)$  is the imaginary component.

Calculate the total current when the system is faulted and unfaulted to determine if there is adequate sensitivity for this pickup setting. Use the following two assumptions for the insulation resistance to calculate the current during normal operating conditions and a ground fault:

$R_{\text{Stator}} = 100$  kilo-Ohms (normal operating conditions)

$R_{\text{Stator}} = 5$  kilo-Ohms (ground fault)

There maybe only 2 to 3 milli-amperes or less in difference for the total current when the system is faulted and unfaulted for applications that have a large value of capacitive coupling to ground ( $C_O$  greater than 1.5 micro-Farads) when combined with a low value for the grounding resistor ( $R_N$  less than 0.3 Ohms). Use the real component of the total current for these applications as there will be a larger margin in difference when the system is faulted and unfaulted.

Equipment Description	Surface/Flush Mount Beco. Part No.	OEM Part No.
20 Hz Signal-Generator	430-00426	Siemens 7XT33
20 Hz Band Pass Filter	430-00427	Siemens 7XT34
20 Hz Measuring Current Transformer 400-5 A CT	430-00428	ITI CTWS-60-T50-401

Table 4-12 Low Frequency Signal Injection Equipment Part Number Cross Reference

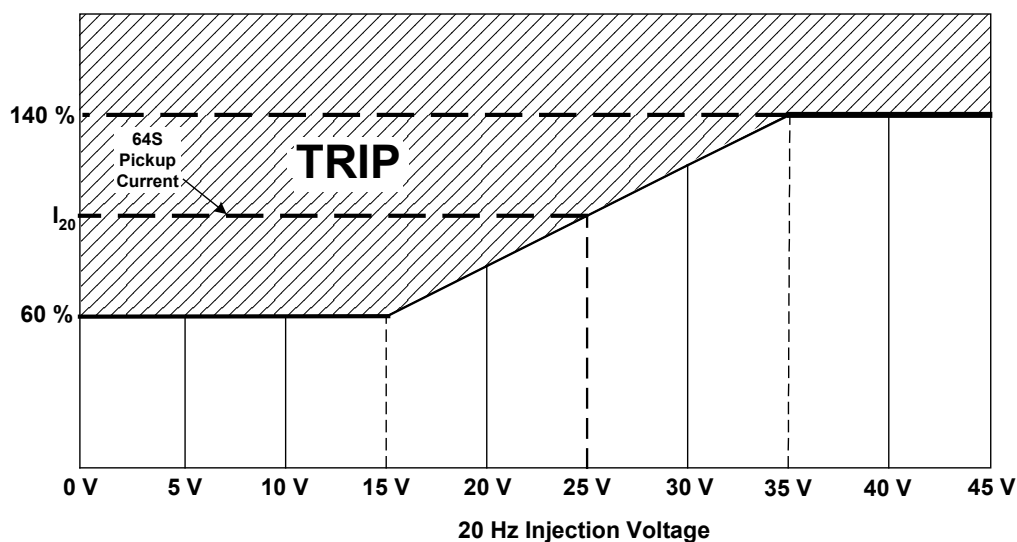


Figure 4-78 Voltage Restraint Characteristic

64S: 100% Stator Ground

Underfrequency Inhibit ( $\leq 40\text{Hz}$ ): ☒ Disable ☐ Enable Disable

Voltage Restraint: ☒ Disable ☐ Enable

Total Current Pickup:  2.0  ☐ Disable ☒ Enable

Real Component Current:  2.0  ☐ Disable ☒ Enable

Time Delay:  1

Outputs

<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-79 100% Stator Ground Protection (64S) Setpoint Ranges

### 67N Residual Directional Overcurrent

The Residual Directional Overcurrent function (67N) provides protection from ground faults. The 67N function can provide generator ground fault protection. It can also provide directional discrimination when multiple generators are bused together. The 67N Function is subject to the following configuration limitations:

- $V_X$  polarization cannot be selected if 25 (Sync) function is enabled.
- $3V_0$  polarization can only be used with Line-Ground VT configuration.
- 67N Function is not available if 87GD is enabled.

The 67N Function operates on the residual current either from internal calculation ( $3I_0$ ) using  $I_A$ ,  $I_B$  and  $I_C$  or using a residual current input from  $I_N$  input of the relay (this is preferred compared to  $3I_0$ ). The relay can be polarized with the neutral voltage ( $V_N$ ), broken delta voltage connected at  $V_X$  input

or  $3V_0$  calculated using  $V_A$ ,  $V_B$  and  $V_C$  inputs. The function provides both definite time and inverse time elements. The inverse time element provides several curves. The curves available for use are shown in **Appendix D, Inverse Time Curves**. They cover a range from 1.5 to 20 times the pickup setting. An additional one cycle time delay should be added to these curves in order to obtain the relay operating time. Inverse time curves saturate beyond 20 times pickup. For currents in excess of 20 times pickup, operating times are fixed at the 20 time pickup level.

To obtain maximum sensitivity for fault currents, the directional element is provided with a maximum sensitivity angle adjustment (MSA). This setting is common to both the 67NDT and 67NIT elements. The pickup sensitivity of the relay remains constant for  $90^\circ$  either side of the so-called Maximum Sensitivity Angle (MSA). At angles over  $90^\circ$  from MSA, the relay operation is blocked. Typical MSA setting for a generator internal ground fault protector is approximately  $150^\circ$ .

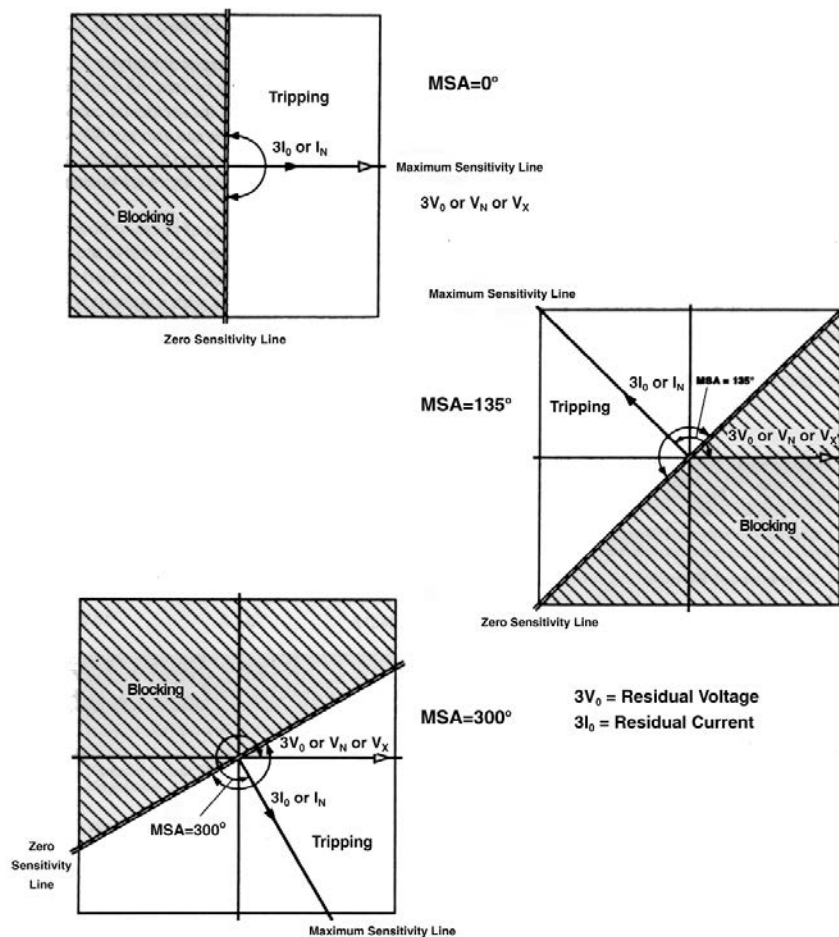


Figure 4-80 Residual Directional Overcurrent (67N) Trip Characteristics

67NDT PICKUP _____ Amps	Pickup value for the 67N element.
67NDT DIR ELEMENT disable ENABLE	Directional discrimination enable. When disabled, this function will work like a 50N.
67NDT DELAY _____ Cycles	Time Delay setting.
67NIT PICKUP _____ Amps	Inverse Time Pickup
67NIT DIR ELEMENT disable ENABLE	Directional discrimination enabled. When disabled, this function will operate like 51N.
67NIT CURVE bdef binv bvinv beinv→	Select the inverse time curve.
67NIT TIME DIAL _____	Time dial setting
67N MAXSENSITIVITYANGLE _____ Degrees	See <a href="#">Figure 4-80</a> for Max Sensitivity Angle (MSA) settings.
67N OPERATING CURRENT 3I0 in	Select the operating current.
67N POLARIZING QUANTITY 3V0 vn vx	Select the polarization voltage. If 3V <sub>0</sub> is selected, VT configuration must be set to Line-Ground.

**67N: Residual Directional Overcurrent** [X]

**Definite Time**

Pickup:  0.5 [Left Arrow] [Right Arrow] 240.0 (A) [Disable]

Time Delay:  1 [Left Arrow] [Right Arrow] 8160 (Cycles)

Directional Element: ☐ Disable ☒ Enable

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**Inverse Time**

Pickup:  0.25 [Left Arrow] [Right Arrow] 12.00 (A) [Disable]

Time Dial:  0.5 [Left Arrow] [Right Arrow] 11.0

Directional Element: ☐ Disable ☒ Enable

**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 Mod. Inverse  
☐ IEEE Very Inverse  
☐ IEEE Extremely Inverse

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

**Setting**

Max Sensitivity Angle:  0 [Left Arrow] [Right Arrow] 359 (Degree)

Operating Current: ☒ 3I0 ☐ IN      Polarizing Quantity: ☐ 3V0 (Calculated) ☒ VN ☐ VX

[Save] [Cancel]

Figure 4-81 Residual Directional Overcurrent (67N) Setpoint Ranges

## 78 Out-of-Step

The Out-of-Step function (78) is used to protect the generator from out-of-step or pole slip conditions. This function uses one set of blinders, along with a supervisory MHO element. Ranges and increments are presented in [Figure 4-84](#).

The pickup area is restricted to the shaded area in [Figure 4-82](#), Out-of-Step Relay Characteristics, defined by the inner region of the MHO circle, the region to the right of the blinder A and the region to the left of blinder B. For operation of the blinder scheme, the operating point (positive sequence impedance) must originate outside either blinder A or B, and swing through the pickup area for a time greater than or equal to the time delay setting and progress to the opposite blinder from where the swing had originated. When this scenario happens, the tripping logic is complete. The contact will remain closed for the amount of time set by the seal-in timer delay.

$X_T$  = Transformer Reactance

$X_S$  = System Reactance

$X_d'$  = Transient Reactance of the Generator

Consider, for example, [Figure 4-82](#). If the Out-of-step swing progresses to impedance  $Z_0(t_0)$ , the

MHO element and the blinder A element will both pick up. As the swing proceeds and crosses blinder B at  $Z_1(t_1)$ , blinder B will pick up. When the swing reaches  $Z_2(t_2)$ , blinder A will drop out. If TRIP ON MHO EXIT option is disabled and the timer has expired ( $t_2 - t_1 > \text{time delay}$ ), then the trip circuit is complete. If the TRIP ON MHO EXIT option is enabled and the timer has expired, then for the trip to occur the swing must progress and cross the MHO circle at  $Z_3(t_3)$  where the MHO element drops out. Note the timer is active only in the pickup region (shaded area). If the TRIP ON MHO EXIT option is enabled, a more favorable tripping angle is achieved, which reduces the breaker tripping duty. The benefit in setting to trip the breaker upon exiting the MHO characteristic is to allow the circuit breaker to open when the angle between the generator and system voltages is  $90^\circ$  or less, a more favorable angle with higher impedance for arc interruption where the current flow at trip is reduced. The relay can also be set with a Pole Slip Counter. The relay will operate when the number of pole slips are equal to the setting, provided the Pole Slip Reset Time was not expired. Typically, the Pole Slip Counter is set to 1, in which case the Pole Slip Reset Time is not applicable.

78 DIAMETER _____ Ohms	Typical setting is $(1.5X_T + 2X_d')$
78 OFFSET _____ Ohms	Typical setting is $-2X_d'$ .
78 BLINDER IMPEDANCE _____ Ohms	Typical setting is $(1/2) (X_d' + X_T + X_S) \tan(\Theta - (\delta/2))$ . Typical value for $\delta$ is $120^\circ$ .
78 IMPEDANCE ANGLE _____ Degrees	Typical setting for $\Theta$ is $90^\circ$ .
78 DELAY _____ Cycles	The time delay should be set based on the stability study. In the absence of such a study, it can be set between 3 and 6 cycles.
78 TRIP ON MHO EXIT disable enable	This setting is typically enabled.
78 POLE SLIP COUNT _____ slips	Typical setting is 1 pole slip.
78 POLE SLIP RESET TIME _____ Cycles	Typical setting is 120 cycles.

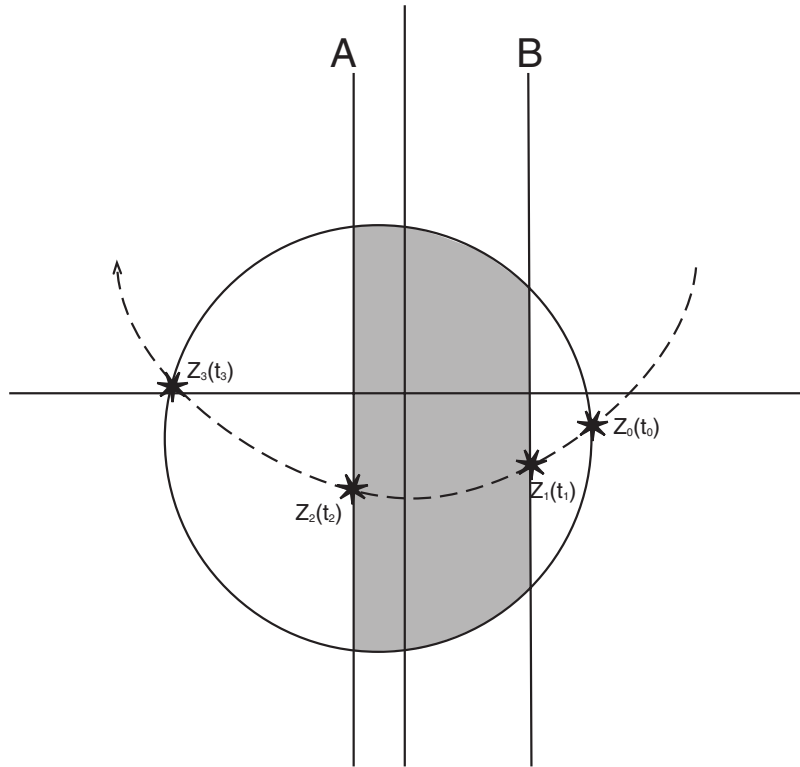


Figure 4-82 Out-of-Step Relay Characteristics

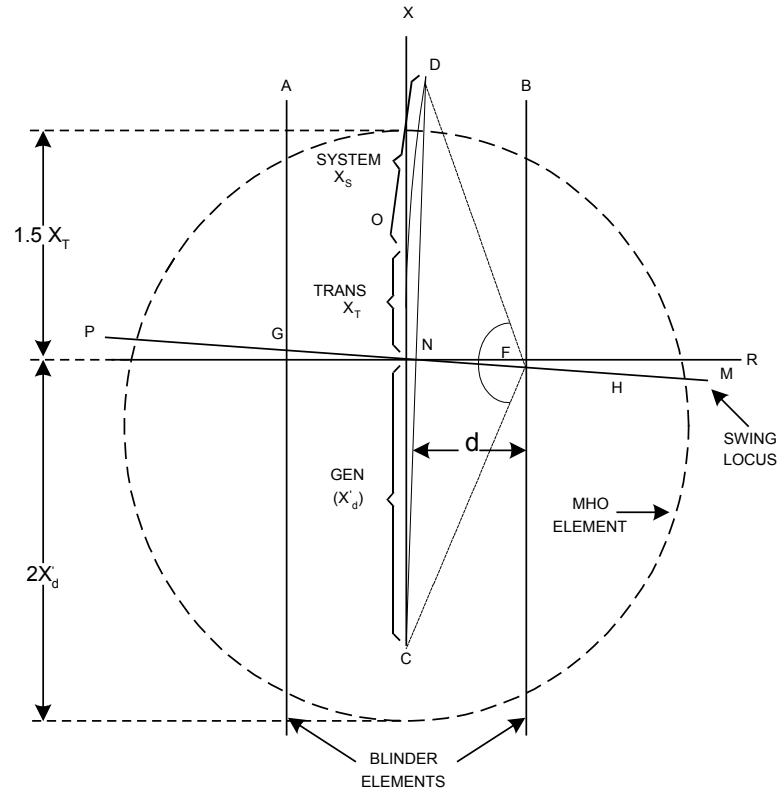


Figure 4-83 Out-of-Step Protection Settings

78: Out of Step

Circle Diameter: 15.1 0.1 100.0 (Ohm) Disable

Offset: -10.8 -100.0 100.0 (Ohm)

Blinder Impedance: 6.5 0.1 50.0 (Ohm)

Impedance Angle: 90 0 90 (Degree)

Pole Slip Counter: 1 1 20

Pole Slip Reset Time: 1 1 8160 (Cycles)

Time Delay: 120 1 8160 (Cycles)

Trip on MHO Exit: ☒ Disable ☐ Enable

Outputs

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

Blocking Inputs

<input checked="" type="checkbox"/> FL	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Save Cancel

Figure 4-84 Out-of-Step (78) Setpoint Ranges



## 81 Frequency

The Frequency function (81) provides either overfrequency or underfrequency protection of the generator. It has four independent pickup and time delay settings. The overfrequency mode is automatically selected when the frequency setpoint is programmed higher than the base frequency (50 or 60 Hz), and the underfrequency mode selected when the setpoint is programmed below the base frequency. Ranges and increments are presented in [Figure 4-86](#).

The steam turbine is usually considered to be more restrictive than the generator at reduced frequencies because of possible natural mechanical resonance in the many stages of the turbine blades. If the generator speed is close to the natural frequency of any of the blades, there will be an increase in vibration. Cumulative damage due to this vibration can lead to cracking of the blade structure.

Sample settings of the 81 function are shown in [Figure 4-85](#). The frequency functions are automatically disabled when the input voltage (positive sequence) is very low (typically between 2.5 V and 15 V, based on the frequency.)

The 81 function should be disabled using breaker contact when the unit is offline.

These magnitude and time settings describe a curve (as shown in [Figure 4-85](#), Example of Frequency (81) Trip Characteristics) which is to be coordinated with the capability curves of the turbine and generator as well as the system underfrequency load-shedding program. These capabilities are given by a description of areas of prohibited operation, restricted time operation, and continuous allowable operation.

The underfrequency function is usually connected to trip the machine whereas the overfrequency function is generally connected to an alarm.

In order to prevent mis-operation during switching transients, the time delay should be set to greater than five (5) cycles.

81 #1 PICKUP	_____ Hz
81 #1 DELAY	_____ Cycles
81 #2 PICKUP	_____ Hz
81 #2 DELAY	_____ Cycles
81 #3 PICKUP	_____ Hz
81 #3 DELAY	_____ Cycles
81 #4 PICKUP	_____ Hz
81 #4 DELAY	_____ Cycles

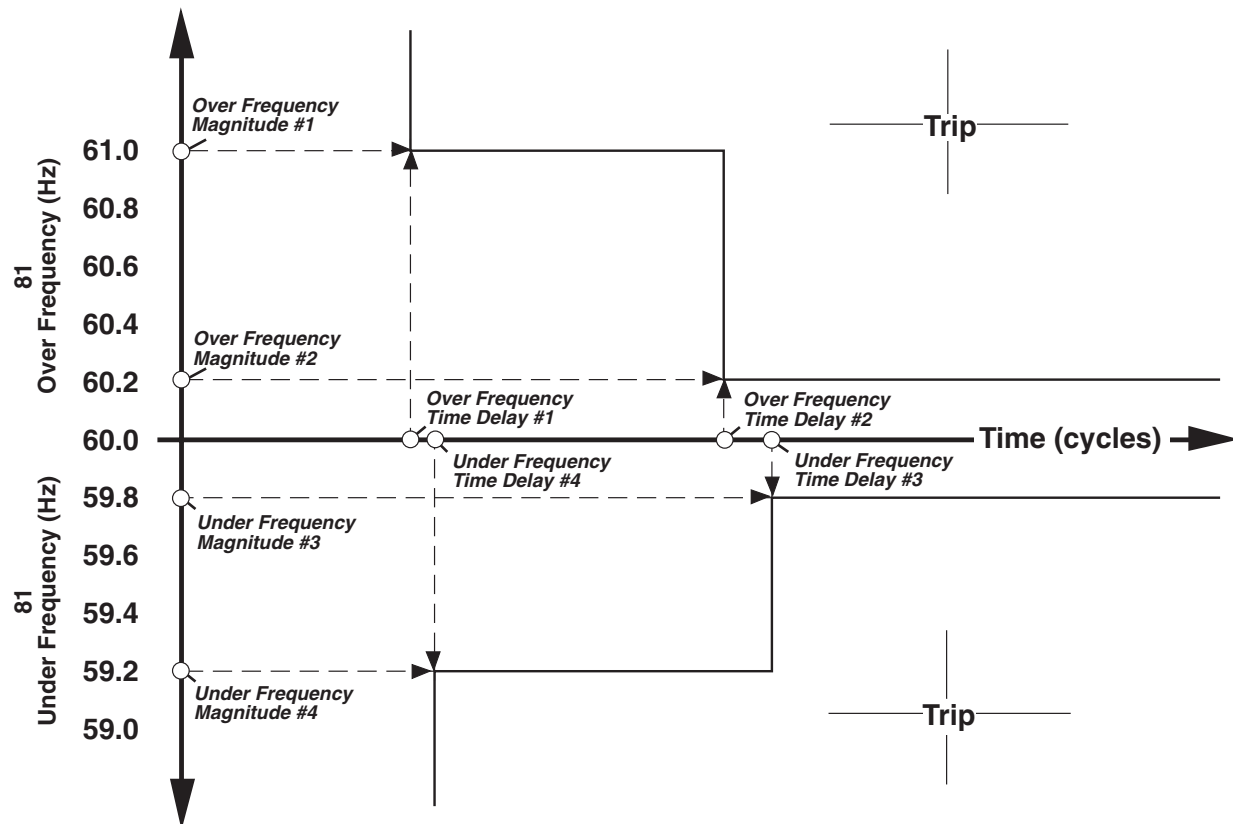


Figure 4-85 Example of Frequency (81) Trip Characteristics

**81: Over/Under Frequency** X

---

**#1**

Pickup:  50.00   67.00 (Hz)

Time Delay:  3   65500 (Cycles)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**#2**

Pickup:  50.00   67.00 (Hz)

Time Delay:  3   65500 (Cycles)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input checked="" type="checkbox"/> FL	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**#3**

Pickup:  50.00   67.00 (Hz)

Time Delay:  3   65500 (Cycles)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

---

**#4**

Pickup:  50.00   67.00 (Hz)

Time Delay:  3   65500 (Cycles)

**Outputs**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14	<input type="checkbox"/> 15	<input type="checkbox"/> 16
<input type="checkbox"/> 17	<input type="checkbox"/> 18	<input type="checkbox"/> 19	<input type="checkbox"/> 20	<input type="checkbox"/> 21	<input type="checkbox"/> 22	<input type="checkbox"/> 23	

**Blocking Inputs**

<input type="checkbox"/> FL	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9
<input type="checkbox"/> 10	<input type="checkbox"/> 11	<input type="checkbox"/> 12	<input type="checkbox"/> 13	<input type="checkbox"/> 14

Figure 4-86 Frequency (81) Setpoint Ranges

**81A Frequency Accumulator**

Frequency Accumulation feature (81A) provides an indication of the amount of off frequency operation accumulated.

Turbine blades are designed and tuned to operate at rated frequencies, operating at frequencies different than rated can result in blade resonance and fatigue damage. In 60 Hz machines, the typical operating frequency range for 18 to 25 inch blades is 58.5 to 61.5 Hz and for 25 to 44 inch blades is between 59.5 and 60.5 Hz. Accumulated operation, for the life of the machine, of not more than 10 minutes for frequencies between 56 and 58.5 Hz and not more than 60 minutes for frequencies between 58.5 and 59.5 Hz is acceptable on typical machines.

The 81A function can be configured to track off nominal frequency operation by either set point or when the frequency is within a frequency band.

When using multiple frequency bands, the lower limit of the previous band becomes the upper limit for the next band, i.e., Low Band #2 is the upper limit for Band #3, and so forth. Frequency bands must be used in sequential order, 1 to 6. Band #1 must be enabled to use Bands #2–#6. If any band is disabled, all following bands are disabled.

When frequency is within an enabled band limit, accumulation time starts (there is an internal ten cycle delay prior to accumulation), this allows the underfrequency blade resonance to be established to avoid unnecessary accumulation of time. When accumulated duration is greater than set delay, then the 81A function operated the programmed output contact. The contact can be used to alert the operator or trip the machine.

The accumulator status can be set to preserve the accumulated information from previous devices. This allows the relay to begin accumulating information at a pre-defined value. This setpoint is only available through IPScom® Communications Software.

81A #1 HIGH BAND PICKUP
_____ Hz
81A #1 LOW BAND PICKUP
_____ Hz
81A #1 DELAY
_____ Cycles
81A #2 LOW BAND PICKUP
_____ Hz
81A #2 DELAY
_____ Cycles
81A #3 LOW BAND PICKUP
_____ Hz
81A #3 DELAY
_____ Cycles

81A #4 LOW BAND PICKUP
_____ Hz
81A #4 DELAY
_____ Cycles
81A #5 LOW BAND PICKUP
_____ Hz
81A #5 DELAY
_____ Cycles
81A #6 LOW BAND PICKUP
_____ Hz
81A #6 DELAY
_____ Cycles

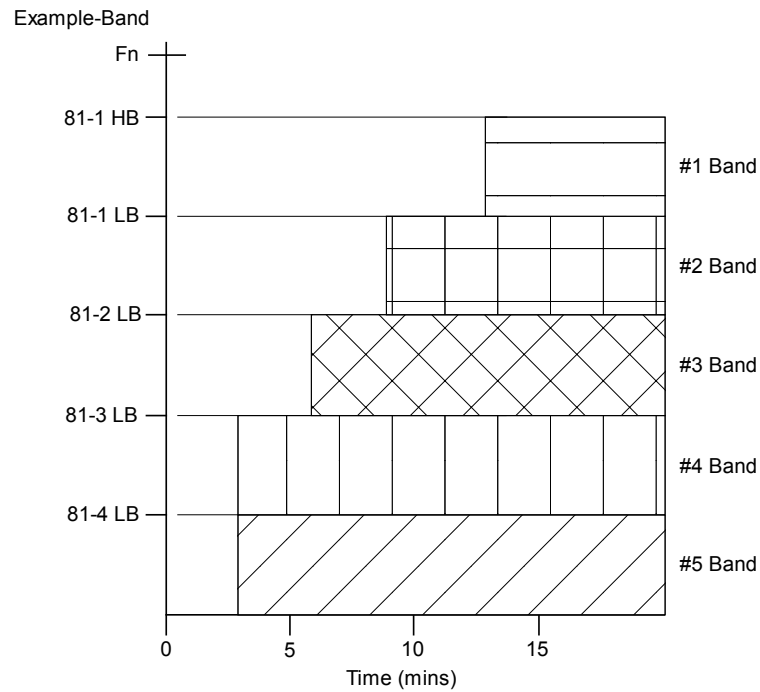


Figure 4-87 Frequency Accumulator (81A) Example Bands

Figure 4-88 Frequency Accumulator (81A) Setpoint Ranges

### 81R Rate of Change of Frequency

The Rate of Change of Frequency function (81R) can be used for load shedding or tripping applications.

The function also has an automatic disable feature which disables 81R function during unbalanced faults and other system disturbances. This feature uses negative sequence voltage to block the 81R function. When the measured negative sequence voltage exceeds the inhibit setting, the function 81R and metering are blocked. The time delay and magnitude settings of 81R should be based on simulation studies. The ranges and increments are shown in [Figure 4-89](#).

81r #1 PICKUP
_____ Hz/s
81R #1 DELAY
_____ Cycles
81R #2 PICKUP
_____ Hz/s
81R #2 DELAY
_____ Cycles
81R NEG SEQ VOLT INHIBIT
_____ %

**81R: Rate of Change of Frequency**

**#1**

Pickup:  0.10   20.00 (Hz/s)

Time Delay:  3   8160 (Cycles)

**Outputs**

☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**#2**

Pickup:  0.10   20.00 (Hz/s)

Time Delay:  3   8160 (Cycles)

**Outputs**

☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8  
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16  
☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

**Blocking Inputs**

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4  
☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9  
☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

**Setting**

Negative Sequence Voltage Inhibit:  0   99 (%)

Figure 4-89 Rate of Change of Frequency (81R) Setpoint Ranges

### 87 Phase Differential

The Phase Differential function (87) is a percentage differential with an adjustable slope of 1–100%. Although this protection is used to protect the machine from all internal winding faults, single-phase to ground faults in machines with high impedance grounding may have currents less than the sensitivity of the differential relay (typically between 3 and 30 primary amps). Ranges and increments are presented in [Figure 4-91](#).

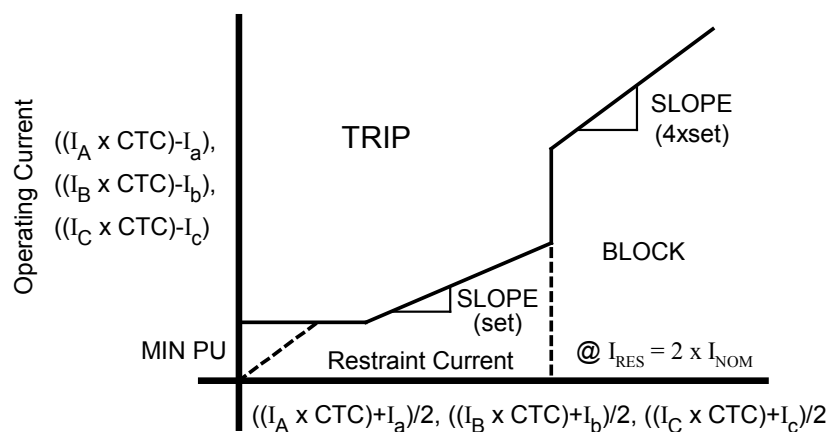
Turn-to-turn faults are not detected by differential relays because the current into the generator equals the current out (see functions 50DT and 59X for turn-to-turn fault protection.) Even though the percentage differential relay is more tolerant of CT errors, all CTs should have the same characteristics and accuracies.

To provide restraint for CT saturation at high offset currents, the slope is automatically adjusted (at a restraining current equal to two times nominal current) to four times the slope setting, see [Figure 4-90](#).

For very high currents in large generators, the proximity of CTs and leads in different phases can cause unbalanced currents to flow in the secondaries. These currents must be less than the minimum sensitivity of the relay.

There are two elements in this function. Element #2 is intended to provide phase differential protection for SFC (Static Frequency Converter) starting gas turbine generator applications. Element #1 should be disabled with a contact blocking input during a converter start operation (generator off-line), since the current is carried by only neutral side CTs and the resulting differential current may mis-operate 87#1 function. The 87#2 element, which is set with a higher current pickup, will still provide protection for this condition.

87 #1 PICKUP _____ Amps	A typical setting is 0.3 amps.
87 #1 SLOPE _____ %	A typical setting is 10%.
87 #1 DELAY _____ Cycles	A typical setting is one cycle. Typical settings given above assume matched current transformer performance, and that transformer inrush of the unit transformer does not cause dc saturation of the generator CTs. If there is a significant difference in current transformer ratings (C800 vs C200, for example), or if saturation of the generator CTs is expected during energizing of the step up transformer, more appropriate settings might be 0.5 A pick up, 20% slope, and a delay of 5 to 8 cycles.
87 #2 PICKUP _____ Amps	
87 #2 SLOPE _____ %	
87 #2 DELAY _____ Cycles	If line side and neutral side CTs do not have the same ratio, the ratio error can be corrected (the line side measured current is multiplied by the phase CT correction settings.)
87 PHASE CT CORRECTION _____	Phase CT Correction = $\frac{\text{Line Side CTR}}{\text{Neutral Side CTR}}$



Where  $I_A$  and  $I_a$  are generator high side and neutral side currents respectively, and CTC is the CT Phase correction.

Figure 4-90 Differential Relay (87) Operating Characteristics

87: Phase Differential Current

#1

Pickup: 0.40 0.20 3.00 (A) Disable

Time Delay: 2 1 8160 (Cycles)

Percent Slope: 20 1 100 (%)

Outputs

☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

#2

Pickup: 3.00 0.20 3.00 (A) Disable

Time Delay: 1 1 8160 (Cycles)

Percent Slope: 1 1 100 (%)

Outputs

☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☒ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Setting

Phase CT Correction: 1.00 0.50 2.00

Save Cancel

Figure 4-91 Phase Differential (87) Setpoint Ranges



### 87GD Ground (Zero Sequence) Differential

The Zero Sequence Differential function (87GD) provides ground fault protection for low impedance grounded generator applications. High sensitivity and fast operation can be obtained using this function. Ranges and increments are presented in [Figure 4-92](#).

The relay provides a CT Ratio Correction Factor ( $R_C$ ) which removes the need for auxiliary CTs when the phase and neutral CT ratios are different.

When the system can supply zero sequence current to the ground fault (such as when several generators are bussed together), the 87GD function operates directionally. The directional element calculates the product  $(-3I_0I_N\cos\theta)$  for directional indication. The relay will operate only if  $I_0$  (Zero sequence current derived from phase CTs) and  $I_N$  (Neutral current from Neutral CT) have the opposite polarity, which is the case for internal generator faults.

The advantage of directional supervision is the security against ratio errors and CT saturation during faults external to the protected generator.

The directional element is inoperative if the residual current ( $3I_0$ ) is approximately less than 0.2 A, in which case the algorithm automatically disables the directional element and the 87GD function becomes non-directional differential. The pickup quantity is then calculated as the difference between the corrected triple zero-sequence current ( $R_C3I_0$ ) and the neutral current ( $I_N$ ). The magnitude of the difference ( $R_C3I_0 - I_N$ ) is compared to the relay pickup.

For security purposes during external high phase-fault currents causing CT saturation, this function is disabled any time the value of  $I_N$  is less than approximately 0.20 amps.

■ **NOTE:** When 87GD is enabled, 67N function is not available.

87GD PICKUP
_____ Amps
87GD DELAY
_____ Cycles
87GD C.T. RATIO CORRECT
_____

A typical setting is 0.2 amps. (Relay amps = primary amps  $\div$  CT ratio.) For higher values of  $R_C$ , noise may create substantial differential current making higher pickup settings desirable.

▲ **CAUTION:** Do NOT set the Delay to less than 2 Cycles.

In order to prevent mis-operation during external faults with CT saturation conditions, a time delay of 6 cycles or higher is recommended.

CT Ratio Correction Factor = (Phase CT Ratio)/(Neutral CT Ratio)

87GD: Ground Differential

Pickup: 0.20 0.20 10.00 (A) Disable

Pick-up Delay: 1 1 8160 (Cycles)

CT Ratio Correction: 0.10 0.10 7.99

Outputs

☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs

☒ FL ☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-92 Ground Differential (87GD) Setpoint Ranges

## Breaker Monitoring

The Breaker Monitoring feature calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current (IT) or current squared ( $I^2T$ ) 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 operate a

programmable output contact. The accumulated value for each phase can be displayed as an actual value. The accumulation starts after a set time delay from the trip initiate command to account for the time it takes for the breaker to start opening its contacts. The accumulation continues until the current drops below 10% of the nominal current setting or 10 cycles, whichever occurs first.

■ **NOTE:** Preset Accumulator Setpoints are only available through IPScorn®.

BM PICKUP	_____ kA-cycles
BM INPUT INITIATE	i6 i5 i4 i3 i2 i1
BM OUTPUT INITIATE	08 07 06 05 04 03 02 01
BM DELAY	_____ Cycles
BM TIMING METHOD	it i2t

Expanded Inputs IN7–IN14 (if equipped) must be set using IPScorn.

Expanded Outputs OUT9–OUT23 (if equipped) must be set using IPScorn.

BM: Breaker Monitoring

Pickup: 10 0 50000 (kA Cycles) Disable

Time Delay: 10.0 0.1 4095.9 (Cycles)

Timing Method Selection: ☒ IT ☐ I<sup>2</sup>T

Preset Accumulator Phase A: 0 0 50000 (kA Cycles)

Preset Accumulator Phase B: 0 0 50000 (kA Cycles)

Preset Accumulator Phase C: 0 0 50000 (kA Cycles)

Output Initiate

☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Input Initiate

☐ 1 ☒ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Outputs

☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23

Blocking Inputs

☐ FL ☐ 1 ☐ 2 ☐ 3 ☒ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14

Save Cancel

Figure 4-93 Breaker Monitor (BM) Setpoint Ranges

### Trip Circuit Monitoring

External connections for the Trip Circuit Monitoring function are shown in [Figure 4-94](#). 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-3425A 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

---

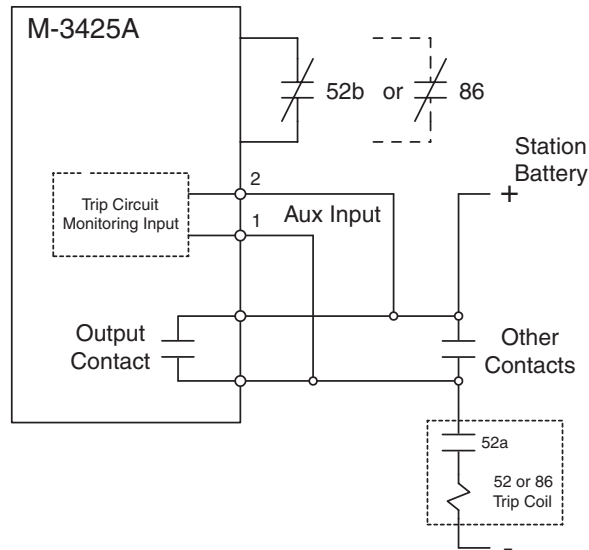


Figure 4-94 Trip Circuit Monitoring Input

Figure 4-95 Trip Circuit Monitor (TC) Setpoint Ranges

### **IPSlogic™**

The relay provides six logic functions and associated IPSlogic. The logic 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® Communications Software. The IPSlogic cannot be programmed using the Human-Machine Interface (HMI).

---

IPS LOGIC

USE IPSCOM TO CONFIGURE

---

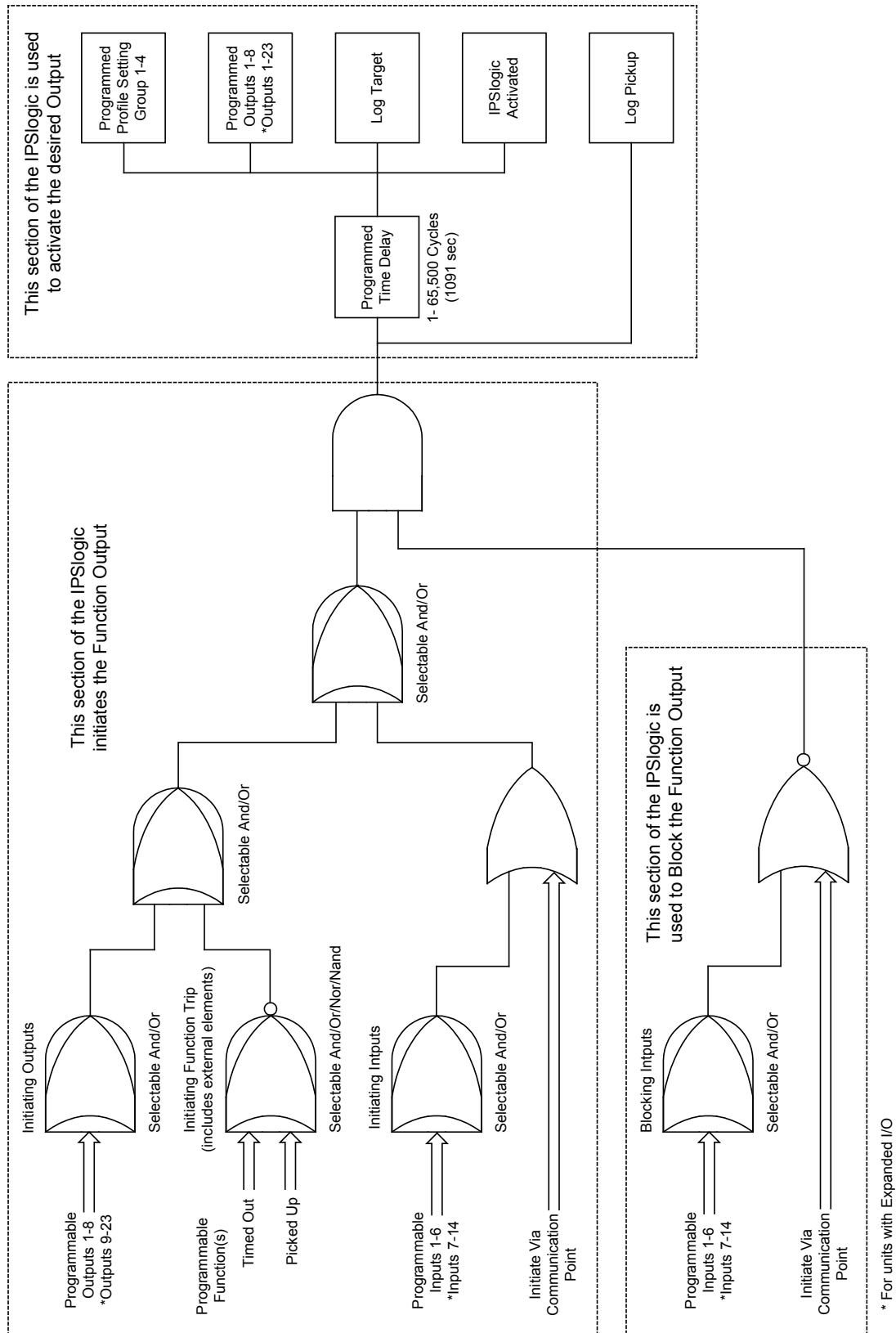


Figure 4-96 IPSlogic™ Function Setup

### Settings and Logic Applicable when IPSlogic™ Function(s) programmed using IPScom®

There are four initiating input sources: Initiating Outputs, Initiating Function Trips, Function Pickup (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 activation state of the input function selected in the Initiating Function can be either timeout (Trip) or pickup. 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 IPScom IPSlogic Function programming screen is shown in [Figure 4-97](#).

The screenshot shows the 'IPSlogic' programming interface. It features a top navigation bar with tabs #1 through #6. The main area is divided into several functional blocks:

- Initiating Outputs:** A grid of checkboxes for outputs 1 through 23. Checkboxes 3 and 4 are selected.
- Initiating Function Pickup:** A button labeled 'Initiating Function Pickup'.
- Initiating Function Timeout:** A button labeled 'Initiating Function Timeout'.
- Initiating Inputs:** A grid of checkboxes for inputs 1 through 14. Checkboxes 4 and 5 are selected.
- Blocking Inputs:** A grid of checkboxes for inputs 1 through 14. Checkboxes 1 and 2 are selected.
- Logic Diagram:** A central area showing a logic circuit. It includes OR gates combining inputs from the Initiating Outputs, Initiating Inputs, and Blocking Inputs sections. The circuit also includes an AND gate and a NOT gate.
- Timing:** A section for 'Time Delay' set to 30 and 'Reset/Dropout Delay' set to 0. It also includes radio buttons for 'Reset' and 'Dropout'.
- Outputs:** A grid of checkboxes for outputs 1 through 23. Checkboxes 2 and 3 are selected.
- Profile Switch:** A section with radio buttons for profiles #1, #2, #3, #4, and 'Not Activated'. Profile #2 is selected.
- Buttons:** 'Save' and 'Cancel' buttons at the bottom right.

#### ■ NOTES:

1. This logic gate may be selected as either AND or OR.
2. This logic gate may be selected as AND, OR, NOR, or NAND.

Figure 4-97 IPSlogic Function Programming

Initiating Function Pickup

Functions				
<input type="checkbox"/> 21 #1	<input type="checkbox"/> 32 #3	<input type="checkbox"/> 50/27	<input type="checkbox"/> 64F #2	<input type="checkbox"/> 81R #1
<input type="checkbox"/> 21 #2	<input type="checkbox"/> 40 #1	<input type="checkbox"/> 51N	<input type="checkbox"/> 64S	<input type="checkbox"/> 81R #2
<input type="checkbox"/> 21 #3	<input type="checkbox"/> 40 #2	<input type="checkbox"/> 51V	<input type="checkbox"/> 67N DT	<input type="checkbox"/> 87 #1
<input type="checkbox"/> 24 DT #1	<input type="checkbox"/> 40 VC#1	<input type="checkbox"/> 59 #1	<input type="checkbox"/> 67N IT	<input type="checkbox"/> 87 #2
<input type="checkbox"/> 24 DT #2	<input type="checkbox"/> 40 VC#2	<input type="checkbox"/> 59 #2	<input type="checkbox"/> 78	<input type="checkbox"/> 87GD
<input type="checkbox"/> 24 IT	<input type="checkbox"/> 46 DT	<input type="checkbox"/> 59 #3	<input type="checkbox"/> 81 #1	<input type="checkbox"/> IPSL #1
<input type="checkbox"/> 25 D	<input type="checkbox"/> 46 IT	<input type="checkbox"/> 59D	<input type="checkbox"/> 81 #2	<input type="checkbox"/> IPSL #2
<input type="checkbox"/> 25 S	<input type="checkbox"/> 49 #1	<input type="checkbox"/> 59N #1	<input type="checkbox"/> 81 #3	<input type="checkbox"/> IPSL #3
<input type="checkbox"/> 27 #1	<input type="checkbox"/> 49 #2	<input type="checkbox"/> 59N #2	<input type="checkbox"/> 81 #4	<input type="checkbox"/> IPSL #4
<input type="checkbox"/> 27 #2	<input type="checkbox"/> 50 #1	<input type="checkbox"/> 59N #3	<input type="checkbox"/> 81A #1	<input type="checkbox"/> IPSL #5
<input type="checkbox"/> 27 #3	<input type="checkbox"/> 50 #2	<input type="checkbox"/> 59X #1	<input type="checkbox"/> 81A #2	<input type="checkbox"/> IPSL #6
<input type="checkbox"/> 27TN #1	<input type="checkbox"/> 50BF	<input type="checkbox"/> 59X #2	<input type="checkbox"/> 81A #3	<input type="checkbox"/> BM
<input type="checkbox"/> 27TN #2	<input type="checkbox"/> 50DT #1	<input type="checkbox"/> 60FL	<input type="checkbox"/> 81A #4	<input type="checkbox"/> TC
<input type="checkbox"/> 32 #1	<input type="checkbox"/> 50DT #2	<input type="checkbox"/> 64B	<input type="checkbox"/> 81A #5	
<input type="checkbox"/> 32 #2	<input type="checkbox"/> 50N	<input type="checkbox"/> 64F #1	<input type="checkbox"/> 81A #6	

OK

Figure 4-98 Selection Screen for Initiating Function Pickup

Initiating Function Timeout

Functions				
<input type="checkbox"/> 21 #1	<input type="checkbox"/> 32 #3	<input type="checkbox"/> 50/27	<input type="checkbox"/> 64F #2	<input type="checkbox"/> 81R #1
<input type="checkbox"/> 21 #2	<input type="checkbox"/> 40 #1	<input type="checkbox"/> 51N	<input type="checkbox"/> 64S	<input type="checkbox"/> 81R #2
<input type="checkbox"/> 21 #3	<input type="checkbox"/> 40 #2	<input type="checkbox"/> 51V	<input type="checkbox"/> 67N DT	<input type="checkbox"/> 87 #1
<input type="checkbox"/> 24 DT #1	<input type="checkbox"/> 40 VC#1	<input type="checkbox"/> 59 #1	<input type="checkbox"/> 67N IT	<input type="checkbox"/> 87 #2
<input type="checkbox"/> 24 DT #2	<input type="checkbox"/> 40 VC#2	<input type="checkbox"/> 59 #2	<input type="checkbox"/> 78	<input type="checkbox"/> 87GD
<input type="checkbox"/> 24 IT	<input type="checkbox"/> 46 DT	<input type="checkbox"/> 59 #3	<input type="checkbox"/> 81 #1	<input type="checkbox"/> IPSL #1
<input type="checkbox"/> 25 D	<input type="checkbox"/> 46 IT	<input type="checkbox"/> 59D	<input type="checkbox"/> 81 #2	<input type="checkbox"/> IPSL #2
<input type="checkbox"/> 25 S	<input type="checkbox"/> 49 #1	<input type="checkbox"/> 59N #1	<input type="checkbox"/> 81 #3	<input type="checkbox"/> IPSL #3
<input type="checkbox"/> 27 #1	<input type="checkbox"/> 49 #2	<input type="checkbox"/> 59N #2	<input type="checkbox"/> 81 #4	<input type="checkbox"/> IPSL #4
<input type="checkbox"/> 27 #2	<input type="checkbox"/> 50 #1	<input type="checkbox"/> 59N #3	<input type="checkbox"/> 81A #1	<input type="checkbox"/> IPSL #5
<input type="checkbox"/> 27 #3	<input type="checkbox"/> 50 #2	<input type="checkbox"/> 59X #1	<input type="checkbox"/> 81A #2	<input type="checkbox"/> IPSL #6
<input type="checkbox"/> 27TN #1	<input type="checkbox"/> 50BF	<input type="checkbox"/> 59X #2	<input type="checkbox"/> 81A #3	<input type="checkbox"/> BM
<input type="checkbox"/> 27TN #2	<input type="checkbox"/> 50DT #1	<input type="checkbox"/> 60FL	<input type="checkbox"/> 81A #4	<input type="checkbox"/> TC
<input type="checkbox"/> 32 #1	<input type="checkbox"/> 50DT #2	<input type="checkbox"/> 64B	<input type="checkbox"/> 81A #5	
<input type="checkbox"/> 32 #2	<input type="checkbox"/> 50N	<input type="checkbox"/> 64F #1	<input type="checkbox"/> 81A #6	

OK

Figure 4-99 Selection Screen for Initiating Function Timeout

### DO/RST (Dropout/Reset) Timer Feature

The DO/RST timer can be set as either Dropout or Reset mode. The operation of the Dropout Delay Timer and the Reset Delay Timer are described below.

### Dropout Delay Timer

The Dropout Delay Timer logic is presented in [Figure 4-100](#). The Dropout Delay Timer feature allows the user to affect an output time delay that starts when the IPSlogic PU Status drops out (A) and can hold the Output (D) status true beyond the Output Seal In Delay value (C).

However, the Seal In Delay (E) may hold the Output (B) true if the time after IPSlogic PU Status dropout (A) and Dropout Delay Timer value (D) are less than the Seal In Delay time (E).

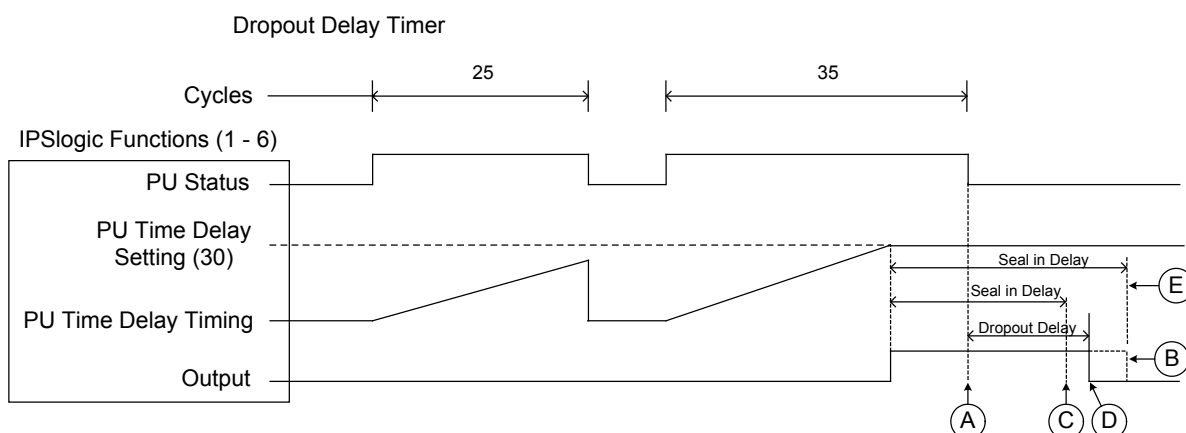


Figure 4-100 Dropout Delay Timer Logic Diagram

### Reset Delay Timer

The Reset Delay Timer logic is presented in [Figure 4-101](#). The Reset Delay Timer feature allows the user to delay the reset of the PU Time Delay Timer and hold the accumulated timer value (A) for the duration of the Reset Time Delay time period (B). The Reset Delay Timer starts when the IPSlogic PU Status drops out (C). The Reset Delay Timer starts when the IPSlogic PU Status drops out (C).

If the IPSlogic PU Status remains dropped out (D) after the reset delay has timed out, then the IPSlogic PU timer value will be reset to zero (E).

If the IPSlogic PU Status reasserts (F) while the Reset Delay Timer is still timing, then the PU Timer Delay begins timing from the accumulated value (G).

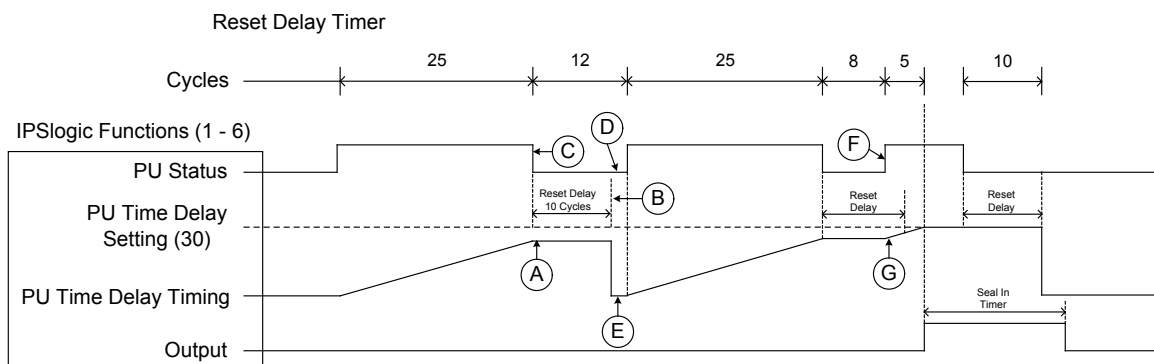


Figure 4-101 Reset Delay Timer Logic Diagram



# 5 Installation

5.1	General Information .....	5-1
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5.3	External Connections .....	5-8
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## 5.1 General Information

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

The person or group responsible for the installation of the relay 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 Settings and Setpoints**. Further, a 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**.

### Service Conditions and Conformity to CE Standard

Stating conformance to CE Standard EN 61010-1 2001, operation of this equipment within the following service conditions does not present any known personnel hazards outside of those stated herein:

- 5° to 40° Centigrade
- Maximum relative humidity 80% for temperatures up to 31° C, decreasing in a linear manner to 50% relative humidity at 40° C.

This equipment will function properly, and at stated accuracies beyond the limits of this CE Standard, as per the equipment's specifications, stated in this Instruction Book.

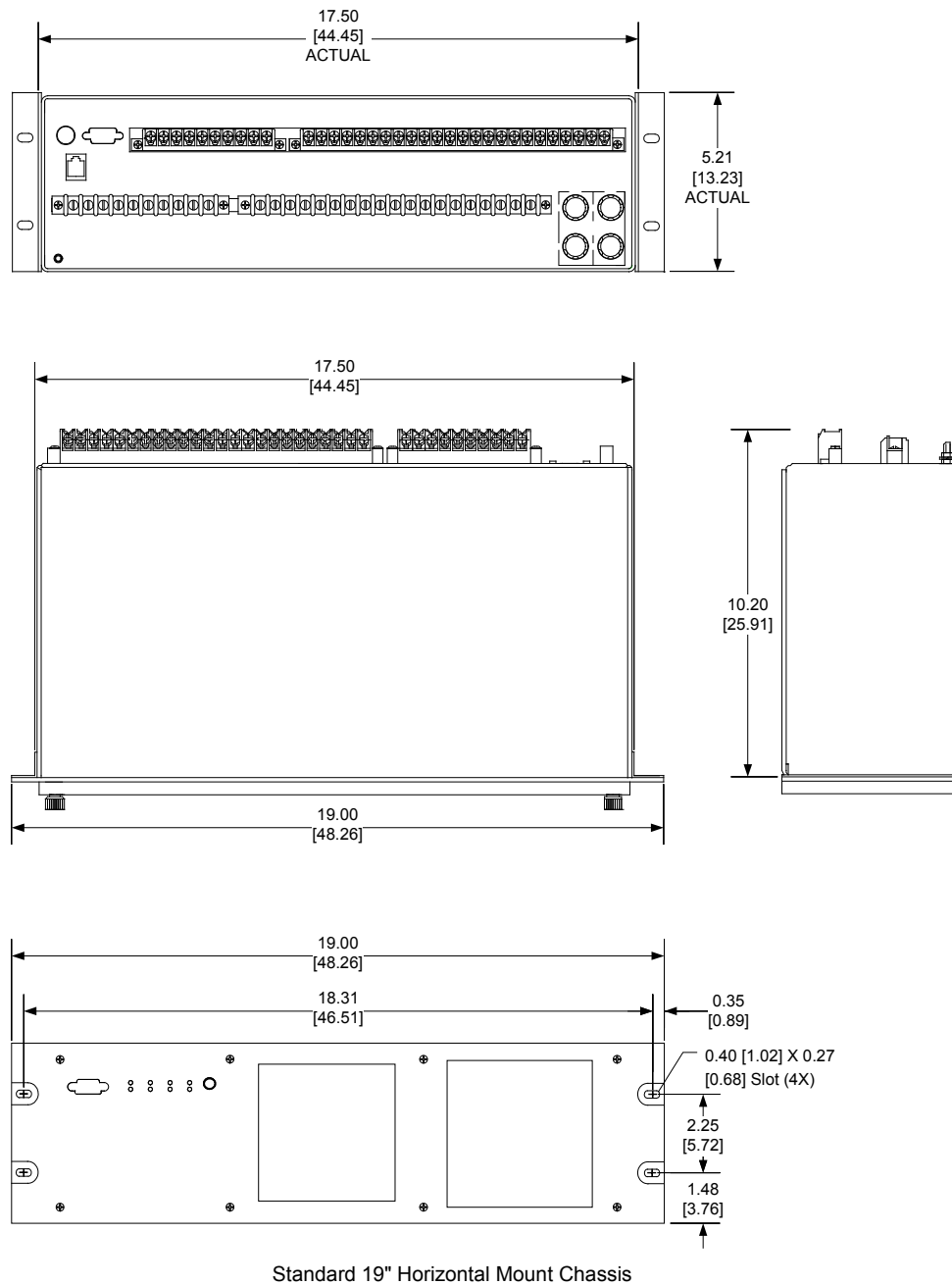
It is suggested the terminal connections illustrated here be transferred to *station* one-line wiring and three-line connection diagrams, *station* panel drawings and *station* DC wiring schematics.

If during the commissioning of the M-3425A Generator Protection Relay, additional tests are desired, **Chapter 6, Testing**, may be consulted.

Chapter 4, System Setup and Setpoints details the setup procedure. This includes details necessary for input of the communications data, unit setup data, configure relays data, the individual setpoints and time settings for each function, and oscillograph recorder setup information. Chapter 2 Operation, guides the operator through the status and metering screens, including monitoring the status and information on viewing the target history.

## 5.2 Mechanical/Physical Dimensions

Figure 5-1 through Figure 5-6 contain physical dimensions of the relay that may be required for mounting the unit on a rack.



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

Figure 5-1 M-3425A Horizontal Chassis Mounting Dimensions Without Expanded I/O (H1)

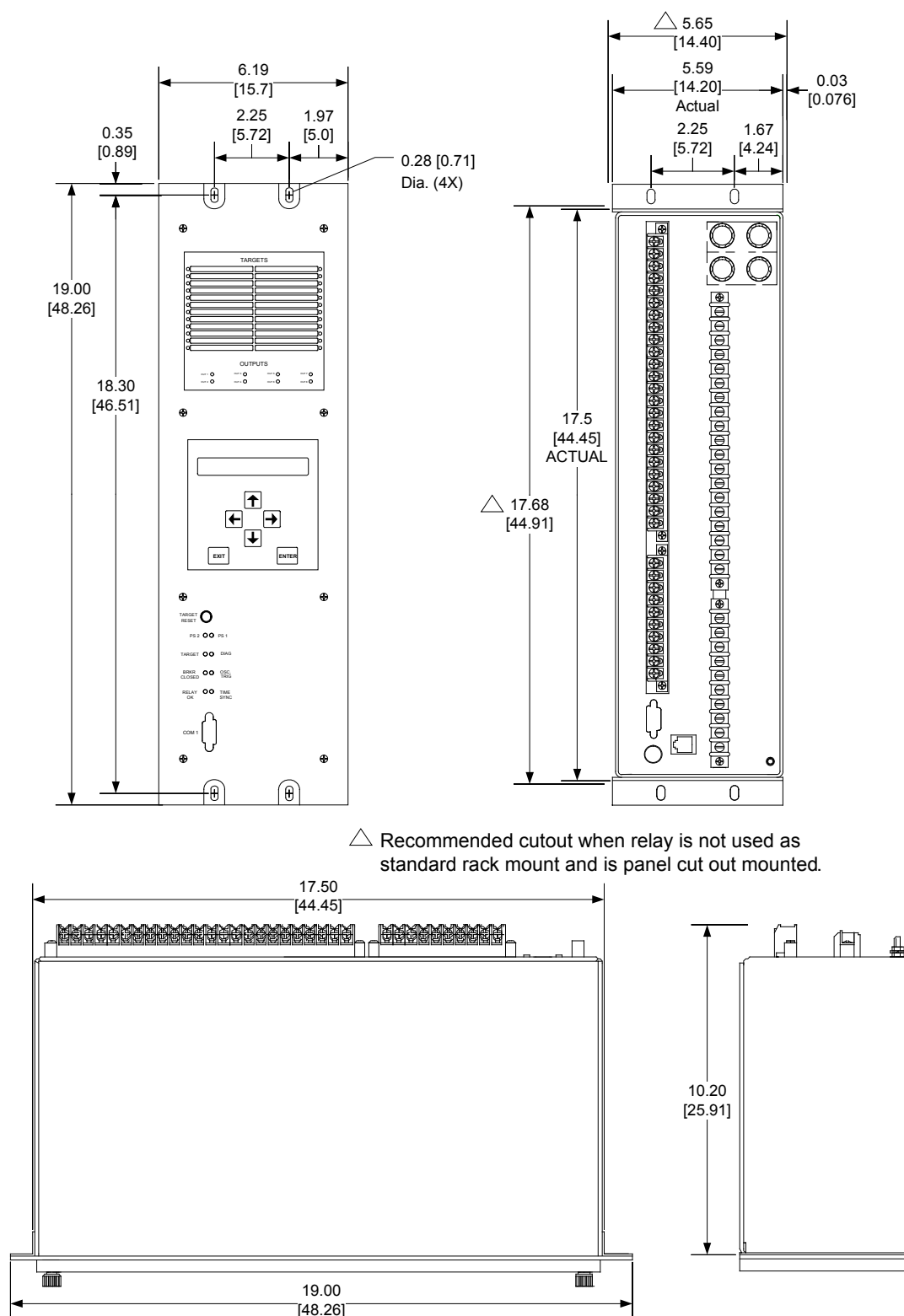
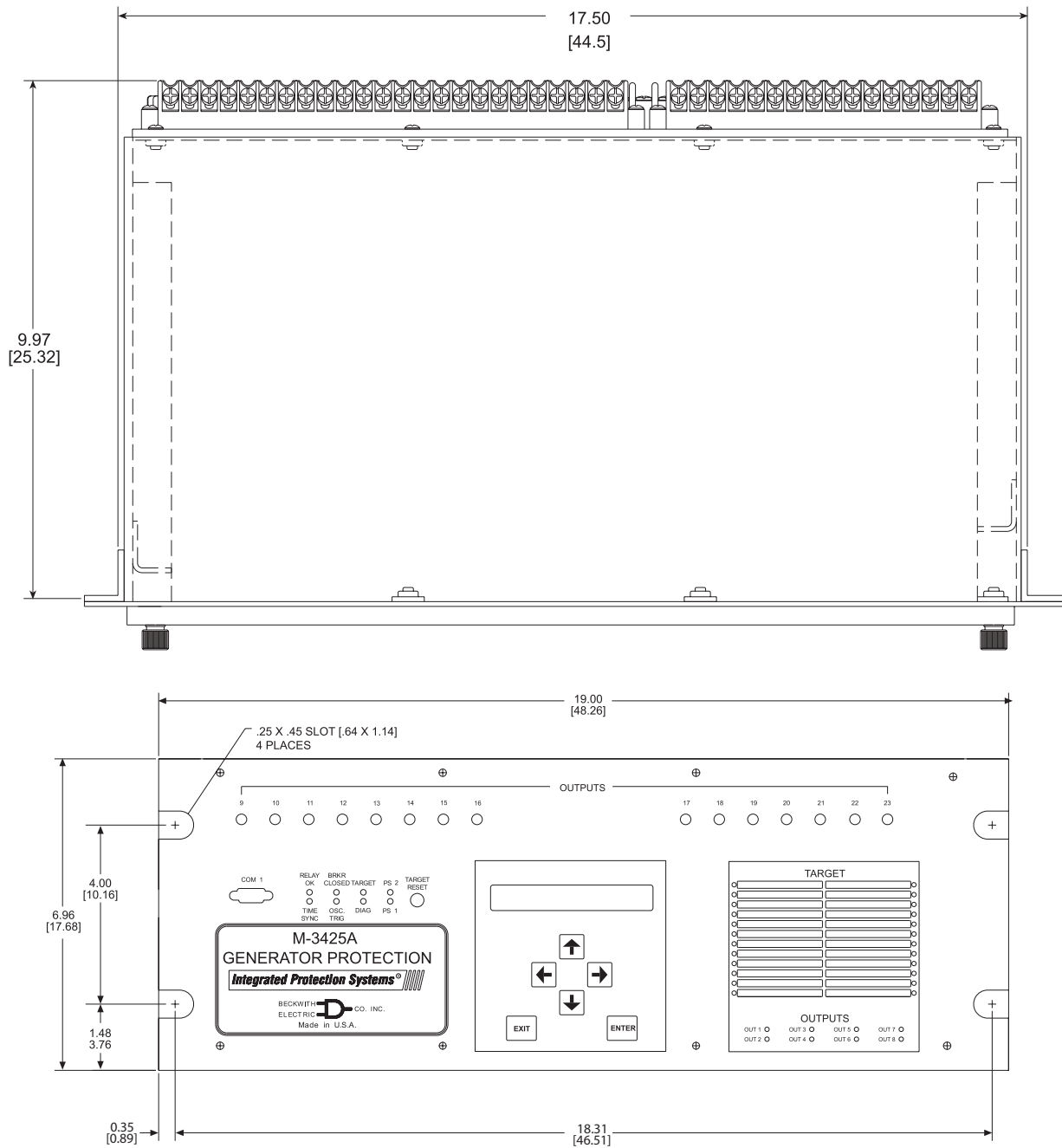
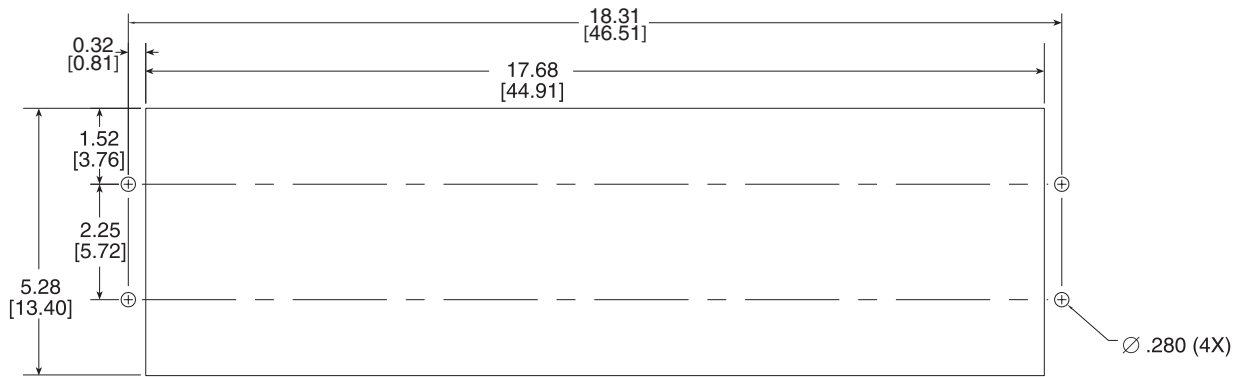


Figure 5-2 M-3425A Vertical Chassis Mounting Dimensions Without Expanded I/O (H2)

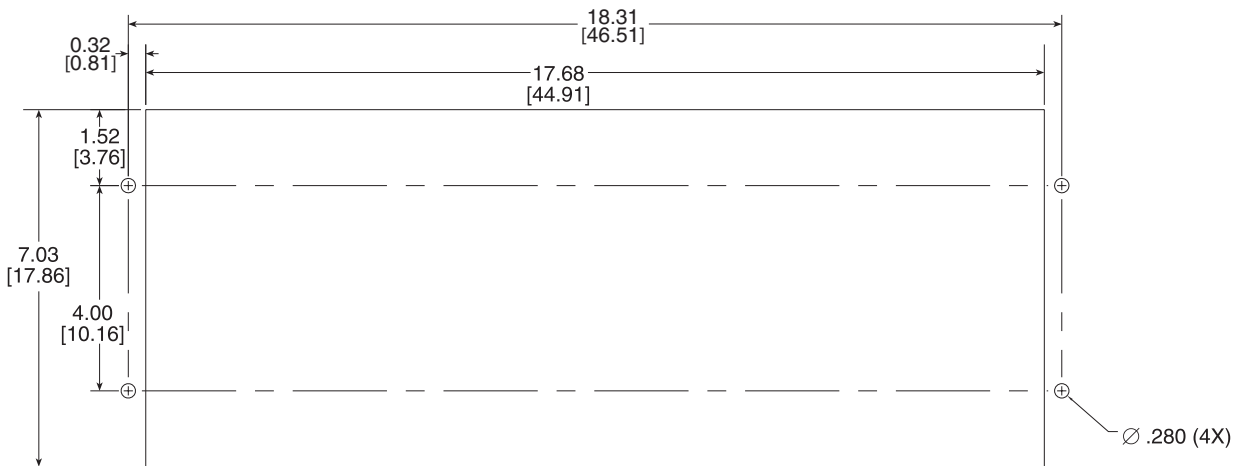


■NOTE: Dimensions in brackets are in centimeters.

Figure 5-3 M-3425A Mounting Dimensions Horizontal and Vertical Chassis With Expanded I/O



RECOMMENDED CUTOUT (H1)  
STANDARD 3 UNIT PANEL M-3425A (HORIZONTAL)



RECOMMENDED CUTOUT  
4 UNIT PANEL M-3425A (EXPANDED I/O HORIZONTAL AND VERTICAL)

TOLERANCE: .XX±.015

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

*Figure 5-4 M-3425A Panel Mount Cutout Dimensions*

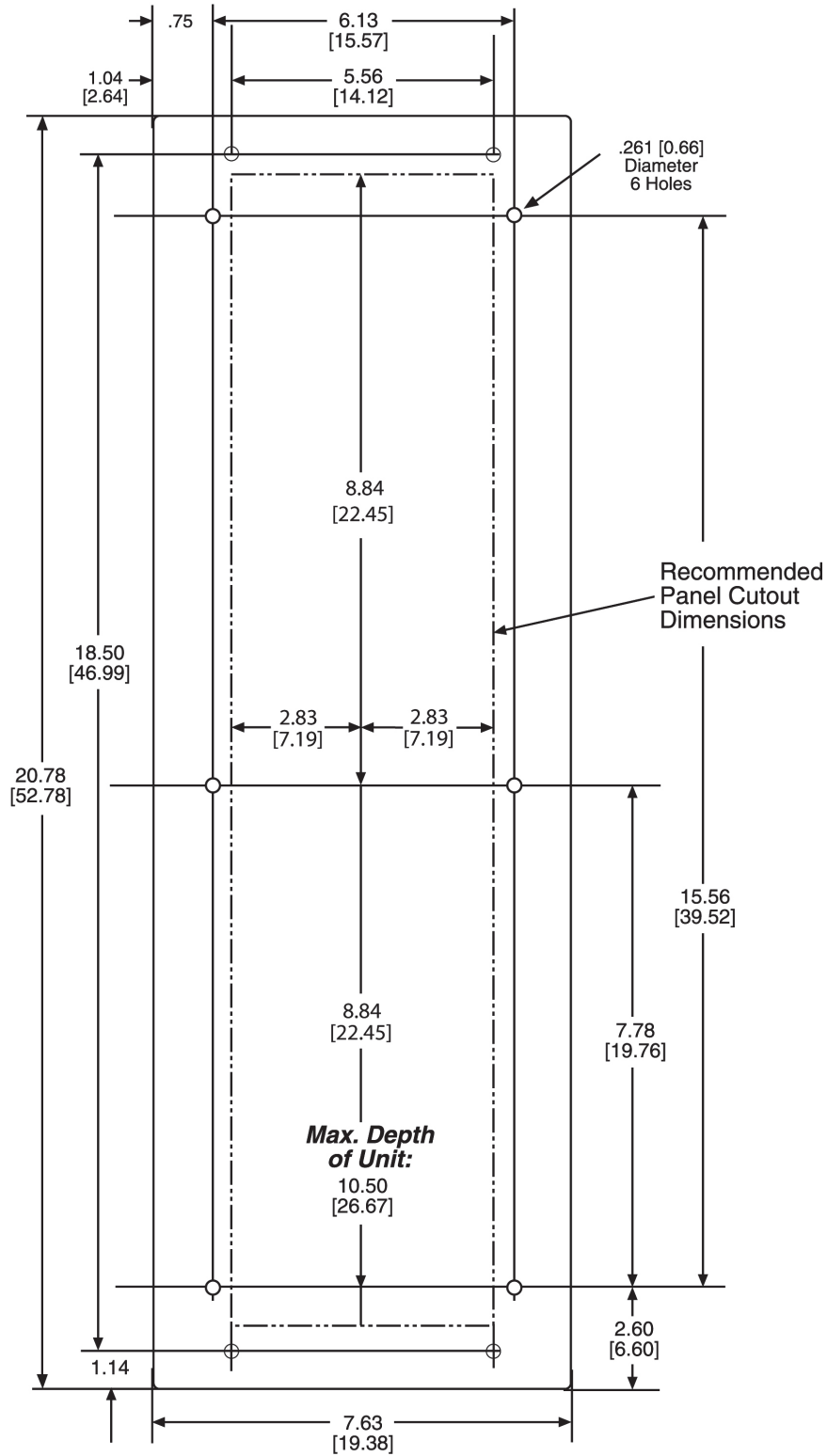
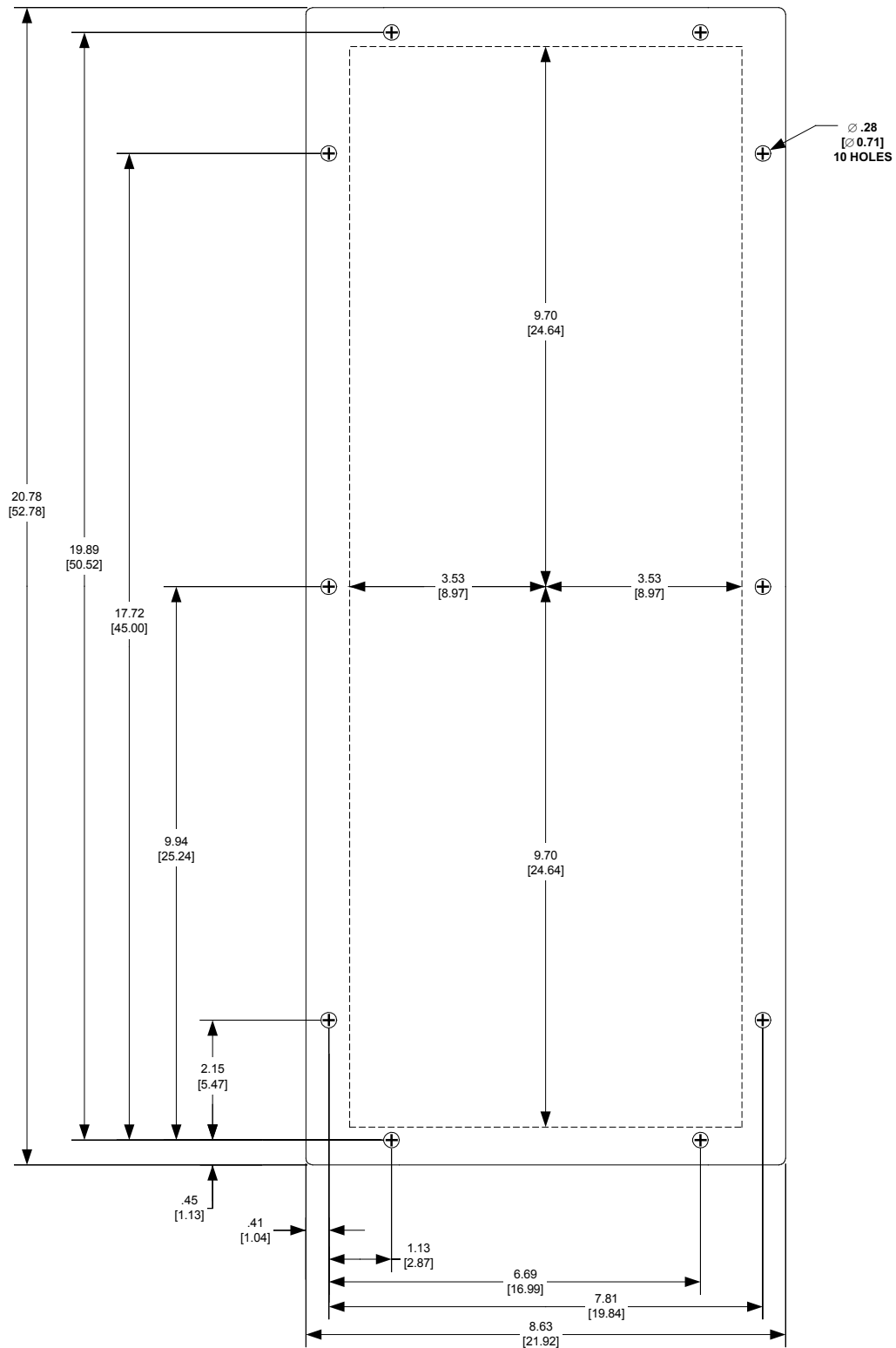


Figure 5-5 Mounting Dimensions for GE L-2 Cabinet H3 and H4



FRONT VIEW (H5)

Figure 5-6 (H5) Mounting Dimensions

### 5.3 External Connections

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

● **WARNING:** ONLY DRY CONTACTS must be connected to inputs (terminals 5 through 10 with 11 common and terminals 68 through 75 with 66 and 67 common) 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-3425A. 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 and CSA 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.

#### Power Supply

When the M-3425A without expanded I/O is equipped with the optional second power supply (Figure 5-7), the power source may be the same or two different sources.

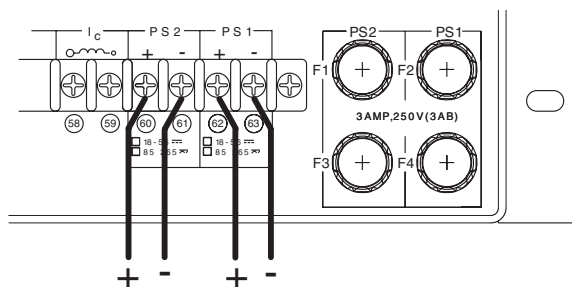


Figure 5-7 Optional Dual Power Supply

When the M-3425A with expanded I/O is equipped with two (not redundant) power supplies, the power supplies must be powered from the same source (Figure 5-8).

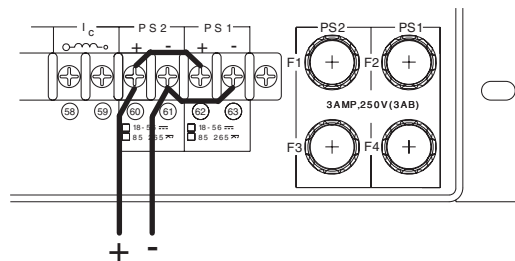


Figure 5-8 Expanded I/O Power Supply

#### Grounding Requirements

The M-3425A 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-3425A'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

- **Terminals 1–34 & 66–105:** 12.0 in-lbs
- **Terminals 35–65:** 8.0 in-lbs, minimum, and 9.0 in-lbs, maximum

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

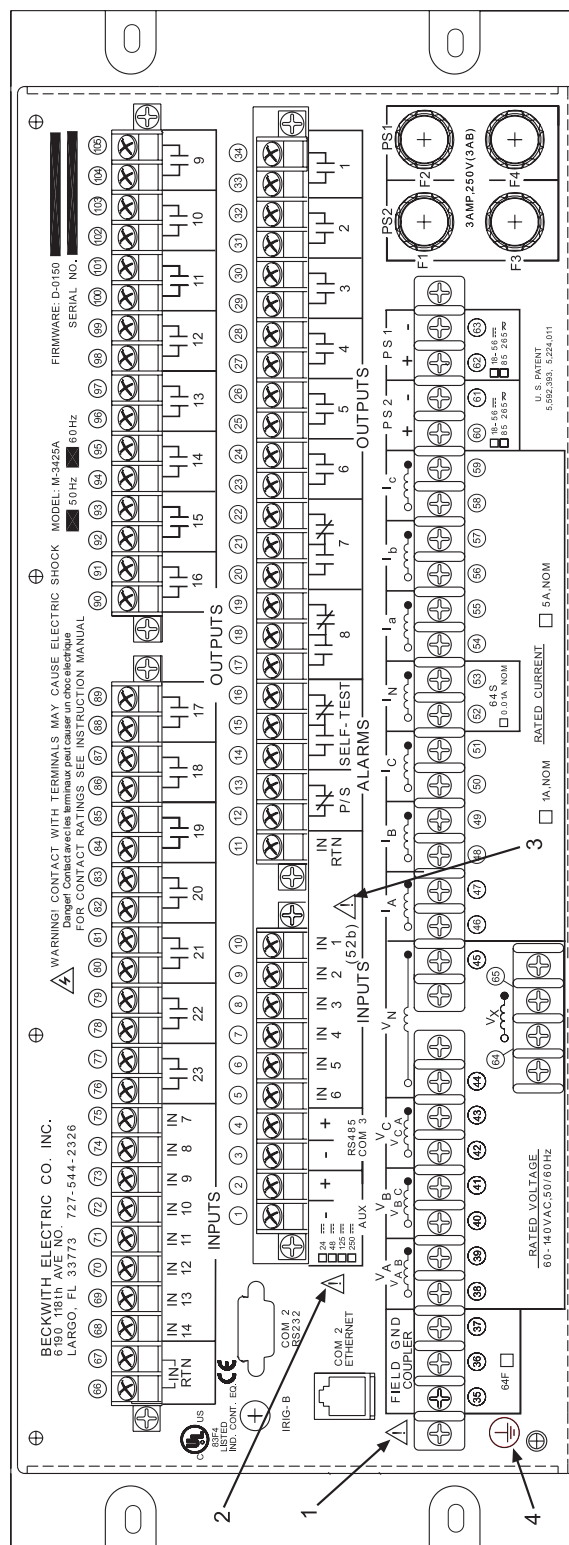
#### Relay Outputs

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. 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.

#### Replacement Fuses

F1–F4 replacement fuses must be fast-acting 3 Amp, 250 V (3AB) Beckwith Electric Part Number 420-00885.





*Figure 5-9 External Connections*

1. See M-3425A Instruction Book Section 2.3, Setpoints and Time Settings, subsection for 64B/F Field Ground Protection.
2. Before making connections to the Trip Circuit Monitoring input, see M-3425A Instruction Book 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.
3. **▲ CAUTION:** ONLY DRY CONTACTS must be connected to inputs (terminals 5 through 10 with 11 common and terminals 68 through 75 with 66 and 67 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.
4. **● WARNING:** The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.

To fulfill requirements for UL and CSA listing, 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.

**Torque Requirements:**

- Terminals 1–34, 66–105: 12.0 in-lbs
- Terminals 35–63: 8.0 in-lbs, minimum, and 9.0 in-lbs, maximum.

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

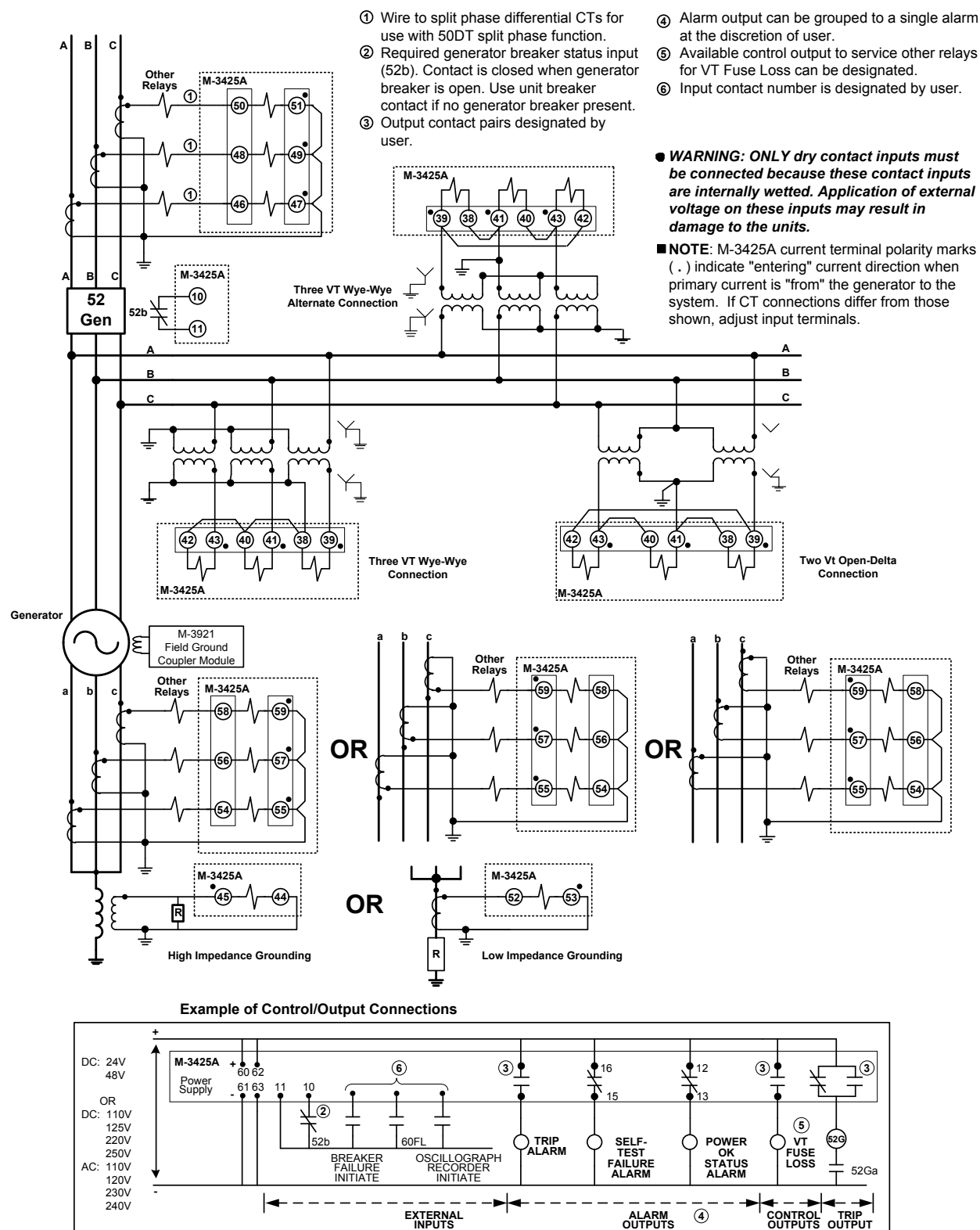


Figure 5-10 Three-Line Connection Diagram

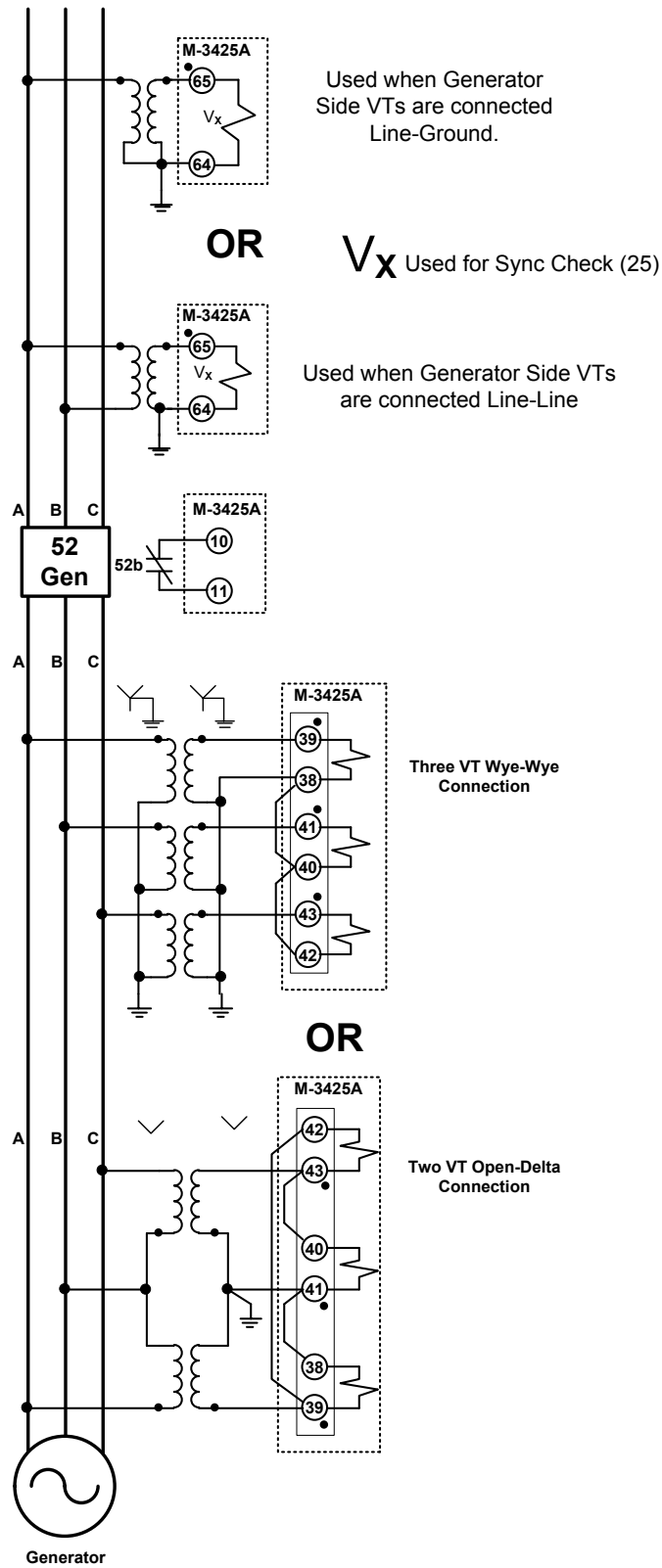
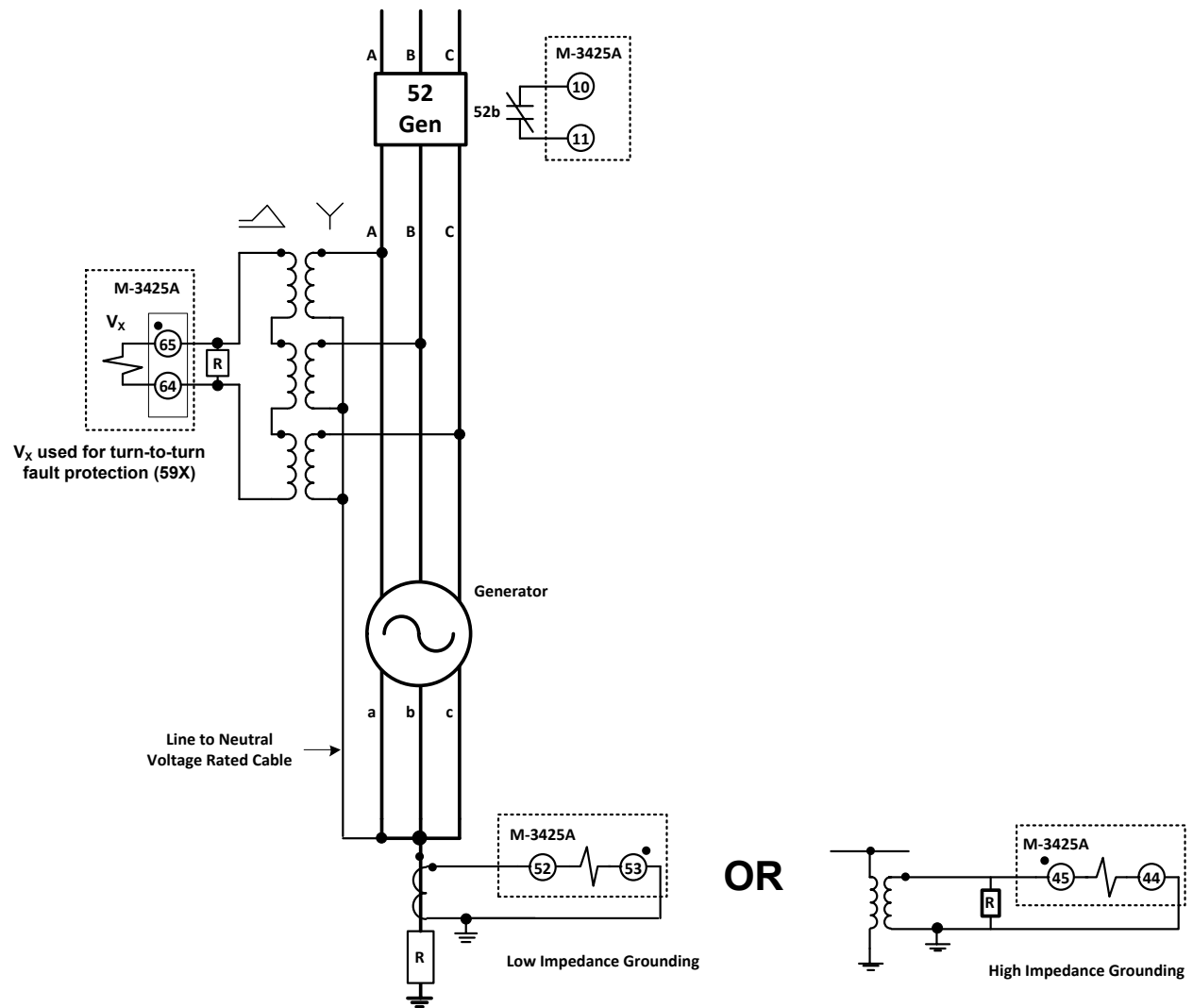


Figure 5-11 Function 25 Sync Check Three-Line Connection Diagram



■ **NOTE:** If 59X is enabled for Turn to Turn Fault Protection, then the 25 Function is not available.

Figure 5-12 Function 59X Turn to Turn Fault Protection Three-Line Connection Diagram

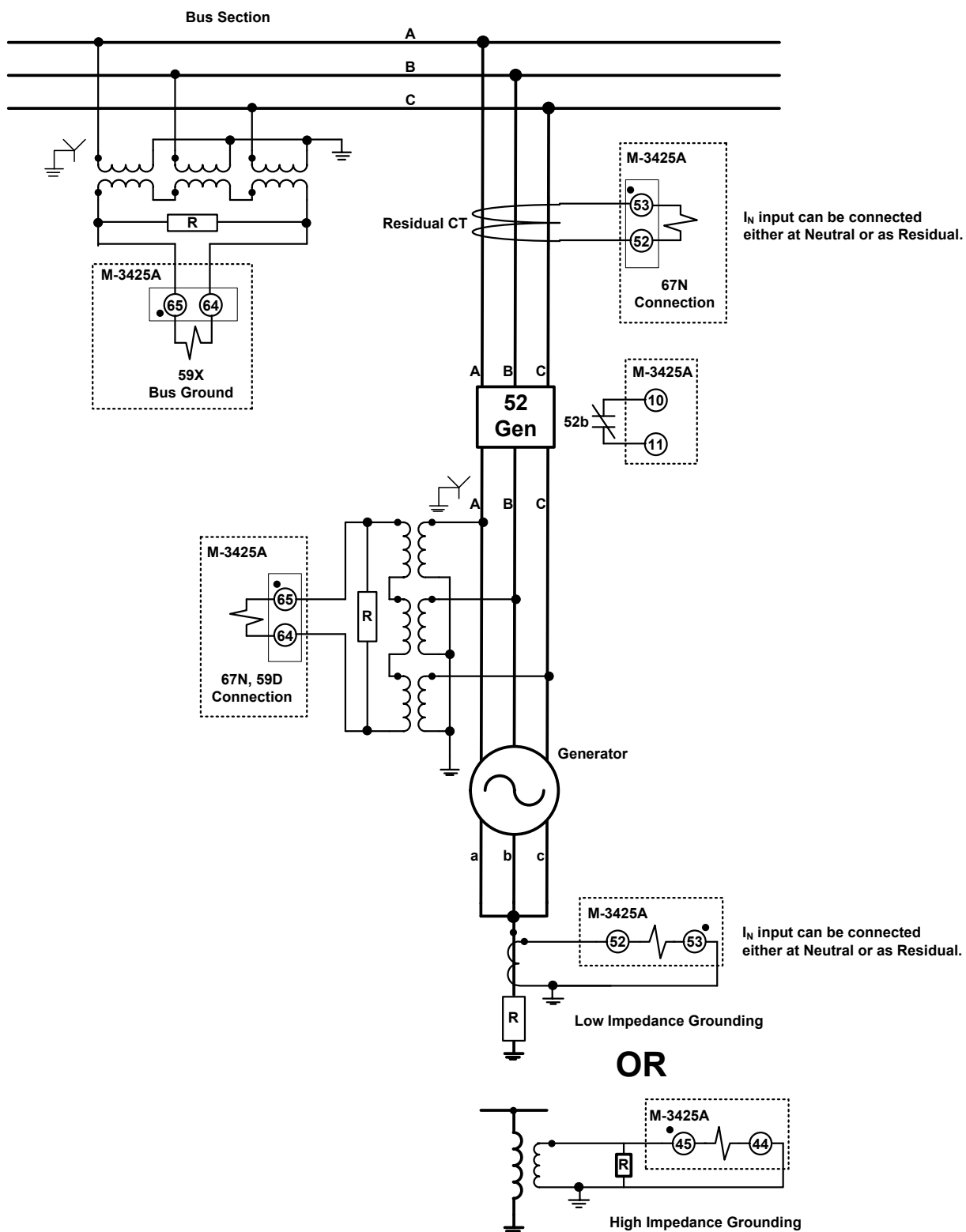


Figure 5-13 Function 67N, 59D, 59X (Bus Ground) Three-Line Connection Diagram

## 5.4 Commissioning Checkout

During field commissioning, check the following to ensure that the CT and VT connections are correct.

1. Press **ENTER**. After a short delay, the unit should display

---

VOLTAGE RELAY

VOLT curr freq v/hz pwr →

---

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

---

STATUS

← config sys STAT →

---

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

---

VOLTAGE STATUS

VOLT curr freq v/hz →

---

4. Press **ENTER**. The unit should display either  $V_A$ ,  $V_B$ ,  $V_C$  (line-to-ground connections) or  $V_{AB}$ ,  $V_{BC}$ ,  $V_{CA}$  (line-to-line or line-ground to line-line connections).

---

PHASE VOLTAGE

A=      B=      C=

---

Compare these voltages with actual measurements using a voltmeter. If there is a discrepancy, check for loose connections to the rear terminal block of the unit. If line-ground to line-line voltage selection is used, the voltages displayed are  $\sqrt{3}$  times of the line-ground voltages applied.

5. Press **ENTER** to display the Neutral Voltage:

---

NEUTRAL VOLTAGE

\_\_\_\_\_ Volts

---

The neutral voltage should be near zero volts.

6. Press **ENTER** to display  $V_X$  Voltage:

---

VX VOLTAGE

\_\_\_\_\_ Volts

---

7. Press **ENTER** to display Third Harmonic Differential Ratio:

---

3RD HARMONIC DIFF RATIO

\_\_\_\_\_

---

Press **ENTER** once more to display the line side Third Harmonic Voltage:

---

3RD HARMONIC 3V0 VOLT

\_\_\_\_\_

---

8. Press **ENTER** to display Stator Low Frequency Injection (20 Hz) Voltage:

---

STATOR LOW FREQUENCY INJECT.

\_\_\_\_\_ Volts

---

9. Display positive, negative and zero sequence voltages. Press **ENTER** until the unit displays:

---

POS SEQUENCE VOLTAGE

\_\_\_\_\_ Volts

---

The positive sequence voltage should be  $V_{POS} \approx V_A \approx V_B \approx V_C$  or  $V_{AB} \approx V_{BC} \approx V_{CA}$ .

10. Press **ENTER** until the unit displays:

---

NEG SEQUENCE VOLTAGE

\_\_\_\_\_ Volts

---

The negative sequence voltage should be  $V_{NEG} \approx 0$ .

11. Press **ENTER** until the unit displays:

---

ZERO SEQUENCE VOLTAGE  
 \_\_\_\_\_ Volts

---

The zero sequence voltage should be  $V_{ZERO} \approx 0$ .

If the negative sequence voltage shows a high value and the positive sequence voltage is close to zero, the phase sequence is incorrect and proper phases must be reversed to obtain correct phase sequence. If the phase sequence is incorrect, frequency- and power-related functions will not operate properly and the **Frequency Status** menu will read **DISABLE**.

If positive, negative and zero sequence voltages are all present, check the polarities of the VT connections and change connections to obtain proper polarities.

12. Press **ENTER** until the unit displays:

---

3RD HARMONIC NTRL VOLT  
 \_\_\_\_\_ Volts

---

13. Press **ENTER** until the unit displays:

---

FIELD GND MEAS. CIRCUIT  
 \_\_\_\_\_ mV

---

14. Press **EXIT** until the unit displays:

---

VOLTAGE STATUS  
 VOLT curr freq v/hz →

---

15. Press the right arrow to display:

---

CURRENT STATUS  
 volt CURR freq v/hz →

---

16. Press **ENTER** to display line currents ( $I_A$ ,  $I_B$ ,  $I_C$ ). The unit should display:

---

PHASE CURRENT  
 A=      B=      C=

---

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.

17. Press **ENTER** for the unit to display:

---

PHASE CURRENT  
 a=      b=      c=

---

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.

18. Press **ENTER** for the unit to display:

---

DIFFERENTIAL CURRENT  
 A=      B=      C=

---

Differential current should be near zero amps. If a significant amount of differential current is present, check the CT polarities.

19. Press **ENTER** for the unit to display:

---

NEUTRAL CURRENT  
 \_\_\_\_\_ Amps

---

20. Press **ENTER** for the unit to display:

---

GND DIFFERENTIAL CURRENT  
 \_\_\_\_\_ Amps

---

21. Press **ENTER** for the unit to display:

---

STATOR LOW FREQ INJECT.  
 I=mAmps

---

22. Press
- ENTER**
- to display:

---

 POS SEQUENCE CURRENT  
 \_\_\_\_\_ Amps
 

---

The positive sequence current should be  $I_{POS} \approx I_a \approx I_b \approx I_c$ .

23. Press
- ENTER**
- to display:

---

 NEQ SEQUENCE CURRENT  
 \_\_\_\_\_ Amps
 

---

Negative sequence current should near zero amperes.

24. Press
- ENTER**
- to display:

---

 ZERO SEQUENCE CURRENT  
 \_\_\_\_\_ Amps
 

---

The zero sequence current should be  $I_{ZERO} \approx 0A$ . If a significant amount of negative or zero sequence current (greater than 25% of  $I_A, I_B, I_C$ .) then either the phase sequence or the polarities are incorrect. Modify connections to obtain proper phase sequence and polarities.

25. Press
- ENTER**
- to display:

---

 F49 THERMAL CURRENT #1  
 \_\_\_\_\_ Amps
 

---

Press **ENTER** once more to display:

---

 F49 THERMAL CURRENT #2  
 \_\_\_\_\_ Amps
 

---

26. Press
- EXIT**
- , then the Right arrow to display:

---

 FREQUENCY STATUS  
 volt curr FREQ v/hz →
 

---

27. Press
- ENTER**
- to display:

---

 FREQUENCY  
 \_\_\_\_\_ Hz
 

---

28. Press
- ENTER**
- to display:

---

 RATE OF CHANGE FREQUENCY  
 \_\_\_\_\_ Hz/Sec
 

---

29. Press
- EXIT**
- , then right arrow to display:

---

 V/HZ STATUS  
 volt curr freq V/HZ →
 

---

30. Press
- ENTER**
- to display:

---

 VOLTS PER HERTZ  
 \_\_\_\_\_ %
 

---

31. Press
- EXIT**
- , then right arrow to display:

---

 POWER STATUS  
 ← POWR imped sync brkr →
 

---

32. Press
- ENTER**
- to display real power and check its sign. The unit should display:

---

 REAL POWER  
 \_\_\_\_\_ PU \_\_\_\_\_ W
 

---

The sign should be positive for forward power and negative for reverse power. If the sign does not agree with actual conditions, check the polarities of the three neutral-end CTs and/or the PTs.

33. Press
- ENTER**
- for the unit to display:

---

 REACTIVE POWER  
 \_\_\_\_\_ PU \_\_\_\_\_ VAr
 

---

34. Press
- ENTER**
- for the unit to display:

---

 APPARENT POWER  
 \_\_\_\_\_ PU \_\_\_\_\_ VA
 

---

35. Press
- ENTER**
- to display:

---

 POWER FACTOR  
 \_\_\_\_\_ Lag/Lead
 

---



36. Press **EXIT** and then right arrow to display:

---

IMPEDANCE STATUS

← powr IMPED sync brkr →

---

37. Press **ENTER** to display:

---

IMPEDANCE Zab (Ohms)

R= X=

---

Press **ENTER** once more to display:

---

IMPEDANCE Zbc (Ohms)

R= X=

---

Press **ENTER** once more to display:

---

IMPEDANCE Zca (Ohms)

R= X=

---

38. Press **ENTER** to display:

---

IMPEDANCE POS SEQ (Ohms)

R= X=

---

39. Press **ENTER** to display:

---

FIELD GND RESISTANCE

\_\_\_\_\_ Ohms

---

40. Press **EXIT** and then right arrow to display:

---

SYNC CHECK STATUS

← powr impd SYNC brkr →

---

41. Press **ENTER** to display:

---

PHASE ANGLE

\_\_\_\_\_ DEGREES

---

42. Press **ENTER** to display:

---

DELTA VOLTAGE

\_\_\_\_\_ Volts L0

---

43. Press **ENTER** to display:

---

DELTA FREQUENCY

\_\_\_\_\_ Hz HI

---

44. Press **EXIT**, then right arrow until unit displays:

---

BREAKER MON ACC. STATUS

← power impd sync BRKR →

---

45. Press **ENTER** to display:

---

BREAKER MON ACC. STATUS

A= A-cycles

---

Press **ENTER** to cycle through Acc. Status screens for B and C.

46. Press **EXIT**, then right arrow until unit displays:

---

81A ACCUMULATORS STATUS

← FREQ\_ACC i/o timer →

---

47. Press **ENTER** to display:

---

81A #1 ACCUMULATORS STAT

\_\_\_\_\_ Cycles

---

Pressing **ENTER** will display a status screen for each of the six elements.

48. Press **ENTER** to display:

---

81A #1 ACC. STARTUP TIME

00-20XX 00:00:00:000

---

Pressing **ENTER** will display a status screen for each of the six elements.

49. Press **EXIT**, then right arrow until unit displays:

---

IN/OUT STATUS

← freq\_acc I/O timer →

---

50. Press **ENTER** to display:

---

FL I6 I5 I4 I3 I2 I1

---

Press **ENTER** again to view outputs:

---

o8 o7 o6 o5 o4 o3 o2 o1

---

51. Press **EXIT**, then arrow button to display:

---

TIMER STATUS  
← freq\_acc i/o TIMER →

---

52. Press **ENTER** to display:

---

51V DELAY TIMER  
A=      B=      C=

---

53. Press **ENTER** to display:

---

51N DELAY TIMER  
\_\_\_\_\_ %

---

54. Press **ENTER** to display:

---

46IT DELAY TIMER  
\_\_\_\_\_ %

---

55. Press **ENTER** to display:

---

24IT DELAY TIMER  
\_\_\_\_\_ %

---

56. Press **EXIT**, then right arrow until unit displays:

---

RELAY TEMPERATURE  
← TEMP count powerup →

---

57. Press **ENTER** to display:

---

RELAY TEMPERATURE  
\_\_\_\_\_ C

---

58. Press **EXIT**, then right arrow until unit displays:

---

COUNTERS  
← temp COUNT powerup →

---

59. Press **ENTER** to display:

---

OUTPUT COUNTER 1

---

Pressing **ENTER** will display a status screen for each of the 23 outputs.

60. Press **ENTER** to display:

---

ALARM COUNTER

---

61. Press **EXIT**, then right arrow until the unit displays:

---

TIME OF LAST POWER UP  
← temp count POWERUP →

---

62. Press **ENTER** to display:

---

TIME OF LAST POWER UP  
05-Jan-2003 20:39:29

---

■ **NOTE:** The CT and VT polarities can be easily verified by looking at the oscillographic waveforms, using M-3801D IPSplot® *PLUS* analysis software.

63. Press **EXIT**, then right arrow until the unit displays:

---

ERROR CODES  
← ERROR check

---

64. Press **ENTER** to display:

---

ERROR CODES (LAST)

---

Pressing **ENTER** will display a status screen for three previous error codes.

65. Press **ENTER** to display:

RST LOCATION

0000 CBR=\_\_\_ BBR=\_\_\_

66. Press **ENTER** to display:

COMM ERROR CODE (LAST)

\_\_\_\_\_

67. Press **ENTER** to display:

COMM PACKET COUNTER

\_\_\_\_\_

68. Press **ENTER** to display:

COMM RX ERROR COUNTER

\_\_\_\_\_

69. Press **ENTER** to display:

SELFTEST COUNTER

\_\_\_\_\_

70. Press **ENTER** to display:

RESET COUNTER

\_\_\_\_\_

71. Press **ENTER** to display:

POWERLOSS COUNTER

\_\_\_\_\_

72. Press **EXIT**, then right arrow until the unit displays:

CHECKSUMS

← error CHECK

73. Press **ENTER** to display:

SETPOINTS CHECKSUM

EECS= BBCS= CAL=

74. Press **ENTER** to display:

CALIBRATION CHECKSUM

EECS= BBCS= CAL=

75. Press **ENTER** to display:

ROM CHECKSUM

\_\_\_\_\_

## 5.5 Circuit Board Switches and Jumpers

See [Figure 5-14](#), M-3425A Circuit Board for Jumper and Switch locations.

### Accessing Switches and Jumpers

● **WARNING:** Operating personnel must not remove the cover or expose the printed circuit board while power is applied. IN NO CASE may the circuit-based jumpers or switches be moved with power applied.

● **WARNING:** The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit. See Figure 5-9, Note #4.

▲ **CAUTION:** This unit contains MOS circuitry, which can be damaged by static discharge. Care should be taken to avoid static discharge on work surfaces and service personnel.

1. De-energize the M-3425A.
2. Remove the screws that retain the front cover.
3. Remove the "J" connectors from the corresponding plugs, P4, 5, 6, 7, 9 and 11.
4. Loosen the two circuit board retention screws (captured).
5. Remove the circuit board from the chassis.
6. Jumpers J5, J18, J20, J21, J22, J46, J60, and J61 are now accessible. See [Figure 5-14](#), M-3425A Circuit Board for locations.
7. Dipswitch SW1 is now accessible. See Figure 5-14 for location.
8. Insert circuit board into chassis guides and seat firmly.
9. Tighten circuit board retention screws.
10. Reconnect "J" connectors to corresponding plugs.
11. Reinstall cover plate.

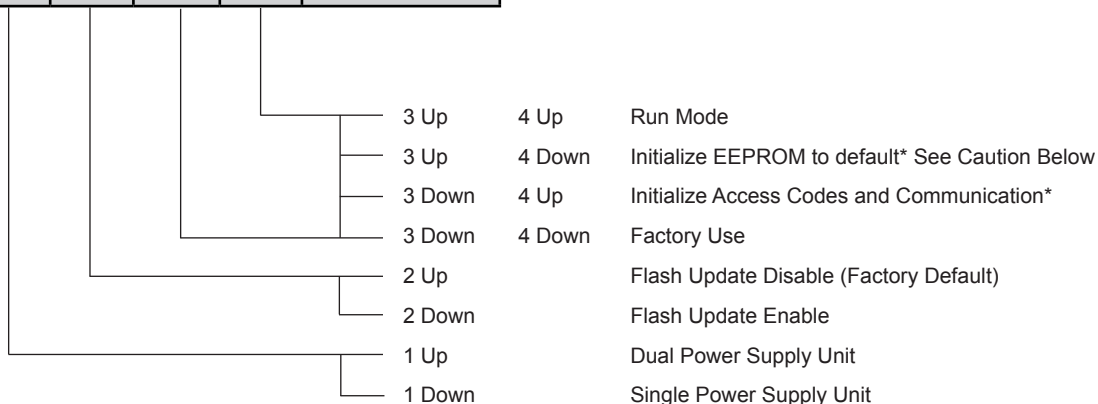
Jumper	Position	Description
J5	A to B B to C	Demodulated IRIG-B TTL signal on Pin 6 COM2 Modulated IRIG-B signal BNC (Default)
J18	A to B B to C	COM3 200 ohm termination resistor inserted COM3 no termination (Default)
J46	A to B B to C	COM3 shares Baud Rate with COM1 COM3 shared Baud Rate with COM2 (Default)
J60	A to B A to C	Connects DCD signal to Pin 1 of COM2 (Default) Connects +15V to Pin 1 of COM2
J61	B to C A to B	Connects -15V to Pin 9 of COM2 COM2 Pin 9 float (Default)

■ **NOTE:** Short circuit protection (100 ma limit) is incorporated on pins 1 and 9 when used for +/- 15V.

Table 5-1 Jumpers

Dipswitch SW1				
1	2	3	4	
	X	X	X	Open (Up)
X				Closed (Down)

*Switches should not be changed while unit is energized.*



*\* After power up, the OK LED light remains off and the Diagnostic LED will illuminate when operation has been satisfactorily completed.*

**▲ CAUTION:** A loss of calibration, setpoints, and configuration will occur when the EEPROM is initialized to default.

*Table 5-2 Dip Switch SW-1*

TRIP CIRCUIT MONITOR INPUT VOLTAGE SELECT			
Input Voltage	Jumper J20 Position	Jumper J21 Position	Jumper J22 Position
24 V dc	A to B	A to B	A to B
48 V dc	B to C	A to B	A to B
125 V dc	B to C	B to C	A to B
250 V dc*	B to C	B to C	B to C

*\* Default as shipped from factory.*

*Table 5-3 Trip Circuit Monitor Input Voltage Select Jumper Configuration*

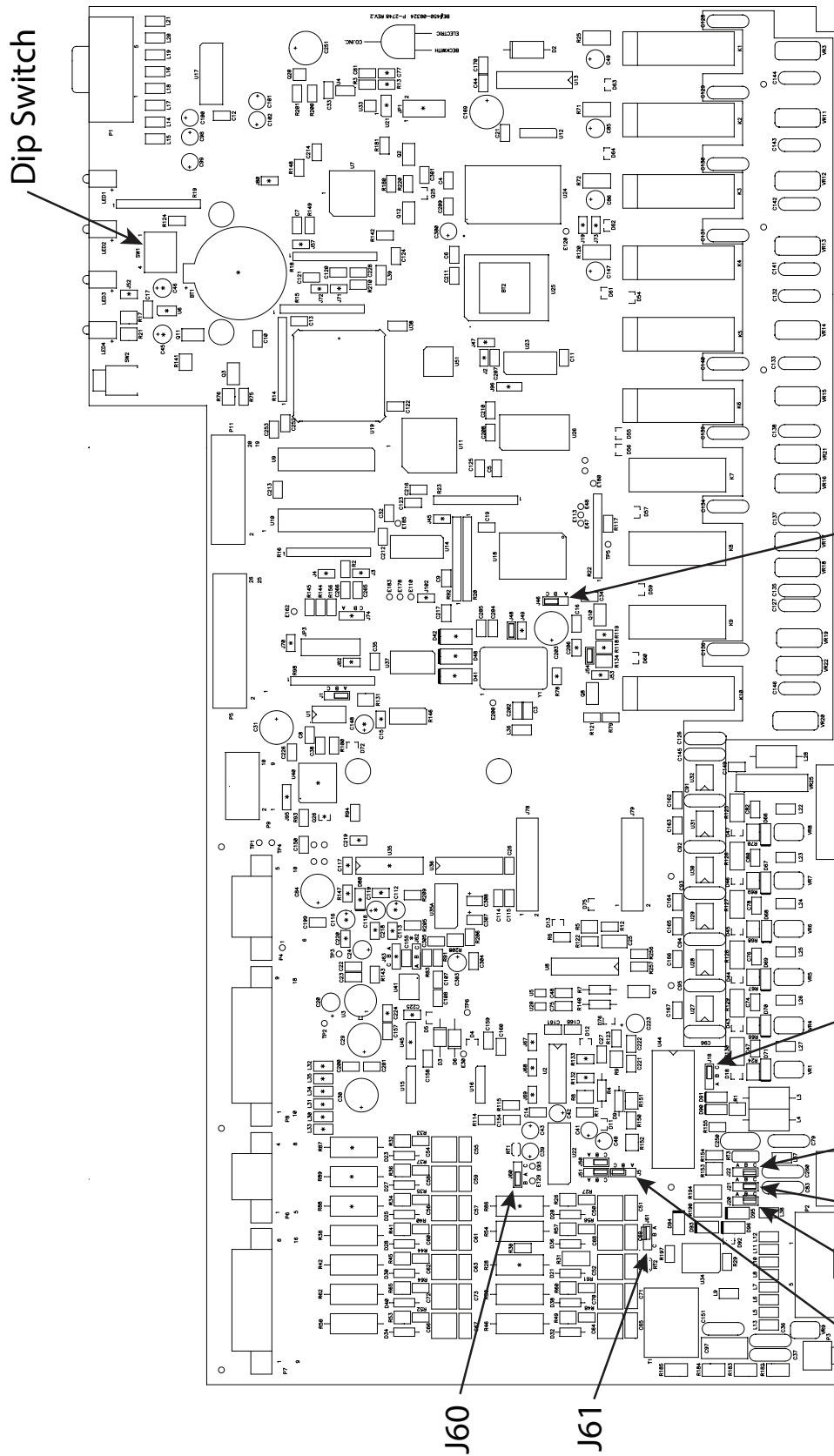


Figure 5-14 M-3425A Circuit Board

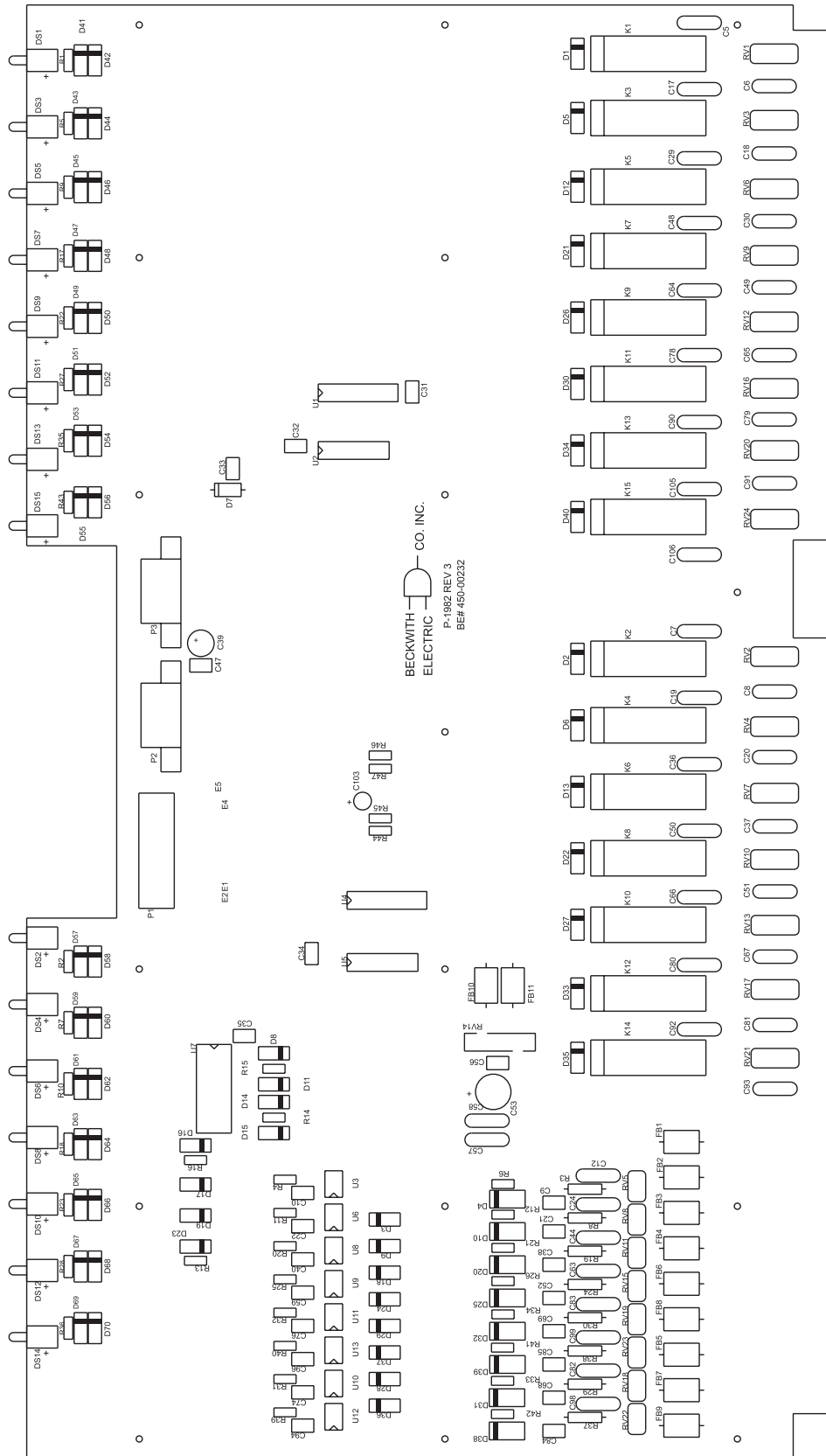
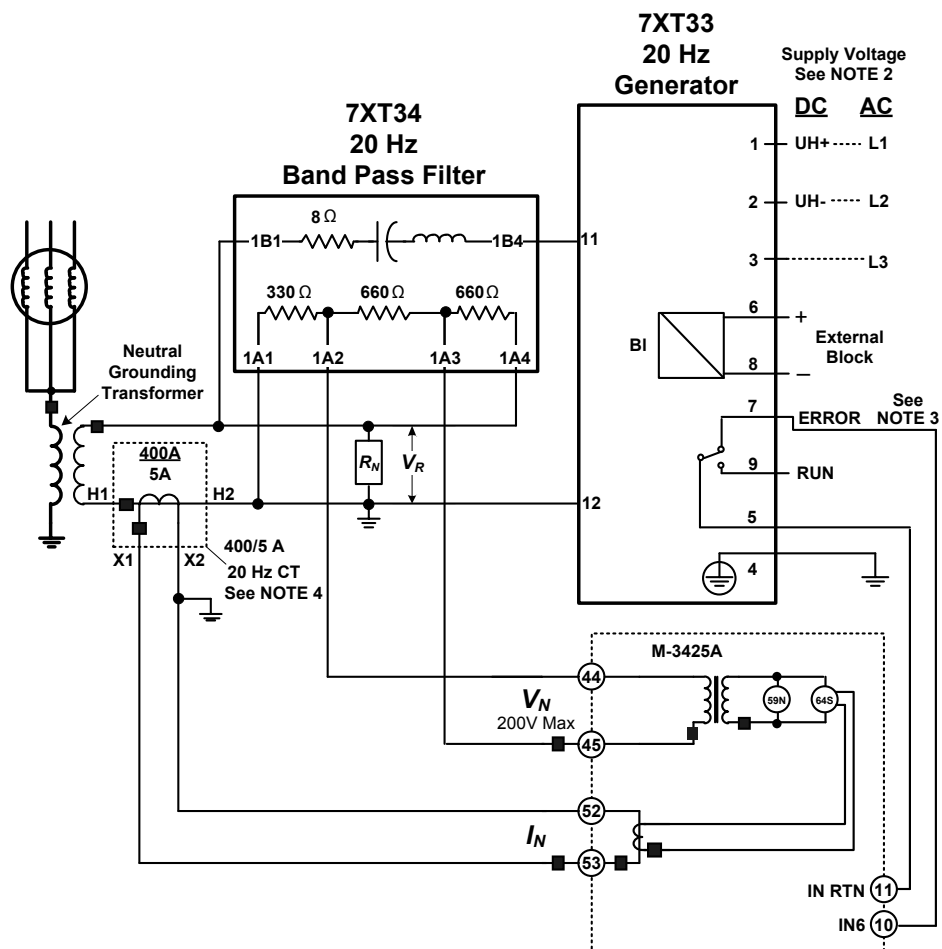


Figure 5-15 M-3425A Circuit Board (Expanded I/O)

## 5.6 Low Frequency Signal Injection Equipment

[Figure 5-16](#) and [Figure 5-17](#) represent typical connections for the Low Frequency Signal Injection Equipment. Refer to [Figure 5-18](#) through [Figure 5-22](#) for equipment mounting dimensions.

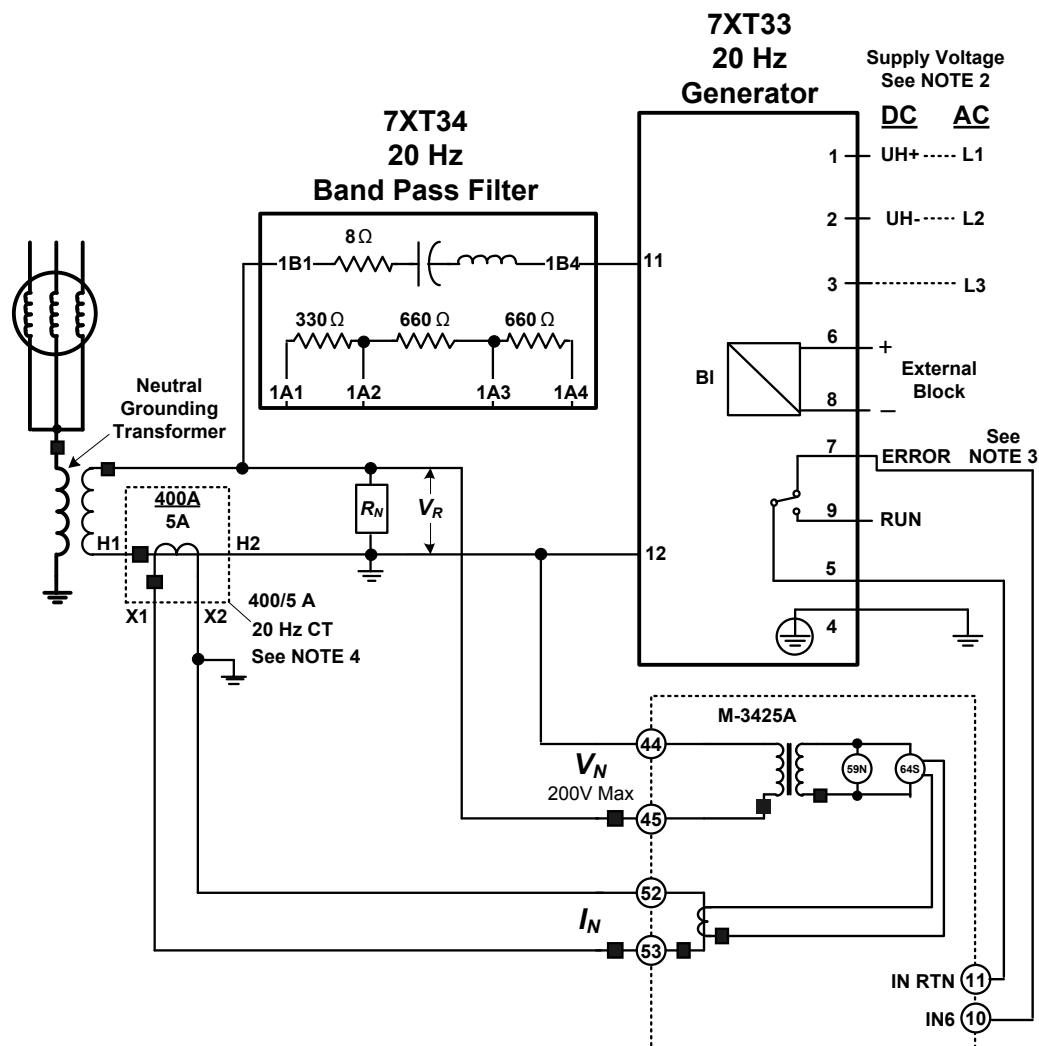


*Figure 5-16 Voltage Divider Connection Diagram*

■ **NOTES:**

1. Use the Voltage Divider Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage > 200 Vac.
2. Refer to [Table 4-10](#) and [Table 4-11 on page 4-102](#).
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.





*Figure 5-17 Straight Through Connection Diagram*

■ **NOTES:**

1. Use the Straight Through Connection for applications with a Neutral Grounding Transformer secondary rating that will result in worst-case 50/60 Hz ground fault voltage < 200 Vac.
2. Refer to [Table 4-10](#) and [Table 4-11 on page 4-102](#).
3. Connections from 20 Hz Generator terminals 5 and 7 to M-3425A terminals 10 and 11 are used to provide operational status of the 20 Hz relay to the M-3425A. Input 6 (IN6) is shown in the figure, but any other unused input can be used. This input should be programmed to initiate an alarm via the M-3425A for local/remote communications when the 20 Hz Generator is out-of-service. This input can also be used to enable the 27TN function to provide 100% stator ground protection when the 20 Hz Generator is out-of-service.
4. The current transformer provided by Beckwith Electric Co. is T50 Class and begins to saturate at 50V. Both the primary and secondary of the current transformer are connected to ground. These two factors reduce the concern regarding insulation of the current transformer.

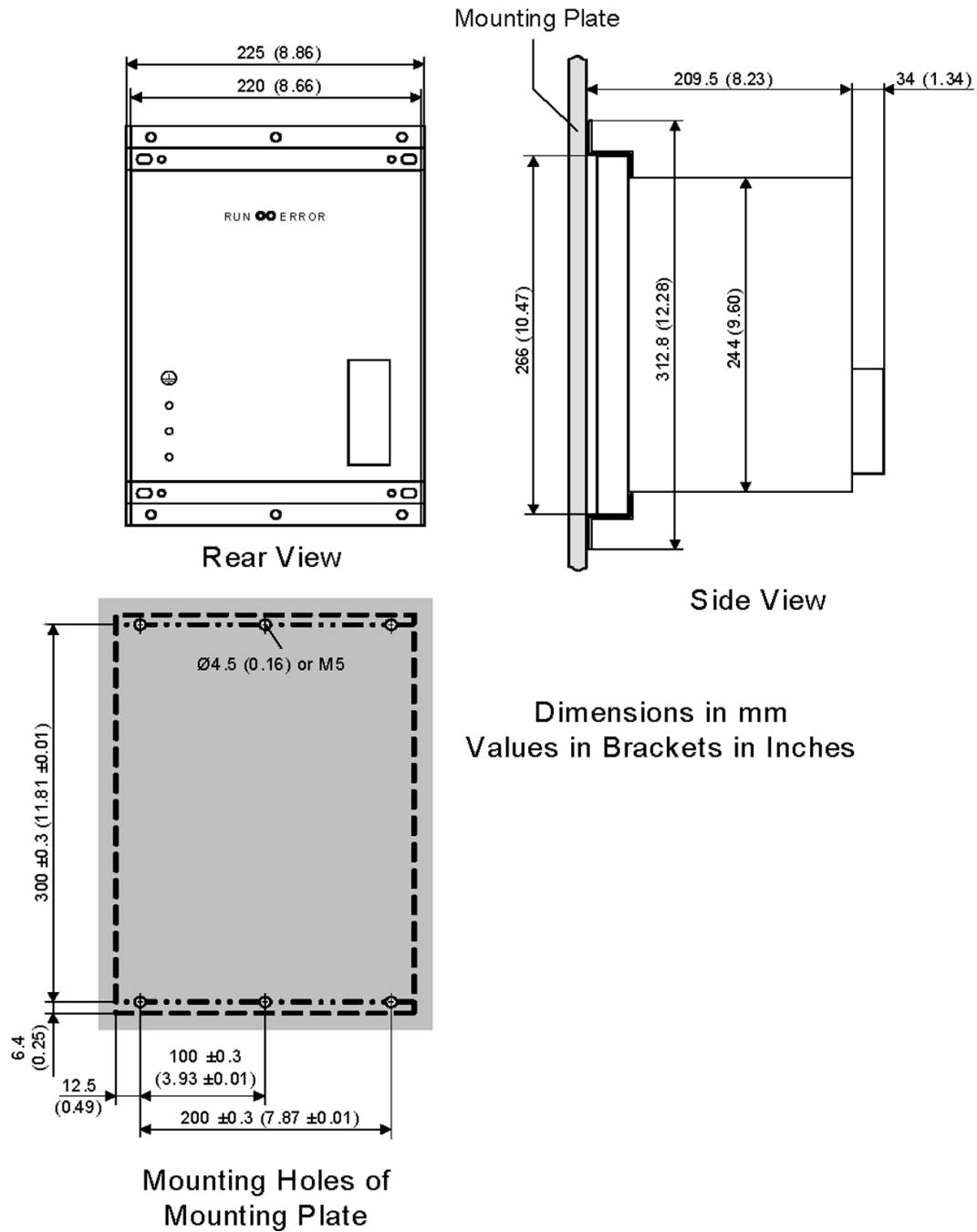


Figure 5-18 20 Hz Frequency Generator Housing Panel Surface Mount

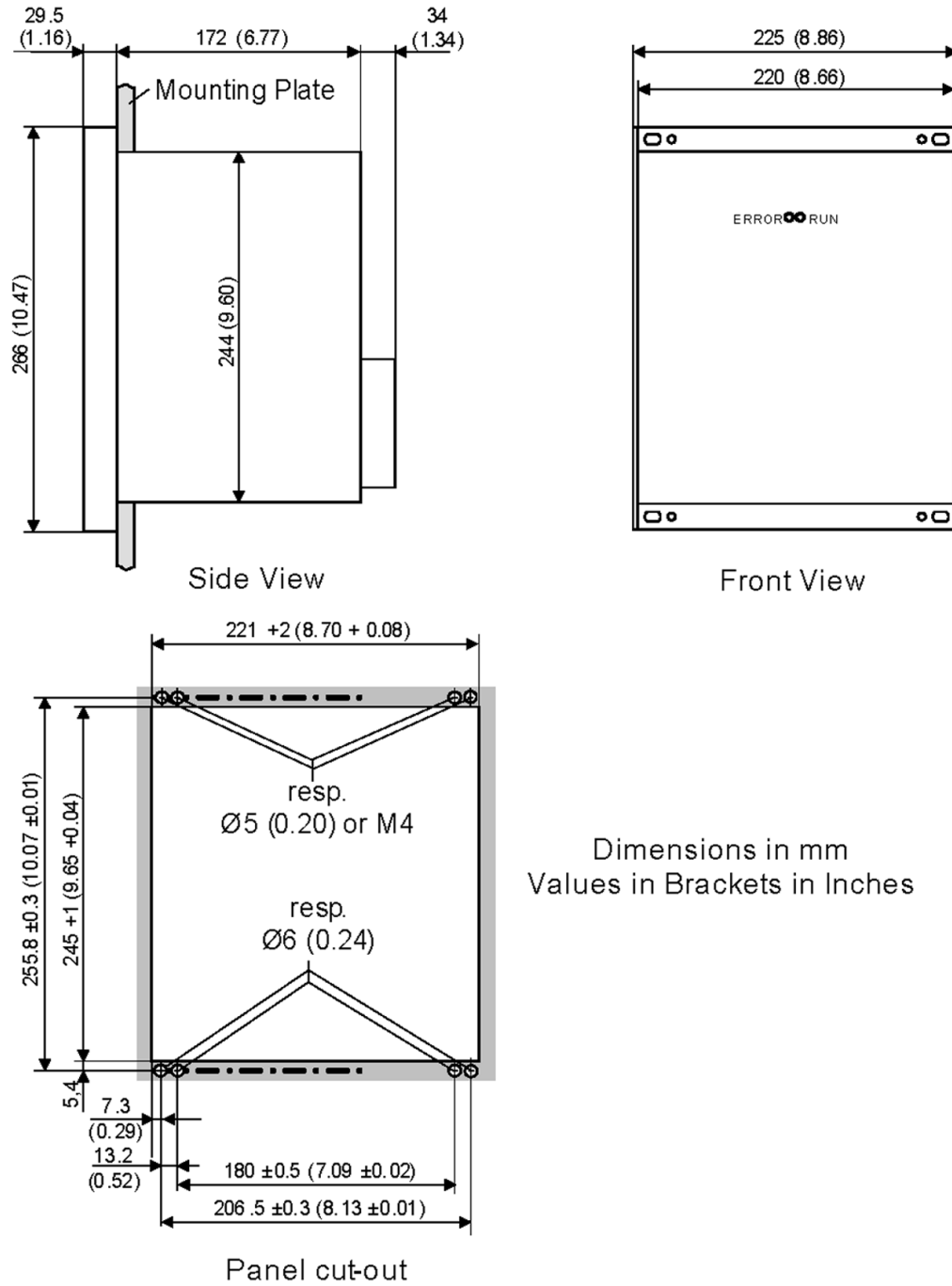


Figure 5-19 20 Hz Frequency Generator Housing Panel Flush Mount

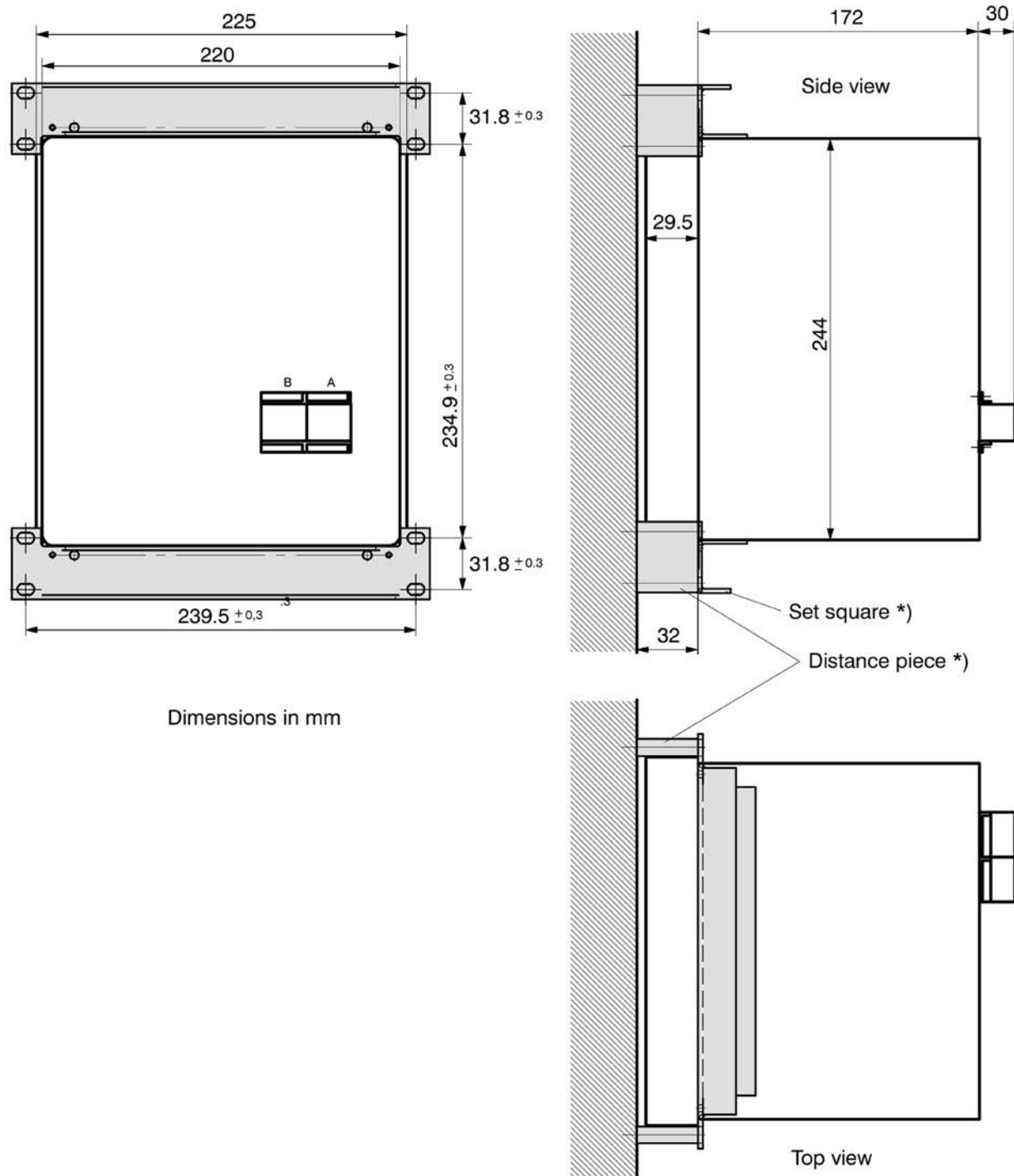


Figure 5-20 20 Hz Band Pass Filter Housing Panel Surface Mount

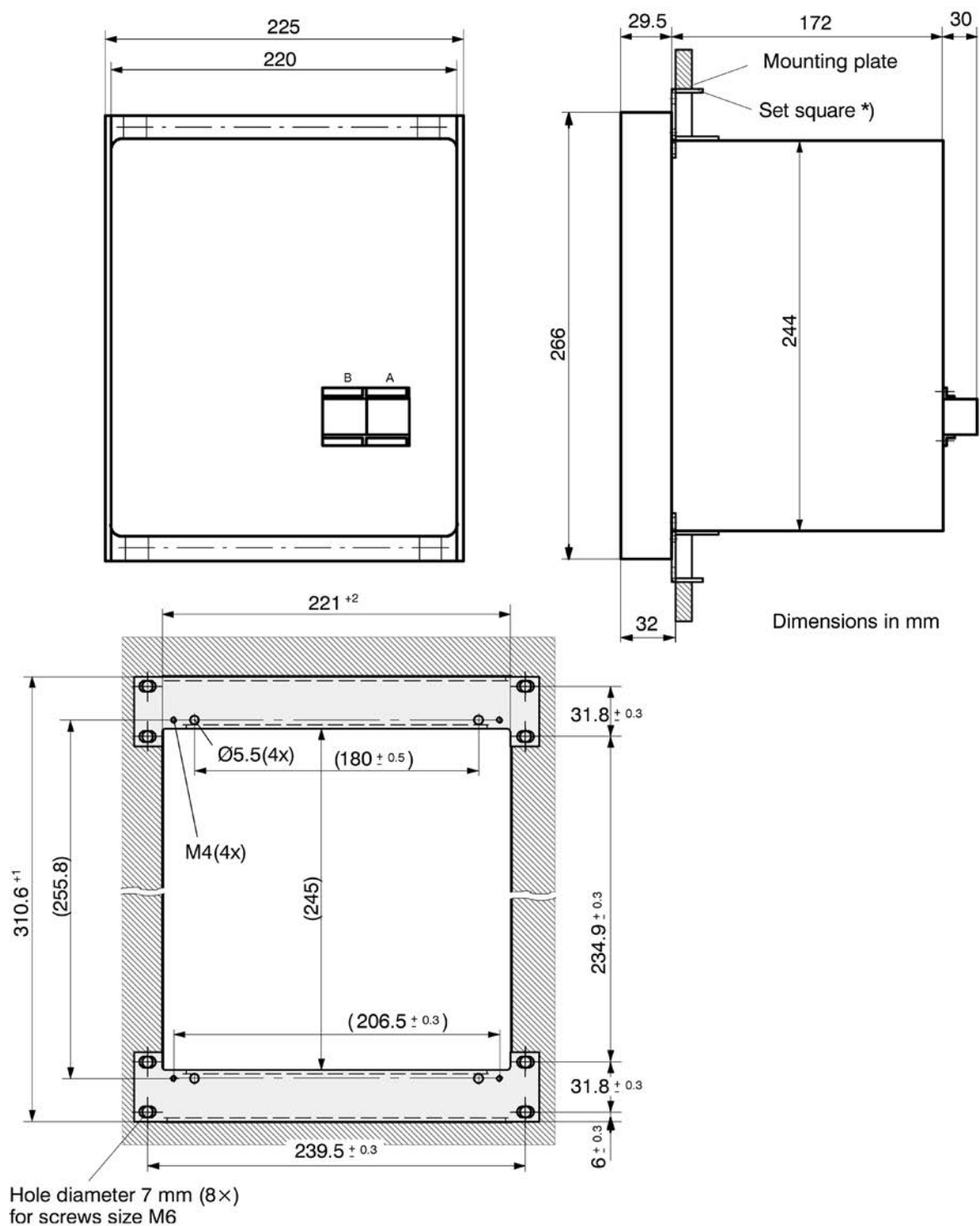


Figure 5-21 20 Hz Band Pass Filter Housing Panel Flush Mount

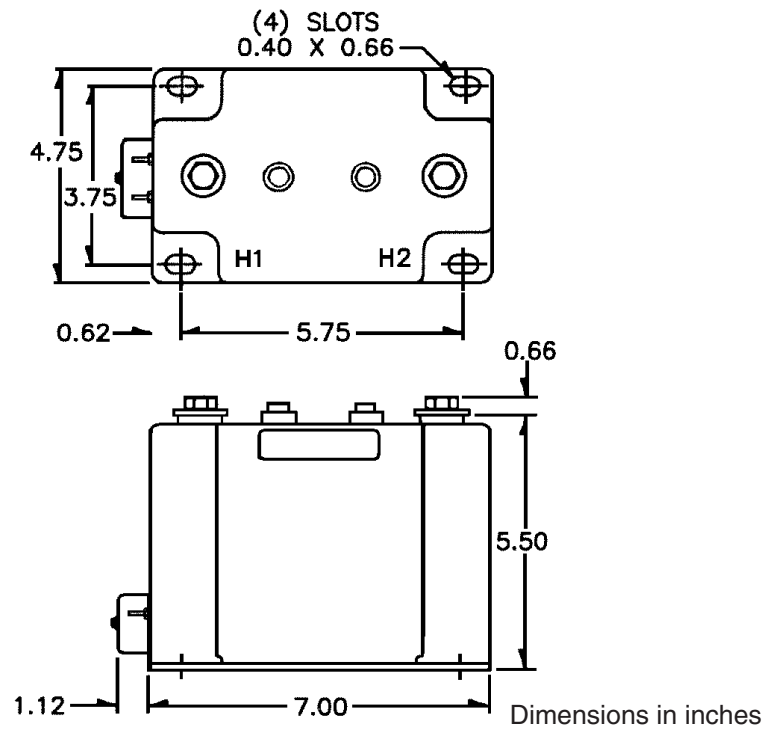


Figure 5-22 20 Hz Measuring Current Transformer 400-5 A CT

## 5.7 IPScom® Communications and Analysis Software Installation

### IPScom Installation and Setup

IPScom runs with the Microsoft Windows® 2000 operating system or later. IPScom is available on CD-ROM, or may be downloaded from our website at [www.beckwithelectric.com](http://www.beckwithelectric.com)

The S-3400 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 IBM PC-compatible computer that provides at least the following:

- 8 MB of RAM
- Microsoft Windows 2000 or later
- CD-ROM drive
- one serial (RS-232) communication port
- pointing device (mouse)

### 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 (see [Figure 5-23](#)) is located in Becoware. The default location for the application files is on drive C:, in the new subdirectory "IPScom" (C:\Becoware\IPScom).



Figure 5-23 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.

## 5.8 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 5-23](#)) from the Becoware folder or Desktop. The IPScom **Main Screen** is displayed.
3. Select the **Connect** menu item. IPScom will display the **Serial Port Dialog Screen**.
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. Press **EXIT** as necessary to exit the HMI.
- f. Select the **Connect** menu item. IPSCOM will display the **Serial Port Dialog Screen**.
- 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 IPSCOM command(s) as desired.

To close the communication channel when connected locally, select Communication/Disconnect from the main screen menu bar.

## 5.9 Initial Setup Procedure

The M-3425A Generator Protection Relay is shipped from the factory with all functions disabled (user will only be able to enable purchased functions).

The Setup Procedure provided below is a suggested setup procedure for initially entering settings into the relay. While it is written for HMI-equipped units, the same procedure is applicable when setting the relay through remote communication utilizing S-3400 IPSCOM® Communications Software.

Following the Setup Procedure are several sections which provide additional detail concerning the settings required for proper commissioning.

### Setup Procedure

■ **NOTE:** Configuration Record forms are available in Appendix A, Configuration Record Forms, to record settings for future reference.

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 5-7](#) or [Figure 5-8](#).
2. When power is initially applied, the M-3425A 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 2-2 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. Refer to the instructions in Section 5.8, **Activating Initial Local Communications**. Also refer to **Chapter 3, IPScom®**, S-3400 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. For units without HMI, refer to Section 5.5, Circuit Board Switches & Jumpers.

■ **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, System Setup 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-3425A and connect external input and output contacts according to the rear panel terminal block markings as shown in [Figure 5-9](#) through [Figure 5-13](#), External Connections as applicable.

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# 6

## Testing

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## 6.1 Equipment/Test Setup

No calibration is necessary, as the M-3425A Generator 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 6.4, Auto Calibration (or see Chapter 3, IPScom, Tool/Calibration subsection for units without an HMI). These test procedures are based on the prerequisite that the functions are enabled and have settings as described in **Chapter 4, System Setup and Setpoints**, and that the unit is fitted with the optional HMI module.

### Equipment Required

The following equipment is required to carry out the test procedures:

1. Two Digital Multimeters (DMM) with 10 A current range.
2. 120 Vac or 0 to 125 Vdc variable supply for system power.
3. Three-phase independent voltage sources (0 to 250 V) variable phase to simulate VT inputs.
4. Three-phase independent current sources (0 to 25 A) variable phase to simulate CT inputs.
5. Electronic timer accurate to at least 8 ms.

6. For relays with the 64F/B option:
  - a. Resistor decade box capable of 500 ohms to 150 kOhms, able to step in 100 ohm increments.
  - b. Capacitors ranging from 0.15 mf to 10 mf.
7. For relays with the 64S option:
  - a. 20 Hz Voltage Generator (variable) 0 to 40 V.
  - b. 20 Hz Current Generator (variable) 0 to 40 mA.

### Setup

1. Connect system power to the power input terminals 62 (hot) and 63 (neutral). The relay can be ordered with a nominal input power supply of 110/120/230/240 Vac, 110/125/220/250 Vdc or 24/48 Vdc. An optional redundant power supply is available.

■ **NOTE:** The proper voltage for the relay is clearly marked on the power supply label affixed to the rear panel.

2. For each test procedure, connect the voltage and current sources according to the configuration listed in the test procedure and follow the steps outlined.

■ **NOTE:** The phase angles shown here use leading angles as positive and lagging angles as negative. Some manufacturers of test equipment have used lagging angles as positive, in which case  $V_B = 120\text{ V} \angle 120^\circ$  and  $V_C = 120\text{ V} \angle 240^\circ$ . Similarly other voltages and currents phase angles should be adjusted. These test configurations are for ABC phase rotation. They must be adjusted appropriately for ACB phase rotation.

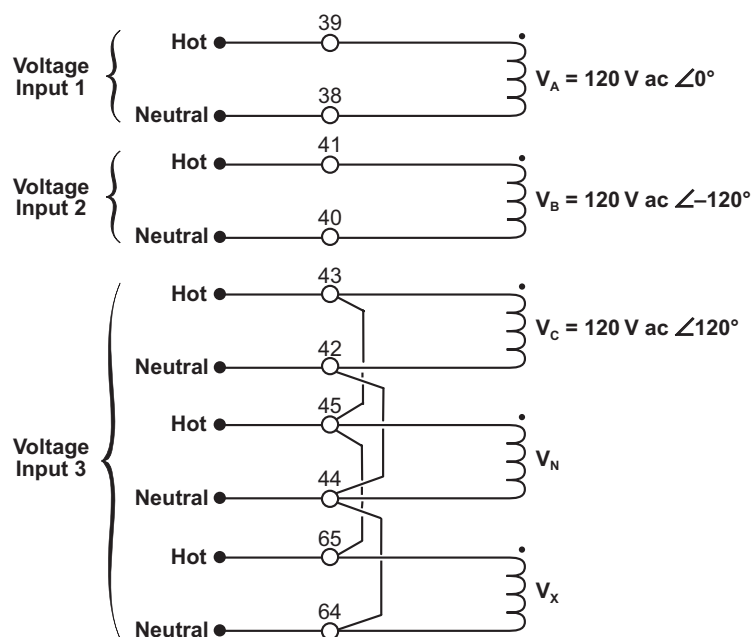


Figure 6-1 Voltage Inputs: Configuration V1

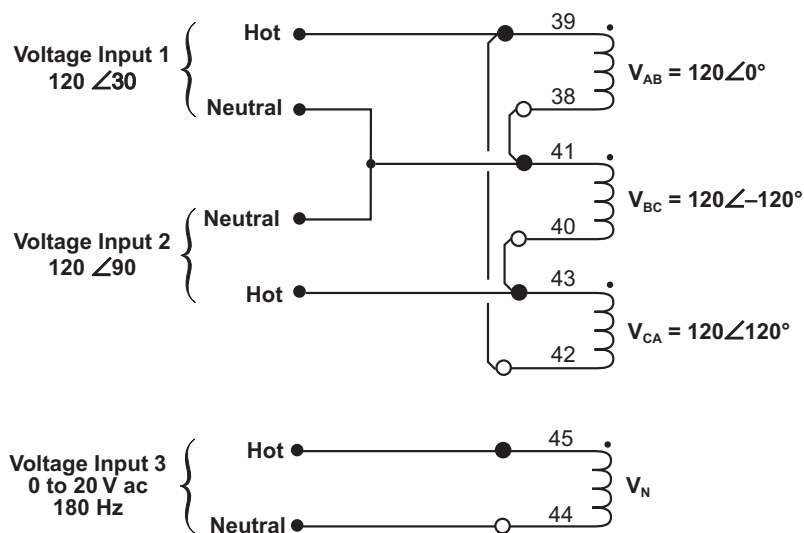


Figure 6-2 Voltage Inputs: Configuration V2

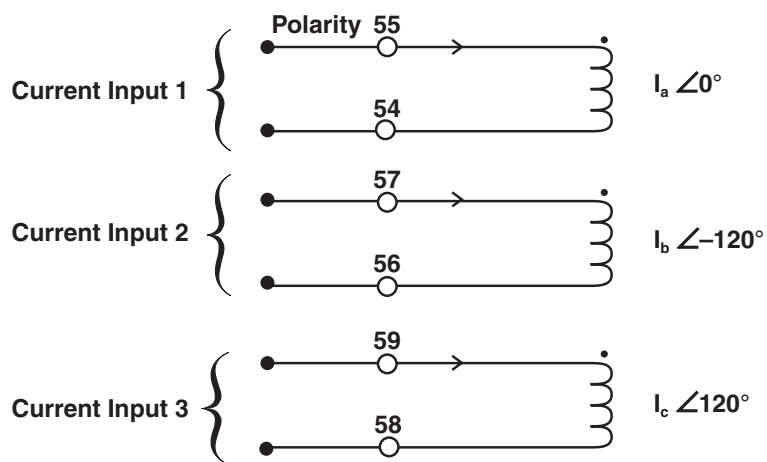


Figure 6-3 Current Inputs: Configuration C1

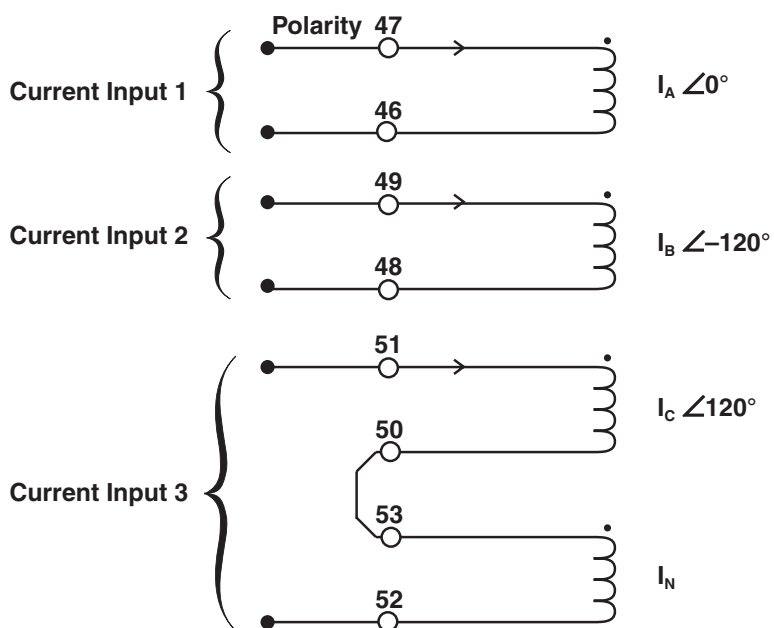


Figure 6-4 Current Inputs: Configuration C2

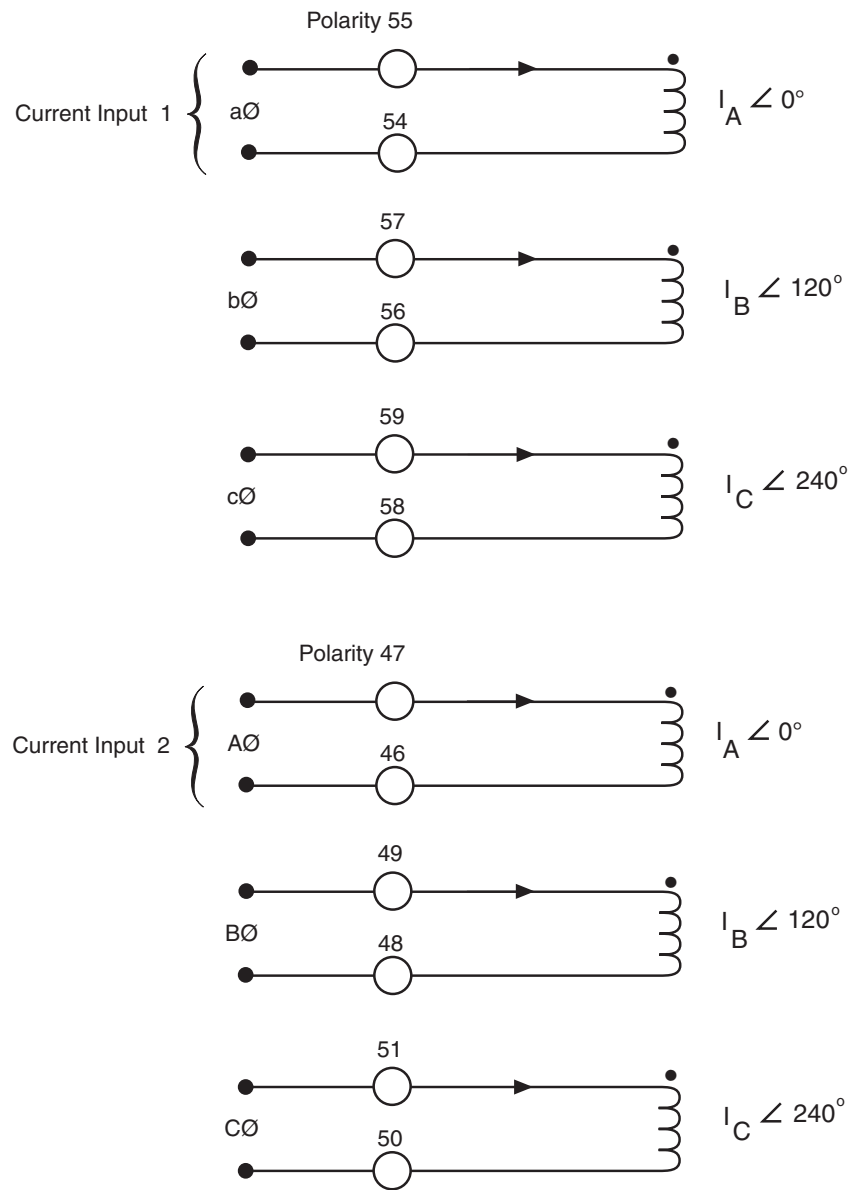


Figure 6-5 Current Configuration C3

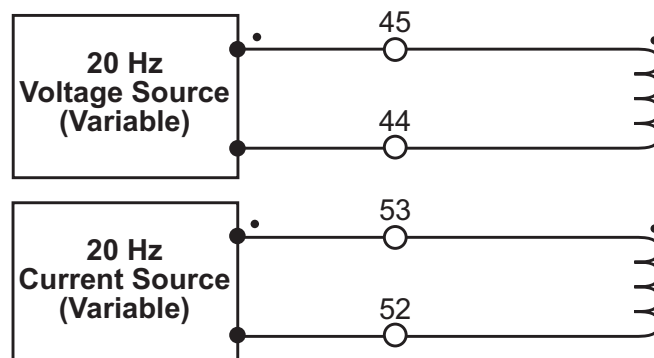


Figure 6-6 64S Test Configuration

## 6.2 Functional Test Procedures

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**, 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 – pg 6–3 to 6–5  
 Output Contact Numbers – pg 6–70  
 Relay Configuration Table – pg A–2 and A–3  
 Setpoint & Timing Record Form – pg A–4 to A–44



## 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 following sequence of actions will take place in the following order:
  - a. The unit will display the following:

---

POWER ON SELFTESTS

XXXXXXXXXXXXXXXXXXXX

---

- b. All LEDs will illuminate for approximately 1 second.
- c. The **POWER** and **RELAY OK** LEDs will remain illuminated, all other LEDs will extinguish.
- d. The unit will display the following:

---

POWER ON SELFTESTS

PASS

---

- e. The unit will display the model number:

---

BECKWITH ELECTRIC CO.

M-3425A Expanded

---

- f. The unit will display the firmware version.

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BECKWITH ELECTRIC

D-0150xx.xx.xx

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- g. The unit will display the serial number.

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Beckwith electric co.

SERIAL NUMBER xxx

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- h. The **POWER** LED(s) will illuminate.
  - i. The **RELAY OK** LED will flash (or stay on as programmed in the diagnostic menu).
  - j. The **BREAKER CLOSED** LED will remain illuminated. If the relay breaker position contact **IN1** is connected to a breaker position contact (52b) and the breaker is open the LED will be extinguished.
3. The power-on self-tests end with the unit displaying the system date, time and default logo.
  4. If there are any recorded targets they are then displayed.

## 21 Phase Distance (#1, #2 or #3)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** Configuration C1

TEST SETTINGS:	Diameter	P	Ohms	(0.1 to 100)
	1 Amp CT Rating			(0.5 to 500.0)
	Offset	O	Ohms	(-100 to 100)
	1 Amp CT Rating			(-500.0 to 500.0)
	Impedance Angle	A	Degrees	(0 to 90)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)
VT Configuration	Line-Ground or Line-Line			

■ **NOTE:** It would be efficient to disable the element with the higher “reach” (Diameter plus Offset) setting first (*lower current*), and test the lower reach setting operation, since the higher reach setting operation can be tested without disabling the lower setting.

### Test Setup:

1. Determine the Function 21 Phase Distance settings to be tested.
2. Enter the Function 21 Phase Distance settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.
6. The level of current at which pickup operation is to be expected for an individual setting is determined as follows:
  - a. Define “reach” as  $R \text{ ohms} = (P \text{ ohms} + O \text{ ohms})$  [ $O$ , usually set at zero ohms].
  - b. For Line-Ground configuration, define “current” as  $I = ((\text{Selected Voltage}) / R \text{ ohms})$ . The voltage level may be selected based on the desired test current level. For Line-Line configuration, define “current” as  $I = ((\text{Selected Voltage} / \sqrt{3}) / R \text{ ohms})$ .

### Pickup Test:

1. Set the three-phase voltages to the Selected Voltage value from Step 6b above.
2. Set the phase angle between the voltage and current inputs at (**A**) degrees from settings above (for Line-Line configuration, set the phase angle at (**A**–30°).
3. Press and hold the **TARGET RESET** pushbutton, then slowly increase the three-phase input currents until the **21 PHASE DISTANCE** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.

The level at which the **21 PHASE DISTANCE** actuates should be equal to  $I$  calculated in Step 6 with the resulting impedance  $\pm 0.1$  ohms or 5%.

4. Release the **TARGET RESET** pushbutton, then decrease the three-phase input currents. The assigned **OUTPUT** LEDs will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of the current ( $I$ ) found in Step 6, and start timing. The contacts will close after  $D$  cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

## 24 Volts/Hz Definite Time (#1 or #2)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Definite Time Pickup	P	%	(100 to 200)
	Time Delay	D	Cycles	(30 to 8160)
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** It would be efficient to disable the 24 Definite Time element with the lower pickup setting first and test the higher setting operation, since the lower setting operation can be tested without disabling the higher setting.

### Test Setup:

1. Determine the Function 24 Volts/Hz Definite Time settings to be tested.
2. Enter the Function 24 Volts/Hz Definite Time settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. The Volts per Hertz pickup level at a percentage setting at Nominal Frequency (50 or 60 Hz) is: Pickup voltage =  $(P\% \div 100) \times (\text{Nominal Voltage})$  where the Nominal Values have been programmed in the system setup data described in Section 4.2, System Setup and are recorded in Appendix A Configuration Record Forms.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the voltage on Phase A until the **24 VOLTS/Hz** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level of operation will equal to **P** volts  $\pm 1\%$ .
2. Release the **TARGET RESET** pushbutton, then decrease the Phase A voltage. The assigned **OUTPUT** LED(s) will extinguish.
3. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately (**P** + 10 volts) volts, and start timing. The contacts will close after **D** cycles  $\pm 25$  cycles.
3. Repeat Pickup Test and Time Test for Phase B and C.

## 24 Volts/Hz Inverse Time

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Inverse Time Pickup	P	%	(100 to 200)
	Inverse Time Curve	C		(1 to 4)
	Time Dial (Curve 1)	K		(1 to 100)
	Time Dial (Curves 2-4)			(0.0 to 9.0)
	Reset Rate	R	Seconds	(1 to 999)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Function 24 Volts/Hz Inverse Time settings to be tested.
2. Enter the Function 24 Volts/Hz Inverse Time settings to be tested utilizing either the HMI or IPScom® Communications Software.siriusx
3. Enter a Function 24 Volts/Hz Definite Time Pickup #1 setting of 140%, with a Delay of 1200 cycles.
4. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
5. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
6. The Volts/Hz pickup level of a percentage setting at nominal frequency (50 or 60 Hz) is: Pickup voltage =  $(P\% \div 100) \times (\text{Nominal Voltage})$  where the Nominal Values have been programmed in the system setup data described in Section 4.2, System Setup and are recorded in Appendix A Configuration Record Forms.
7. Test levels may be chosen at any percentages of Nominal Voltage which are a minimum of 5% higher than the pickup percentage, **P**%. (Suggest 4 or 5 test levels chosen and calculated in Step 6.)

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the voltage on Phase A until the **24 VOLTS/Hz** LED light illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level of operation will equal **P** volts  $\pm 1\%$ .
2. Release the **TARGET RESET** pushbutton, then decrease the Phase A voltage. The assigned **OUTPUT** LED(s) will extinguish.
3. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply a voltage equal to the chosen test level calculated in Step 6 to Phase A and start timing.  
The operating time will be as 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  $\pm 1\%$  of the pickup value.
3. Press and hold the **TARGET RESET** pushbutton.
4. Reduce the applied voltage and start timing when the voltage drops below the pickup value, stop timing when the **TARGET** LED extinguishes. The time should be the reset time within  $\pm 1\%$ .
5. Repeat Pickup Test and Time Test for all chosen test levels. The curve portion extending to lower than **P**% V/Hz values are inactive and can be ignored. The tested points verify the operating times of the function.

■ **NOTE:** If retesting is required, remove power from the unit or wait for the programmed reset time period before the next test to assure resetting of the timer.

## 25D Dead Check

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Dead V1	See Below		
	Dead V <sub>X</sub>	See Below		
	Dead V1 & V <sub>X</sub>	See Below		
	Dead Input Enable	DIN	Input	(1 to 6)
		Expanded I/O		(7 to 14)
	Dead Time Delay	DD	Cycles	(1 to 8160)
	Dead Voltage Limit	DVL	Volts	(0 to 60)
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Function 25D Dead Check settings to be tested.
2. Enter the Function 25D Dead Check settings to be tested utilizing either the HMI or IPScorn® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. The 25D function requires positive sequence voltage and V<sub>X</sub> for testing. The following tests will reference the positive sequence voltage as V1.
5. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
6. Set V1 and V<sub>X</sub> to the **Nominal Voltage**.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Dead V1 Hot V<sub>X</sub> Test:

1. Enable Dead V1 Hot V<sub>X</sub> and disable Dead V<sub>X</sub> Hot V1 (if enabled) utilizing either the HMI or IPScorn Communications Software..
2. Set V1 to **DVL +5 V**.
3. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the voltage applied to V1 until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScorn Function Status screen. The voltage level should be equal to **DVL**  $\pm 0.5$  V or  $\pm 0.5$  %.
4. Release the **TARGET RESET** pushbutton, then increase the voltage applied to V1. The **OUTPUT** LED will extinguish.
5. Set V1 to the **Nominal Voltage**.
6. Decrease V<sub>X</sub> to less than **DVL**, verify that the function does not operate.

**Dead V<sub>X</sub> Hot V1 Test:**

1. Enable Dead V<sub>X</sub> Hot V1 and disable Dead V1 Hot V<sub>X</sub> (if enabled) utilizing either the HMI or IPScom Communications Software.
2. Set V1 to the **Nominal Voltage**.  
The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
3. Set V<sub>X</sub> to **DVL +5 V**.
4. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the voltage applied to V<sub>X</sub> until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level should be equal to **DVL ±0.5 V** or **±0.5 %**.
5. Release the **TARGET RESET** pushbutton, then increase the voltage applied to V<sub>X</sub>. The **OUTPUT** LED will extinguish.
6. Set V<sub>X</sub> to the **Nominal Voltage**.
7. Decrease V1 to less than **DVL**, verify that the function does not operate.

**Dead V1 Dead V<sub>X</sub> Test:**

1. Enable Dead V1 Dead V<sub>X</sub> utilizing either the HMI or IPScom Communications Software.
2. Disable Dead V<sub>X</sub> Hot V1 and Dead V1 Hot V<sub>X</sub> (if enabled).
3. Set V1 and V<sub>X</sub> to **DVL +5 V**.
4. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the voltage applied to V1 and V<sub>X</sub> until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level should be equal to **DVL ±0.5 V** or **±0.5 %**.
5. Release the **TARGET RESET** pushbutton, then increase the voltage applied to V1 and V<sub>X</sub>. The **OUTPUT** LED will extinguish.
6. Set V1 to **Nominal Voltage**.
7. Decrease V<sub>X</sub> to less than **DVL**, then verify that the function does not operate.
8. Set V<sub>X</sub> to **Nominal Voltage**.
9. Decrease V1 to less than **DVL**, then verify that the function does not operate.

**Dead Input Enable Test:**

1. Select one of the Dead Inputs (**DIN**) and activate it.
2. Repeat the Dead V<sub>X</sub> Hot V1 Test and Dead V1 Hot V<sub>X</sub> Test, verify that the function operates as in Dead V<sub>X</sub> Hot V1 Test and Dead V1 Hot V<sub>X</sub> Testing.
3. Deactivate the **DIN** and repeat the Dead V<sub>X</sub> Hot V1 Test and Dead V1 Hot V<sub>X</sub> Test once more. Verify that the function does not operate.
4. Disable Dead Input feature.

**Dead Timer Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Enable Dead V1 Dead V<sub>X</sub>, utilizing either the HMI or IPScom Communications Software.
3. Set V1 and V<sub>X</sub> to **DVL +5 V**.
4. Remove V1 and V<sub>X</sub> and start timing. The contacts will close within -1 to +3 cycles or **±1%**.

## 25S Sync Check

<b>VOLTAGE INPUTS:</b>	Configuration V1			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	Phase Angle Limit	PA	Degrees	(0 to 90)
	Voltage Limits			
	Upper Limit	UL	Volts	(60 to 140)
	Lower Limit	LL	Volts	(40 to 120)
	Sync Check Time Delay	SD	Cycles	(1 to 8160)
	Delta Voltage Limit	DV	Volts	(1.0 to 50.0)
	Delta Frequency Limit	DF	Hz	(0.001 to 0.500)
	Phase Select			(AB, BC, CA)
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Function 25S Sync Check settings to be tested.
2. Enter the Function 25S Sync Check settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. The 25 function requires only one phase voltage and  $V_X$  for testing in the Line-to-Ground configuration. The phase voltage used for reference may be selected through the **System Setup** menu. The following tests will reference the phase voltage as V1, although any phase may be used for testing. Line-to-Line testing will follow the same procedures, with V1 representing the proper Line-to-Line phase input. Each test below can be performed using any of the three phases as a reference.
5. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
6. Set V1 and  $V_X$  to the **Nominal Voltage**.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Phase Angle Limit Test:

1. Establish a phase angle difference of more than **PA**  $+5^\circ$ .
2. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the phase angle difference until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom® Function Status screen. The phase angle difference should be equal to **PA**  $\pm 1^\circ$ .
3. Release the **TARGET RESET** pushbutton, then increase the phase angle difference. The **OUTPUT** LED will extinguish.



**Upper Voltage Limit Test:**

1. Apply a voltage 5 V greater than **UL** to V1.
2. Ensure  $V_X$  voltage is less than UL but greater than LL. Slowly decrease the voltage applied to V1 until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage should be equal to **UL**  $\pm 0.5$  V or  $\pm 0.5$  %.
3. Increase the voltage applied to V1. The **OUTPUT** LED will extinguish. If desired, repeat this test using  $V_X$ .

**Lower Voltage Limit Test:**

1. Apply a voltage 5 V less than **LL** to V1.
2. Ensure  $V_X$  voltage is greater than LL but less than UL. Slowly increase the voltage applied to V1 until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level should be equal to **LL**  $\pm 0.5$  V or  $\pm 0.5$  %.
3. Decrease the voltage applied to V1. The **OUTPUT** LED will extinguish. If desired, repeat this test using  $V_X$ .

**Sync Check Time Delay Test:**

1. Set V1 and  $V_X$  to the **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
2. Establish a phase angle difference of more than **PA**  $+5^\circ$ .
3. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
4. Remove the phase angle difference and start timing. The contacts will close after **SD** cycles within -1 to +3 cycles or  $\pm 1$  %.

**Delta Voltage Test:**

1. Set the Upper and Lower Voltage limits to their maximum and minimum values, respectively.
2. Set  $V_X$  to 140 V and V1 to 40 V.
3. Press and hold the **TARGET RESET** pushbutton, then slowly increase the voltage applied to V1 until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage difference should be equal to **DV**  $\pm 0.5$  V.
4. Release the **TARGET RESET** pushbutton, then decrease the voltage applied to V1. The **OUTPUT** LED will extinguish. If desired, repeat the test using  $V_X$  with V1 at 140 volts.

**Delta Frequency Test:**

1. Set V1 and  $V_X$  to the **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
2. Set the frequency of V1 to 0.05 less than **Nominal Frequency** –**DF**.
3. Press and hold the **TARGET RESET** pushbutton, then slowly increase the frequency of V1 until Output **Z** LED illuminates, or the pickup indicator illuminates on the IPScom® Function Status screen. The frequency difference value should be equal to **DF**  $\pm 0.0007$  Hz or 5 %.
4. Release the **TARGET RESET** pushbutton, then decrease the frequency of V1. The **OUTPUT** LED will extinguish. If desired, repeat the test using  $V_X$  with V1 at Nominal Frequency.

## 27 Phase Undervoltage, 3 Phase (#1, #2, #3)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	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 23)

■ **NOTE:** If 27 #1 and 27 #2 have different pickup settings, it would be efficient to disable the one with the higher setting first and test the lower setting operation. The higher setting operation could then be tested without disabling the lower setting.

### Test Setup:

1. Determine the Function 27 Phase Undervoltage settings to be tested.
2. Enter the Function 27 Phase Undervoltage settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the Phase A input voltage until the **27 PHASE UNDERVOLTAGE** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The voltage level should be equal to **P** volts  $\pm 0.5$  V or  $\pm 0.5\%$ . When both RMS and Line-Ground to Line-Line is selected, the accuracy is  $\pm 0.8$  V or  $\pm 0.75\%$ .
2. Release the **TARGET RESET** pushbutton, then increase the Phase A input voltage to the nominal voltage, the **OUTPUT** LEDs will extinguish.
3. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately (**P** – 1) volts and start timing.  
The contacts will close after **D** cycles  $\leq 20$  cycles or  $\pm 1\%$ (RMS), or  $\pm 1$  cycle or  $\pm 0.5\%$  (DFT), whichever is greater.
3. Repeat Pickup Test and Time Test for Phase B and C.

## 27TN Third-Harmonic Undervoltage, Neutral (#1 or #2)

**VOLTAGE INPUTS:** Configuration V2

**CURRENT INPUTS:** See Below

<b>TEST SETTINGS:</b>	Pickup	P	Volts	(0.10 to 14.0)
	Positive Sequence Volt Block	PSV	Volts	(5 to 180)
	Forward Power Block	FP	PU	(0.01 to 1.00)
	Reverse Power Block	RP	PU	(-1.00 to -0.01)
	Lead VAR Block	-VAR	PU	(-1.00 to -0.01)
	Lag VAR Block	+VAR	PU	(0.01 to 1.00)
	Lead Power Factor Block	PFLoad	PU	(0.01 to 1.00)
	Lag Power Factor Block	PFLag	PU	(0.01 to 1.00)
	High Band Forward Power Block	HFP	PU	(0.01 to 1.00)
	Low Band Forward Power Block	LFP	PU	(0.01 to 1.00)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	( 1 to 8)
			Expanded I/O	(9 to 23)

■ **NOTE:** If 27TN #1 and 27 #2 have different pickup settings, it would be efficient to disable the one with the higher setting first and test the lower setting operation. The higher setting operation could then be tested without disabling the lower setting.

### Test Setup:

1. Determine the Function 27TN Third-Harmonic Undervoltage, Neutral settings to be tested.
2. Enter the Function 27TN Third-Harmonic Undervoltage, Neutral settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-2](#), Voltage Inputs: Configuration V2.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the neutral voltage input until the **27TN/59D 100% STATOR GND** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The voltage level should be equal to **P** volts  $\pm 0.1$  V or  $\pm 1\%$ .
2. Release the **TARGET RESET** pushbutton, then increase the neutral voltage to nominal voltage. The **OUTPUT** LED(s) will extinguish.
3. Press **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately (**P** -1) volts and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

**Positive Sequence Voltage Block Test:**

1. Decrease the neutral voltage input to less than **P** volts.
2. Apply a three phase voltage input greater than **PSV** volts.  
The **27TN/59D 100% STATOR GND** LED will illuminate, then the **OUTPUT** LED will illuminate when the delay setting has timed out.
3. Enable the Positive Sequence Voltage Block utilizing either the HMI or IPScom® Communications Software.
4. Decrease the applied three phase voltage until the **OUTPUT** LED(s) extinguishes.  
The voltage level should be equal to **PSV** volts  $\pm 0.5$  V or  $\pm 0.5\%$ .
5. Disable the Positive Sequence Voltage Block utilizing either the HMI or IPScom Communications Software.

**Forward/Reverse Power Block Test:**

1. Apply a three phase nominal voltage input.  
The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
2. Apply a nominal current input consistent with [Figure 6-3](#), Current Inputs: Configuration C1.  
The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

■ **NOTE:** The POWER Real p.u. value can be obtained utilizing either the HMI (Status/Power Status) or IPScom® Communications Software (Relay/Monitor/Secondary Status).

3. Adjust three phase voltage and current inputs to obtain a **Power Real p.u.** value greater than **FP**.
4. Enable the Forward Power Block utilizing either the HMI or IPScom Communications Software.
5. Decrease the applied three phase current until the **OUTPUT** LED(s) extinguishes.  
The **Power Real p.u.** value should be equal to **FP**  $\pm 0.01$  PU or  $\pm 2\%$ .
6. Utilizing either the HMI or IPScom Communications Software disable the Forward Power Block and then enable the Reverse Power Block.
7. Adjust three phase voltage and current inputs to obtain a **Power Real p.u.** value greater than **RP**.
8. Decrease the applied three phase current until the **OUTPUT** LED(s) extinguishes.  
The **Power Real p.u.** value should be equal to **RP**  $\pm 0.01$  PU or  $\pm 2\%$ .
9. Disable the Reverse Power Block utilizing either the HMI or IPScom Communications Software.

**Lead/Lag VAR Block Test:**

1. Apply a three phase nominal voltage input.  
The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
2. Apply a nominal current input consistent with [Figure 6-3](#), Current Inputs: Configuration C1.  
The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

■ **NOTE:** The POWER Reactive var value can be obtained utilizing either the HMI (Status/Power Status) or IPScom® Communications Software (Relay/Monitor/Secondary Status).

3. Adjust three phase voltage and current inputs to obtain a **Power Reactive VAR** value greater than **-VAR**.

The **27TN/59D 100% STATOR GND** LED will illuminate, then the **OUTPUT** LED will illuminate when the delay setting has timed out.

4. Enable the Lead VAR Block utilizing either the HMI or IPScom® Communications Software.
5. Adjust the applied three phase current phase angles until the **OUTPUT** LED(s) extinguishes.  
The **Power Reactive var** value should be equal to **-VAR**  $\pm 0.01$  PU or  $\pm 2\%$ .
6. Utilizing either the HMI or IPScom® Communications Software disable the Lead VAR Block and then enable the Lag VAR Block.
7. Adjust three phase voltage and current inputs to obtain a **Power Reactive var** value greater than **+VAR**.
8. Adjust the applied three phase current phase angles until the **OUTPUT** LED(s) extinguishes.  
The **Power Reactive var** value should be equal to **+VAR**  $\pm 0.01$  PU or  $\pm 2\%$ .
9. Disable the Lag VAR Block utilizing either the HMI or IPScom Communications Software.

#### **Lead/Lag Power Factor Block Test:**

1. Apply a three phase nominal voltage input.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

2. Apply a nominal current input consistent with [Figure 6-3](#), Current Inputs: Configuration C1.

The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

3. Adjust three phase voltages and currents to obtain a Lead Power Factor Block value greater than **PFLed**.

The **27TN/59D 100% STATOR GND** LED will illuminate, then the **OUTPUT** LED will illuminate when the delay setting has timed out.

4. Enable the Power Factor Lead Block utilizing either the HMI or IPScom Communications Software.
5. Adjust three phase voltage phase angles until the **OUTPUT** LED(s) extinguishes.  
The **Power Factor Lead Block** value should be equal to **PFLed**  $\pm 0.03$  or  $\pm 3\%$ .
6. Disable the Power Factor Lead Block.
7. Enable the Power Factor Lag Block.

8. Adjust three phase voltages and currents to obtain a Lag Power Factor Block value greater than **PFLag**.

The **27TN/59D 100% STATOR GND** LED will illuminate, then the **OUTPUT** LED will illuminate when the delay setting has timed out.

9. Enable the Power Factor Lag Block utilizing either the HMI or IPScom Communications Software.
10. Adjust three phase voltage phase angles until the **OUTPUT** LED(s) extinguishes.  
The **Power Factor Lag Block** value should be equal to **PFLag**  $\pm 0.03$  PU or  $\pm 3\%$ .
11. Disable the Power Factor Lag Block.

**Forward Power Block (Band) Test:**

1. Apply a three phase nominal voltage input.  
The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
2. Apply a nominal current input consistent with [Figure 6-3](#), Current Inputs: Configuration C1.  
The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
3. Enable the High/Low Band Forward Power Block utilizing either the HMI or IPScom Communications Software.
4. Adjust three phase voltages and currents to obtain a High/Low Forward Power Block value either greater than the Low Band Forward Power Block **LFP**, or less than the High Band Forward Power Block **HFP**  
The **27TN/59D 100% STATOR GND** LED will illuminate, then the **OUTPUT** LED will illuminate when the delay setting has timed out.
5. Adjust the three phase current until the **OUTPUT** LED(s) extinguishes.  
The **Power Real p.u.** value should be within the High Band and Low Band setpoint band  $\pm 0.1$  PU or  $\pm 2\%$ .
6. Disable the High/Low Band Forward Power Block.

### 32 Directional Power, 3 Phase (#1, #2, #3)

<b>VOLTAGE INPUTS:</b>	Configuration V1			
<b>CURRENT INPUTS:</b>	Configuration C1			
<b>TEST SETTINGS:</b>	Pickup	P	PU	(-3.000 to +3.000)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)
	VT Configuration	Line-Ground		
	Power Sensing	(Over/Under)		
	#3 Directional Power Sensing	(Real/Reactive)		

■ **NOTE:** It would be efficient to disable the element with the lower pickup setting first and test the higher setting operation, since the lower setting operation can be tested without disabling the higher setting.

#### Test Setup:

1. Determine the Function 32 Directional Power settings to be tested.
2. Enter the Function 32 Directional Power settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.
6. The level of current at which operation is to be expected for an individual power setting is given by multiplying the PU pickup value (**P** above) by the **Nominal Current** value previously input to the relay. The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
7. Set the three phase voltages to the **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

#### Pickup Test, Positive/Forward Over Power Flow:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the three phase currents until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The level of operation will be equal to that calculated in Step 6,  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
2. Release the **TARGET RESET** pushbutton.
3. Decrease the currents. The **OUTPUT** LED(s) will extinguish.
4. Press **TARGET RESET** pushbutton to reset targets.

**Pickup Test, Negative/Reverse Over Power Flow:**

1. Set the phase currents at 180 degrees from the respective phase voltages.
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase the three phase currents until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom® Function Status screen. The level of operation will be equal to that calculated in Step 6,  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
3. Release the **TARGET RESET** pushbutton.
4. Decrease the three phase currents. The **OUTPUT** LED(s) will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Pickup Test, Positive Forward Under Power Flow:**

1. Set the phase currents in phase with the respective phase voltages.
2. Select Underpower sensing utilizing either the HMI or IPScom Communications Software.
3. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the three phase currents until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The level of operation will be equal to that calculated in Step 6,  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
4. Release the **TARGET RESET** pushbutton.
4. Increase the three phase currents. The **OUTPUT** LED(s) will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Pickup Test, Negative/Reverse Under Power Flow:**

1. Set the phase currents at 180 degrees from the respective phase voltages.
2. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the three phase currents until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The level of operation will be equal to that calculated in Step 6,  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
3. Release the **TARGET RESET** pushbutton.
4. Increase the three phase currents. The **OUTPUT** LED(s) will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Pickup Test, Reactive Over Power (Element #3 Only):**

1. Set the Three phase voltages, current magnitudes and phase angles to less than the **Reactive p.u.** pickup level.
2. Press and hold the **TARGET RESET** pushbutton, then slowly swing current angles until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The level of operation will be equal to the Reactive Pickup  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
3. Release the **TARGET RESET** pushbutton.
4. Adjust phase angles until the **OUTPUT** LED(s) extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.



**Pickup Test, Reactive Under Power (Element #3 Only):**

1. Set the Three phase voltages, current magnitudes and phase angles to greater than the **Reactive p.u.** pickup level.
2. Press and hold the **TARGET RESET** pushbutton, then slowly swing current angles until the **32 DIRECTIONAL POWER** LED illuminates, or the pickup indicator illuminates on the IPScom<sup>®</sup> Function Status screen. The level of operation will be equal to the Reactive Pickup  $\pm 2\%$  or  $\pm 0.002$  PU, whichever is greater.
3. Release the **TARGET RESET** pushbutton.
4. Adjust phase angles until the **OUTPUT** LED(s) extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of the pickup current and start timing. The contacts will close after **D** cycles within +16 cycles or  $\pm 1\%$ .

**40 Loss of Field (#1 or #2, VC #1 or #2)****VOLTAGE INPUTS:** Configuration V1**CURRENT INPUTS:** Configuration C1

<b>TEST SETTINGS:</b>	Circle Diameter	P	Ohms	(0.1 to 100)
	1 Amp CT Rating			(0.5 to 500)
	Offset	O	Ohms	(-50 to 50)
	1 Amp CT Rating			(-250 to 250)
	Time Delay	D	Cycles	(1 to 8160)
	Voltage Control	V	Volts	(5 to 180)
	Delay with VC		Cycles	(1 to 8160)
	Directional Element	E	Degrees	(0 to 20)
	Programmed Outputs	Z	OUT	(1 to 8)
			Expanded I/O	(9 to 23)
	VT Configuration		Line-Ground	

■ **NOTE:** It would be efficient to disable the function with the higher “reach” (diameter minus offset) setting first (lower current) and test the lower “reach” setting operation. Since the higher setting operation can be tested without disabling the lower setting, the 40 functions will be enabled when the tests are complete.

**Test Setup:**

1. Determine the Function 40 Loss of Field settings to be tested.
2. Enter the Function 40 Loss of Field settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.

■ **NOTE:** For proper testing, use  $I \leq 3 \times \text{CT rating}$ .

6. The level of current at which operation is to be expected for an individual setting is as follows:
  - a. Define “reach” as  **$R \text{ ohms} = (P - O \text{ ohms})$**  where **O** is usually negative.
  - b. Define “trip current” as  **$I = (\text{Selected Voltage} \div R \text{ ohms})$** . The voltage level may be selected based on the desired test current level.
  - c. Define “offset current” as  **$IO = (\text{Selected Voltage} \div O \text{ ohms})$** .
7. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Selected Voltage** value from Step 6, and set the phase angle between the voltage and current inputs to  $90^\circ$  (current leading voltage).

**Pickup Test:**

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the three-phase currents until the **40 LOSS OF FIELD** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The level will be equal to “**I**” calculated in Step 6 with the resulting impedance within  $\pm 0.1$  ohms or  $\pm 5\%$ .
2. If the offset setting is negative, continue to increase the three-phase currents until the **40 LOSS OF FIELD** LED light extinguishes, or the pickup indicator extinguishes on the IPScom® Function Status screen. The level will be equal to “**IO**” calculated in Step 6 with the resulting offset impedance within  $\pm 0.1$  ohms or  $\pm 5\%$ .
3. Release the **TARGET RESET** pushbutton.
4. Decrease the three-phase currents. The **OUTPUT LED(s)** will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Selected Voltage** value from Step 6, and set the phase angle between the voltage and current inputs to  $90^\circ$  (current leading voltage).
3. Apply **I** + 10% Amps and start timing. Contacts will close after **D** cycles  $\pm 1$  cycle or  $\pm 1\%$ .

**Time Test With Voltage Control:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Enable the Voltage Control setting utilizing either the HMI or IPScom Communications Software.
3. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to a voltage where the positive sequence voltage is less than the Voltage Control setting.
4. Set phase currents and phase angles to establish the impedance value within the mho pickup and start timing. Contacts will close after **D** cycles  $\pm 1$  cycle or  $\pm 1\%$ .

## 46 Negative Sequence Overcurrent Definite Time

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C1 (MODIFIED)			
<b>TEST SETTINGS:</b>	Pickup Def Time	P	%	(3 to 100)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** Although no voltage input is required for the testing of the 46 function, it is suggested that Nominal Voltage be applied to restrain the functions which use both voltage and current inputs for operation.

### Test Setup:

1. Determine the Function 46 Negative Sequence Overcurrent Definite Time settings to be tested.
2. Enter the Function 46 Negative Sequence Overcurrent Definite Time settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1 (Modified). Modify Configuration C1 by exchanging Current Input 2 and 3 (Phase B current = Input 3 and Phase C current = Input 2).

■ **NOTE:** For proper testing, use  $I \leq 3 \times CT$  rating.

5. The level of current at which operation is to be expected for an individual setting is given by; Pickup current =  $(P\% \div 100) \times \text{Nominal Current}$  previously input to the relay. The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the three-phase currents until the **NEG SEQ OVERCURRENT 46** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen. The level will be equal to pickup current calculated in Step 5,  $\pm 0.5\%$  of 5 A.
2. Release the **TARGET RESET** pushbutton.
3. Decrease the three-phase currents. The **OUTPUT** LED(s) will extinguish.
4. Press **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply current of at least (**1.1 x pickup**) amps and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

## 46 Negative Sequence Overcurrent Inverse Time

<b>VOLTAGE INPUTS:</b>	None		
<b>CURRENT INPUTS:</b>	Configuration C1 (MODIFIED)		
<b>TEST SETTINGS:</b>	Pickup Inv Time	P	% (3 to 100)
	Time Dial Setting	K	(1 to 95)
	Maximum Trip Time	D	Cycles (600 to 65,500)
	Reset Time	R	Seconds (1 to 600)
	Programmed Outputs	Z	OUT (1 to 8)
		Expanded I/O	(9 to 23)

■ **NOTE:** Although no voltage input is 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.

### Test Setup:

1. Determine the Function 46 Negative Sequence Overcurrent Inverse Time settings to be tested.
2. Enter the Function 46 Negative Sequence Overcurrent Inverse Time settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1 (Modified). Modify Configuration C1 by exchanging Current Input 2 and 3 (Phase B current = Input 3 and Phase C current = Input 2).

■ **NOTE:** For proper testing, use  $I \leq 3 \times CT$  rating.

5. The current pickup level at a percentage setting is: Pickup current =  $(P\% \div 100) \times \text{Nominal Current}$  previously input to the relay.
  - a. Test levels may be chosen at any percentages of Nominal Current which are a minimum of 5% higher than the pickup percentage, **P%**. (Suggest 4 or 5 test levels chosen and calculated in amps.)
  - b. The **Nominal Current** value is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply currents equal to the chosen test levels calculated in Step 5 and start timing. The operating time will be as read from [Figure 4-47](#), Negative Sequence Inverse Time Curves, negative sequence current in % of Nominal Current and appropriate **K** (Time Dial) setting, or the maximum trip time (whichever is faster).

■ **NOTE:** If retesting is required, power should be removed from the unit or wait **R** seconds before the next test to assure resetting of the timer.

3. Repeat Step 2 for all test levels chosen.

### Reset Time Test:

1. Press and hold the **TARGET RESET** pushbutton.
2. Reduce the applied voltage and start timing when the voltage decreases to less than the pickup value, stop timing when the **TARGET** LED extinguishes, or the pickup indicator extinguishes on the IPScom Function Status screen. The time should be approximately equal to the reset time setting **R**.

■ **NOTE:** If retesting is required, power should be removed from the unit or wait for the reset time before the next test to assure resetting of the timer.

## 49 Stator Overload Protection (#1, #2)

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C1			
<b>TEST SETTINGS:</b>	Time Constant	$\tau$	Minutes	(1.0 to 999.9)
	Max Overload Current	$I_{max}$	Amps	(1 to 10)
	1 Amp CT Rating			(.2 to 2)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

- Determine the Function 49 Stator 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:
  - $\tau$  = time constant
  - $I_0$  = pre-load current
  - $I_{max}$  = maximum allowed continuous overload current
- Enter the Function 49 Stator Overload settings to be tested utilizing either the HMI or IPScom® Communications Software.
- Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
- Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.
- Calculate  $t$  (time to trip in minutes) for the desired test settings as follows:

Where:

$$t = \tau \times \ln \left( \frac{I_L^2 - I_{PL}^2}{I_L^2 - I_{max}^2} \right)$$

Where:  $t$  = time to trip in minutes

$\tau$  = time constant

$I_L$  = relay current (applied)

$I_{PL}$  = pre-load current

$I_{max}$  = maximum allowed continuous overload current

### Pickup Test:

- Press and hold the **TARGET RESET** pushbutton, then slowly increase the current until the **STATOR OVERLOAD 49** LED illuminates or the pickup indicator illuminates on the IPScom Function Status screen.  
The current level of operation will be ( $I_{max}$ ) Amps  $\pm 0.1$  A ( $\pm 0.02$  Amp for 1 A CT) or  $\pm 3\%$ .
- Release the **TARGET RESET** pushbutton, then decrease the current. The **OUTPUT** LED will extinguish.
- 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 Stator Overload 49 #1 and 49 #2 current values can be obtained utilizing either the HMI (Status/Current Status) or IPScom® Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Stator Overload 49 #1 and 49 #2 current values. If the either 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 current (**I**) to the relay greater than (**I<sub>max</sub>**) Amps and start timing.

The time to trip should be **t** minutes  $\pm 5\%$ .

**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 Stator Overload 49 #1 and 49 #2 current values can be obtained utilizing either the HMI (Status/Current Status) or IPScom Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Stator Overload 49 #1 and 49 #2 current values. If the either 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<sub>o</sub>**) Amps and allow current readings to stabilize.
4. Apply a three phase current (**I**) to the relay greater than (**I<sub>max</sub>**) Amps and start timing.

The time to trip should be **t** minutes  $\pm 5\%$ .

## 50 Instantaneous Phase Overcurrent (#1, #2)

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C1			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.1 to 240.0)
	1 Amp CT Rating			(0.1 to 48.0)
	Delay		Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
			Expanded I/O	(9 to 23)

■ **NOTE:** Although no voltage input is required for the testing of the 50 function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation.

### Test Setup:

1. Determine the Function 50 Instantaneous Phase Overcurrent settings to be tested.
2. Enter the Function 50 Instantaneous Phase Overcurrent settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input 3 (Phase C) until the **PHASE OVERCURRENT 50** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The current level of operation will be (**P**) amps  $\pm 0.1$  amps or  $\pm 3\%$ .
2. Release the **TARGET RESET** pushbutton.
3. Decrease the current input. The **OUTPUT LED(s)** will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of **P** amps and start timing. The operating time will be  $\pm 1$  cycle or 1%.
3. Reduce Current Input 3, to 0 amps.
4. Test may be repeated using Current Inputs 1 (Phase A) and 2 (Phase B) individually.



## 50BF/50BF-N Breaker Failure

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C2 to test 50BF-Ph (inject into line side current inputs)			
<b>TEST SETTINGS:</b>	50BF-Ph Pickup	P	Amps	(0.10 to 10.00)
	1 Amp CT Rating			(0.02 to 2.00)
	50BF-N Pickup	N	Amps	(0.10 to 10.00)
	1 Amp CT Rating			(.02 to 2.00)
	Time Delay	D	Cycles	(1 to 8160)
	Breaker Failure Initiate	B	OUT	(1 to 8)
	Input Initiate	I	IN	(1 to 6)
		Expanded I/O		(7 to 14)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
2. Connect test current inputs as shown in [Figure 6-5](#), Current Inputs: Configuration C3. Current Input #2 only.

### Test Setup for 50BF-Ph Generator Breaker Failure Operation:

1. Determine the Function 50BF-Ph Generator Breaker Failure settings to be tested.
2. Utilizing either the HMI or IPScom® Communications Software enter the following settings:
  - a. Enable the 50BF-Phase Element and disable the 50BF-Neutral Element
  - b. 50BF-Ph Pickup Setting > **P** amps, Time delay setting = **D** cycles.

### Testing 50BF-Ph Generator Breaker Failure Operation:

1. Externally short any ONE set of contacts (I) IN shown above.
2. Short IN1 (connect contacts 10 & 11) to simulate 52b contact closure (breaker open). Alternatively, the external contact may be operated if all connections are made.
3. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input 3 until the **50BF BREAKER FAILURE** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The current level of operation will be (**P**) amps  $\pm 0.1$  amps or  $\pm 2\%$ .
4. Release the **TARGET RESET** pushbutton.
5. Decrease the current input. The **OUTPUT** LED(s) extinguish.
6. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test 50BF-Ph Generator Breaker Failure Operation:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of **P** amps and start timing. The operating time will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .
3. Reduce Current Input 3, to 0 amps.

**Test Setup for 50BF-N Generator Breaker Failure Operation:**

1. Determine the Function 50BF-Ph Generator Breaker Failure settings to be tested.
2. Utilizing either the HMI or IPScom® Communications Software enter the following settings:
  - a. Enable the 50BF-Neutral Element and the 50BF-Phase Element
  - b. 50BF-N Pickup Setting = **N** amps, 50BF-Ph Pickup Setting = **P** amps, Time delay setting = **D** cycles.

**Testing 50BF-N Generator Breaker Failure Operation:**

1. Short IN1 (connect contacts 10 & 11) to simulate 52b contact closure (breaker open).
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input 3 until the **50BF BREAKER FAILURE** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
  
The current level of operation will be (**N**) amps  $\pm 0.1$  amps or  $\pm 2\%$ . Note that 50BF-Ph must be picked up in order for 50BF-N to operate.
3. Release the **TARGET RESET** pushbutton.
4. Decrease the current input. The **OUTPUT** LED(s) extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test 50BF-N Generator Breaker Failure Operation:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of **N** amps and start timing. The operating time will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .
3. Reduce Current Input 3, to 0 amps.

**Test Setup for HV Breaker Failure Operation:**

1. Utilizing either the HMI or IPScom Communications Software enter the following settings:
  - a. Disable the 50BF-Neutral Element and 50BF-Phase Element.
  - b. Select 1 input initiate from #2 to #6, utilizing either the HMI or IPScom Communications Software.
  - c. Time delay setting = **D** cycles
  - d. Input 1 IN breaker closed state.

**Testing HV Breaker Failure Operation:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Initiate operation by externally shorting any ONE set of contacts (**I**) IN except Input 1 above. Remove short from Input (1) IN. The operating time will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

## 50/27 Inadvertent Energizing

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** Configuration C1

<b>TEST SETTINGS:</b>	50 Pickup	P	Amps	(0.50 to 15.00)
	1 Amp CT Rating			(.01 to 3.00)
	27 Pickup	V	Volts	(5 to 130)
	Pickup Delay	D	Cycles	(1 to 8160)
	Dropout Delay	T	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Function 50/27 Inadvertent Energizing settings to be tested.
2. Enter the Function 50/27 Inadvertent Energizing settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.

### 50 Overcurrent Test and 27 Undervoltage Test:

1. Set Voltage inputs to zero volts, then verify the Pickup Time Delay times out after a minimum of **D** cycles.
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase the Phase A current (Input 1) until the **50/27 INADVERTENT ENRGNG** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The level of operation will be (**P**) amps  $\pm 0.1$  A or  $\pm 2\%$ .
3. If desired, set the dropout time delay (**T**) to minimum setting.
4. Press and hold the **TARGET RESET** pushbutton, then slowly increase the voltage input in stages (waiting at least **T** cycles between each voltage change) until the **50/27 INADVERTENT ENRGNG** LED extinguishes, or the pickup indicator extinguishes on the IPScom Function Status screen.  
The level of operation will be **V** volts  $\pm 0.5$  Volts.

### 27 Pickup Delay and Dropout Delay Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Input approximately 110% of **P** amps (pickup setting).
3. Reduce voltage to 0 volts and start timing. The operating time to close will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .
4. Input approximately 110% of **V** volts (pickup setting) and start timing. The operating time to open will be **T** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

■ **NOTE:** When RMS (total waveform) is selected, timing accuracy is  $\leq 20$  cycles or  $\pm 1\%$ .

**50DT Definite Time Overcurrent (for split-phase differential), #1 or #2**

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C2			
<b>TEST SETTINGS:</b>	Pickup A Phase	A	Amps	(0.20 to 240.00)
	1 Amp CT Rating			(0.04 to 48.00)
	Pickup B Phase	B	Amps	(0.20 to 240.00)
	1 Amp CT Rating			(0.04 to 48.00)
	Pickup C Phase	C	Amps	(0.20 to 240.00)
	1 Amp CT Rating			(0.04 to 48.00)
	Delay		Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** Although no voltage input is required for the testing of the 50DT 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 will need to also be disabled for the test and enabled after the tests are complete.

**Test Setup:**

1. Determine the Function 50DT Definite Time Overcurrent settings to be tested.
2. Enter the Function 50DT Definite Time Overcurrent settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable the functions listed above. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test current inputs as shown in [Figure 6-4](#), Current Inputs: Configuration C2.
5. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

**Pickup Test:**

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the Phase A Current Input until the **PHASE OVERCURRENT 50** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.

The current level of operation will be (**A**) amps  $\pm 0.1$  amps or  $\pm 3\%$ .

2. Release the **TARGET RESET** pushbutton.
3. Decrease the Phase A Current Input. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of **A** amps and start timing. The operating time will be  $\pm 1$  cycle or  $\pm 1\%$ , whichever is greater.
3. Reduce Phase A Current Input to 0 amps.
4. Repeat Steps 2 and 3 for Phase B & C.
5. If testing is complete, enable any functions disabled for this test.

## 50N Instantaneous Neutral Overcurrent

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	As described			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.1 to 240.0)
	1 Amp CT Rating			(0.1 to 48.0)
	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** Although no voltage input is required for the testing of the 50N function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation.

### Test Setup:

1. Determine the Function 50N Instantaneous Neutral Overcurrent settings to be tested.
2. Enter the Function 50N Instantaneous Neutral Overcurrent settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input  $I_N$  (terminals 53 and 52) until the **NEUTRAL O/C 50N/51N** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The current level of operation will be (**P**) amps  $\pm 0.1$  amps or  $\pm 3\%$ .
2. Release the **TARGET RESET** pushbutton.
3. Decrease Current Input  $I_N$ . The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply approximately 110% of **P** amps to Current Input  $I_N$  (terminals 53 and 52) and start timing. The operating time will be **D** cycles  $\pm 1$  Cycle or  $\pm 1\%$ .
3. Reduce Current Input  $I_N$  to 0 amps.

## 51N Inverse Time Neutral Overcurrent

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	As described			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.25 to 12.00)
	1 Amp CT Rating			(0.05 to 2.40)
	BECO Time Curves (definite time/inverse/very inverse/extremely inverse)			
	Time Dial Setting	K		(0.5 to 11.0)
	IEC Inverse Time Curves: <sup>1</sup> (inverse/very inverse/extremely inverse/long time inverse)			
	IEEE Curves (moderately inverse/very inverse/extremely inverse)			
	Time Dial Setting	K		(0.5 to 15.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

<sup>1</sup> Either a standard curve or an IEC curve must be selected.

■ **NOTE:** Although no voltage input is required for the testing of the 51N function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation.

### Test Setup:

1. Determine the Function 51N Inverse Time Neutral Overcurrent settings to be tested.
2. Enter the Function 51N Inverse Time Neutral Overcurrent settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Refer to Appendix D, Inverse Time Curves. Test levels may be chosen in terms of multiples of pickup value and associated time in seconds. (Suggest 4 or 5 test levels chosen and calculated in amps.)

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply current equal to the chosen test level calculated in Step 6 to Current Input  $I_N$  (Terminals 53 and 52) and start timing.  
  
Operating time will be within  $\pm 3$  cycles or  $\pm 3\%$  whichever is greater.
3. Repeat Steps 2 and 3 for all test levels chosen. The tested points verify the operating times of the function.

## 51V Inverse Time Phase Overcurrent with Voltage Control/Restraint

<b>VOLTAGE INPUTS:</b>	Configuration V1			
<b>CURRENT INPUTS:</b>	Configuration C1			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.50 to 12.00)
	1 Amp CT Rating			(0.10 to 2.40)
	BECO Time Curves (definite time/inverse/very inverse/extremely inverse)			
	Time Dial Setting	K		(0.5 to 11.0)
	IEC Inverse Time Curves: <sup>1</sup> (inverse/very inverse/extremely inverse/long time inverse)			
	IEEE Curves (moderately inverse/very inverse/extremely inverse)			
	Time Dial Setting	K		(0.5 to 15.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

<sup>1</sup> Either a standard curve or an IEC curve must be selected.

### Test Setup:

1. Determine the Function 51V Inverse Time Phase Overcurrent settings to be tested.
2. Enter the Function 51V Inverse Time Phase Overcurrent settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1
6. Test levels may be chosen at any ampere values which are a minimum of 50% higher than the pickup amps, **P Amps**. It is suggested that the user select 4 or 5 test levels to verify curve.

### Pickup Test:

1. If Voltage Control or Voltage Restraint is enabled, then disable 51V Voltage Control/Restraint utilizing either the HMI or IPScom Communications Software.
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase the Phase A Current Input until the **PHASE OVERCURRENT 51V** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
  
The current level of operation will equal **P Amps**  $\pm 0.1A$  or  $\pm 1\%$ .
3. Release the **TARGET RESET** pushbutton.
4. Reduce the Phase A Current Input to 0 amps. The assigned **OUTPUT** LED(s) will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. If Voltage Control or Voltage Restraint is enabled, then disable 51V Voltage Control/Restraint utilizing either the HMI or IPScom Communications Software.
3. Apply current equal to the chosen test level calculated in Step 6 to Phase A Current Input and start timing. The operating time will be as read from the appropriate Inverse Curve Family and **K** (Time Dial) setting in Appendix D, Inverse Time Curves. The accuracy specified is valid for currents above 1.5 times the pickup current.
4. Reduce Phase A Current Input to 0 amps. The **OUTPUT** LED(s) will extinguish.
5. Press the **TARGET RESET** pushbutton to reset targets.
6. Repeat Steps 3, 4 and 5 for all test levels chosen.

**Voltage Control Test:**

1. If Voltage Control is disabled, then enable 51V Voltage Control utilizing either the HMI or IPScom® Communications Software.
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase the Phase A (B,C) Current Input until the **PHASE OVERCURRENT 51V** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.
3. Release the **TARGET RESET** pushbutton.
4. When the assigned **OUTPUT** LED(s) illuminates, then increase the Phase A(B,C) Input Voltage to at least 0.5 Volts greater than **V Volts**.  
The assigned **OUTPUT** LED(s) will extinguish at **V Volts**  $\pm 0.5$  V or  $\pm 0.5\%$ .
5. Press the **TARGET RESET** pushbutton to reset targets.
6. Reduce Phase A (B,C) Current Input to 0 amps.
7. Decrease the Phase A (B,C) Input Voltage to **Nominal Voltage**.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

**Voltage Restraint Test:**

1. If Voltage Restraint is disabled, then enable 51V Voltage Restraint utilizing either the HMI or IPScom Communications Software.
2. Set **P Amps** equal to 2 Amps utilizing either the HMI or IPScom Communications Software.
3. Apply current equal to 1.5 Amps to the Phase Current Input.
4. Increase the Phase A (B,C) Input Voltage to 75% of **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.  
The **PHASE OVERCURRENT 51V** LED will illuminate, or the pickup indicator illuminates on the IPScom Function Status screen.
5. Repeat Steps 2, 3 and 4 with reduced input voltage values and current reduced by the same percentage as value (see [Figure 4-61](#)).



## 59 Phase Overvoltage, 3-Phase (#1, #2, #3)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Pickup	P	Volts	(5 to 180)
	Time Delay	D	Cycles	(1 to 8160)
	Input Voltage Select	(Phase, Positive or Negative Sequence)		
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** If 59 #1 and 59 #2 have different pickup settings, it would be efficient to disable the one with the lower setting first and test the higher setting operation. The lower setting operation could then be tested without disabling the higher setting.

### Test Setup:

1. Determine the Function 59 RMS Overvoltage settings to be tested.
2. Enter the Function 59 RMS Overvoltage settings to be tested utilizing either the HMI or IPScorn® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage**.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase the Phase A Voltage Input until the **59 PHASE OVERVOLTAGE** LED illuminates, or the pickup indicator illuminates on the IPScorn Function Status screen.

The voltage level of operation should be equal to **P Volts**  $\pm 0.5$  V or  $\pm 0.5\%$ . When both RMS and Line-Ground to Line-Line is selected, the accuracy is  $\pm 0.8$ V or  $\pm 0.75\%$

2. Release the **TARGET RESET** pushbutton.
3. Decrease the Phase A Voltage Input to **Nominal Voltage**. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply (**P+1**) Volts to the Phase A (B,C) Voltage Input and start timing. The contacts will close after **D** cycles  $\pm 1$  cycle or  $\pm 1\%$  (DFT) or within  $\leq 20$  cycles or  $\pm 1\%$  (RMS).
3. Reduce Phase A (B,C) Voltage Input to **Nominal Voltage**.
4. Repeat Steps 2 and 3 for Phase B & C.

## 59D Third-Harmonic Voltage Differential

<b>VOLTAGE INPUTS:</b>	As described		
<b>CURRENT INPUTS:</b>	None		
<b>TEST SETTINGS:</b>	Ratio		(0.1 to 5.0)
	Time Delay	D	Cycles (1 to 8160)
	Line Side Voltage	LSV	( $V_X$ or $3V_O$ Calculated)
	Programmed Outputs	Z	OUT (1 to 8)
		Expanded I/O	(9 to 23)

### Test Setup:

1. Determine the Function 59D Third-Harmonic Voltage Differential settings to be tested.
2. Enter the Function 59D Third-Harmonic Voltage Differential settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect a voltage input to  $V_N$  at 180 Hz (150 Hz for 50 Hz unit) terminal numbers 44 and 45.

### Pickup Test:

■ **NOTE:** If  $3V_O$  is being used, then use anyone of the phase voltages or all three at zero sequence.

1. Apply a voltage less than  $V_N$  to the selected line side voltage ( $V_X$  or  $3V_O$ ) at 180 Hz (150 Hz for 50 Hz unit).
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase Voltage to the selected line side Input ( $V_X$  or  $3V_O$ ) until the **59D THIRD HARM VOLT DIFF** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.
2. Release the **TARGET RESET** pushbutton.
3. Decrease the Voltage Input ( $V_X$  or  $3V_O$ ) to less than the ratio pickup level. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply a voltage greater than the ratio pickup level and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

■ **NOTE:** When RMS (total waveform) is selected, timing accuracy is  $\leq 20$  cycles or  $\pm 1\%$ .

**59N Overvoltage, Neutral Circuit or Zero Sequence (#1, #2, #3)**

<b>VOLTAGE INPUTS:</b>	As described			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	Pickup	P	Volts	(5.0 to 180)
	Time Delay	D	Cycles	(1 to 8160)
	Neg. Seq. Voltage Inhibit	NSV	%	(1.0 to 100.0)
	Zero Seq. Voltage Inhibit	ZSV	%	(1.0 to 100.0)
	Zero Seq. Voltage Selection	3V <sub>0</sub> or V <sub>X</sub>		
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** If 59N #1 and 59N #2 have different pickup settings, it would be efficient to disable the one with the lower setting first and test the higher setting operation. The lower setting operation could then be tested without disabling the higher setting.

**Test Setup:**

1. Determine the Function 59N RMS Overvoltage settings to be tested.
2. Enter the Function 59N RMS Overvoltage settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect a voltage input to V<sub>N</sub> terminal numbers 44 and 45.

**Pickup Test:**

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase Voltage Input V<sub>N</sub> until the **59N NEUT/GND OVERVOLT** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.

The voltage level of operation should be equal to **P Volts** ±0.5 V or ±0.5%.

2. Release the **TARGET RESET** pushbutton.
3. Decrease the Voltage Input V<sub>N</sub> to 0 volts. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply (**P+1**) Volts and start timing. The contacts will close after **D** cycles within ±1 cycle or ±1%. When 64S is purchased, the time delay accuracy is -1 to +5 cycles.

**Negative Sequence Voltage Inhibit Test:**

1. Apply a voltage greater than **P (P +1)** to  $V_N$  and ensure that Negative Sequence Voltage is less than the Inhibit setting.
2. Press and hold the **TARGET RESET** pushbutton. The **59N NEUT/GND OVERVOLT** LED will illuminate, or the pickup indicator will illuminate on the IPScom Function Status screen.
3. Release the **TARGET RESET** pushbutton.
4. Increase the Voltage Input to greater than the Negative Sequence Voltage Inhibit setting. The **OUTPUT** LED(s) will extinguish.  
The voltage level of operation should be equal to **NSV Volts**  $\pm 0.5$  V or  $\pm 0.5\%$ .
5. Press the **TARGET RESET** pushbutton to reset targets.

**Zero Sequence Voltage Inhibit Test:**

■ **NOTE:** If  $3V_0$  is being used, then use any one of the phase voltages or all three at zero sequence.

1. Apply a voltage greater than **P (P +1)** to  $V_N$  and ensure that Zero Sequence Voltage is greater than the Inhibit setting.
2. Press and hold the **TARGET RESET** pushbutton. The **59N NEUT/GND OVERVOLT** LED will illuminate, or the pickup indicator will illuminate on the IPScom Function Status screen.
3. Release the **TARGET RESET** pushbutton.
4. Decrease the Voltage Input ( $V_X$  or  $3V_0$ ) to less than the Zero Sequence Voltage Inhibit setting. The **OUTPUT** LED(s) will extinguish.  
The voltage level of operation should be equal to **ZSV Volts**  $\pm 0.5$  V or  $\pm 0.5\%$ .
5. Press the **TARGET RESET** pushbutton to reset targets.

## 59X Multi-purpose Overvoltage (#1 or #2)

<b>VOLTAGE INPUTS:</b>	As described			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	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 23)

■ **NOTE:** If 59X #1 and 59X #2 have different pickup settings, it would be efficient to disable the one with the lower setting first and test the higher setting operation. The lower setting operation could then be tested without disabling the higher setting.

### Test Setup:

1. Determine the Function 59X Overvoltage settings to be tested.
2. Enter the Function 59X Overvoltage settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect a voltage input to V<sub>X</sub> terminal numbers 64 and 65.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase Voltage Input V<sub>X</sub> until the **59N NEUT/GND OVERVOLT** LED illuminates, or the pickup indicator illuminates on the IPScom Function Status screen.  
The voltage level of operation should be equal to **P Volts**  $\pm 0.5$  V or  $\pm 0.5\%$ .
2. Release the **TARGET RESET** pushbutton.
3. Decrease the Voltage Input V<sub>X</sub> to 0 volts. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply (**P+1**) Volts and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

## 60FL VT Fuse Loss Detection

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** Configuration C1

<b>TEST SETTINGS:</b>	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** It is necessary for “FL” to be designated as an initiating input (see Section 4.4, System Setpoints) before this function can be tested.

■ **NOTE:** Refer to [Figure 4-70](#), Fuse Loss (60FL) Function Logic, for single phase and three phase fuse loss.

### Test Setup:

1. Determine the Function 60FL VT Fuse Loss Detection settings to be tested.
2. Enter the Function 60FL VT Fuse Loss Detection settings to be tested utilizing either the HMI or IPScom® Communications Software. (FL initiate must be selected for this test.)
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Connect test current inputs as shown in [Figure 6-3](#), Current Inputs: Configuration C1.
6. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Disconnect the Phase A (B,C) Voltage Input and start timing. The **60FL V.T. FUSE LOSS** LED and Output **Z** LEDs will illuminate, or the pickup indicator illuminates on the IPScom Function Status screen.  
The operating time will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .
3. Reconnect the Phase A (B,C) Voltage Input.
4. Press the **TARGET RESET** pushbutton to reset targets.
5. Repeat Steps 2, 3 and 4 for Phase B and C.

### Time Test - Three Phase Fuse Loss:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Enable Three Phase Fuse Loss Detection utilizing either the HMI or IPScom Communications Software.
3. Disconnect Phase A, B and C Voltage Inputs and start timing. The **60FL V.T. FUSE LOSS** LED and Output **Z** LEDs will illuminate, or the pickup indicator illuminates on the IPScom Function Status screen. The operating time will be **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .
4. Reconnect the Phase A, B and C Voltage Inputs.
5. Press the **TARGET RESET** pushbutton to reset targets.

**64F Field Ground Protection (#1 or #2)**

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	Pickup	P	kOhms	(5 to 100)
	Time Delay	D	Cycles	(1 to 8160)
	Injection Frequency	IF	Hz	(0.10 to 1.00)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

**Test Setup:**

1. Determine the Function 64F Field Ground Protection settings to be tested.
2. Enter the Function 64F Field Ground Protection settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect an M-3921 Field Ground Coupler and decade box as described in [Figure 6-7](#), Field Ground Coupler.
5. Set decade box resistance to 10% greater than pickup **P** kOhms.

**Pickup Test:**

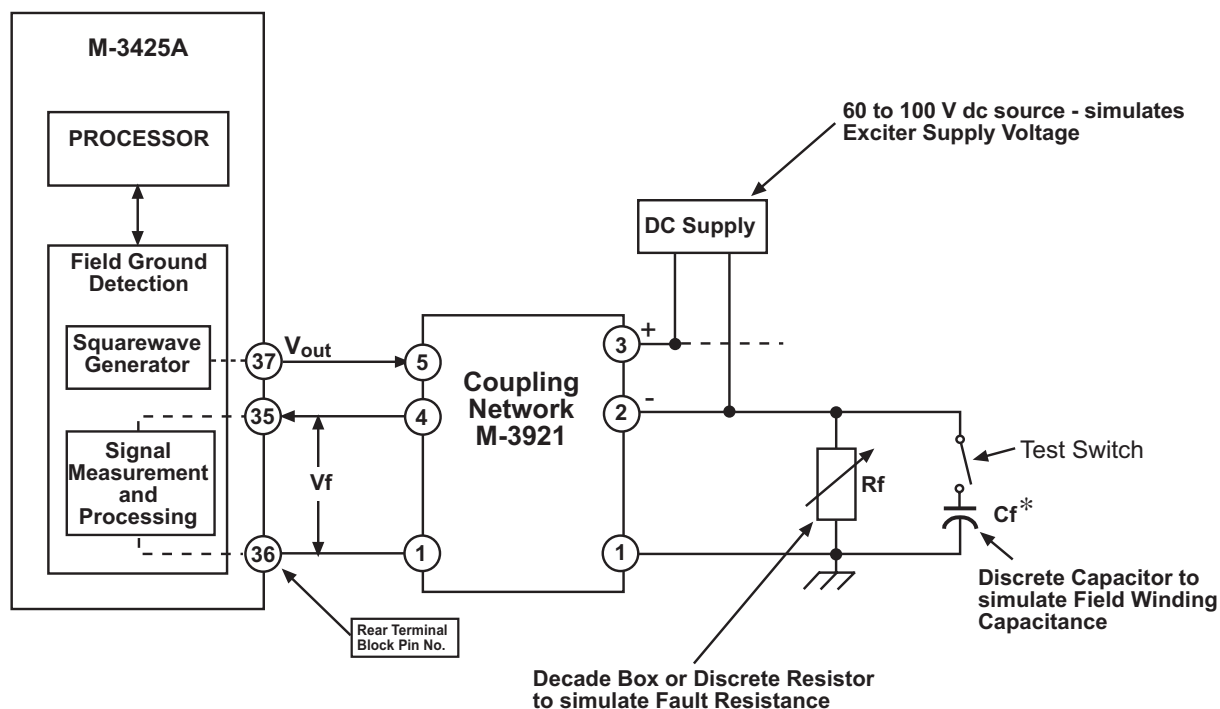
1. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the resistance on the decade box until the **FIELD GND/BRUSH LIFT 64F/B** LED illuminates or the pickup indicator on the IPScom Function Status screen illuminates.  
The level of operation will be **P** kOhms  $\pm 1$  kOhms or  $\pm 10\%$ .
2. Release the **TARGET RESET** pushbutton.
3. Increase the resistance on the decade box. The **OUTPUT** LED(s) will extinguish.
4. Press the **TARGET RESET** pushbutton to reset targets.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Set the resistance on the decade box to 90% of **P** and start timing. The operating time will be after **D** cycles, within  $\pm(2/IF + 1)$ .

When the capacitance value and the operating frequency have been determined, the actual insulation resistance can be verified by installing a variable resistor (5 to 100 K $\Omega$ ) and a discrete capacitor to the coupler module (M-3921).

● **WARNING:** When auto-calibrating, the jumper used to short pins 2 & 3 *must* be removed when calibration is complete. Placing the M-3921 in service with this jumper installed will result in serious damage.



\*The value of C<sub>f</sub> should approximate the rotor capacitance.

Figure 6-7 Field Ground Coupler



## 64B Brush Lift-Off Detection

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	Pickup	P	mV	(0 to 5000)
	Time Delay	D	Cycles	(1 to 8160)
	Injection Frequency	IF	Hz	(0.10 to 1.00)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Function 64F Field Ground Protection settings to be tested.
2. Enter the Function 64F Field Ground Protection settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect a M-3921 Field Ground Coupler and the test equipment described in [Figure 6-7](#), Field Ground Coupler.
5. Set Rf to open (infinity) and Cf to 1  $\mu$ F.

### Pickup Test:

1. Access the **FIELD GND MEAS. CIRCUIT** display under the **VOLTAGE** menu in **STATUS**. Set the pickup (**P**) to 110% of the displayed value.  
Refer to Section 2.2, Operation, for details that describe how to access the **STATUS MENU** which contains the **FIELD GND MEAS. CIRCUIT** value in mV.
2. Press and hold the **TARGET RESET** pushbutton, then Open the Test Switch. The **FIELD GND/BRUSH LIFT 64F/B** LED will illuminate or the pickup indicator on the IPScom Function Status screen will illuminate.
3. Close the Test Switch. The **FIELD GND/BRUSH LIFT 64F/B** LED will extinguish or the pickup indicator on the IPScom Function Status screen will extinguish.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Remove the capacitance connected to the decade box and start timing. The operating time will be after **D** cycles, within  $\pm(2/IF + 1)$  sec.

## 64S 100% Stator Ground Protection by Low Frequency Injection

<b>VOLTAGE INPUTS:</b>	Adjustable 20 Hz Voltage Source (0 to 40 V)			
<b>CURRENT INPUTS:</b>	Adjustable 20 Hz Current Source (0 to 100 mA)			
<b>TEST SETTINGS:</b>	Total Current Pickup	P	mA	(2 to 75)
	Real Component Pickup	P/2	mA	(2 to 75)
	Time Delay	D	Cycles	(1 to 8160)
	Voltage Restraint			(Enabled/Disabled)
	Under Frequency Inhibit			(Enabled/Disabled)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine settings for F64S to be tested.
2. Enter the settings for F64S into the relay to be tested using either the HMI or IPScom Communications software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.

### Pickup Test (Voltage Restraint Disabled and Under Frequency Inhibit Disabled):

1. Enable the Total Current Pickup.
2. Disable the Real Component of Current Pickup.
3. Adjust the 20 Hz voltage generator to apply 25  $\angle 0^\circ$  volts across terminals 44 and 45.
4. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to **P** mA  $\pm 2$  mA or  $\pm 10\%$ .
5. Release the **TARGET RESET** pushbutton.
6. Disable the Total Current Pickup.
7. Enable the Real Component of Current Pickup.
8. Adjust the 20 Hz Voltage Generator to apply 25  $\angle 0^\circ$  Volts across terminals 44 and 45.
9. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current at an angle of 60 degrees leading the 20 Hz voltage applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to **P** mA  $\pm 2$  mA or  $\pm 10\%$ .
10. Release the **TARGET RESET** pushbutton.
11. Decrease the applied 20 Hz current to 0 mA and the applied 20 Hz voltage to 0 Volts.

**Pickup Test (Voltage Restraint Enabled and Under Frequency Inhibit Disabled):**

1. Enable the Total Current Pickup.
2. Disable the Real Component of Current Pickup.
3. Adjust the 20 Hz voltage generator to apply 25  $\angle 0^\circ$  volts across terminals 44 and 45.
4. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to **P** mA  $\pm 2$  mA or  $\pm 10\%$ .
5. Release the **TARGET RESET** pushbutton.
6. Adjust the 20 Hz Voltage Generator to apply 35  $\angle 0^\circ$  Volts across terminals 44 and 45.
7. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current at an angle of 60 degrees leading the 20 Hz voltage applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to 1.4 **P** mA  $\pm 2$  mA or  $\pm 10\%$ .
8. Release the **TARGET RESET** pushbutton.
9. Disable the Total Current Pickup.
10. Enable the Real Component of Current Pickup.
11. Adjust the 20 Hz voltage generator to apply 25  $\angle 0^\circ$  volts across terminals 44 and 45.
12. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current at an angle of 60 degrees leading the 20 Hz voltage applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to **P** mA  $\pm 2$  mA or  $\pm 10\%$ .
13. Release the **TARGET RESET** pushbutton.
14. Adjust the 20 Hz Voltage Generator to apply 35  $\angle 0^\circ$  Volts across terminals 44 and 45.
15. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current at an angle of 60 degrees leading the 20 Hz voltage applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The 20 Hz current level should be equal to 1.4(**P**) mA  $\pm 2$  mA or  $\pm 10\%$ .
16. Release the **TARGET RESET** pushbutton.
17. Decrease the applied 20 Hz test voltage and current to zero.

**Pickup Test (Voltage Restraint Disabled and Under Frequency Inhibit Enabled):**

1. Apply balanced nominal three-phase voltage to  $V_A$  ( $V_{AB}$ ),  $V_B$  ( $V_{BC}$ ), and  $V_C$  ( $V_{CA}$ ) at nominal frequency (that is, 50 or 60 Hz).
2. Enable the Total Current Pickup.
3. Disable the Real Component of Current Pickup.
4. Adjust the 20 Hz voltage generator to apply 25  $\angle 0^\circ$  volts across terminals 44 and 45.
5. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current applied to terminals 52 and 53 until the **27TN/59D/64S STATOR GND** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
  
The 20 Hz current level should be equal to **P** mA  $\pm 2$  mA or  $\pm 10\%$ . The functions should pickup and close the trip contact output.
6. Release the **TARGET RESET** pushbutton.
7. Decrease the applied 20 Hz test voltage and current to zero.
8. Enable under frequency inhibit.
9. Decrease the frequency of the balanced nominal three-phase voltage to  $V_A$  ( $V_{AB}$ ),  $V_B$  ( $V_{BC}$ ), and  $V_C$  ( $V_{CA}$ ) to 30 Hz.
10. Adjust the 20 Hz Voltage Generator to apply 25  $\angle 0^\circ$  Volts across terminals 44 and 45.
11. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the 20 Hz current applied to terminals 52 and 53 until the 20 Hz current level is equal to **P** mA. This function should not pick up.
12. Release the **TARGET RESET** pushbutton.
13. Decrease the applied 20 Hz test voltage and current to zero.

**Timer Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Enable the Total Current Pickup.
3. Disable the Real Component of Current Pickup.
4. Disable Voltage Restraint.
5. Disable Under Frequency Inhibit.
6. Adjust the 20 Hz Voltage Generator to apply 25  $\angle 0^\circ$  Volts across terminals 44 and 45.
7. Step the 20 Hz current applied to terminals 52 and 53 to a value greater than **P** and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ . Time delay accuracy in cycles is based on 20 Hz frequency.

## 67N Residual Directional Overcurrent, Definite Time

<b>VOLTAGE INPUTS:</b>	See Below			
<b>CURRENT INPUTS:</b>	See Below			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.50 to 240.0)
	1 Amp			(0.1 to 48.0)
	Directional Element	See Below		
	Time Delay	D	Cycles	(1 to 8160)
	Max Sensitivity Angle	MSA	Degrees	(0 to 359)
	Operating Current	3I <sub>o</sub> or I <sub>N</sub>		
	Polarization Type*	V <sub>N</sub> , V <sub>X</sub> , 3V <sub>O</sub> (Calculated)		
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)

\* V<sub>X</sub> cannot be selected if Function 25 (Sync) is enabled. 3V<sub>O</sub> can only be used with Line-Ground VT.

### Test Setup:

1. Determine the Function 67NDT Residual Directional Overcurrent, Definite Time settings to be tested.
2. Enter the Function 67N Residual Directional Overcurrent, Definite Time settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Disable the Directional Element.
5. Connect inputs for the polarization type and operating current selected for testing.

### Pickup Test (non-directional):

1. Apply current 10% less than pickup **P** to the operating current. If 3I<sub>o</sub>, use any one of I<sub>A</sub>, I<sub>B</sub>, or I<sub>C</sub>, or all three in zero sequence.
2. Press and hold the **TARGET RESET** pushbutton in, then slowly increase the current applied to the selected operating current until the **GND DIFF/DIR O/C 87GD/67N** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The level should be equal to **PI3 Amps** ± 0.1A or ± 3%.
3. Release the **TARGET RESET** pushbutton.
4. Decrease the current applied to all phases of the selected operating current. The **OUTPUT** LED will extinguish.

**Directional Test:**

1. Enable the Directional Element utilizing either the HMI or IPScom Communications Software.
2. Press the **TARGET RESET** pushbutton to reset targets.
3. Set the voltage of the selected polarization type to the **Nominal Voltage** (If  $3V_0$  is selected, use any one of the phase voltages, or all three in zero sequence.) The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
4. Set the current angle to an angle greater than  $100^\circ$  from **MSA**.
5. Apply current 10% greater than **P** to the input of the selected operating current.
6. Press and hold the **TARGET RESET** pushbutton, then slowly swing the angle of the selected operating current applied towards the **MSA** until the **GND DIFF/DIR O/C 87GD/67N** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
  
The angle should be equal to A  $-90^\circ$  or  $+90^\circ$ , depending to which side of **MSA** the current has been set.
7. Release the **TARGET RESET** pushbutton.
8. Swing the current angle away from the **MSA**. The **OUTPUT** LED will extinguish.

**Timer Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Disable the Directional Element utilizing either the HMI or IPScom Communications Software.
3. Apply **P** +10% Amps to the input of the selected operating current, and start timing. The contacts will close after **D** cycles within -1 to +3 cycles or  $\pm 1\%$ .

## 67N Residual Directional Overcurrent, Inverse Time

<b>VOLTAGE INPUTS:</b>	See Below			
<b>CURRENT INPUTS:</b>	See Below			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.25 to 12.0)
	1 Amp CT Rating			(0.05 to 2.40)
	Directional	See Below		
	BECO Inverse Time Curves			
	Definite Time\Inverse\Very Inverse\Extremely Inverse			
	Time Dial	TD		(0.5 to 11.0)
	IEC Inverse Time Curves			
	IECI / IECVI / IECEI / IECLTI			
	Time Dial	TD		(0.05 to 1.10)
	IEEE Inverse Time Curves			
	IEEEI/IEEEVI/IEEEEI			
	Time Dial	TD		(0.5 to 15)
	Operating Current	3I <sub>O</sub> or I <sub>N</sub>		
	Max Sensitivity Angle	MSA	Output	(0 to 359)
	Polarization Type	V <sub>N</sub> , V <sub>X</sub> , 3V <sub>O</sub> (Calculated)		
	Programmed Outputs	Z	Output	(1 to 8)
		Expanded I/O		(9 to 23)

Polarization Type V<sub>N</sub>, V<sub>X</sub>, 3V<sub>O</sub> (Calculated)

Programmed Outputs Z Output (1 to 8)  
Expanded I/O (9 to 23)

\* V<sub>X</sub> cannot be selected if Function 25 (Sync) is enabled. 3V<sub>O</sub> can only be used with Line-Ground VT.

### Test Setup:

1. Determine the Function 67N Residual Directional Overcurrent, Inverse Time settings to be tested.
2. Enter the Function 67N Residual Directional Overcurrent, Inverse Time settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Disable Directional Element.
5. Refer to Appendix D, **Inverse Time Curves**, and IEC equations below to calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.

IEC Class A Standard Inverse	IEC Class B Very Inverse	IEC Class C Extremely Inverse	IEC Class D Long Time Inverse
$t = TD \times \left[ \frac{0.14}{M^{0.02} - 1} \right]$	$t = TD \times \left[ \frac{13.5}{M - 1} \right]$	$t = TD \times \left[ \frac{80}{M^2 - 1} \right]$	$t = TD \times \left[ \frac{120}{M - 1} \right]$
<b>Curve 5</b>	<b>Curve 6</b>	<b>Curve 7</b>	<b>Curve 8</b>

$t$  = time in seconds TD = Time Dial setting M = current in multiples of pickup

### Time Delay Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply the input current used in the calculations from Step 5 to the input of the selected operating current, and start timing.

The operating time will be  $\pm 3$  cycles or  $\pm 5\%$  of the calculated time. Repeat this step for each test level chosen. The points tested verify the operation of this function.

**Directional Test:**

1. Enable Directional Element.
2. Press the **TARGET RESET** pushbutton to reset targets.
3. Apply **Nominal Voltage** to the input of the selected Polarization Type. If  $3V_0$ , use any one of the phase voltages, or all three at zero sequence.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

4. Set the current angle to an angle greater than  $100^\circ$  from **MSA**.
5. Apply current 10% greater than **PI3**, (**for type 3, use P**) to all three phases.
6. Press and hold the **Target Reset** pushbutton, then slowly swing the angle of the selected operating current towards the **MSA** until the **GND DIFF/DIR O/C 87GD/67N** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The angle should be equal to **A**  $-90^\circ$  or  $+90^\circ$ , depending to which side of **MSA** the current has been set.
7. Release the **TARGET RESET** pushbutton.
8. Swing the current angle away from the **MSA**. The **OUTPUT** LED will extinguish.



## 78 Out of Step

<b>VOLTAGE INPUTS:</b>	Configuration V1			
<b>CURRENT INPUTS:</b>	Configuration C1			
<b>TEST SETTINGS:</b>	Circle Diameter	P	Ohms	(0.1 to 100)
	1 Amp CT Rating			(0.5 to 500)
	Offset	O	Ohms	(-100 to 100)
	1 Amp CT Rating			(-500 to 500)
	Impedance Angle	A	Degrees	(0 to 90)
	Time Delay	D	Cycles	(1 to 8160)
	Blinder Impedance	B	Ohms	(0.1 to 50.0)
	1 Amp CT Rating			(0.5 to 250.0)
	Pole Slip Counter			(1 to 20)
	Pole Slip Reset		Cycles	(1 to 8160)
	Trip on MHO Exit	See Below		
	Programmed Output	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. An accurate stopwatch is required for this test.
2. Determine the Function 78 Out of Step settings to be tested.
3. Establish communications with the relay utilizing IPScorm® Communications Software.
4. Enter the Function 78 Out of Step settings to be tested utilizing IPScorm Communications Software.
5. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
6. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
7. Connect test current inputs as shown in [Figure 6-4](#), Current Inputs: Configuration C1.
8. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage**.

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Pickup Test:

1. Disable the Function 78 Out of Step **TRIP ON MHO EXIT** setting, then set the delay, **D**, to a minimal setting (2–3 cycles).
2. Open the IPScorm Out-of-Step Diagram Screen, [Figure 3-16](#) (Relay/Monitor/Out of Step Diagram Screen).
3. While monitoring the Positive Sequence Impedance, set the magnitude and phase angle of the Input Currents to a point similar to point **Z<sub>0</sub>** in [Figure 4-82](#).
4. Press and hold the **TARGET RESET** pushbutton, then sweep the current angle towards point **Z<sub>1</sub>**.  
When the impedance passes through point **Z<sub>1</sub>**, verify that the **78 OUT OF STEP** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.
5. Pause testing until the delay timer has time to expire, then continue to sweep the current angle to point **Z<sub>2</sub>**, and verify output **Z** operates as point **Z<sub>2</sub>** is crossed, and resets after the seal-in time delay.
6. If testing is complete, then reduce voltages and currents to zero.

**Blocking on Stable Swing Test:**

1. While monitoring the Positive Sequence Impedance, set the magnitude and phase angle of the Input Currents to a point outside of the mho circle.
2. While monitoring the Positive Sequence Impedance, set the magnitude and phase angle of the Input Currents to point **Z<sub>0</sub>** in [Figure 4-82](#).
3. Press and hold the **TARGET RESET** pushbutton, then sweep past point **Z<sub>1</sub>**.  
When the impedance passes through point **Z<sub>1</sub>**, verify that the **78 OUT OF STEP** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.
4. Pause testing until the delay timer has time to expire, then reverse the sweep direction and sweep the current angle to point **Z<sub>1</sub>**.  
As point **Z<sub>1</sub>** is crossed, verify output **Z** does not operate and the **78 OUT OF STEP** LED extinguishes or the function status indicator on the **Monitor Function Status** screen indicates that the function has reset.
6. If testing is complete, then reduce voltages and currents to zero.

**Pickup Test (Trip on mho Exit):**

1. Enable the **TRIP ON MHO EXIT** setting.
2. While monitoring the Positive Sequence Impedance, set the magnitude and phase angle of the Input Currents to point **Z<sub>0</sub>** in [Figure 4-82](#).
3. Press and hold the **TARGET RESET** pushbutton, then sweep the current angle towards point **Z<sub>1</sub>**.  
When the impedance passes through point **Z<sub>1</sub>**, verify that the **78 OUT OF STEP** LED illuminates or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.
4. Pause testing until the delay timer has time to expire, then continue to sweep the current angle to beyond point **Z<sub>2</sub>**. Verify that output **Z** does not operate as point **Z<sub>2</sub>** is crossed.
5. Sweep the impedance further towards point **Z<sub>3</sub>**. Verify output **Z** operates as point **Z<sub>3</sub>** is crossed, and resets after the seal-in time delay has timed out.
6. If testing is complete, then reduce voltages and currents to zero.

## 81 Frequency (#1, #2, #3, #4)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Pickup	P	Hz	(50.00 to 67.00)
	50 Hz Relay			(40.00 to 57.00)
	Time Delay	D	Cycles	(3 to 65,500)
	50 Hz Relay			
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** It would be efficient to disable the elements with the settings nearest to nominal frequency first (testing over or underfrequency functions).

### Test Setup:

1. Determine the Function 81 Frequency settings to be tested.
2. Enter the Function 81 Frequency settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage** (nominal frequency). The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

### Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase/decrease the Input Voltage ( $V_A$ ,  $V_B$ , and  $V_C$ ) Frequency until the **FREQUENCY/ROCOF 81/81R** LED illuminates or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The frequency level will be equal to  $P \text{ Hz} \pm 0.02 \text{ Hz}$  only if  $P$  is within 3 Hz of  $F_{\text{nom}}$ , otherwise,  $\pm 0.1 \text{ Hz}$ .
2. Increase/decrease the Input Voltage ( $V_A$ ,  $V_B$ , and  $V_C$ ) Frequency to nominal input frequency. The **OUTPUT** LED(s) will extinguish.
3. Press **TARGET RESET** pushbutton to reset targets.

### Time Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply ( $P +$  or  $- 0.5$ ) Hz and start timing. The contacts will close after  $D$  cycles within  $\pm 2$  cycles or  $\pm 1\%$ , whichever is greater.

**81A Frequency Accumulator (Band #1, #2, #3, #4, #5, #6)**

<b>VOLTAGE INPUTS:</b>	V1			
<b>CURRENT INPUTS:</b>	None			
<b>TEST SETTINGS:</b>	High Pickup (#1 only)	P	Hz	(50.00 to 67.00)
	50 Hz Relay			(40.00 to 57.00)
	Low Pickup	P	Hz	(50.00 to 67.00)
	50 Hz Relay			(40.00 to 57.00)
	Delay	D	Cycles	(3 to 360,000)
	Acc Status		Cycles	(0 to 360,000)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

**Test Setup:**

1. Determine the Function 81A Frequency Accumulator settings to be tested.
2. Enter the Function 81A Frequency Accumulator settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
5. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage** (nominal frequency). The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

**Output Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Set the frequency to a value between the upper and lower limits of the selected band under test and start timing.
3. Utilizing either the HMI (Status/81A Accumulator Status) or IPScom Communications Software (Relay/Monitor/Accumulator Status), verify that the Accumulator Status value for the band under test is incrementing.  
Output Contacts **Z** will close after **D** cycles within  $\pm 2$  cycles or 1%.
4. Repeat Steps 1 to 3 for the remaining bands if desired.

## 81R Rate of Change of Frequency (#1, #2)

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Pickup	P	Hz/Sec	(0.10 to 20.00)
	Time Delay	D	Cycles	(3 to 8160)
	Negative Sequence			
	Voltage Inhibit	N	%	(0 to 99)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

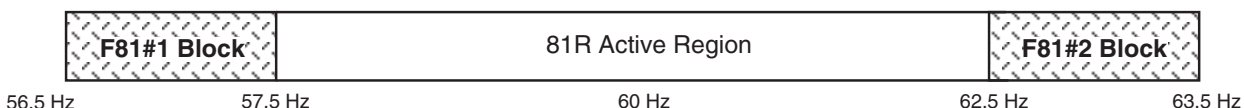
### Test Setup:

1. It is recommended that the 81 Function be used to establish a window of operation for the 81R Function which is smaller than the actual sweep range of the frequency applied. This is accomplished as follows:

■ **NOTE:** The frequencies given are suggested for testing rates below 10 Hz/Sec. Higher rates will require consideration of the capabilities of the test equipment involved.

- a. Enable the **81#1** with a unique Output assigned, a Pickup Setting of 1 Hz greater than the minimum frequency of the ramp and a time delay and seal-in time setting at minimum (This will result in an operational window that is free of erroneous Hz/Sec measurements when the voltage source begins or ends the sweep.).
- b. Enable the **81#2** with a unique Output assigned, a Pickup Setting of 1 Hz less than the maximum frequency of the ramp and a time delay and seal-in time setting at minimum (This will result in an operational window that is free of erroneous Hz/Sec measurements when the voltage source begins or ends the sweep.).

■ **NOTE:** Using this setup, it is important to remember that the 81 elements being used will be operating in the 81R blocking regions, and the 81R contact operation must be distinguished from the 81 contacts.



- c. Utilizing a jumper, connect the **81#1** and **81#2** assigned Outputs to a unique Input.
  - d. Set the 81R Function to block on this input.
2. Determine the Function 81R Rate of Change of Frequency settings to be tested.
  3. Enter the Function 81R Rate of Change of Frequency settings to be tested utilizing either the HMI or IPScom Communications Software.
  4. Disable all other functions prior to testing with the exception of Function 81. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.

■ **NOTE:** Testing of the 81R function requires a 3-phase voltage source capable of smoothly sweeping the frequency of all voltages at a variable rate, continuously.

5. Connect test voltage inputs as shown in [Figure 6-1](#), Voltage Inputs: Configuration V1.
6. Set the three-phase voltages  $V_A$ ,  $V_B$ , and  $V_C$  to the **Nominal Voltage** (nominal frequency).

The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

**Pickup Test:**

1. Calculate the time for the pickup setting, then apply a sweep rate of 25% less than the Pickup (**P**) to all three phases.
2. Press and hold the **TARGET RESET** pushbutton, then slowly decrease the sweep time until the **FREQUENCY/ROCOF 81/81R** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.

The level should be equal to **P**  $\pm 0.05$  Hz/Sec. or  $\pm 5$  %.

3. Release the **TARGET RESET** pushbutton, then increase the sweep time. The **OUTPUT** LED will extinguish.

**Negative Sequence Voltage Inhibit Test:**

1. Press the **TARGET RESET** pushbutton to reset targets.
2. Apply **Nominal Voltage** to all three phases at a sweep rate 25% above **P**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.

Verify that the **FREQUENCY/ROCOF 81/81R** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.

3. Swing the phase angle of a Phase Voltage and monitor the Positive and Negative Sequence Voltage levels. The **81R OUTPUT** should reset when the negative sequence voltage is **N** %,  $\pm 0.5$ % of the positive sequence voltage.

**Timer Test:**

1. Press the **TARGET RESET** pushbutton to reset targets.
2. Apply **Nominal Voltage** to all three phases at a sweep rate 25% below **P**. The **Nominal Voltage** value previously input to the relay is described in Section 4.2, Setup System and should be recorded in Appendix A Configuration Record Forms.
3. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
4. Apply a sweep rate 25% above **P** and start timing. The contacts will close after **D** cycles within +20 cycles.

## 87 Phase Differential (#1 or #2)

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	Configuration C3			
<b>TEST SETTINGS:</b>	Minimum Pickup	P	Amps	(0.20 to 3.00)
	1 Amp CT Rating			(0.04 to 0.60)
	Percent Slope	S	%	(1 to 100)
	Time Delay	D	Cycles	(1 to 8160)
	CT Correction			(0.5 to 2.0)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

■ **NOTE:** Although a voltage input is not required for the testing of the 87 function, it is suggested that Nominal Voltage be applied to restrain the functions which use both voltage and current inputs for operation.

### Test Setup:

1. Determine the Function 87 Phase Differential settings to be tested.
2. Enter the Function 87 Phase Differential settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect test current inputs as shown in [Figure 6-5](#), Current Inputs: Configuration C3.

### Minimum Pickup Test:

1. Set Current Input 1(I<sub>a</sub>) to 0 Amps.
2. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input 2 (I<sub>A</sub>) until the **PHASE DIFF CURRENT 87** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The current level of operation will be equal to **P** amps  $\pm 0.1$  A or  $\pm 5\%$ .
3. Release the **TARGET RESET** pushbutton, then decrease the Current Input 2 (I<sub>A</sub>). The **OUTPUT** LED(s) will extinguish.
4. Press **TARGET RESET** pushbutton to reset targets.
5. Repeat Steps 1,2,3 and 4 for each remaining phase exchanging I<sub>A(B,C)</sub> and I<sub>a(b,c)</sub> as appropriate.

### Timer Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply a current level to Current Input 2 (I<sub>A</sub>) at least 10% greater than the minimum current pickup level and start timing. The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ . When the Time Delay is set to 1 cycle, the relay operation is less than 1-1/2 cycles.

**Slope Test:**

1. Define a representative number of testing points to verify the trip curve.
2. For each  $I_a$  (Current Input 1) test point defined in Step 1, calculate the expected operating current  $I_A$  (Current Input 2) as follows:

$(I_A - I_a)$ Difference in currents	> is greater than	$(I_A + I_a)$ sum of the currents	x times	Slope/100 the per unit slope	÷2 ÷2
---	----------------------	--------------------------------------	------------	---------------------------------	----------

or  $I_A = [(1+K) \div (1-K)] \times I_a$  where  $K = S/200$  and where  $S$  is % slope input above.

■ **NOTE:** For tests above the restraint current  $\{(I_A + I_a)/2\}$  value of 2X Nominal Current; use a slope % value equal to 4 times the input slope value (S) for these computations.

3. Set Current Input 1 ( $I_a$ ) and Current Input 2 ( $I_A$ ) to the values chosen in Step 1 and calculated in Step 2 respectively.
4. Press and hold the **TARGET RESET** pushbutton, then slowly increase either Current Input 1 or 2 until the **PHASE DIFF CURRENT 87** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
  
The current level of operation will be equal to  $I_A \pm 0.1$  A or  $\pm 2\%$  slope calculation. The difference in current must be greater than minimum pickup current for proper operation.
5. Release the **TARGET RESET** pushbutton, then decrease the larger **CURRENT**. The **OUTPUT** LED(s) will extinguish.
6. Press **TARGET RESET** pushbutton to reset targets.



## 87GD Ground Differential

<b>VOLTAGE INPUTS:</b>	None			
<b>CURRENT INPUTS:</b>	As described			
<b>TEST SETTINGS:</b>	Pickup	P	Amps	(0.20 to 10.00)
	1 Amp CT Rating			(0.04 to 2.00)
<b>▲ CAUTION:</b> Do NOT set the delay to less than 2 Cycles				
	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 23)

### Test Setup:

1. Determine the Function 87GD Ground Differential settings to be tested.
2. Enter the Function 87GD Ground Differential settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Disable all other functions prior to testing. Refer to Section 4.4 System Setpoints, for details that describe disabling/enabling functions.
4. Connect a current input to I<sub>N</sub> terminals 53 and 52.
5. Connect a current input to I<sub>A</sub> terminals 46 and 47, or I<sub>B</sub> terminals 48 and 49.

### Non-Directional Pickup Test:

1. Press and hold the **TARGET RESET** pushbutton, then slowly increase Current Input I<sub>N</sub> (terminals 53 and 52) until the **GND DIFF/DIR O/C 87GD/67N** LED illuminates, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The current level of operation will be equal to **P** amps  $\pm 0.1$  A or  $\pm 5\%$ .
2. Release the **TARGET RESET** pushbutton, then decrease the Current Input I<sub>N</sub> to 0 Amps. The **OUTPUT** LED(s) will extinguish.
3. Press **TARGET RESET** pushbutton to reset targets.

### Timer Test:

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply a current level to Current Input I<sub>N</sub> at least 10% greater than the minimum current pickup level and start timing. The contacts will close after **D** cycles within +1 to -2 cycles or  $\pm 1\%$ .
3. Decrease the Current Input I<sub>N</sub> to 0 Amps.

***Directional Time Test:***

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Apply a current of 1.0 Amp with a phase angle of 0 degrees to Current Input IN (terminals 53 and 52).
3. Apply a current of **P** – 0.9 amps with a phase angle of 180 degrees to either Current Input I<sub>A</sub> or I<sub>B</sub> and start timing.

The contacts will close after **D** cycles within  $\pm 1$  cycle or  $\pm 1\%$ .

4. Decrease the applied currents to 0 Amps.
5. Press the **TARGET RESET** pushbutton to reset targets.
6. Set the phase angle of the Current Input selected in Step 3, to 0 degrees, the Current Inputs are now in phase.
7. Reapply a current of 1.0 Amp to Current Input I<sub>N</sub> (terminals 53 and 52).
8. Reapply a current of **P** – 0.9 Amps to the Current Input selected in Step 3, and start timing.

The relay will not operate. If the I<sub>A</sub> or I<sub>B</sub> current input value is reduced to 140 ma or less and the difference current exceeds the pickup value, the relay will operate regardless of polarities of the currents.

9. Decrease the applied currents to 0 Amps.

**BM Breaker Monitoring**

<b>VOLTAGE INPUTS:</b>	None		
<b>CURRENT INPUTS:</b>	As Described		
<b>TEST SETTINGS:</b>	Pickup	P	kAmps (kA <sup>2</sup> )* (0 to 50,000)
	Delay	D	Cycles (0.1 to 4095.9)
	Timing Method		(IT or I <sup>2</sup> T)
	Preset Accumulators		
	Phase A, B, or C		kAmp (kA <sup>2</sup> ) Cycles* (0 to 50,000)
	Programmed Outputs	Z	OUT (1 to 8)
	Blocking Inputs		(1 to 6)
		Expanded I/O	(7 to 14)
	Output Initiate		(1 to 8)
		Expanded I/O	(9 to 23)
	Input Initiate		(1 to 6)
		Expanded I/O	(7 to 14)

\* kA/kA cycles or kA<sup>2</sup>/kA<sup>2</sup> 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 a current input to I<sub>A</sub> terminals 46 and 47, I<sub>B</sub> terminals 48 and 49, and I<sub>C</sub> terminals 50 and 51.
4. Connect inputs for the polarization type selected for testing.

**Accumulator Test:**

1. Apply a current value that considers Timing Method and Pickup Setting to current input I<sub>A</sub>.
2. Place a jumper between the designated input and/or energize output contact selected as initiate.
3. Utilizing either the HMI (Status/Breaker Monitor Accumulator Status) or IPScom Communications Software (Relay/Monitor/Accumulator Status), verify that the Accumulator Status value for Phase A increments in D cycles  $\pm 1$  cycles or  $\pm 1\%$ .
4. De-energize the output and/or remove the jumper placed in Step 2.
5. Decrease applied I<sub>A</sub> current to 0 amps.
6. If desired, repeat test for I<sub>B</sub> and I<sub>C</sub>.

**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 pre-set the accumulator values to just below the target setting.

2. Utilizing either the HMI (Status/Breaker Monitor Accumulator Status) or IPScom Communications Software (Relay/Monitor/Accumulator Status) to monitor the accumulator value, place a jumper between the designated input or energize the output contact selected as initiate and then remove the jumper and/or de-energize the output.

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  $\pm 1$  cycle or  $\pm 1\%$  from the last initiate.

4. If desired, repeat test for  $I_B$  and  $I_C$ .

## Trip Circuit Monitoring

**VOLTAGE INPUTS:** As Described

**CURRENT INPUTS:** None

<b>TEST SETTINGS:</b>	Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)

### Test Setup:

1. Determine the Trip Circuit Monitoring function settings to be tested.
2. Disable all other functions prior to testing. Refer to 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 V dc (marked on the rear of the relay) to terminals 1 (–) and 2 (+) 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 V dc marked on the rear of the relay) to terminals 1 and 2.
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, or the function status indicator on the **Monitor Function Status** screen will indicate that the Trip Circuit Monitoring function has actuated.

The contacts will close after **D** cycles within  $\pm 1$  cycle or 1%.

4. Simulate a 52b contact open by connecting a jumper between terminal 11 (INRTN) and terminal 10 (IN1) which the **BRKR CLOSED** and **OUTPUT** LEDs on the front of the relay should extinguish.

Also, the function status indicator on the **Monitor Function Status** screen will indicate that the Trip Circuit Monitoring function has cleared and the Secondary Status screen will indicate that the breaker is closed.

5. Remove the jumper installed in Step 4.

The contacts will close after **D** cycles within  $\pm 1$  cycle or 1%.

**IPSlogic™ (#1, #2, #3, #4, #5, #6)****VOLTAGE INPUTS:** As Needed**CURRENT INPUTS:** As Needed

<b>TEST SETTINGS:</b>	Time Delay	D	Cycles	(1 to 8160)
	Programmed Outputs	Z	OUT	(1 to 8)
		Expanded I/O		(9 to 23)
	Blocking Inputs			(1 to 6)
		Expanded I/O		(7 to 14)
	Output Initiate			(1 to 8)
		Expanded I/O		(9 to 23)
	Function Initiate Pickup			(All Available Functions)
	Function Initiate Time Out			
	Initiate by Communication			
	Input Initiate			(1 to 6)
		Expanded I/O		(7 to 14)
	Block from Communication			

**Test Setup:**

1. Refer to [Figure 4-96](#), IPSlogic Function Setup, for logic gate configurations.
2. Select gate configuration (AND/OR/NAND/NOR) 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.

**Time Test:**

1. Connect a timer to output contacts (**Z**) so that the timer stops timing when the contacts (**Z**) close.
2. Connect a jumper from IN RTN (Terminal 11) to the designated Inputs (Terminals 1–6) for the IPSlogic gates and start timing. The **IPS LOGIC** LED and the **OUTPUT** LED will illuminate, or the function status indicator on the **Monitor Function Status** screen indicates that the function has picked up.  
The operating time will be **D** cycles  $\pm 1$  cycle or  $\pm 1\%$ .

**Blocking Input Test:**

1. Press and hold the **TARGET RESET** pushbutton, then place a jumper from IN RTN (terminal 11) to the designated Blocking Inputs (terminals 1-6) to be tested. The **EXTERNAL #1 EXT 1** LED will extinguish.
2. Repeat Step 1 for each designated external triggering contact.

## 6.3 Diagnostic Test Procedures

### Overview

The diagnostic test procedures perform basic functional relay tests to verify the operation of the front-panel controls, inputs, outputs, and communication ports.

● **WARNING: 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.**

The diagnostic menu includes the following tests:

- OUTPUT (Output Test Relay)
- INPUT (Input Test Status)
- LED (Status LED Test)
- TARGET (Target LED Test)
- EX\_IO (Expanded I/O Test, Not Available at this time)
- BUTTON (Button Test)
- DISP (Display Test)
- COM1 (COM1 Loopback Test)
- COM2 (COM2 Loopback Test)
- COM3 (COM3 Echo Test 2-Wire)

Each test is described individually in this section.

The diagnostic menu also provides access to the following relay feature settings:

- CLOCK (Clock On/Off)
- LED (Relay OK LED Flash/Solid)
- CAL (Auto Calibration)
- FACTORY (Factory Use Only)

Auto Calibration is described in detail in Section 6.4, Auto Calibration.

### Entering Relay Diagnostic Mode

● **WARNING: 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.**

1. Press **ENTER** to access the main menu.
2. Press the right arrow pushbutton until the following is displayed:

---

```

SETUP UNIT
←  SETUP exit

```

---

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

---

```

SOFTWARE VERSION
VERS sn access number →

```

---

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

---

```

DIAGNOSTIC MODE
←  time error DIAG

```

---

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

---

```

PROCESSOR WILL RESET!
ENTER KEY TO CONTINUE

```

---

● **WARNING: 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 →
←  button disp →
←  com1 com2 com3 clock →
←  led cal factory

```

---

This marks the beginning of the diagnostic menu. The left arrow and right arrow pushbuttons are used to navigate within the diagnostic menu. Exiting the diagnostic menu is accomplished by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then pressing **EXIT** a second time.

**Output Relay Test (Output Relays 1–23 and 25)**

■ **NOTE:** This test does not include testing of Power Supply Relay (Output Relay 24).

1. Ensure the protected equipment is in a configuration/state that can support relay output testing.
2. Confirm the positions of the outputs in the unoperated or **OFF** position. This can be accomplished by connecting a DMM (Digital Multimeter) across the appropriate contacts and confirming open or closed. The de-energized or **OFF** position for outputs 1 through 25 are listed in [Table 6-1](#).

Relay Output Number	Normally Open Contact	Normally Closed Contact*
1	33-34	--
2	31-32	--
3	29-30	--
4	27-28	--
5	25-26	--
6	23-24	--
7	21-20	21-22
8	17-18	18-19
9	104-105	--
10	102-103	--
11	100-101	--
12	98-99	--
13	96-97	--
14	94-95	--
15	92-93	--
16	90-91	--
17	88-89	--
18	86-87	--
19	84-85	--
20	82-83	--
21	80-81	--
22	78-79	--
23	76-77	--
<b>Power Supply (24)</b>	--	12-13
<b>Self-Test (25)</b>	14-15	15-16

\* "Normal" position of the contact corresponds to the OFF (de-energized) state of the relay.

*Table 6-1 Output Contacts*

3. If the relay is already in the Diagnostic Mode, then go to Step 4.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 4.

4. Ensure that the Diagnostic Menu is selected to OUTPUT (Upper Case).

---

OUTPUT TEST (RELAY)

---

-----  
**OUTPUT** input led target →

← button disp →

← com1 com2 com3 clock →

← led cal factory

---

If OUTPUT is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select OUTPUT.

5. Press **ENTER**, the relay will display the following:

---

RELAY NUMBER

1

---

6. Select the Output Relay (from [Table 6-1](#)) to be tested, utilizing the Up/Down arrow pushbuttons.
7. Press **ENTER**. The following will be displayed for the selected relay:

---

RELAY NUMBER 1

OFF on

---

8. Select **ON** (Upper Case) utilizing the Right arrow pushbutton. The relay will respond as follows:

- a. Output relay energizes (On position)
- b. Appropriate red **OUTPUT** LED illuminates, if equipped.

If testing all output relays, then press **EXIT** to return to the output relay selection menu, then repeat Steps 6, 7 and 8 for each output relay.

9. The DMM can now be used to verify that the output relay contact is in the operated or **ON** position. The readings should be the opposite of the initial reading determined in Step 2.
10. When output relay testing is complete then restore all output relays to their de-energized or **OFF** positions listed in [Table 6-1](#) and press **EXIT** to return to the Diagnostic Menu.
11. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.



### Output Relay Test (Power Supply Relay 24)

The power supply output relay can be tested by performing the following:

■ **NOTE:** For this test the relay is not required to be in the Diagnostic Mode.

1. Ensure the protected equipment is in a configuration/state that can support relay output testing.
2. Confirm the position of output relay 24 in the unoperated or **OFF** position. This can be accomplished by connecting a DMM (Digital Multimeter) across the appropriate contacts and confirming open or closed. The de-energized or **OFF** position for Output 24 is listed in [Table 6-1](#).
3. Remove power from the relay. The DMM can now be used to verify that output relay 24 contact is in the operated or **ON** position. The reading should be the opposite of the initial reading determined in Step 2.
4. Restore power to the relay.

### Input Test (Control/Status)

The **INPUT TEST** menu enables the user to determine the status of the individual control/status inputs. Individual inputs can be selected by number using the up and down arrow pushbuttons. The status of the input will then be displayed.

Input Number	Common Terminal	Terminal
1 (52b)	11	10
2	11	9
3	11	8
4	11	7
5	11	6
6	11	5
<b>Expanded I/O Inputs</b>		
7	66 or 67	75
8	66 or 67	74
9	66 or 67	73
10	66 or 67	72
11	66 or 67	71
12	66 or 67	70
13	66 or 67	69
14	66 or 67	68

Table 6-2 Input Contacts

1. Ensure the protected equipment is in a configuration/state that can support relay input testing.
2. If the relay is already in the Diagnostic Mode, then go to Step 3.  
  
If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 3.
3. Ensure that the Diagnostic Menu is selected to **INPUT** (Upper Case).

---

INPUT TEST (RELAY)

output **INPUT** led target →

-----  
← button disp →

← com1 com2 com3 clock →

← led cal factory

---

If INPUT is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select INPUT.

4. Press **ENTER**. The following is displayed:

---

INPUT NUMBER

1

---

5. Select the Input Relay (from [Table 6-2](#)) to be tested utilizing the Up/Down arrow pushbuttons.
6. Press **ENTER**. The following is displayed for the selected relay:

---

INPUT NUMBER 1

CIRCUIT OPEN

---

7. If no external control/status inputs are connected to the relay, then place a jumper between the **IN RTN** terminal (terminal #11 for Inputs 1–6, and either terminal #66 or #67 for Inputs 7–14) and the **IN1** terminal (terminal #10). See [Table 6-2](#) for terminals for inputs 2 through 14.

Alternatively, if this specific input is being used in this application and the external wiring is complete, the actual external control/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

---

8. Remove the jumper between the **IN RTN** terminal (terminal #11 for Inputs 1–6, and either terminal #66 or #67 for Inputs 7–14) and the **IN1** terminal (terminal #10).

The following is immediately displayed:

---

INPUT NUMBER 1

CIRCUIT OPEN

---

9. If testing all inputs, press **EXIT** to return to the input selection menu, then repeat Steps 5, 6, 7 and 8 for each input.
10. When input testing is complete then insure all jumpers have been removed and press **EXIT** to return to the Diagnostic Menu.
11. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

## Status LED Test

The **STATUS LED TEST** menu enables the user to check the front-panel LEDs individually.

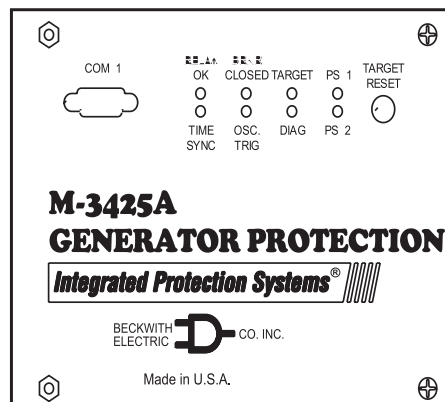


Figure 6-8 Status LED Panel

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to LED (Upper Case).

---

### STATUS LED TEST

output input LED target →

← button disp →

← com1 com2 com3 clock →

← led cal factory

---

If LED is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select LED.

3. Press **ENTER**. LED #1 (**RELAY OK**) illuminates and the following is displayed:

---

### STATUS LED TEST

LED NUMBER 1 = ON

---

4. If testing all Status LEDs, press the right arrow pushbutton to toggle through the remaining LEDs illustrated in [Figure 6-8](#), with the exception of the **PS1** and **PS2** LEDs.
5. When Status LED testing is complete press **EXIT** to return to the Diagnostic Menu.
6. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

### Target LED Test

The **TARGET LED TEST** menu allows the user to check the M-3925A Target Module LEDs individually.

TARGETS			
<input type="radio"/> 24	VOLTS/Hz	PHASE OVERCURRENT	50
<input type="radio"/> 27	PHASE UNDERVOLTAGE	PHASE OVERCURRENT	51V
<input type="radio"/> 59	PHASE OVERVOLTAGE	NEUTRAL O/C	50N/51N
<input type="radio"/> 27TN/59D/64S	STATOR GND	SPLIT PHASE DIFF	50DT
<input type="radio"/> 59N/59X	NEUT/GND OVERVOLT	STATOR OVERLOAD	49
<input type="radio"/> 32	DIRECTIONAL POWER	NEG SEQ OVERCURRENT	46
<input type="radio"/> 21	PHASE DISTANCE	FIELD GND/BRUSH LIFT	64F/B
<input type="radio"/> 40	LOSS OF FIELD	FREQUENCY	81/81R/81A
<input type="radio"/> 78	OUT OF STEP	PHASE DIFF CURRENT	87
<input type="radio"/> 50BF	BREAKER FAILURE	GND DIFF/DIR O/C	87GD/67N
<input type="radio"/> 50/27IN	ADVERTENT ENRGNG	TRIP CIRCUIT MONITOR	TC
<input type="radio"/> 60FL	V.T. FUSE LOSS	IPS LOGIC	LOGIC

OUTPUTS			
<input type="radio"/> OUT 1	<input type="radio"/> OUT 3	<input type="radio"/> OUT 5	<input type="radio"/> OUT 7
<input type="radio"/> OUT 2	<input type="radio"/> OUT 4	<input type="radio"/> OUT 6	<input type="radio"/> OUT 8

Figure 6-9 M-3925A Target Module Panel

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to **TARGET** (Upper Case).

---

TARGET LED TEST

output input led **TARGET** →

---

← button disp →

← com1 com2 com3 clock →

← led cal factory

---

If **TARGET** is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select **TARGET**.

3. Press **ENTER**. Target LED #1 lights and the following is displayed:

---

TARGET LED TEST

LED NUMBER 1 = ON

---

4. If testing all Target LEDs, press the right arrow pushbutton to toggle through the remaining Target LEDs illustrated in [Figure 6-9](#).
5. When Target LED testing is complete press **EXIT** to return to the Diagnostic Menu.
6. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

## Button Test

The **BUTTON TEST** menu selection allows the user to check the M-3931 HMI Module buttons. As each pushbutton is pressed, its name is displayed.

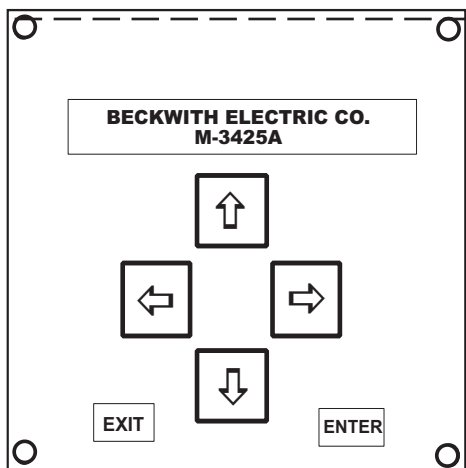


Figure 6-10 M-3931 Human-Machine Interface Module

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to **BUTTON** (Upper Case).

---

### BUTTON TEST

output input led target →

← **BUTTON** disp →

← com1 com2 com3 clock →

← led cal factory

---

If **BUTTON** is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select **BUTTON**.

3. Press **ENTER**. The following is displayed:

---

BUTTON TEST

0

---

■ **NOTE:** Pressing the **EXIT** pushbutton will exit from this test, and therefore should be last pushbutton tested. If it is pushed before this test sequence is completed, the test may be restarted by pushing **ENTER**. Notice that the word **EXIT** is displayed temporarily before the test sequence is exited.

4. Press each pushbutton for test. As each button is pressed, the display will briefly show the name for each key ("RIGHT ARROW", "UP ARROW", etc).
5. When pushbutton testing is complete press **EXIT** to return to the Diagnostic Menu.
6. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

## Display Test

The **DISPLAY TEST** menu selection enables the user to check the display. This test cycles through varying test patterns until **EXIT** is pressed.

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to **DISPLAY TEST** (Upper Case).

---

```

DISPLAY TEST
output input led target →
← button DISP →
-----
← com1 com2 com3 clock →
← led cal factory

```

---

If DISP is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select DISP.

3. Press **ENTER**, the unit will display a sequence of test characters until **EXIT** is pushed.
4. After the test has cycled through completely, press **EXIT** to return to the Diagnostic Menu.
5. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

## COM1/COM2 Loopback Test

The **COM1 LOOPBACK TEST** menu allows the user to test the front-panel RS-232 port. **COM2 LOOPBACK TEST** menu tests the rear panel RS-232 port.

A loopback plug is required for this test. The required 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-3425A COM1/COM2 DB9P

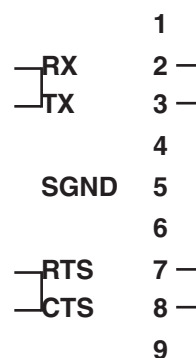


Figure 6-11 COM1/COM2 Loopback Plug

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to **COM1 LOOPBACK TEST** (Upper Case).

---

```

COM1 LOOPBACK TEST
output input led target →
-----
← button disp →
← COM1 com2 com3 clock →
← led cal factory

```

---

If COM1 is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select COM1.

3. Press **ENTER**. The following is displayed:

---

```

com1 loopback test
CONNECT LOOPBACK PLUG

```

---

4. Connect the loop-back plug to **COM1**, the front-panel RS-232C connector.
5. Press **ENTER**, the relay will initiate the loopback test.

If the COM Port passes the loopback test the following will be displayed:

---

```
COM1 LOOPBACK TEST
-DONE -
```

---

If the COM Port fails the loopback test the following will be displayed:

---

```
COM1 LOOPBACK TEST
RX-TX FAIL
```

---

6. Press **EXIT** to return to the DIAGNOSTIC Menu.
7. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.
8. Ensure that the Diagnostic Menu is selected to COM2 LOOPBACK TEST (Upper Case).

---

```
COM2 LOOPBACK TEST
output input led target →
← button disp →
← com1 COM2 com3 clock →
-----
← led cal factory
```

---

If COM2 is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select COM2.

9. Press **ENTER**, then repeat Steps 3 through 6 for **COM2**.

### COM3 Test (2-Wire)

The COM3 Echo Test 2-Wire allows the user to test the RS-485 rear terminal connections for proper operation.

■ **NOTE:** This test requires a PC with an RS-485 converter and terminal emulator software installed.

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to COM3 ECHO TEST 2 WIRE (Upper Case).

---

```
COM3 ECHO TEST 2 WIRE
output input led target →
-----
← button disp →
← com1 com2 COM3 clock →
← led cal factory
```

---

If COM3 is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select COM3.

3. Press **ENTER**. The following is displayed:

---

```
COM3 ECHO TEST 2WIRE
IDLING...9600, N, 8, 1
```

---

4. From 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 6-12](#) for diagram.

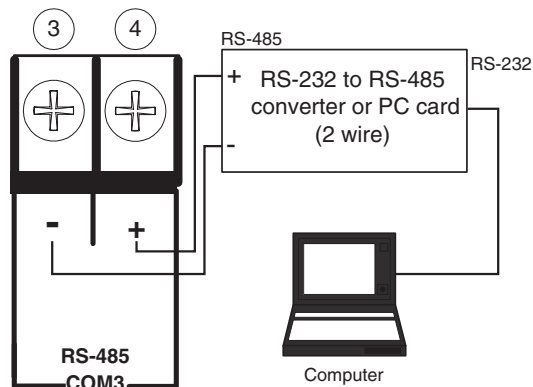


Figure 6-12 RS-485 2-Wire Testing

5. Set the following PC communications parameters:

Baud Rate	9600
Parity	None
Data Bits	8
Stop Bits	1
Duplex	Half

6. Open the terminal emulator program on the PC, then open the COM port for the RS-485 converter.
7. Press a key on the PC keyboard, then verify the following:
  - a. The character pressed is displayed temporarily on the relay display.
  - b. The character pressed is displayed on the PC monitor.
8. When communication has been verified, press **EXIT**, the following is displayed:

---

```
COM3 ECHO TEST 2WIRE
-DONE-
```

---

9. Press **EXIT** to return to the DIAGNOSTIC Menu.
10. Close the COM port on the PC, and exit the terminal program.
11. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

## Clock ON/OFF

This feature provides the user with the ability to either start or stop the clock.

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to **CLOCK ON/OFF** (Upper Case).

---

CLOCK START/STOP

```
output input led target →
-----
← button disp →
← com1 com2 com3 CLOCK →
← led cal factory
```

---

If **CLOCK** is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select **CLOCK**.

■ **NOTE:** '80' will be displayed in the seconds place when the clock is stopped.

3. Press **ENTER**, the following is displayed:
  - a. If the clock is already running the following will be displayed and will continue to update.

---

```
CLOCK TEST
01-Jan-2003 01:01:01
```

---

- b. If the clock was NOT running the following will be displayed:

---

```
CLOCK TEST
01-Jan-2003 01:01:80
```

---

4. To start or stop the clock press **ENTER**, the following is displayed:
  - a. If the clock is already running the following will be displayed:

---

CLOCK TEST  
CLOCK STOP

---



---

CLOCK TEST  
01-Jan-2003 01:01:80

---

- b. If the clock was NOT running the following will be displayed:

---

CLOCK TEST  
CLOCK START

---



---

CLOCK TEST  
01-Jan-2003 01:01:01

---

■ **NOTE:** To preserve battery life the clock should be OFF if the unit is to be left de-energized for a long period of time.

5. The clock can be toggled ON or OFF by pressing any arrow pushbutton or **ENTER**.  
To exit the Clock ON/OFF mode press **EXIT**, the following will be displayed:

---

CLOCK TEST  
- DONE -

---

6. To exit the CLOCK ON/OFF Diagnostic Menu press **EXIT**.
7. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

### Relay OK LED Flash/Illuminated

This feature provides the user with the ability to set the relay OK LED to either Flash or be Illuminated when the relay is working properly.

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to FLASH RELAY OK LED (Upper Case).

---

FLASH RELAY OK LED  
output input led target →  
← button disp →  
← com1 com2 com3 clock →  
← **LED** cal factory

---

If LED (to the left of cal) is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select LED.

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

---

FLASH RELAY OK LED  
OFF on

---

4. Select (upper case) either ON (to flash) or OFF (to illuminate) by pressing the right/left arrow pushbutton once.
5. Press **ENTER**, the following will be displayed:

---

FLASH RELAY OK LED  
- DONE -

---

6. To exit the FLASH RELAY OK LED Diagnostic Menu press **EXIT**.
7. If all Diagnostic Testing is complete, then exit the diagnostic menu by pressing **EXIT**, **PRESS EXIT TO EXIT DIAGNOSTIC MODE** is displayed, then press **EXIT** a second time.

### Auto Calibration

Refer to the following Section 6.4, Auto Calibration, for more information on that function.

---

AUTO CALIBRATION  
← clock led CAL factory

---

### Factory Use Only

This function is provided to allow access by factory personnel.

---

FACTORY USE ONLY  
← clock led cal FACTORY

---



## 6.4 Auto Calibration

■ **NOTE:** The M-3425A Generator Protection Relay has been fully calibrated at the factory. There is no need to recalibrate the unit prior to initial installation. However, in-system calibration of the 64F function may be needed for units purchased with the 64F Field Ground option. Calibration can be initiated using the HMI or IPSutil™ program.

### Phase and Neutral Fundamental Calibration

1. If the relay is already in the Diagnostic Mode, then go to Step 2.

If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to CAL (upper case).

---

FLASH RELAY OK LED

output input led target →  
 ← button disp →  
 ← com1 com2 com3 clock →  
 ← led **CAL** factory

---

If CAL is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select CAL.

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

---

60 HZ CALIBRATION  
 60\_HZ field\_gnd

---

4. Ensure that the 60 HZ Calibration Menu is selected to 60\_HZ (Upper Case).

If 60\_HZ is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select 60\_HZ.

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

---

60 HZ CALIBRATION  
 NOM\_F 3rdh\_F 64s\_f

---

6. Ensure that NOM\_F is selected (Upper Case).

If NOM\_F is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select NOM\_F.

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

---

CONNECT REFERENCE INPUTS  
 PRESS ENTER TO CALIBRATE

---

8. Connect  $V_A = V_B = V_C = V_N = V_X = 120.0$  ( $\pm 0.01$ ) V at  $0^\circ$  phase. (See [Figure 6-14](#).)
9. Connect  $I_a = I_b = I_c = I_A = I_B = I_C = I_N^+ = 5.00^{**}$  Amps at  $0^\circ$  (see [Figure 6-13](#)).

**\*\* For a 1 A CT rating, use 1 A.**

*\*If 64S is purchased, do not put nominal current in the IN channel. The IN input is calibrated separately (see 64S procedure.)*

The calibration can be verified by exiting from the Diagnostic menu and reading status:

$V_A = V_B = V_C = V_N = V_X = 120V$      $V_1 = V_2 = 0$      $V_0 = 120V$   
 $I_A = I_B = I_C = 5 A^{**}$      $I_1 = I_2 = 0$      $I_0 = 5 A^{**}$   
 $I_a = I_b = I_c = 5 A^{**}$

Real=1 pu Reactive=0.0 pu

Power Factor = 1.0

$I_{diffa} = I_{diffb} = I_{diffc} = 0$

Where subscript 0, 1, and 2 represent zero, positive, and negative sequence quantities, respectively.

**\*\* For a 1 A CT rating, use 1 A.**

■ **NOTE:** The phase angle difference between voltage and current input source should be  $0^\circ$ ,  $\pm 0.05^\circ$ , and an accurate low-distortion source should be used. (THD less than 1%).

10. Press **ENTER**, the following will be displayed while the relay is being calibrated:

---

CALIBRATING  
 WAIT

---

When the calibration is complete, the following will be displayed:

---

CALIBRATING  
 DONE

---

11. Remove the calibration source inputs.

### Third Harmonic Calibration

1. If it is desired to calibrate the third harmonic only and the relay is already in the Diagnostic Mode, then go to Step 2.

If it is desired to calibrate the third harmonic only and the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to CAL (upper case).

---

FLASH RELAY OK LED

output input led target →  
 ← button disp →  
 ← com1 com2 com3 clock →  
 ← led **CAL** factory

---

If CAL is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select CAL.

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

---

60 HZ CALIBRATION  
 60\_HZ field\_gnd

---

4. Ensure that the 60 HZ Calibration Menu is selected to 60\_HZ (Upper Case).

If 60\_HZ is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select 60\_HZ.

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

---

60 HZ CALIBRATION  
 nom\_f      3RDH\_F      64s\_f

---

6. Ensure that 3RDH\_F is selected (Upper Case).

If 3RDH\_F is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select 3RDH\_F.

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

---

INPUT 180 HZ  
 PRESS ENTER TO CALIBRATE

---

(150 Hz for 50 Hz units)

8. Connect Voltage Inputs as follows:
  - a. Connect  $V_N = V_X = 10.0$  V, 180 Hz (150 Hz for 50 Hz units). See [Figure 6-15](#).
  - b. Connect  $V_A = V_B = V_C = 120.0$  V, 180 Hz (150 Hz for 50 Hz units). See [Figure 6-16](#).

9. Press **ENTER**, the following will be displayed while the Third Harmonic is calibrated:

---

CALIBRATING  
 WAIT

---

When the calibration is complete, the following will be displayed:

---

AUTO CALIBRATION  
 DONE

---

10. Remove the voltage from  $V_N$  and  $V_X$ .
11. Remove the calibration source inputs.

### 64S 100% Stator Ground by Low Frequency Injection Calibration

1. If it is desired to calibrate the 64S 100% Stator Ground by Low Frequency Injection only and the relay is already in the Diagnostic Mode, then go to Step 2.

If it is desired to calibrate the 64S 100% Stator Ground by Low Frequency Injection only and the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 2.

2. Ensure that the Diagnostic Menu is selected to CAL (upper case).

---

FLASH RELAY OK LED

output input led target →  
 ← button disp →  
 ← com1 com2 com3 clock →  
 ← led **CAL** factory

---

If CAL is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select CAL.

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

---

60 HZ CALIBRATION  
 60\_HZ field\_gnd

---

4. Ensure that the 60 HZ Calibration Menu is selected to 60\_HZ (Upper Case).

If 60\_HZ is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select 60\_HZ.

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

---

60 HZ CALIBRATION  
 nom\_f            3rdh\_f    64S\_F

---

6. Ensure that 64S\_F is selected (Upper Case).

If 64S\_F is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select 64S\_F.

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

---

INPUT 20 HZ  
 PRESS ENTER TO CALIBRATE

---

8. Connect  $V_N=20.0\text{ V}$  ( $\pm 0.01\text{ V}$ ) 20 Hz,  $I_N=20.0\text{ mA}$  ( $\pm 0.01\text{ mA}$ ) 20 Hz. See [Figure 6-6](#).

9. Press **ENTER**, the following will be displayed while the 64S is calibrated:

---

CALIBRATING  
 WAIT

---

When the calibration is complete, the following will be displayed:

---

CALIBRATING  
 DONE

---

10. Remove the voltage from  $V_N$  and  $I_N$ .
11. Remove the calibration source inputs.

## Field Ground Calibration

Field Ground Calibration only applies to units purchased with the 64F Field Ground option. Calibration is necessary for long cable lengths (greater than 100 feet) to compensate for cabling losses from the M-3425A and the M-3921 Coupler module, and therefore should be accomplished in system, after all wiring is complete.

1. Connect the M-3921 Field Ground Coupler box as shown in [Figure 6-7](#), Field Ground Coupler.
2. If the relay is already in the Diagnostic Mode, then go to Step 3.  
  
If the relay is NOT in the Diagnostic Mode, then enter the relay diagnostic mode by performing the steps described in the Entering Relay Diagnostic Mode section of this chapter, then go to Step 3.
3. Ensure that the Diagnostic Menu is selected to CAL (upper case).

---

FLASH RELAY OK LED

output input led target →  
 ← button disp →  
 ← com1 com2 com3 clock →  
 ← led **CAL** factory

---

If CAL is not selected (Upper Case), then use the Right/Left arrow pushbuttons to select CAL.

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

---

60 HZ CALIBRATION  
 60\_HZ field\_gnd

---

5. Ensure that the 60 HZ Calibration Menu is selected to FIELD\_GND (Upper Case).  
  
If FIELD\_GND is not selected (Upper Case), then use the Right arrow pushbutton to select FIELD\_GND.

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

---

CONNECT 1 KOHM REF.  
 PRESS ENTER TO CALIBRATE

---

7. Set the decade box for 1 kΩ resistance, then press **ENTER**, the following will be displayed:

---

CALIBRATING  
 WAIT

---

8. When the calibration is complete the following will be displayed:

---

CALIBRATING  
 DONE

---

9. Press **ENTER**, the unit will display the next resistance in the calibration sequence to be tested.
10. Set the decade box to the resistance specified by the HMI, then press **ENTER**. When the display shows DONE press **ENTER**.
11. Repeat Step 10 until the calibration is complete for 100 kΩ.
12. Press **EXIT** twice to exit the Diagnostic Mode.

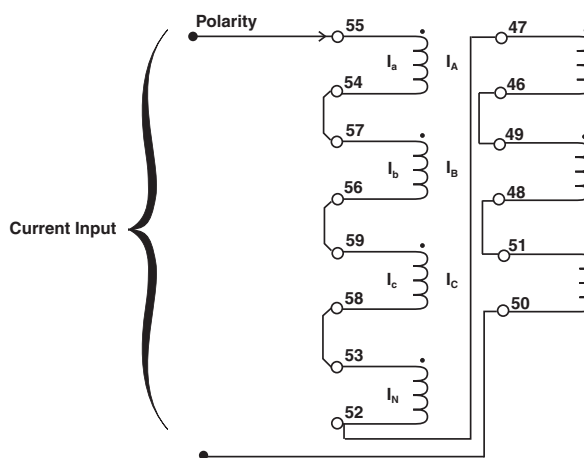


Figure 6-13 Current Input Configuration

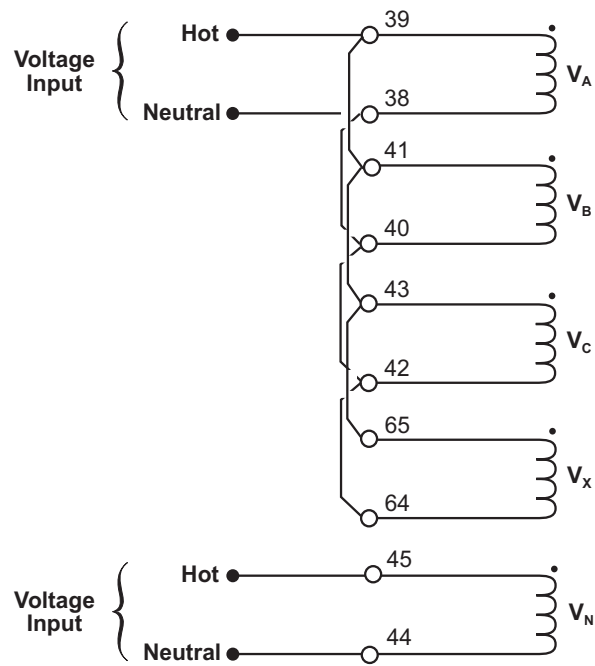


Figure 6-14 Voltage Input Configuration

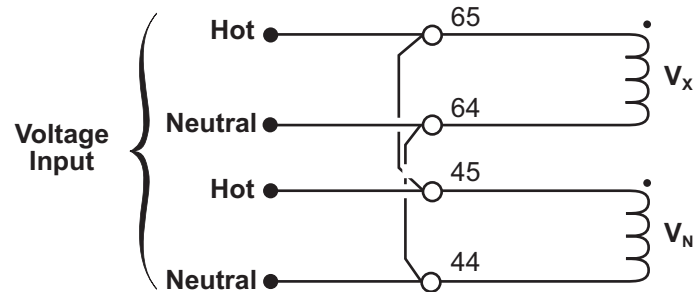


Figure 6-15 Voltage Input Configuration

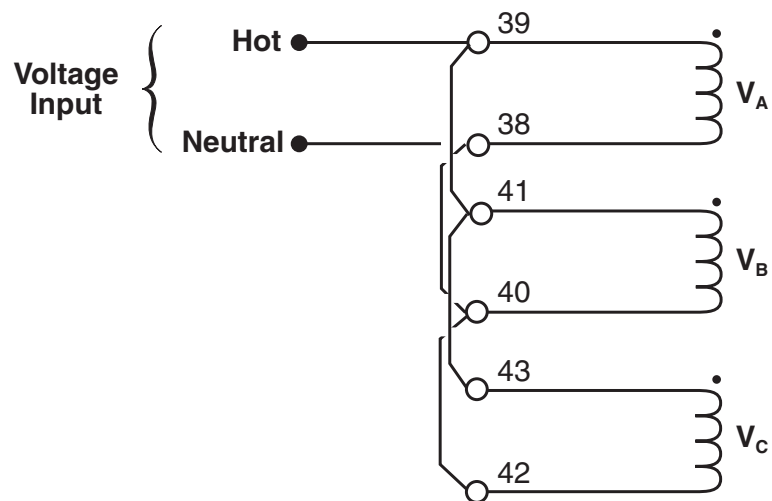


Figure 6-16 Voltage Input Configuration

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# A

## Configuration Record Forms

This Appendix contains forms for copying, and recording the configuration and setting of the M-3425A Generator 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-3400 IPScom® Communication Software or the optional M-3931 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	
21	1																																				
	2																																				
	3																																				
24 Def Time	1																																				
	2																																				
24 Inv Time																																					
25S																																					
25D																																					
27	1																																				
	2																																				
	3																																				
27TN	1																																				
	2																																				
32	1																																				
	2																																				
	3																																				
40	1																																				
	2																																				
46 Def Time																																					
46 Inv Time																																					
49	1																																				
	2																																				
50	1																																				
	2																																				
50BF																																					
50DT	1																																				
	2																																				
50N																																					
50/27																																					
51N																																					
51V																																					
59	1																																				
	2																																				
	3																																				
59D																																					
59N	1																																				
	2																																				
	3																																				
59X	1																																				
	2																																				

■ **NOTE:** The M-3425A is shipped with all functions disabled.

Table A-1 Relay Configuration (page 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		
60FL																																					
64F	1																																				
	2																																				
64B																																					
64S																																					
67N Def Time																																					
67N Inv Time																																					
78																																					
81	1																																				
	2																																				
	3																																				
	4																																				
81A	1																																				
	2																																				
	3																																				
	4																																				
	5																																				
	6																																				
81R	1																																				
	2																																				
87	1																																				
	2																																				
87GD																																					
IPS	1																																				
	2																																				
	3																																				
	4																																				
	5																																				
	6																																				
BM																																					
TCM																																					

■ **NOTE:** The M-3425A is shipped with all functions disabled.

Table A-1 Relay Configuration (page 2 of 2)

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## System Communication Setup

---

### Communication Setup

COM 1 (COM1 Communication Parameters are fixed except "Comm Response Time Delay")

Baud Rate: 9600 Data Bit: 8 Parity: None Stop Bit: 1 Protocol: BECO

Comm Response Time Delay: \_\_\_\_\_ 0 msec–250 msec [100]

COM 2

Baud Rate: ☐ 1200 ☐ 2400 ☐ 4800 ☐ [9600]

Data Bit: [8] (Fixed)

Parity: ☐ [NONE] ☐ ODD ☐ EVEN

Stop Bit: \_\_\_\_\_ [1] or 2

Protocol: ☐ BECO ☐ [MODBUS]

Dead Sync Time: \_\_\_\_\_ 1 msec–3000 msec [50]

Comm Response Time Delay: \_\_\_\_\_ 0 msec–250 msec [100]

COM 3

Baud Rate: [9600] (Fixed)

Data Bit: [8] (Fixed)

Parity: [NONE] (Fixed)

Stop Bit: [1] (Fixed)

Protocol: ☐ [BECO] ☐ MODBUS

Dead Sync Time: \_\_\_\_\_ 1 msec–3000 msec [50]

Comm Response Time Delay: \_\_\_\_\_ 0 msec–250 msec [100]

Communication Address: \_\_\_\_\_ [1]

Communication (COMM) Access Code: \_\_\_\_\_ [9999]

ETHERNET

Ethernet Board: ☐ [Enable] ☐ Disable

DHCP Protocol: ☐ [Enable] ☐ Disable

IP Address: \_\_\_\_\_ [192.168.1.43]

Net Mask: \_\_\_\_\_ [255.255.255.0]

Gateway: \_\_\_\_\_ [192.168.1.1]

Protocol: ☐ BECO (SERCONV) ☐ [MODBUS]

■ **NOTE:** *As Shipped* settings are contained in brackets [ ] where applicable.

*Figure A-1 System Communication Setup*

---

**Setup System**


---

**SYSTEM**

Nominal Voltage: \_\_\_\_\_ 50.0 V – 140.0 V [115.0]

Nominal Current: \_\_\_\_\_ 0.50 A – 6.00 A [5.00]

Phase Rotation: ☐ ACB ☐ [ABC]59/27 Magnitude Select: ☐ [RMS] ☐ DFT50DT Split Phase Diff: ☐ Disable ☐ [Enable]Delta-Y Transform: ☐ [Disable] ☐ Delta-AB ☐ Delta-ACV.T. Configuration: ☐ [Line-to-Line] ☐ Line-to-Ground ☐ Line-to-Ground to Line-to-Line

V.T. Phase Ratio: \_\_\_\_\_:1 1.0 – 6550.0 [120.0]

V.T. Neutral Ratio: \_\_\_\_\_:1 1.0 – 6550.0 [50.0]

V.T. Vx Ratio: \_\_\_\_\_:1 1.0 – 6550.0 [1.0]

C.T. Phase Ratio: \_\_\_\_\_:1 1 – 65500 [1600.0]

C.T. Neutral Ratio: \_\_\_\_\_:1 1 – 65500 [1600.0]

**I/O SETUP****Input Active State (Open):**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**Input Active State (Close):**
☐ [#1]    ☐ [#2]    ☐ [#3]    ☐ [#4]    ☐ [#5]    ☐ [#6]    ☐ [#7]    ☐ [#8]    ☐ [#9]  
☐ [#10]    ☐ [#11]    ☐ [#12]    ☐ [#13]    ☐ [#14]
**Latched Outputs:**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
**Pulsed Outputs:**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
**■NOTE: As Shipped** settings are contained in brackets [ ] where applicable.*Figure A-2 Setup System (page 1 of 2)*

**OUTPUT SEAL-IN TIME****Relay Output 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]  
**Output 17:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 18:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 19:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 20:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 21:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 22:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]  
**Output 23:**   \_\_\_\_\_     2 – 8160 (Cycles) [30]

■ **NOTE:** *As Shipped* settings are contained in brackets [ ] where applicable.

*Figure A-2 Setup System (page 2 of 2)*

---

**System Setpoints and Settings**


---

**21 – Phase Distance**


---

**21 #1**    ☐ Disable   ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1–100.0 (Ohm) [10.0]

Offset: \_\_\_\_\_ -100.0–100.0 (Ohm) [0.0]

Impedance Angle: \_\_\_\_\_ 0–90 (Degree) [45]

 Load Encr. Angle: \_\_\_\_\_ 1–90 (Degree) [45]   ☐ [Disable]   ☐ Enable

Load Encr. R Reach: \_\_\_\_\_ 0.1–100 (Ohm) [10.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Overcurrent SV: \_\_\_\_\_ 0.1–20.0 (A)   ☐ [Disable]   ☐ Enable

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**21 #2**    ☐ Disable   ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1–100.0 (Ohm) [10.0]

Offset: \_\_\_\_\_ -100.0–100.0 (Ohm) [0.0]

Impedance Angle: \_\_\_\_\_ 0–90 (Degree) [45]

 Load Encr. Angle: \_\_\_\_\_ 1–90 (Degree) [45]   ☐ [Disable]   ☐ Enable

Load Encr. R Reach: \_\_\_\_\_ 0.1–100 (Ohm) [10.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Overcurrent SV: \_\_\_\_\_ 0.1–20.0 (A)   ☐ [Disable]   ☐ Enable

☐ [Out of Step Block Disable]   ☐ Out of Step Block Enable

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

*Figure A-3 System Setpoints and Settings (page 1 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**21 – Phase Distance (Cont.'d)**


---

**21 #3**     ☐ Disable   ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1–100.0 (Ohm) [10.0]

Offset: \_\_\_\_\_ -100.0–100.0 (Ohm) [0.0]

Impedance Angle: \_\_\_\_\_ 0–90 (Degree) [45]

 Load Encr. Angle: \_\_\_\_\_ 1–90 (Degree) [45]   ☐ [Disable]   ☐ Enable

Load Encr. R Reach: \_\_\_\_\_ 0.1–100 (Ohm) [10.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Overcurrent SV: \_\_\_\_\_ 0.1–20.0 (A)   ☐ [Disable]   ☐ Enable

Out of Step Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**24 – Volts/Hz Overexcitation**
**Definite Time #1**
**Definite Time #1**     ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ 100–200 (%) [120]

Time Delay: \_\_\_\_\_ 30–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

*Figure A-3 System Setpoints and Settings (page 2 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**24–Volts/Hz Overexcitation (Cont.'d)**


---

**Definite Time #2**
**Definite Time #2**      ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ 100–200 (%) [120]

Time Delay: \_\_\_\_\_ 30 –8160 (Cycles) [30]

**I/O Selection:**
**Outputs**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

**Blocking Inputs**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**Inverse Time**
**Inverse Time**      ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ 100–200 (%) [120]

Time Delay: \_\_\_\_\_ 30 –8160 (Cycles) [30]

Reset Rate: \_\_\_\_\_ 1–999 (Sec) [10]

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  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

**Blocking Inputs**
☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**25–Sync Check**
**25S**   ☐ Disable   ☐ Enable

Phase Angle Window: \_\_\_\_\_ 0–90 (Degrees) [45]

Upper Voltage Limit: \_\_\_\_\_ 60–140 (V) [140]

Lower Voltage Limit: \_\_\_\_\_ 40–120 (V) [120]

Sync Check Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Delta Voltage: \_\_\_\_\_ 1.0 –50.0 (V) [2.0]   ☐ [Disable]   ☐ Enable

Delta Frequency: \_\_\_\_\_ 0.001 –0.500 (Hz) [0.100]   ☐ [Disable]   ☐ Enable

Sync Check Phase   ☐ [Phase AB]   ☐ Phase BC   ☐ Phase CA

*Figure A-3   System Setpoints and Settings (page 3 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**25–Sync Check (Cont.'d)**


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I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**25D** ☐ Disable ☐ Enable

Dead Voltage Limit: \_\_\_\_\_ 0–60 (V) [10]

Dead Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Enable ☐ Dead V1 Hot VX ☐ Hot V1 Dead VX ☐ Dead V1 Dead VX

Dead Input Enable:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**27–Phase Undervoltage****27 #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

*Figure A-3 System Setpoints and Settings (page 4 of 38)*



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**System Setpoints and Settings (Cont.'d)**


---

**27–Phase Undervoltage (Cont.'d)**


---

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**27 #2**    ☐ Disable    ☐ Enable

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**27 #3**    ☐ Disable    ☐ Enable

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**27TN–Third Harmonic Undervoltage, Neutral****27TN #1**    ☐ Disable    ☐ Enable

Pickup: \_\_\_\_\_ 0.10–14.00 (V) [10.00]

Pos. Seq. Voltage Block: \_\_\_\_\_ 5–180 (V) [120]    ☐ [Disable]    ☐ EnableForward Power Block: \_\_\_\_\_ 0.01–1.00 (PU) [0.50]    ☐ [Disable]    ☐ EnableReverse Power Block: \_\_\_\_\_ -1.00– -0.01 (PU) [-0.50]    ☐ [Disable]    ☐ EnableLead VAr Block: \_\_\_\_\_ -1.00– -0.01 (PU) [-0.50]    ☐ [Disable]    ☐ EnableLag VAr Block: \_\_\_\_\_ 0.01– 1.00 (PU) [0.50]    ☐ [Disable]    ☐ EnableLead Power Factor Block: \_\_\_\_\_ 0.01– 1.0 (Lead) [0.50]    ☐ [Disable]    ☐ EnableLag Power Factor Block: \_\_\_\_\_ 0.01– 1.0 (Lag) [0.50]    ☐ [Disable]    ☐ Enable*Figure A-3 System Setpoints and Settings (page 5 of 38)*

---

**System Setpoints and Settings (Cont.'d)**


---

**27TN—Third Harmonic Undervoltage, Neutral (Cont.'d)**

 Hi Band Forward Power Block: \_\_\_\_\_ 0.01–1.0 (PU) [0.50] ☐ [Disable] ☐ Enable

Lo Band Forward Power Block: \_\_\_\_\_ 0.01–1.0 (PU) [0.50]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**27TN #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.10–14.00 (V) [10.00]

 Pos. Seq. Voltage Block: \_\_\_\_\_ 5–180 (V) [120] ☐ [Disable] ☐ Enable

 Forward Power Block: \_\_\_\_\_ 0.01–1.00 (PU) [0.50] ☐ [Disable] ☐ Enable

 Reverse Power Block: \_\_\_\_\_ -1.00– -0.01 (PU) [-0.50] ☐ [Disable] ☐ Enable

 Lead VAr Block: \_\_\_\_\_ -1.00– -0.01 (PU) [-0.50] ☐ [Disable] ☐ Enable

 Lag VAr Block: \_\_\_\_\_ 0.01– 1.00 (PU) [0.50] ☐ [Disable] ☐ Enable

 Lead Power Factor Block: \_\_\_\_\_ 0.01– 1.0 (Lead) [0.50] ☐ [Disable] ☐ Enable

 Lag Power Factor Block: \_\_\_\_\_ 0.01– 1.0 (Lag) [0.50] ☐ [Disable] ☐ Enable

 Hi Band Forward Power Block: \_\_\_\_\_ 0.01–1.0 (PU) [0.50] ☐ [Disable] ☐ Enable

Lo Band Forward Power Block: \_\_\_\_\_ 0.01–1.0 (PU) [0.50]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 6 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**32 – Directional Power**
**32 #1**    ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ -3.000–3.000 (PU) [0.100]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Over/Under Power   ☐ [Over]   ☐ UnderTarget LED   ☐ [Disable]   ☐ Enable

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**32 #2**    ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ -3.000–3.000 (PU) [0.100]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Over/Under Power   ☐ [Over]   ☐ UnderTarget LED   ☐ [Disable]   ☐ Enable

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**32 #3**    ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ -3.000–3.000 (PU) [0.100]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Over/Under Power   ☐ [Over]   ☐ UnderTarget LED   ☐ [Disable]   ☐ EnableDirectional Power Sensing   ☐ [Real]   ☐ Reactive*Figure A-3   System Setpoints and Settings (page 7 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**32 – Directional Power (Cont.'d)**


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I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**40 – Loss of Field**
**40 #1**    ☐ Disable    ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1–100.0 (Ohm) [50.0]

Offset: \_\_\_\_\_ -50.0– 50.0 (Ohm) [0.0]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**40 #1 VC**    ☐ Disable    ☐ Enable

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 8 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**40 – Loss of Field (Cont.'d)**

**40 #2**    ☐ Disable   ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1 – 100.0 (Ohm) [50.0]

Offset: \_\_\_\_\_ -50.0 – 50.0 (Ohm) [0.0]

Time Delay: \_\_\_\_\_ 1 – 8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**40 #2 VC**   ☐ Disable   ☐ Enable

Time Delay: \_\_\_\_\_ 1 – 8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**40 Setting**

Directional Element: \_\_\_\_\_ 0 – 20 (Degree) [0]

Voltage Control: \_\_\_\_\_ 5 – 180 (V) [120]

*Figure A-3 System Setpoints and Settings (page 9 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**46 – Negative Sequence Overcurrent****Definite Time**   ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ 3–100 (%) [50]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14
**Inverse Time**   ☐ Disable   ☐ Enable

Pickup: \_\_\_\_\_ 3–100 (%) [50]

Time Dial: \_\_\_\_\_ 1 –95 [50]

Maximum Time: \_\_\_\_\_ 600–65500 (Cycles) [1000]

Reset Time: \_\_\_\_\_ 1 –600 (Second) [10]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14
*Figure A-3 System Setpoints and Settings (page 10 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**49–Stator Overload Protection**49 #1 ☐ Disable ☐ Enable

Time Constant: \_\_\_\_\_ 1.0–999.9 (min) [10.0]

Max Overload Current: \_\_\_\_\_ 1.00 – 10.00 (A) [5.00]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
49 #2 ☐ Disable ☐ Enable

Time Constant: \_\_\_\_\_ 1.0–999.9 (min) [10.0]

Max Overload Current: \_\_\_\_\_ 1.00 – 10.00 (A) [5.00]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**50–Instantaneous Phase Overcurrent**50 #1 ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.1–240.0 (A) [5.0]

Time Delay: \_\_\_\_\_ 1 – 8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
*Figure A-3 System Setpoints and Settings (page 11 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**50–Instantaneous Phase Overcurrent (Cont.'d)**


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**50 #2**    ☐ Disable    ☐ Enable

Pickup: \_\_\_\_\_ 0.1–240.0 (A) [5.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**50BF–Breaker Failure**
**50BF**    ☐ Disable    ☐ Enable

Phase Current: \_\_\_\_\_ 0.10–10.00 (A) [5.0]

Phase Current Select:    ☐ [Disable]    ☐ Enable

Neutral Current: \_\_\_\_\_ 0.10–10.00 (A) [5.0]

Neutral Current Select:    ☐ [Disable]    ☐ Enable

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 12 of 38)*



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**System Setpoints and Settings (Cont.'d)**


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**50DT – Definite Time Overcurrent**


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**50DT #1**   ☐ Disable   ☐ Enable

Pickup (A): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Pickup (B): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Pickup (C): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**50DT #2**   ☐ Disable   ☐ Enable

Pickup (A): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Pickup (B): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Pickup (C): \_\_\_\_\_ 0.20–240.00 (A) [5.0]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

*Figure A-3 System Setpoints and Settings (page 13 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**50N—Instantaneous Neutral Overcurrent**50N ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.1–240.0 (A)

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**50/27—Inadvertent Energizing**50/27 ☐ Disable ☐ Enable**(50) Overcurrent**

Pickup: \_\_\_\_\_ 0.50–15.0 (A) [5.00]

**(27) Undervoltage**

Pickup: \_\_\_\_\_ 5–130 (V) [100]

Pickup Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Drop-out Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 14 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**51N – Inverse Time Neutral Overcurrent**51N ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.25 – 12.00 (A) [5.00]

Time Dial: \_\_\_\_\_ 0.5 – 11.0 [5.0]

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☐ #17 ☐ #18 ☐ #19 ☐ #20 ☐ #21 ☐ #22 ☐ #23

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14**51V – Inverse Time Phase Overcurrent**51V ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.50 – 12.00 (A) [5.00]

Time Dial: \_\_\_\_\_ 0.5 – 11.0 [5.0]

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

Voltage Control: \_\_\_\_\_ 5 – 180 (V) [100]

☐ [Disable] ☐ Voltage Control ☐ Voltage Restraint

I/O Selection:

Outputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8☐ #9 ☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16☐ #17 ☐ #18 ☐ #19 ☐ #20 ☐ #21 ☐ #22 ☐ #23

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14*Figure A-3 System Setpoints and Settings (page 15 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**59–Phase Overvoltage**59– #1 ☐ Disable ☐ EnableInput Voltage Selection: ☐ Phase ☐ Positive Sequence ☐ Negative Sequence

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

59– #2 ☐ Disable ☐ EnableInput Voltage Selection: ☐ Phase ☐ Positive Sequence ☐ Negative Sequence

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

59– #3 ☐ Disable ☐ EnableInput Voltage Selection: ☐ Phase ☐ Positive Sequence ☐ Negative Sequence

Pickup: \_\_\_\_\_ 5–180 (V) [120]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 16 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**59D–Third Harmonic Voltage Differential**


---

**59D** ☐ Disable ☐ Enable

 Line Side Voltage: ☐ [3V0] ☐ VX

Ratio (VX/VN): \_\_\_\_\_ 0.1–5.0 [1.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Pos. Seq. Voltage Block: \_\_\_\_\_ 5–180 (V) [100] ☐ [Disable] ☐ Enable

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**59N–Neutral Overvoltage**
**59N– #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5.0–180.0 (V) [120.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Neg. Seq. Voltage Inhibit (>): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Inhibit (<): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Selection: ☐ [3V0] ☐ VX

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 17 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**59N–Neutral Overvoltage (Cont.'d)**


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**59N– #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5.0–180.0 (V) [120.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Neg. Seq. Voltage Inhibit (>): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Inhibit (<): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Selection: ☐ [3V0] ☐ VX

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**59N– #3** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5.0–180.0 (V) [120.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

 Neg. Seq. Voltage Inhibit (>): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Inhibit (<): \_\_\_\_\_ 1.0–100.0 (%) [10.0] ☐ [Disable] ☐ Enable

 Zero Seq. Voltage Selection: ☐ [3V0] ☐ VX

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 18 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**59X – Multi-purpose Overvoltage**59X – #1 ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5–180 (V) [100]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

59X – #2 ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5–180 (V) [100]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**60FL – Fuse Loss Detection**60FL ☐ Disable ☐ Enable

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Three Phase Fuse Loss Detection: ☐ [Disable] ☐ Enable

Input Initiate: ☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7  
                                  ☐ #8    ☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 19 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**64F/B – Field Ground Protection****64F – #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5–100 (KOhm) [50]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**64F – #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 5–100 (KOhm) [50]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**64B** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0–5000 (mV)

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**Injection**

Frequency: \_\_\_\_\_ 0.10–1.00 (Hz) [0.20]

*Figure A-3 System Setpoints and Settings (page 20 of 38)*



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**System Setpoints and Settings (Cont.'d)**


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**64S–100% Stator Ground**
**64S** ☐ Disable ☐ Enable

Underfrequency Inhibit( $\leq 40$  Hz): ☐ [Disable] ☐ Enable

Voltage Restraint: ☐ [Disable] ☐ Enable

Total Current Pickup: \_\_\_\_\_ 2.0–75.0 (mA) [10.0] ☐ [Disable] ☐ Enable

Real Component Current: \_\_\_\_\_ 2.0–75.0 (mA) [10.0] ☐ [Disable] ☐ Enable

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**67N– Residual Directional Overcurrent**
**67N– Definite Time** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.5–240 (A) [5.0]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Directional Element: ☐ [Disable] ☐ Enable

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Figure A-3 System Setpoints and Settings (page 21 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**67N– Residual Directional Overcurrent (Cont.'d)**


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**67N– Inverse Time** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.25–12.00 (A) [5.00]

Time Dial: \_\_\_\_\_ 0.5–11.0 [5.0]

Directional Element: ☐ [Disable] ☐ Enable

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☐ #17 ☐ #18 ☐ #19 ☐ #20 ☐ #21 ☐ #22 ☐ #23

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14**Setting**

Max Sensitivity Angle: \_\_\_\_\_ 0–359 (Degree) [0]

Operating Current: ☐ [3I0] ☐ INPolarizing Quantity: ☐ [#V0 (Calculated)] ☐ VN ☐ VX**78–Out of Step****78** ☐ Disable ☐ Enable

Circle Diameter: \_\_\_\_\_ 0.1–100.0 (Ohm) [10.0]

Offset: \_\_\_\_\_ -100.0–100.0 (Ohm) [0.0]

Blinder Impedance: \_\_\_\_\_ 0.1–50.0 (Ohm) [10.0]

Impedance Angle: \_\_\_\_\_ 0–90 (Degree) [45]

Pole Slip Counter: \_\_\_\_\_ 1–20 [5]

Pole Slip Reset Time: \_\_\_\_\_ 1–8160 (Cycles) [30]

Time Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Trip on MHO Exit: ☐ [Disable] ☐ Enable

I/O Selection:

Outputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8☐ #9 ☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16☐ #17 ☐ #18 ☐ #19 ☐ #20 ☐ #21 ☐ #22 ☐ #23

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14*Figure A-3 System Setpoints and Settings (page 22 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**81 – Over/Under Frequency****81 – #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –65500 (Cycles)

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**81 – #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –65500 (Cycles)

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
**81 – #3** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –65500 (Cycles)

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Figure A-3 System Setpoints and Settings (page 23 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**81 – Over/Under Frequency (Cont.'d)**


---

**81 – #4** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 – 65500 (Cycles)

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**81A – Frequency Accumulator**
**81A – #1** ☐ Disable ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 – 360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**81A – #2** ☐ Disable ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 – 360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 24 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**81A–Frequency Accumulator (Cont.'d)**


---

**81A– #3**   ☐ Disable   ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**81A– #4**   ☐ Disable   ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**81A– #5**   ☐ Disable   ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3 –360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

*Figure A-3 System Setpoints and Settings (page 25 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**81A—Frequency Accumulator (Cont.'d)**
**81A— #6** ☐ Disable ☐ Enable

High Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Low Band Pickup: \_\_\_\_\_ 50.00–67.00 (Hz) [65.00]

Time Delay: \_\_\_\_\_ 3–360000 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**81R—Rate of Change of Frequency**
**81R— #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.10–20.00 (Hz) [1.00]

Time Delay: \_\_\_\_\_ 3–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**81R— #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.10–20.00 (Hz) [1.00]

Time Delay: \_\_\_\_\_ 3–8160 (Cycles) [30]

I/O Selection:

Outputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23

Blocking Inputs

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14

**81R Setting**

Negative Sequence Voltage Inhibit: \_\_\_\_\_ 0–99 (%) [10]

*Figure A-3 System Setpoints and Settings (page 26 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**87 – Phase Differential Current****87 – #1** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.20–3.00 (A) [1.0]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Percent Slope: \_\_\_\_\_ 1 –100 (%) [50]

I/O Selection:

## Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

## Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**87 – #2** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.20–3.00 (A) [1.0]

Time Delay: \_\_\_\_\_ 1 –8160 (Cycles) [30]

Percent Slope: \_\_\_\_\_ 1 –100 (%) [50]

I/O Selection:

## Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

## Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**87 Setting**

Phase CT Correction: \_\_\_\_\_ 0.50– 2.0 [1.00]

*Figure A-3 System Setpoints and Settings (page 27 of 38)*

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**System Setpoints and Settings (Cont.'d)**

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**87GD—Ground Differential Current**87 ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0.20–10.0 (A) [1.00]

Pickup Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

CT Ratio Correction: \_\_\_\_\_ 0.10–7.99 [1.00]

I/O Selection:

## Outputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

## Blocking Inputs

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 28 of 38)*



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**System Setpoints and Settings (Cont.'d)**


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**IPSLogic**IPSLogic #1 ☐ Disable ☐ Enable

Initiating Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Initiating Outputs Logic Gate: ☐ [OR] ☐ AND

Initiating Function Pickup:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Timeout:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Pickup/Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None] ☐ NOT

Initiating Inputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Initiating Inputs Logic Gate: ☐ [OR] ☐ ANDInitiate via Communication Point: ☐

Figure A-3 System Setpoints and Settings (page 29 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #1 (Cont.'d)**

Blocking Inputs:

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Outputs/Function Pickup/Function Timeout and Initiating Inputs  
Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]
**IPSLLogic #2** ☐ Disable ☐ Enable

Initiating Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Initiating Outputs Logic Gate: ☐ [OR] ☐ AND

Initiating Function Pickup:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Figure A-3 System Setpoints and Settings (page 30 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLogic #2 (Cont.'d)**


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Initiating Function Timeout:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Pickup/Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None] ☐ NOT

Initiating Inputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Initiating Inputs Logic Gate: ☐ [OR] ☐ ANDInitiate via Communication Point: ☐

Blocking Inputs:

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ AND

Initiating Outputs/Function Pickup/Function Timeout and Initiating Inputs

Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]

Figure A-3 System Setpoints and Settings (page 31 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #3**   ☐ Disable   ☐ Enable

Initiating Outputs:

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8  
☐ #9   ☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14   ☐ #15   ☐ #16  
☐ #17   ☐ #18   ☐ #19   ☐ #20   ☐ #21   ☐ #22   ☐ #23
Initiating Outputs Logic Gate: ☐ [OR]   ☐ AND

Initiating Function Pickup:

☐ 21 #1   ☐ 21 #2   ☐ 21 #3   ☐ 24DT #1   ☐ 24DT #2   ☐ 24IT   ☐ 25D  
☐ 25S   ☐ 27 #1   ☐ 27 #2   ☐ 27 #3   ☐ 27TN #1   ☐ 27TN #2   ☐ 32 #1  
☐ 32 #2   ☐ 32 #3   ☐ 40 #1   ☐ 40 #2   ☐ 40VC #1   ☐ 40VC #2   ☐ 46DT  
☐ 46IT   ☐ 49 #1   ☐ 49 #2   ☐ 50 #1   ☐ 50 #2   ☐ 50BF   ☐ 50DT #1  
☐ 50DT #2   ☐ 50N   ☐ 50/27   ☐ 51N   ☐ 51V   ☐ 59 #1   ☐ 59 #2  
☐ 59 #3   ☐ 59X #1   ☐ 59X #2   ☐ 60FL   ☐ 64B   ☐ 64F #1   ☐ 64F #2  
☐ 64S   ☐ 67N DT   ☐ 67N IT   ☐ 78   ☐ 81 #1   ☐ 81 #2   ☐ 81 #3  
☐ 81 #4   ☐ 81A #1   ☐ 81A #2   ☐ 81A #3   ☐ 81A #4   ☐ 81A #5   ☐ 81A #6  
☐ 81R #1   ☐ 81R #2   ☐ 87 #1   ☐ 87 #2   ☐ 87GD   ☐ IPSL #1   ☐ IPSL #2  
☐ IPSL #3   ☐ IPSL #4   ☐ IPSL #5   ☐ IPS #6   ☐ BM   ☐ TC

Initiating Function Timeout:

☐ 21 #1   ☐ 21 #2   ☐ 21 #3   ☐ 24DT #1   ☐ 24DT #2   ☐ 24IT   ☐ 25D  
☐ 25S   ☐ 27 #1   ☐ 27 #2   ☐ 27 #3   ☐ 27TN #1   ☐ 27TN #2   ☐ 32 #1  
☐ 32 #2   ☐ 32 #3   ☐ 40 #1   ☐ 40 #2   ☐ 40VC #1   ☐ 40VC #2   ☐ 46DT  
☐ 46IT   ☐ 49 #1   ☐ 49 #2   ☐ 50 #1   ☐ 50 #2   ☐ 50BF   ☐ 50DT #1  
☐ 50DT #2   ☐ 50N   ☐ 50/27   ☐ 51N   ☐ 51V   ☐ 59 #1   ☐ 59 #2  
☐ 59 #3   ☐ 59X #1   ☐ 59X #2   ☐ 60FL   ☐ 64B   ☐ 64F #1   ☐ 64F #2  
☐ 64S   ☐ 67N DT   ☐ 67N IT   ☐ 78   ☐ 81 #1   ☐ 81 #2   ☐ 81 #3  
☐ 81 #4   ☐ 81A #1   ☐ 81A #2   ☐ 81A #3   ☐ 81A #4   ☐ 81A #5   ☐ 81A #6  
☐ 81R #1   ☐ 81R #2   ☐ 87 #1   ☐ 87 #2   ☐ 87GD   ☐ IPSL #1   ☐ IPSL #2  
☐ IPSL #3   ☐ IPSL #4   ☐ IPSL #5   ☐ IPS #6   ☐ BM   ☐ TC
Initiating Function Pickup/Timeout Logic Gate: ☐ [OR]   ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None]   ☐ NOT

Initiating Inputs:

☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14
Initiating Inputs Logic Gate: ☐ [OR]   ☐ ANDInitiate via Communication Point: ☐

Blocking Inputs:

☐ FL   ☐ #1   ☐ #2   ☐ #3   ☐ #4   ☐ #5   ☐ #6   ☐ #7   ☐ #8   ☐ #9  
☐ #10   ☐ #11   ☐ #12   ☐ #13   ☐ #14
*Figure A-3   System Setpoints and Settings (page 32 of 38)*

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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #3 (Cont.'d)**Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Outputs/Function Pickup/Function Timeout and Initiating Inputs  
Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]**IPSLLogic #4** ☐ Disable ☐ Enable

Initiating Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Initiating Outputs Logic Gate: ☐ [OR] ☐ AND

Initiating Function Pickup:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Figure A-3 System Setpoints and Settings (page 33 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLogic #4 (Cont.'d)**


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Initiating Function Timeout:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Pickup/Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None] ☐ NOT

Initiating Inputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Initiating Inputs Logic Gate: ☐ [OR] ☐ ANDInitiate via Communication Point: ☐

Blocking Inputs:

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ AND

Initiating Outputs/Function Pickup/Function Timeout and Initiating Inputs

Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]

Figure A-3 System Setpoints and Settings (page 34 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #5** ☐ Disable ☐ Enable

Initiating Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Initiating Outputs Logic Gate: ☐ [OR] ☐ AND

Initiating Function Pickup:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Timeout:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC
Initiating Function Pickup/Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None] ☐ NOT

Initiating Inputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14
Initiating Inputs Logic Gate: ☐ [OR] ☐ ANDInitiate via Communication Point: ☐

Blocking Inputs:

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Figure A-3 System Setpoints and Settings (page 35 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #5 (Cont.'d)**Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Outputs/Function Pickup/Function Timeout and Initiating Inputs  
Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]**IPSLLogic #6** ☐ Disable ☐ Enable

Initiating Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23
Initiating Outputs Logic Gate: ☐ [OR] ☐ AND

Initiating Function Pickup:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Figure A-3 System Setpoints and Settings (page 36 of 38)



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**System Setpoints and Settings (Cont.'d)**


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**IPSLLogic #6 (Cont.'d)**


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Initiating Function Timeout:

☐ 21 #1    ☐ 21 #2    ☐ 21 #3    ☐ 24DT #1    ☐ 24DT #2    ☐ 24IT    ☐ 25D  
☐ 25S    ☐ 27 #1    ☐ 27 #2    ☐ 27 #3    ☐ 27TN #1    ☐ 27TN #2    ☐ 32 #1  
☐ 32 #2    ☐ 32 #3    ☐ 40 #1    ☐ 40 #2    ☐ 40VC #1    ☐ 40VC #2    ☐ 46DT  
☐ 46IT    ☐ 49 #1    ☐ 49 #2    ☐ 50 #1    ☐ 50 #2    ☐ 50BF    ☐ 50DT #1  
☐ 50DT #2    ☐ 50N    ☐ 50/27    ☐ 51N    ☐ 51V    ☐ 59 #1    ☐ 59 #2  
☐ 59 #3    ☐ 59X #1    ☐ 59X #2    ☐ 60FL    ☐ 64B    ☐ 64F #1    ☐ 64F #2  
☐ 64S    ☐ 67N DT    ☐ 67N IT    ☐ 78    ☐ 81 #1    ☐ 81 #2    ☐ 81 #3  
☐ 81 #4    ☐ 81A #1    ☐ 81A #2    ☐ 81A #3    ☐ 81A #4    ☐ 81A #5    ☐ 81A #6  
☐ 81R #1    ☐ 81R #2    ☐ 87 #1    ☐ 87 #2    ☐ 87GD    ☐ IPSL #1    ☐ IPSL #2  
☐ IPSL #3    ☐ IPSL #4    ☐ IPSL #5    ☐ IPS #6    ☐ BM    ☐ TC

Initiating Function Pickup/Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Function Pickup/Timeout Logic Gate: ☐ [None] ☐ NOT

Initiating Inputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Initiating Inputs Logic Gate: ☐ [OR] ☐ ANDInitiate via Communication Point: ☐

Blocking Inputs:

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

Blocking Inputs Logic Gate: ☐ [OR] ☐ ANDBlock via Communication Point: ☐Initiating Outputs/Function Pickup/Function Timeout Logic Gate: ☐ [OR] ☐ ANDInitiating Outputs/Function Pickup/Function Timeout and Initiating Inputs  
Logic Gate: ☐ [OR] ☐ AND

Delay: \_\_\_\_\_ 1–8160 (Cycles) [30]

Reset/Dropout Delay: \_\_\_\_\_ 0–65500 (Cycles) [30] ☐ [Reset] ☐ Dropout

Outputs:

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

Profile Switch: ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ [Not Activated]

Figure A-3 System Setpoints and Settings (page 37 of 38)

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**System Setpoints and Settings (Cont.'d)**


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**BM – Breaker Monitor****BM** ☐ Disable ☐ Enable

Pickup: \_\_\_\_\_ 0–5000 (kA Cycles) [0]

Time Delay: \_\_\_\_\_ 0.1 – 4095.9 (Cycles) [3.0]

Timing Method Selection ☐ [IT] ☐ I<sup>2</sup>T

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  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

**Outputs:**

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

**Input Initiate:**

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8    ☐ #9  
☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**Blocking Inputs:**

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

**TC – Trip Circuit Monitoring****TC** ☐ Disable ☐ Enable

Time Delay: \_\_\_\_\_ 1 – 8160 (Cycles) [30]

**I/O Selection:****Outputs**

☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14    ☐ #15    ☐ #16  
☐ #17    ☐ #18    ☐ #19    ☐ #20    ☐ #21    ☐ #22    ☐ #23

**Blocking Inputs**

☐ FL    ☐ #1    ☐ #2    ☐ #3    ☐ #4    ☐ #5    ☐ #6    ☐ #7    ☐ #8  
☐ #9    ☐ #10    ☐ #11    ☐ #12    ☐ #13    ☐ #14

*Figure A-3 System Setpoints and Settings (page 38 of 38)*

# B Communications

The M-3425A Generator Protection Relay incorporates three serial ports and an optional RJ45 Ethernet port for intelligent, digital communication with external devices. Equipment such as RTU's, data concentrators, modems, 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 optional M-3931 Human-Machine Interface module is accessible remotely through the BECO 2200 or MODBUS data exchange protocol. These protocol documents and the database-specific protocol document are available from the factory or from our website at [www.beckwithelectric.com](http://www.beckwithelectric.com).

The S-3400 IPScom® Communication Software package has been supplied for communication to any IBM compatible computer running under Microsoft® Windows 2000 or higher.

The communication protocols implement 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 relay 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; valid selections are 8,N,2; 8,O,1; 8,E,1; 8,N,1; 8,O,2 or 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 on IPScom communications, refer to **Chapter 3, IPScom**.

## Serial 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).

The RJ45 port can also be purchased in a RS-485 configuration. Utilizing a RJ45 Breakout Adapter the RJ45 port supports 2 wire RS-485 and the DNP3.0 protocol.

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.

## Optional Ethernet Port

The M-3425A, when equipped with the optional Ethernet port can be accessed from a local network with up to 3 concurrent sessions. When the ethernet port is enabled, the COM2 serial port (RS-232) is unavailable for communications. The demodulated IIRIG-B may still be used via the COM2 Port when ethernet is enabled. Although the ethernet connection speed is faster than the RS-232 port (can be up to 10 Mbps), the ethernet module connects internally through the COM2 serial connection and is therefore limited to connection speeds up to 9600 bps.

Either port COM2 (Ethernet) or COM3 may be used to remotely set and interrogate the relay using a local area network, modem or other direct serial connection.

Signal		COM1	COM2
RX	Receive Data	Pin 2	Pin 2
TX	Transmit Data	Pin 3	Pin 3
RTS	Request to Send	Pin 7	Pin 7
CTS	Clear to Send		Pin 8
DTR	Data Terminal Ready	Pin 4	Pin 4
DCD	Data Carrier Detect		Pin 1*
GND	Signal Ground	Pin 5	Pin 5
+15 V			Pin 1*
-15 V			Pin 9*
TTL IRIG-B (+)			Pin 6*
* Optional: See Section 5.5, Circuit Board Switches and Jumpers. $\pm 15$ V ( $\pm 15\%$ ) @ 100 mA maximum.			

Table B-1 Communication Port Signals

■ **NOTE:** Also see Tables 5-1, 5-2 and Figure 5-14.

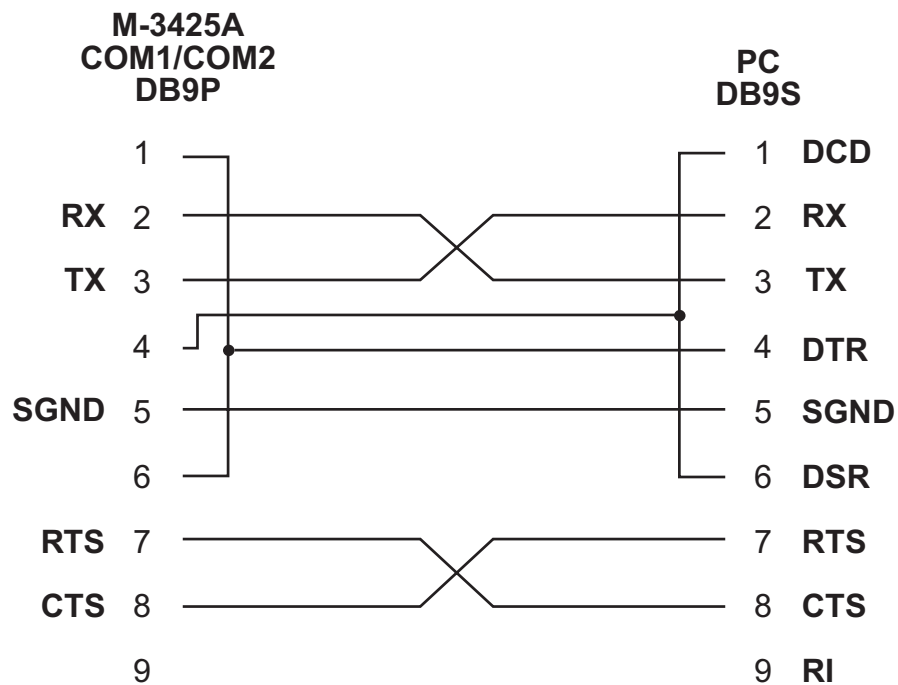


Figure B-1 Null Modem Cable: M-0423

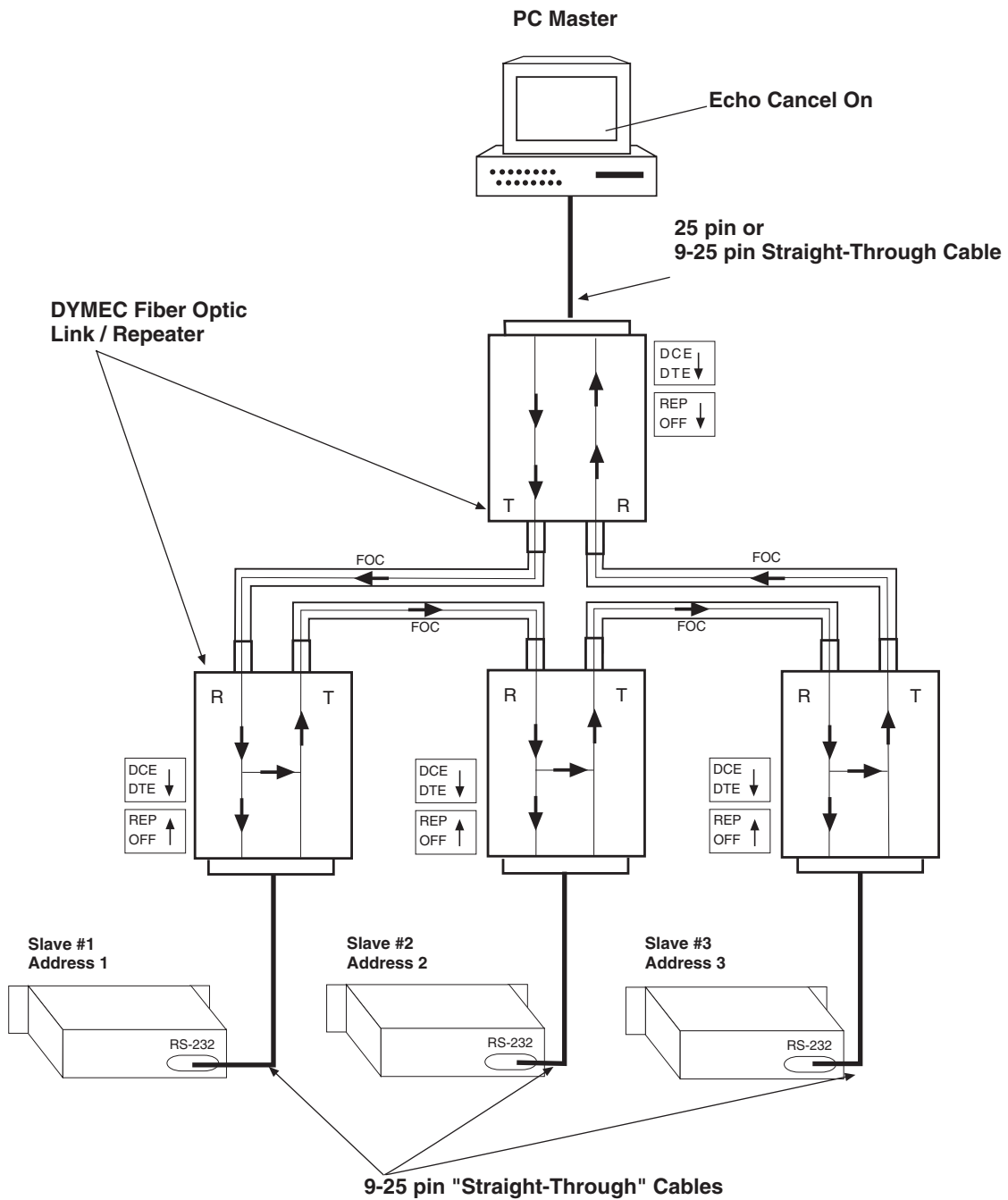


Figure B-2 RS-232 Fiber Optic Network

## COM2 RJ45 Isolated RS-485 2-Wire Network (DNP 3.0 Protocol)

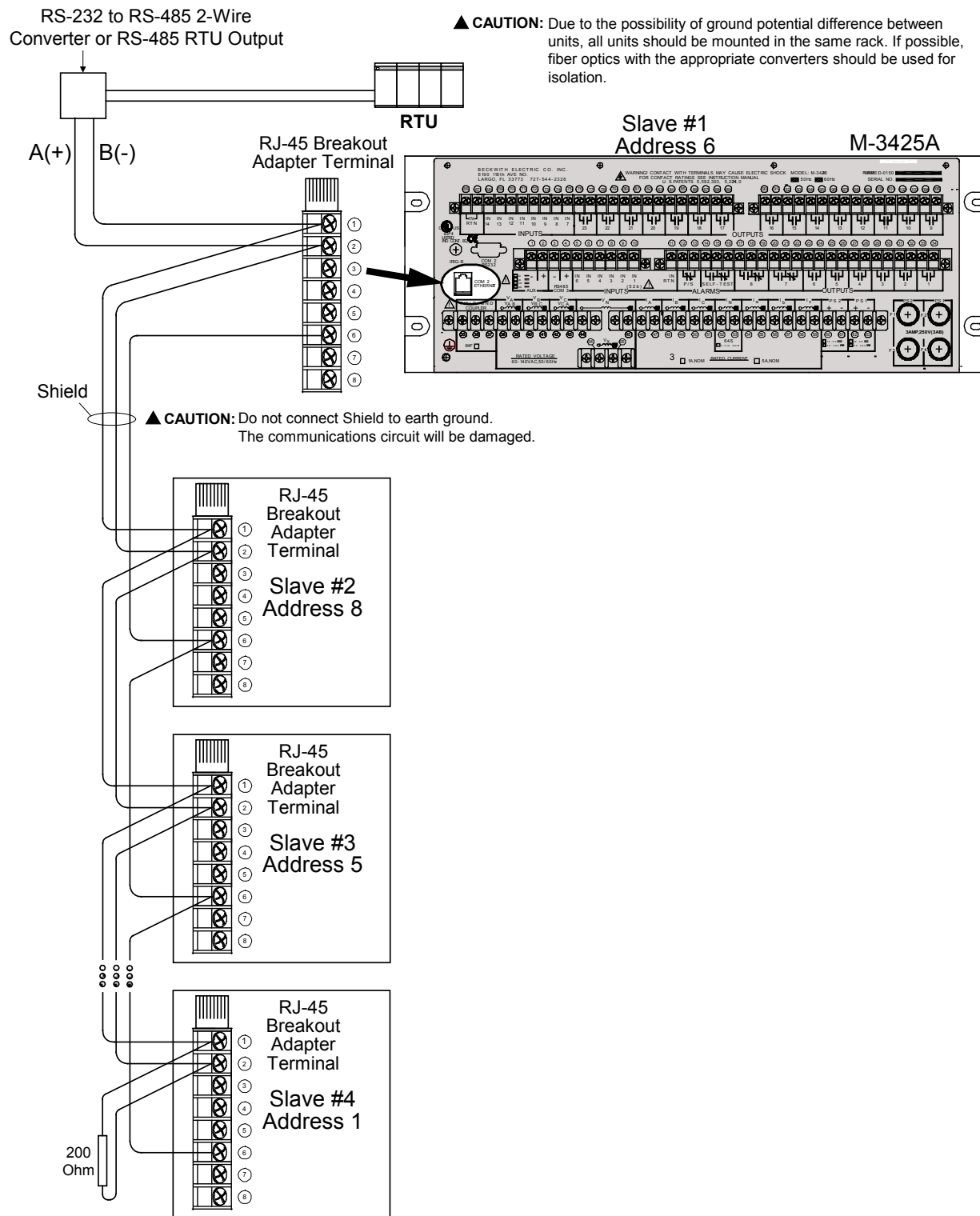
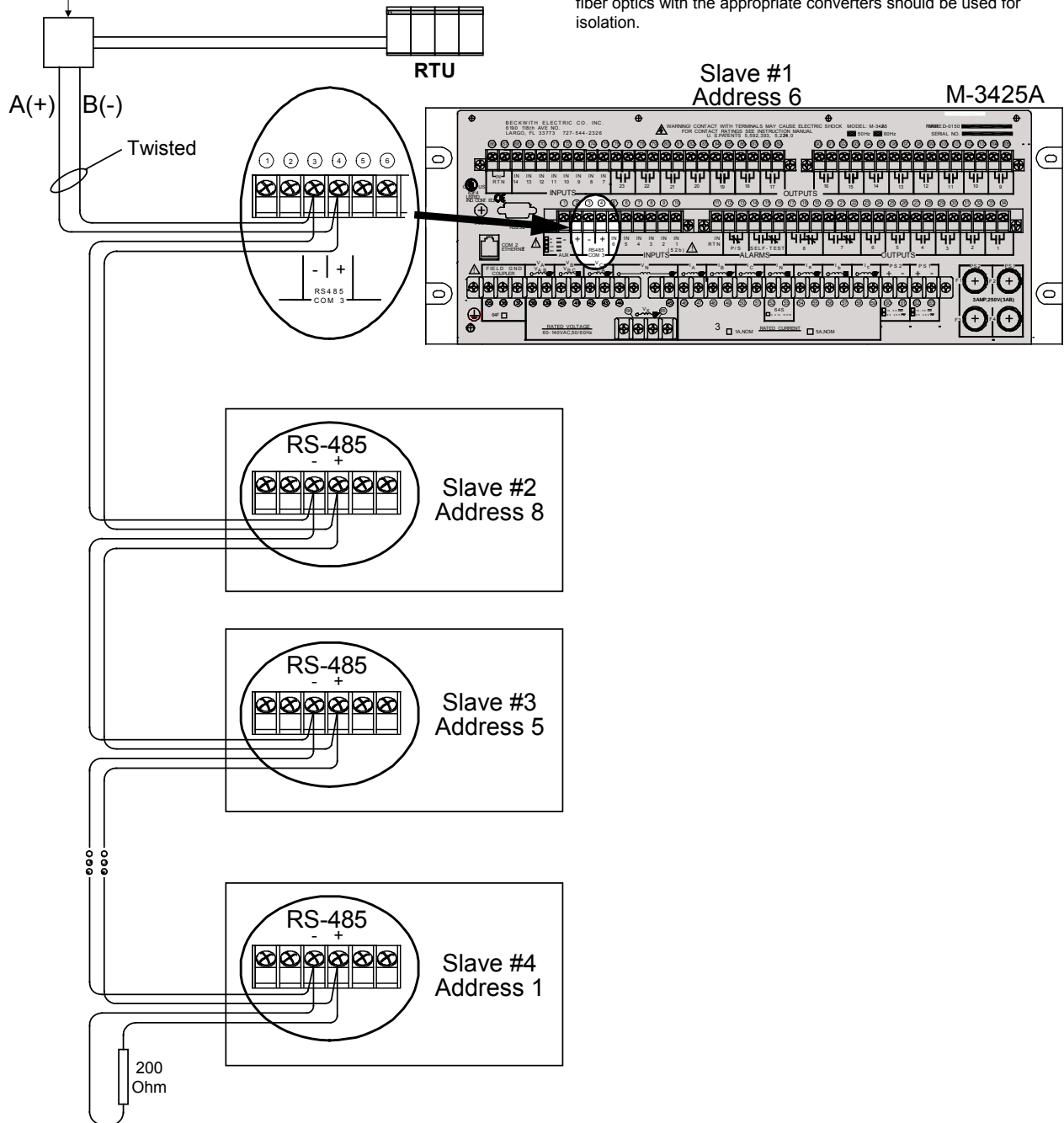


Figure B-3 COM2 RS-485 2-Wire Network DNP

## COM3 RS-485 2-Wire Network (MODBUS or BECO 2200 Protocol)

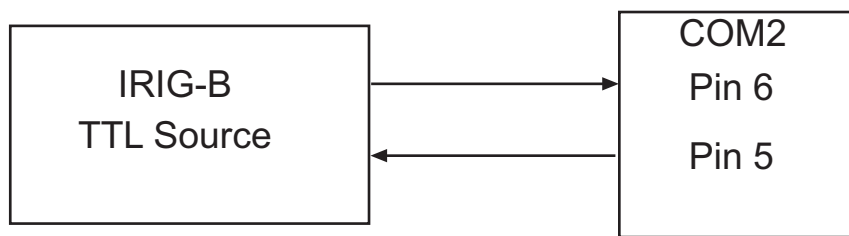
RS-232 to RS-485 2-Wire  
Converter or RS-485 RTU Output

▲ **CAUTION:** Due to the possibility of ground potential difference between units, all units should be mounted in the same rack. If 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 jumper internal to the unit. See Section 5.5, Circuit Board Switches and Jumpers.

Figure B-4 COM3 RJ45 RS-485 2-Wire Network MODBUS



*Figure B-5 COM Pinout for Demodulated TTL Level Signal*



# C

## Self-test Error Codes

1		28	WARNING low battery (BBRAM) warning
2	Battery backed RAM test fail	29	Supply/mux PGA running test fail
3	EEPROM write power-up fail	30	External DSP RAM test fail
4	EEPROM read back power-up fail	31	Unrecognized INT1 code
5	Dual port RAM test fail	32	Values update watchdog fail
6	EEPROM write calibration checksum fail	33	Abort Error
7	EEPROM write setpoint checksum fail loss of power	34	Restart Error
8	EEPROM write setpoint checksum fail loss of battery backed RAM	35	Interrupt Error
9	DMA checksum/physical block fail	36	Trap Error
10	Oscillograph Memory Test fail	37	Calibration running check fail
11	DSP external program RAM fail	38	Ethernet Board not running (Warning)
12	DSP A/D convert fail	39	Not used
13	DSP ground channel fail	40	Interrupt noise INT2
14	DSP reference channel fail	41	Interrupt noise INT1
15	DSP PGA gain fail	42	Not used
16	DSP DSP<-> HOST interrupt 1 fail	43	Not used
17	DSP DSP -> HOST interrupt 2 set fail	44	Oscillograph buffer overflow
18	DSP DSP -> HOST interrupt 2 reset fail	45	Oscillograph buffer underflow
19	DSP program load fail	46	Failure of DSP to calculate calibration phasors
20	DSP not running run mode code	47	Unable to calibrate input (gain)
21	DSP not running primary boot code	48	Unable to calibrate input (phase)
22	DSP DPRAM pattern test fail	49	Not used
23	EEPROM write verify error	50	Stack Overflow
26	WARNING calibration checksum mismatch warning	51	Setpoint Write Overflow
27	WARNING setpoint checksum mismatch warning	52	Field Ground Error

Table C-1 Self-Test Error Codes

Error Code	Description
Comm Channel Lock	An incorrect pass word supplied to the control will result in this message.
Control in Local Mode	This message indicates that the control is being operated locally and serial communication is suspended.
Echo Timeout	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Invalid Data	This error results if incorrect or out-of-range data is entered.
Invalid ID	This message is displayed when attempting to communicate with a device other than the M-3425 series.
Invalid Number of Points	This error results if an incompatible version of IPScom software is used. This is a communication protocol error. Contact a Beckwith Electric Co. factory representative.
Invalid Point Number	This error results if an incompatible version of IPScom software is used. This is a communication protocol error. Contact a Beckwith Electric Co. factory representative.
Read Invalid Checksum	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Read Packet Timeout	This error results when communication with the control is lost while attempting to read data to the control.
Response Timeout	This error results when communication with the control is lost while attempting to read data from the control.
Unknown System Error	This error could be caused by a malfunction of the control.
User Cancel	This message displays when the escape (ESC) key is pressed.
Write Invalid Checksum	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Write Packet Timeout	This error results when communication with the control is lost while attempting to write data to the control.

Table C-2 IPScom® Error Messages

# D Inverse Time Curves

This Appendix contains two sets of Inverse Time Curve Families. The first set is used for Volts per Hertz functions ([Figure D-1](#) through [Figure D-4](#)), and the second set is for the M-3425A functions which utilize the Inverse Time Overcurrent curves ([Figure D-5](#) through [Figure D-15](#)).

■ **NOTE:** [Table D-1A](#) and [Table D-1B](#) contain a list of the data that characterizes Definite Time, Inverse Time, Very Inverse Time, and Extremely Inverse Time Overcurrent Curves.

## Expression for Time Delay Setting Operating time defined by IEC and ANSI/IEEE:

$$t = TD \left[ \frac{A}{M^p - 1} \right]$$

IEC Equation

$$t = \frac{TD}{5} \left[ \frac{A}{M^p - 1} + B \right]$$

IEEE Equation (IEEE Equation Constants are defined at TD of 5)

Where

t = Relay operating time in seconds

TD = Time dial, or time multiplier setting

I = Fault current level in secondary amps

$I_p$  = Tap or pickup current selected

B = Constant

p = Slope constant

A = Slope constant

$$M = \frac{I}{I_p}$$

Setting Time Delay on Overcurrent Relays ANSI/IEEE and IEC Constants for Overcurrent Relays

IDMT Curve Description	Standard	p	A	B
Moderately Inverse	IEEE	0.02	0.0515	0.114
Very Inverse	IEEE	2	19.61	0.491
Extremely Inverse	IEEE	2	28.2	0.1217
Standard Inverse	IEC	0.02	0.14	-
Very Inverse	IEC	1.0	13.5	-
Extremely Inverse	IEC	2.0	80.0	-

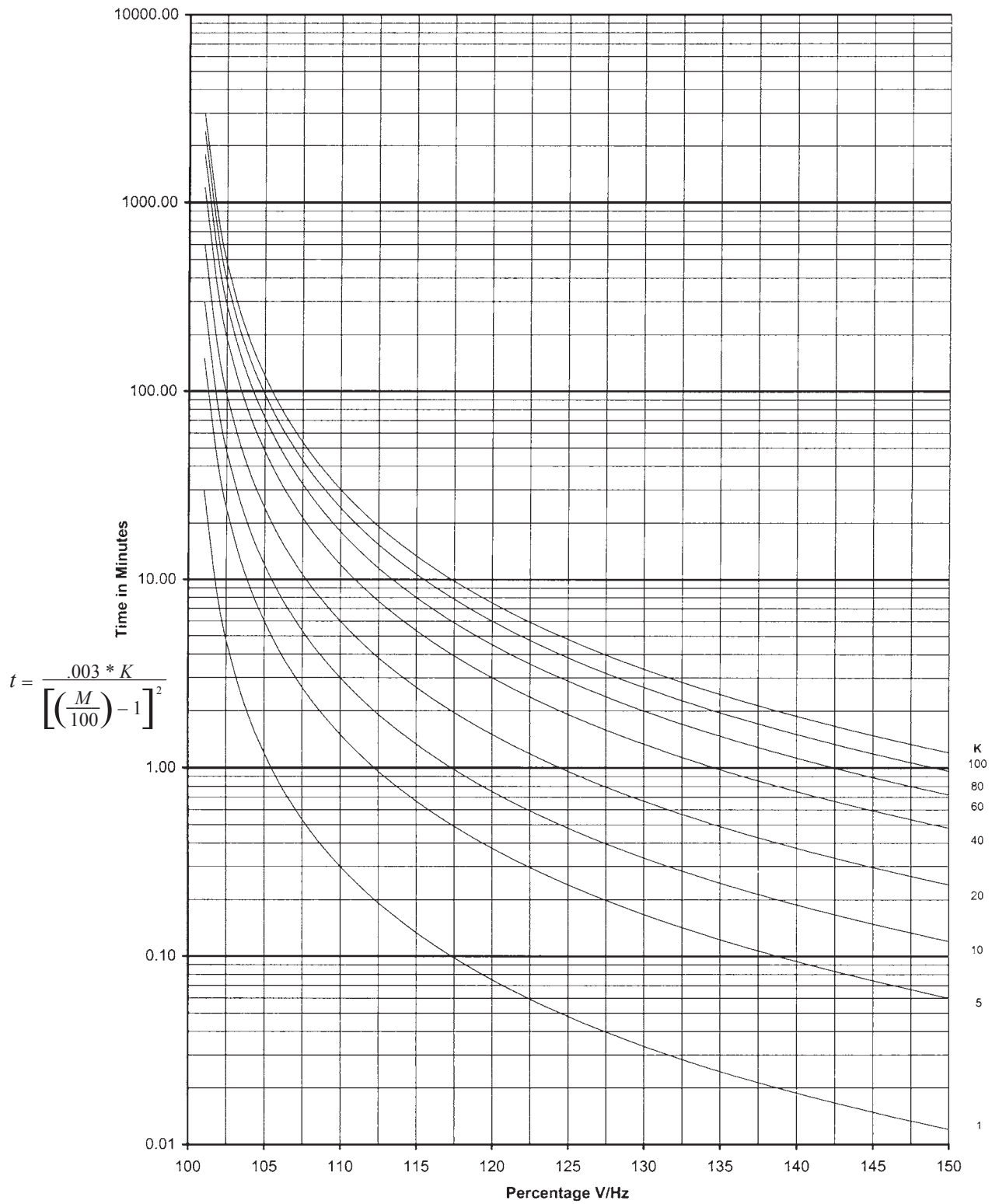


Figure D-1 Volts/Hz (24) Inverse Curve Family #1 (Inverse Square)

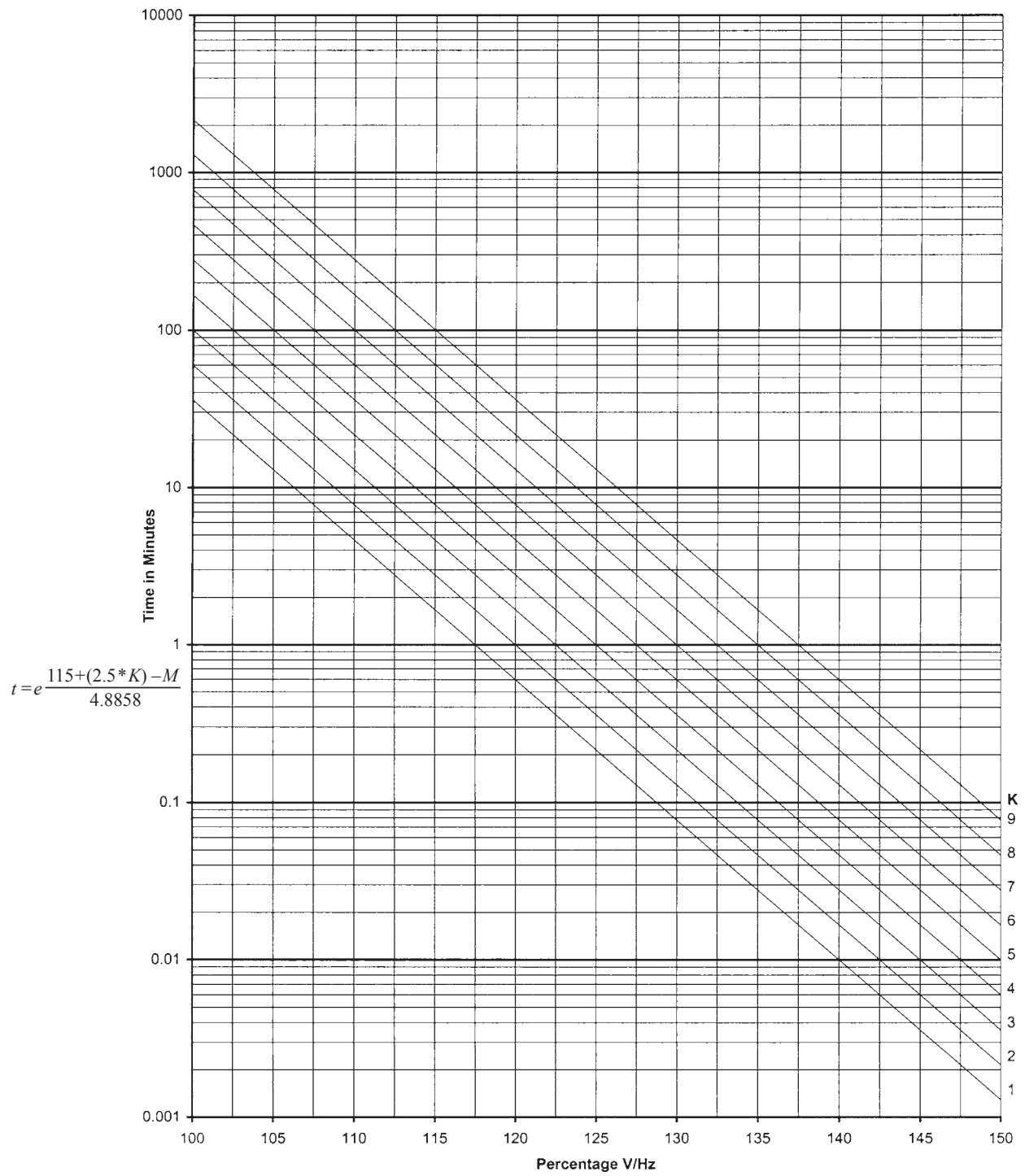


Figure D-2 Volts/Hz (24) Inverse Family Curve #2

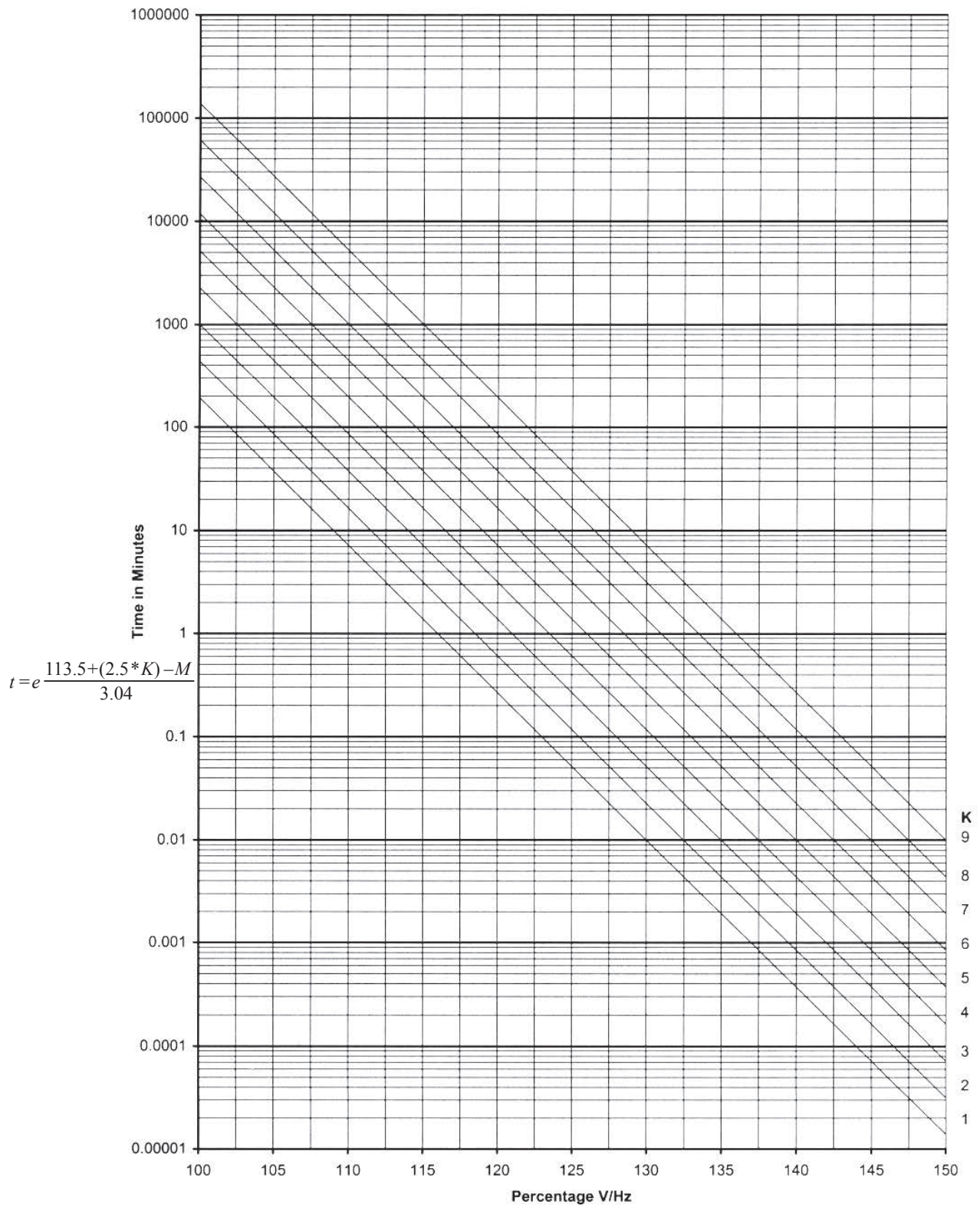


Figure D-3 Volts/Hz (24IT) Inverse Curve Family #3

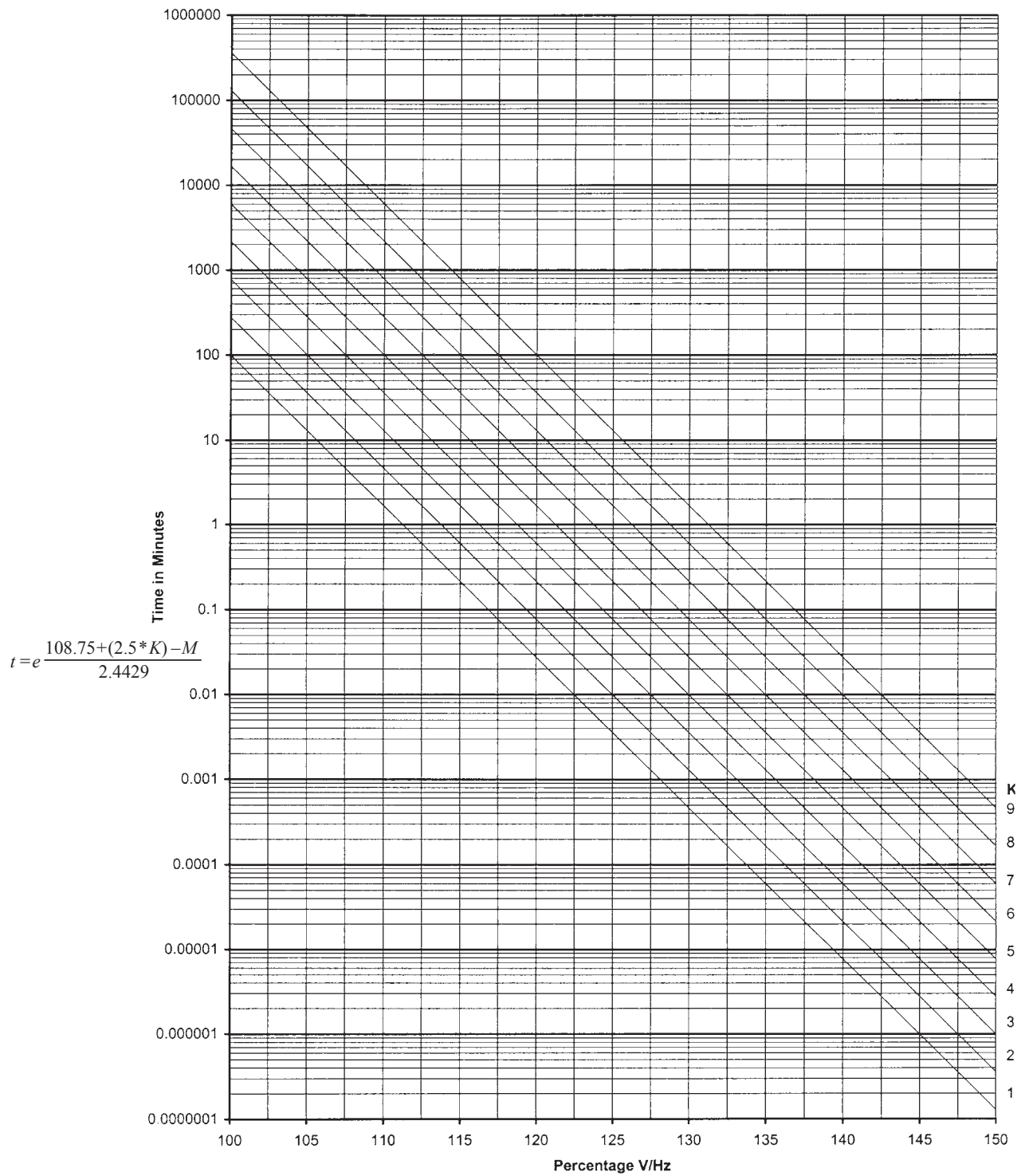


Figure D-4 Volts/Hz (24IT) Inverse Curve Family #4

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
5.20	0.23029	0.39078	0.23269	0.24343
5.40	0.22834	0.37495	0.22254	0.22660

■ **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-3425A Inverse Time Overcurrent Relay Characteristic Curves (1 of 2)*



Multiple of Tap Setting	Definite Time	Inverse Time	Very Inverse Time	Extremely Inverse Time
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-3425A Inverse Time Overcurrent Relay Characteristic Curves (2 of 2)*

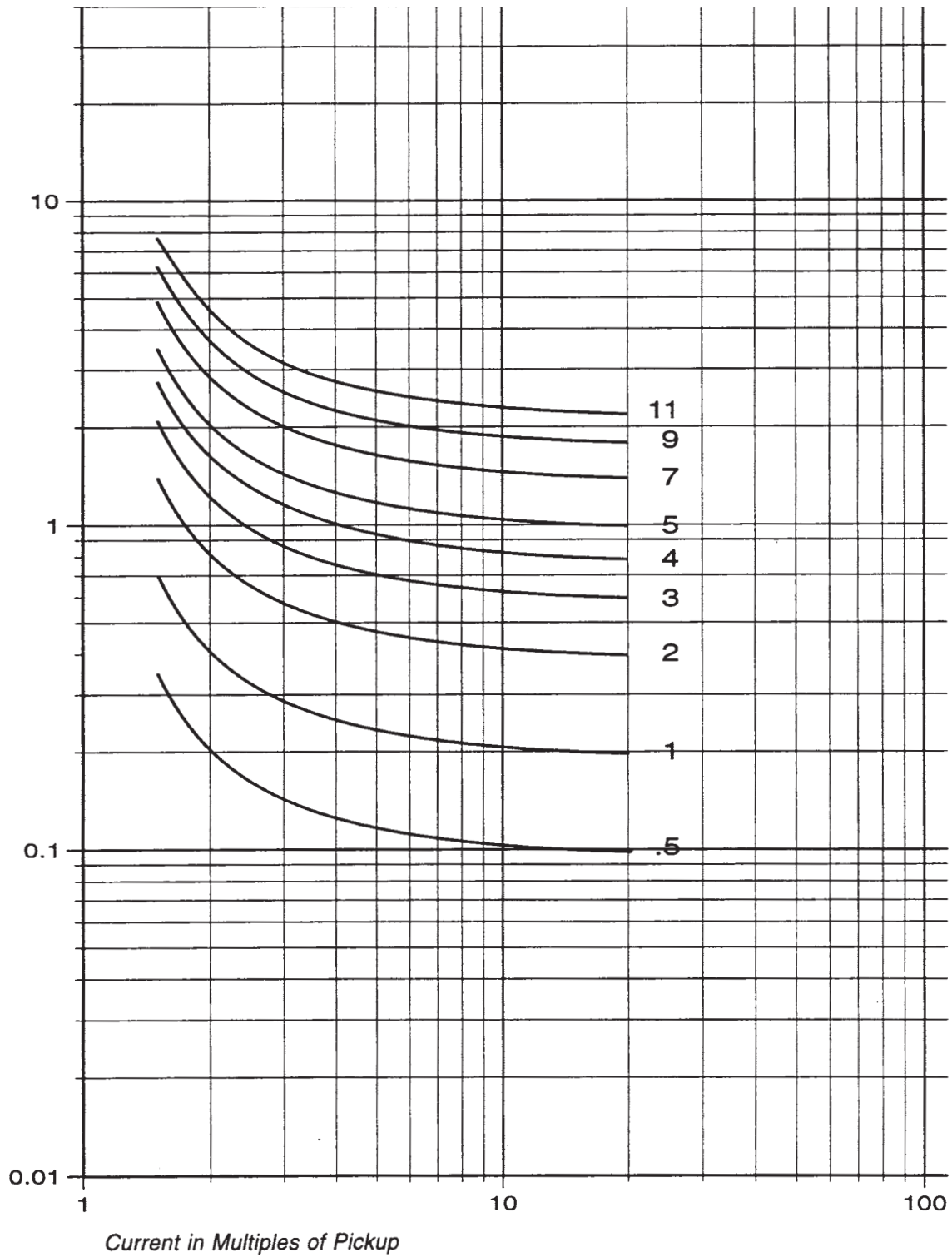


Figure D-5 BECO Definite Time Overcurrent Curve

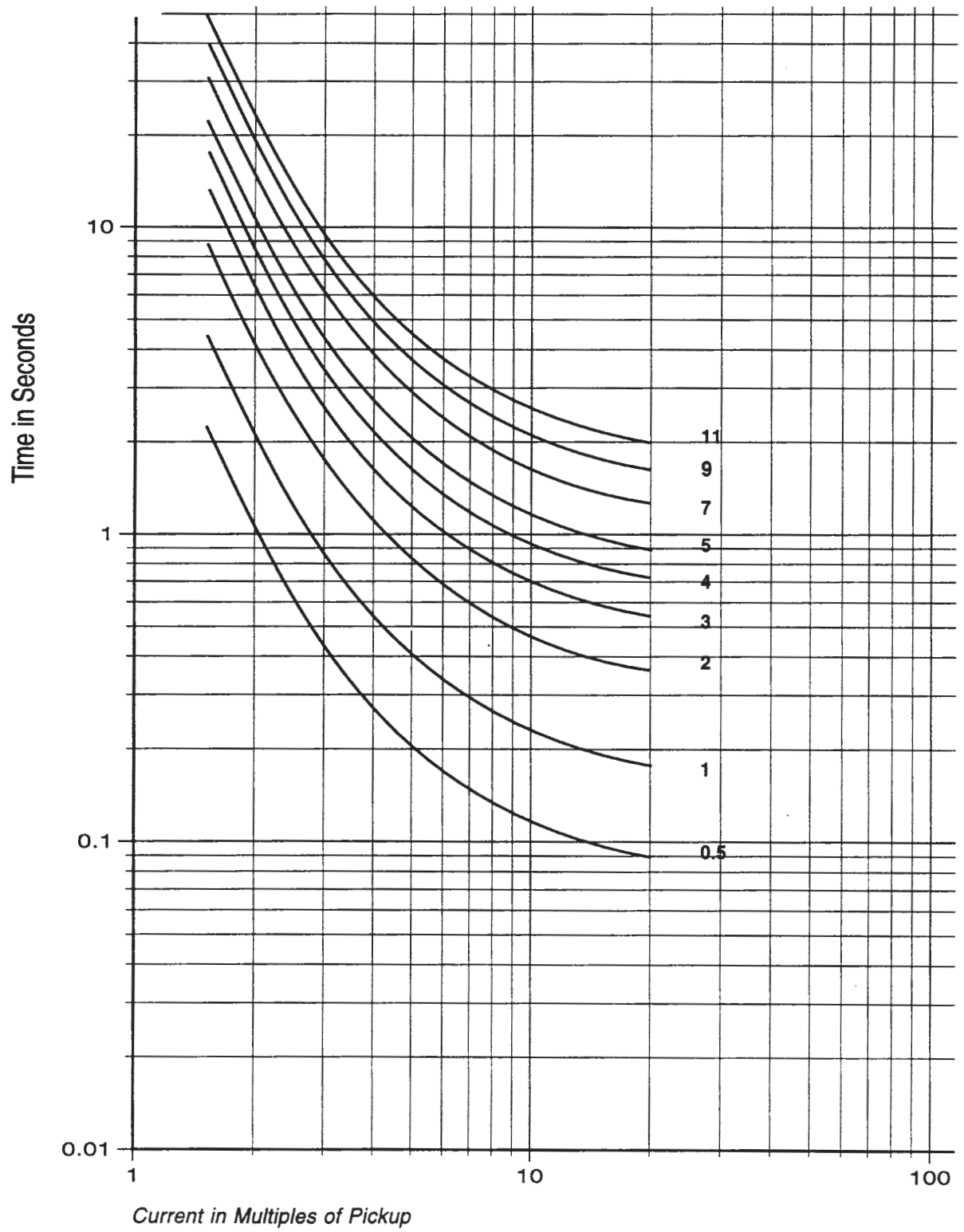


Figure D-6 BECO Inverse Time Overcurrent Curve

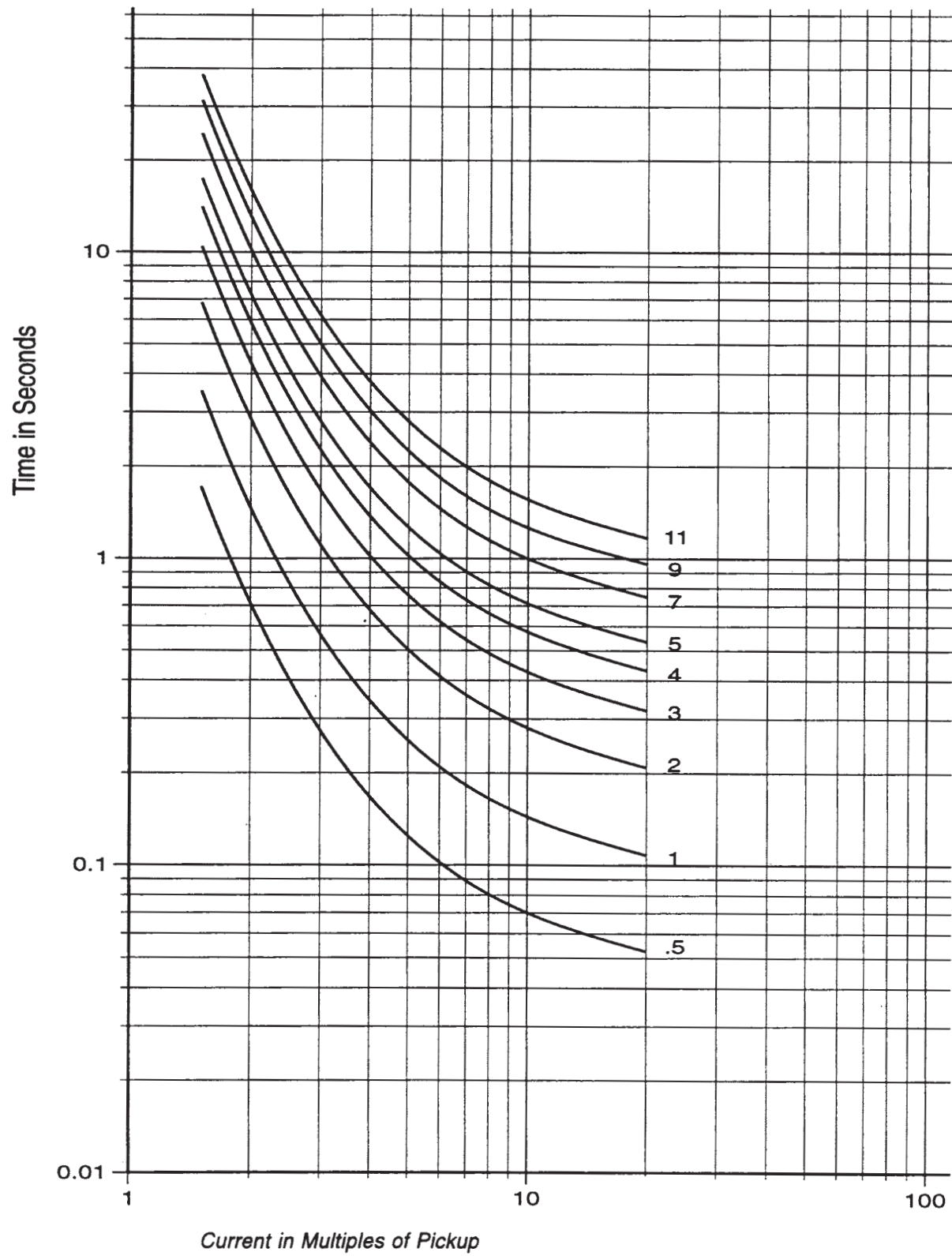


Figure D-7 BECO Very Inverse Time Overcurrent Curve

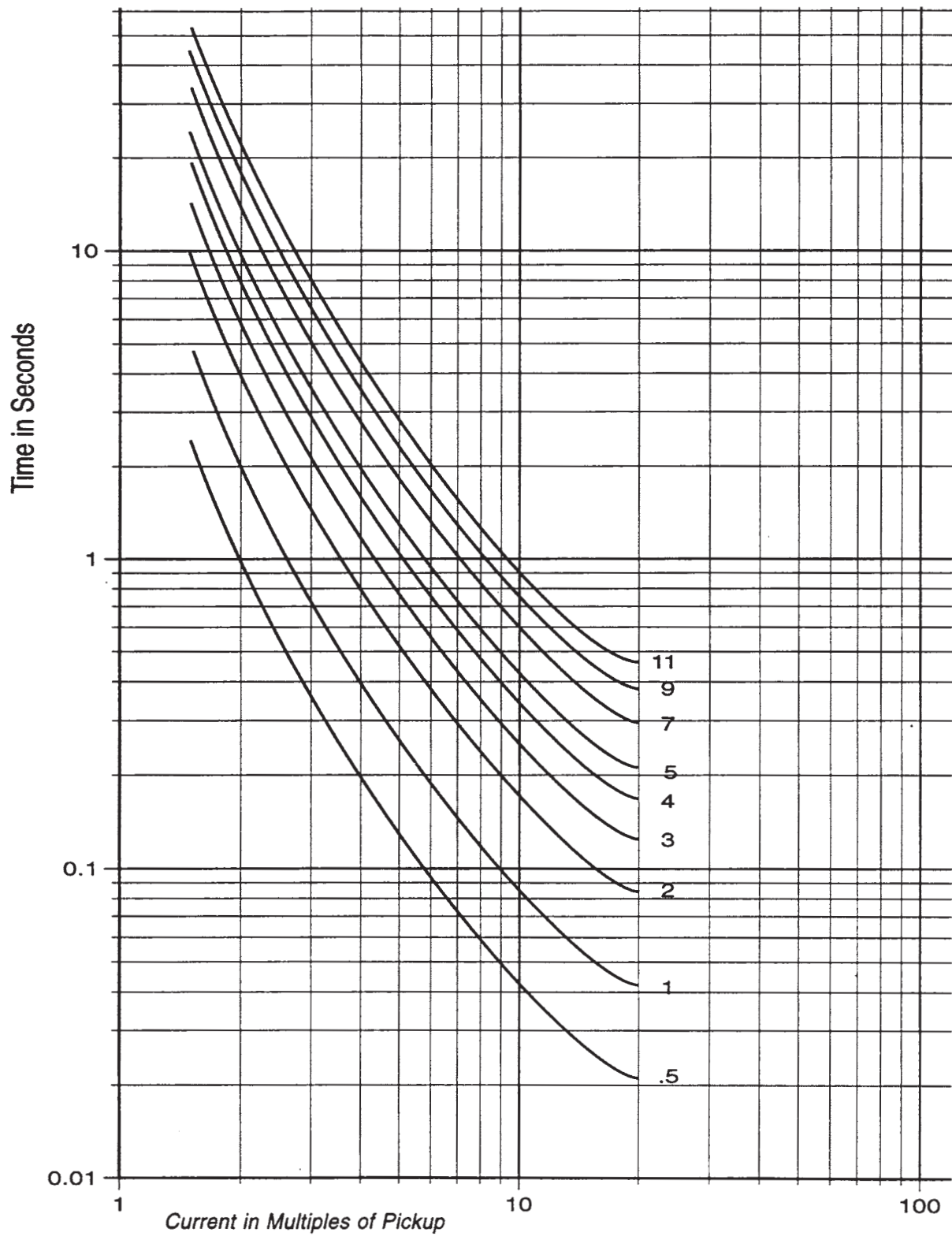
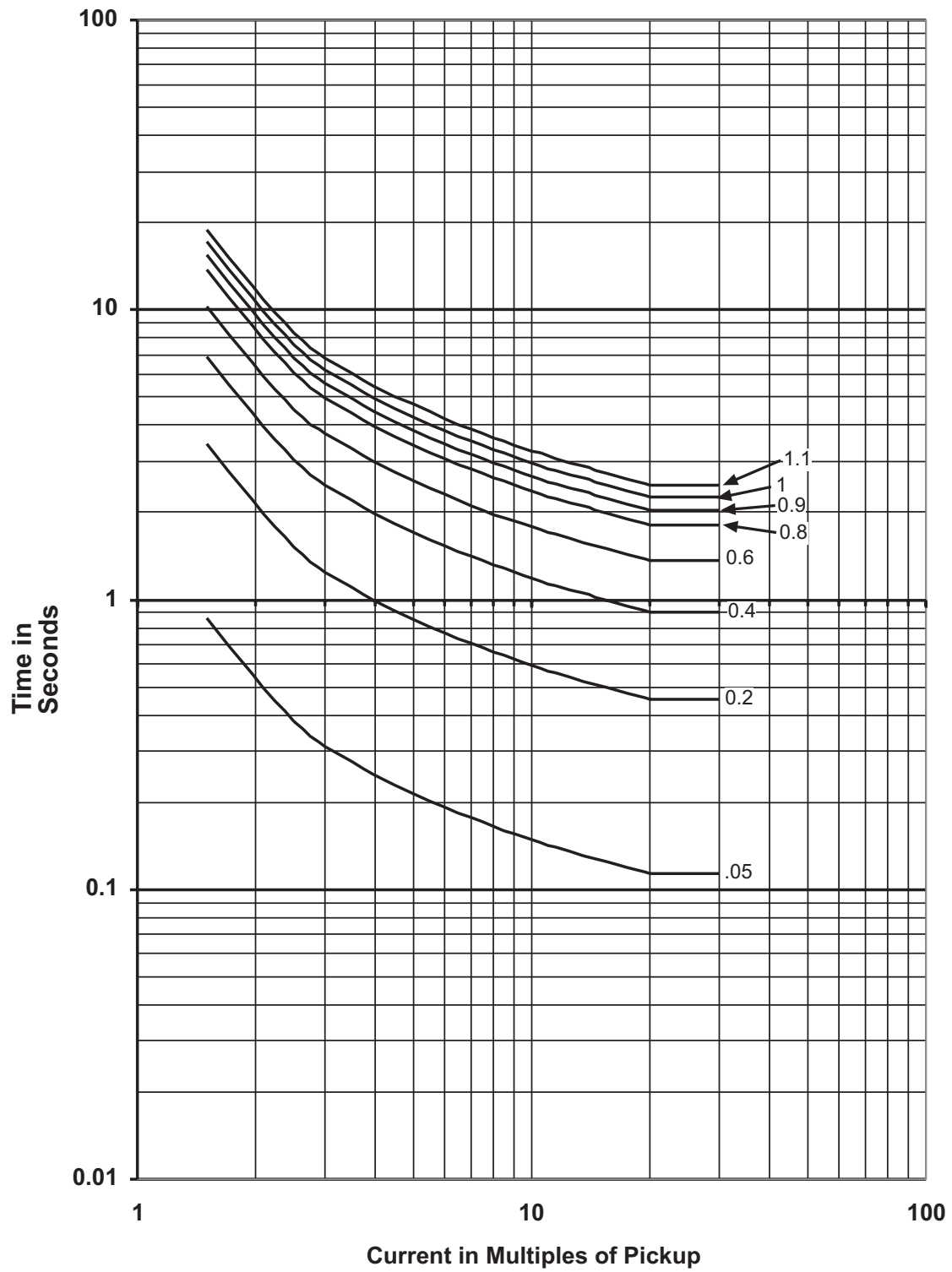
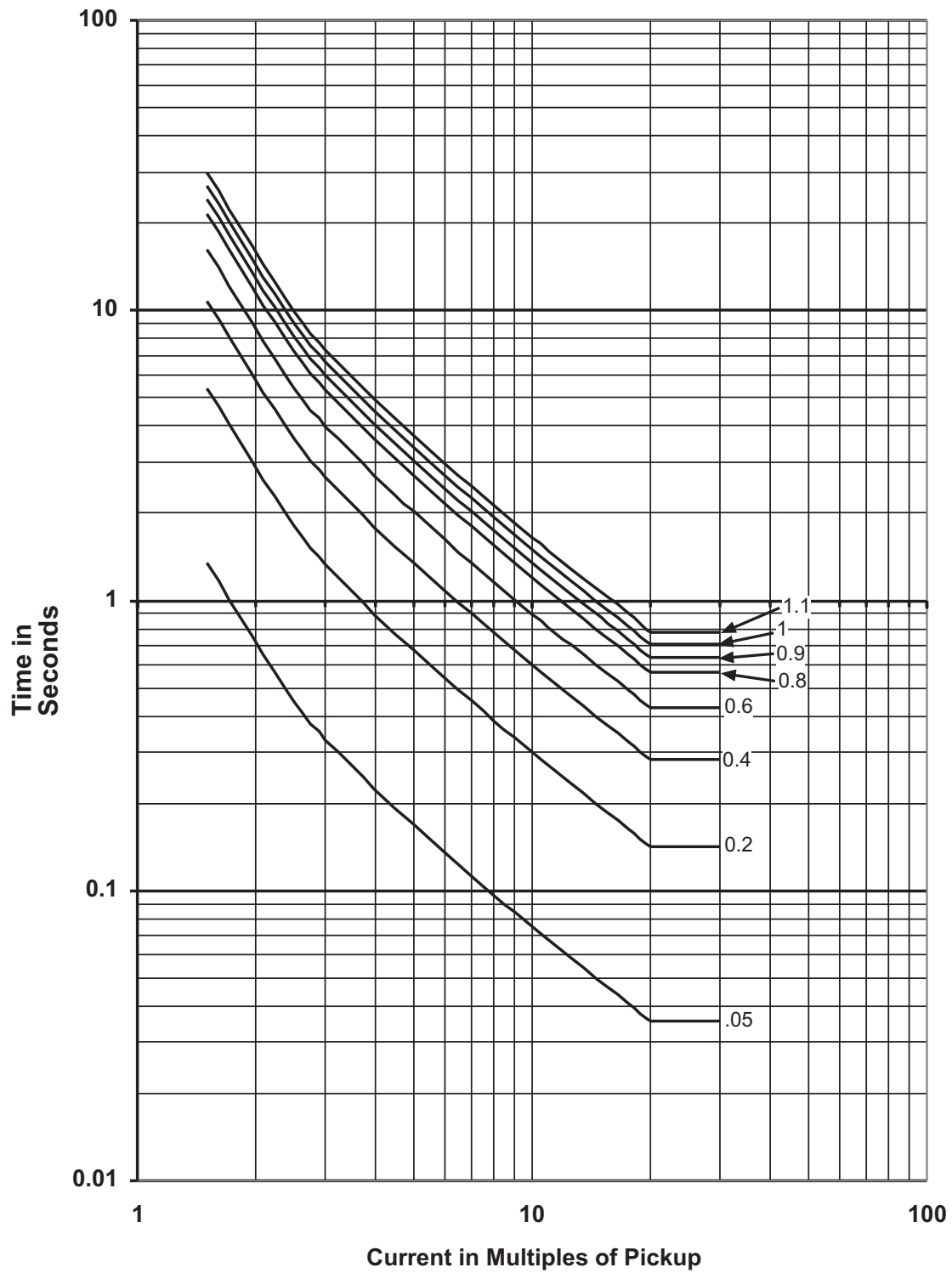


Figure D-8 BECO Extremely Inverse Time Overcurrent Curve



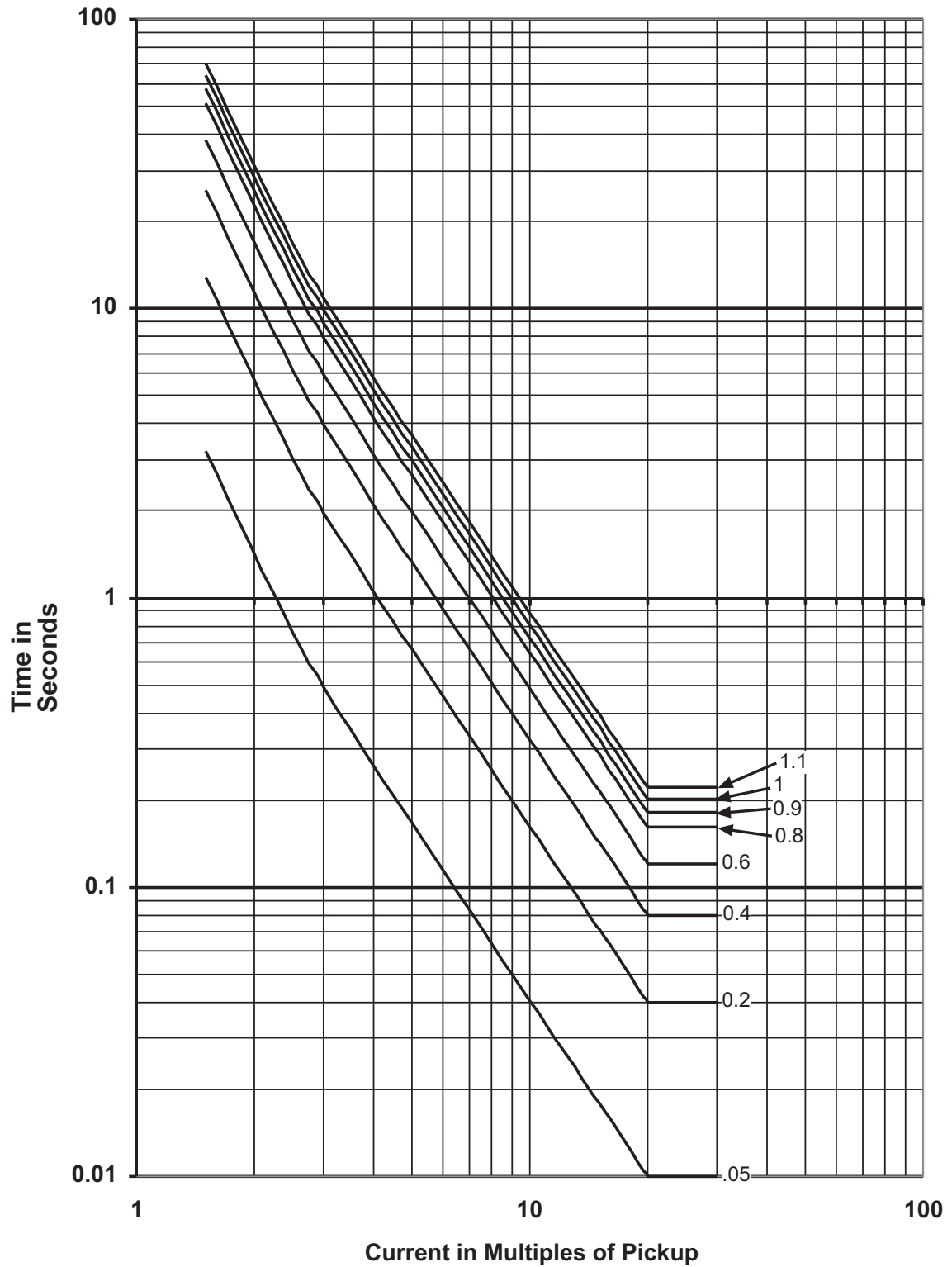
$$t = TD \times \left[ \frac{0.14}{M^{0.02} - 1} \right]$$

Figure D-9 IEC Curve #1 Inverse



$$t = TD \times \left[ \frac{13.5}{M - 1} \right]$$

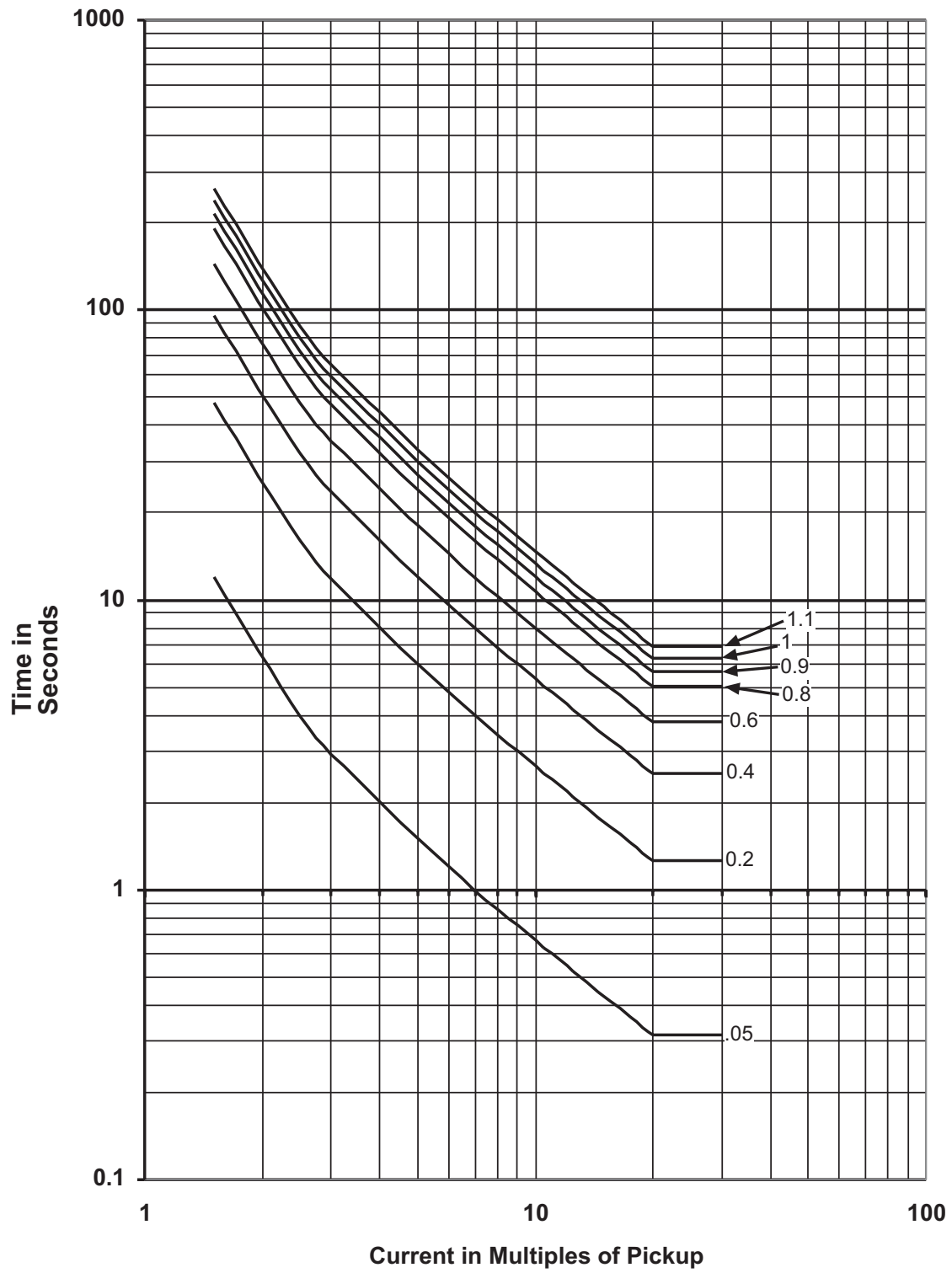
Figure D-10 IEC Curve #2 Very Inverse



$$t = TD \times \left[ \frac{80}{M^2 - 1} \right]$$

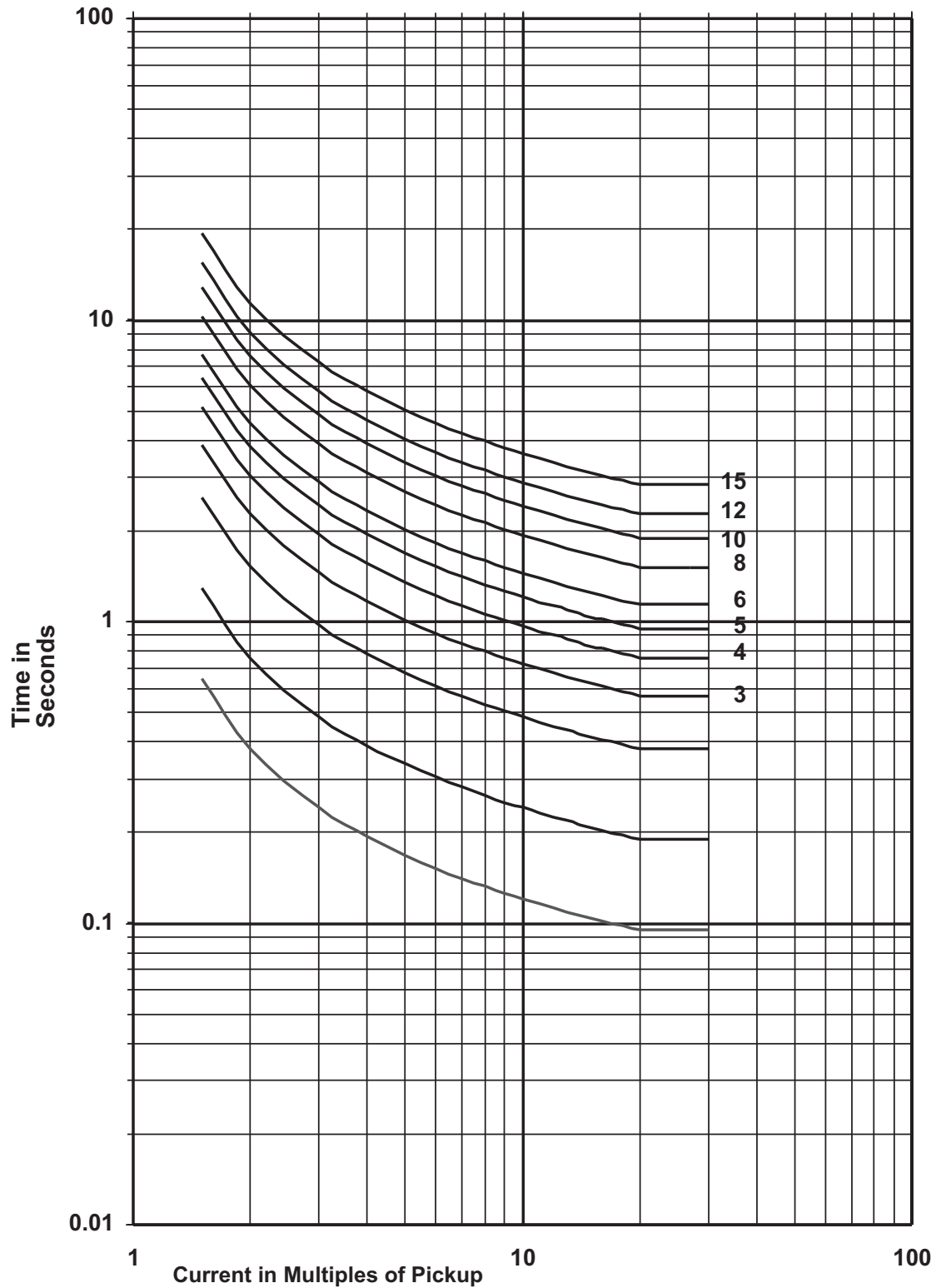
Figure D-11 IEC Curve #3 Extremely Inverse





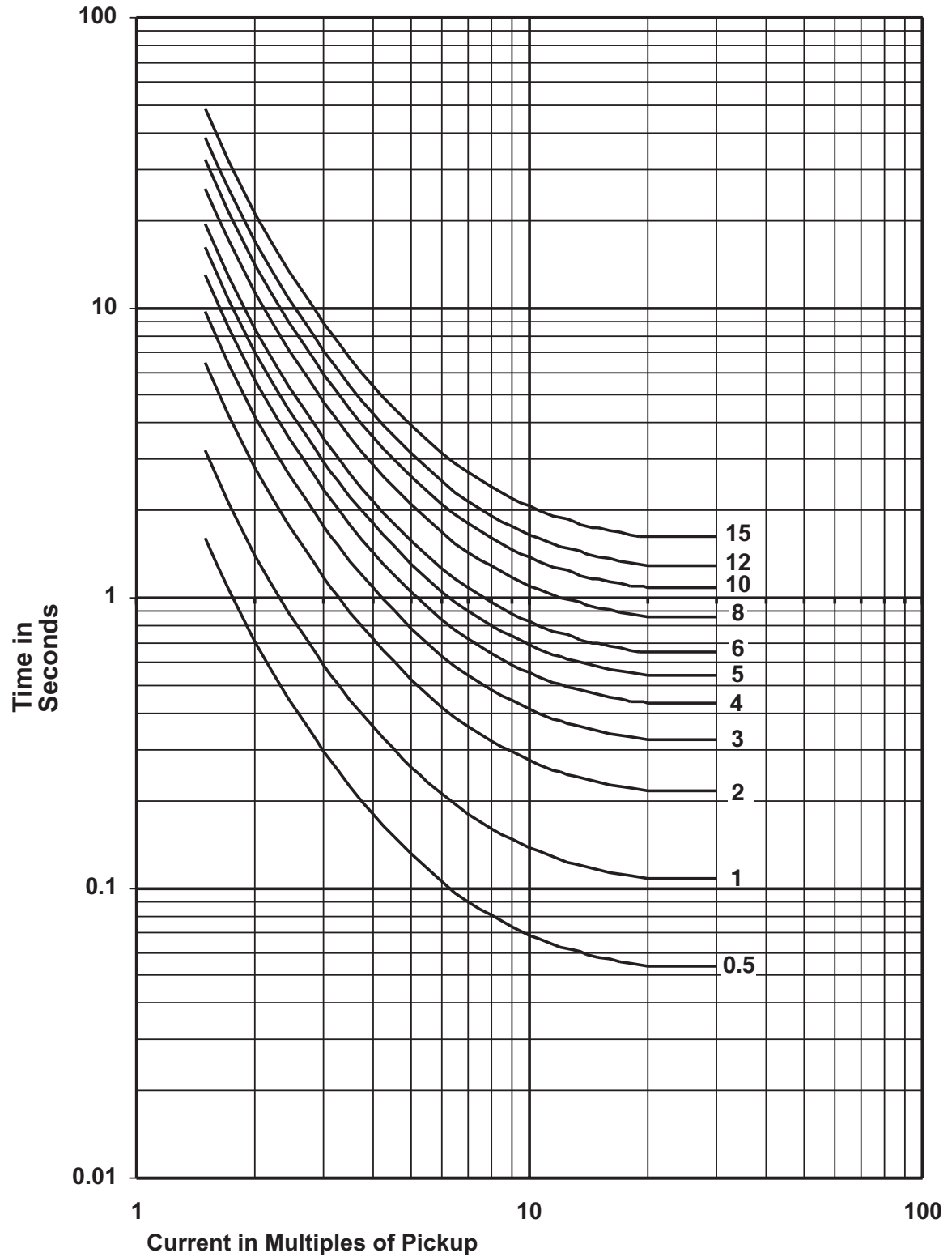
$$t = TD \times \left[ \frac{120}{M - 1} \right]$$

Figure D-12 IEC Curve #4 Long-Time Inverse



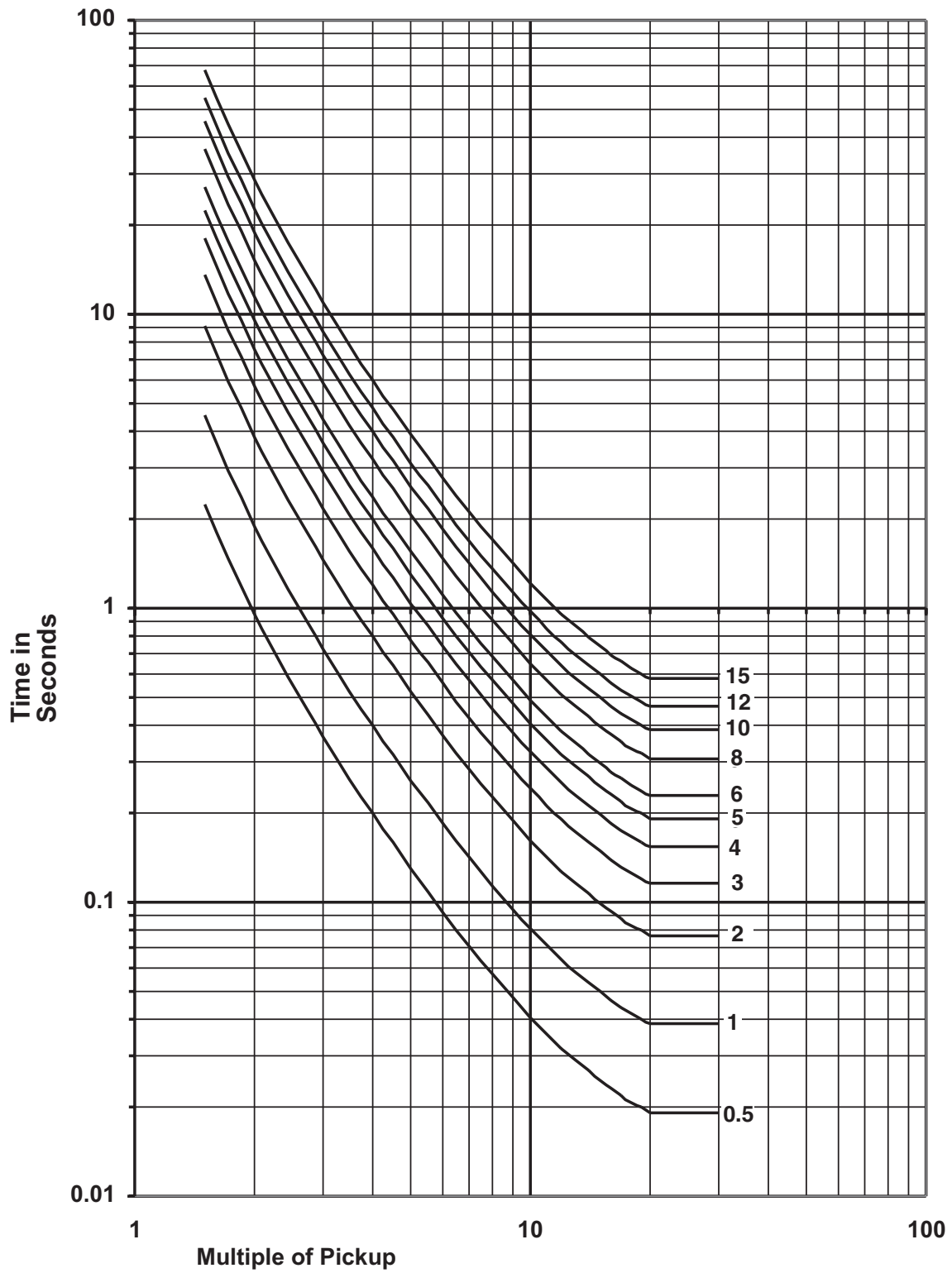
$$t = \frac{TD}{5} \left[ \frac{0.0515}{M^{0.02} - 1} + 0.114 \right]$$

Figure D-13 IEEE (Moderately) Inverse Time Overcurrent Curves



$$t = \frac{TD}{5} \left[ \frac{19.61}{M^2 - 1} + 0.491 \right]$$

Figure D-14 IEEE Very Inverse Time Overcurrent Curves



$$t = \frac{TD}{5} \left[ \frac{28.2}{M^2 - 1} + 0.1217 \right]$$

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-3425A Generator Protection Relay.

## Storage Requirements (Environment)

The recommended storage environment parameters for the M-3425A are:

- The ambient temperature where the M-3425A 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-3425A power supply contains electrolytic capacitors. It is recommended that power be applied to the relay (PS1 and optional PS2 redundant power supply when installed and PS2 on extended output units) 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-3425A includes a removable lithium battery backed TIMEKEEPER® module (Beckwith Electric component U25, Figure 5-14). The TIMEKEEPER module is the M-3425A 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-3425A 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.

### For units with the optional HMI panel:

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

← com1 com2 com3 CLOCK

---

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.

#### For units *without* the optional HMI panel:

1. Verify that the Power Supply (PS) fuses are installed.
2. Determine the unit power supply rating by observing the check box(s) 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. Install IPScom® Communications Software (see Section 5.7 IPScom Communication Software Installation) on a PC that includes the following:
  - Microsoft Windows™ 95 Operating System or above
  - Equipped with a serial port
5. Connect a null modem cable from COM1 of the relay to the PC serial port.
6. Open communications with the relay (see Section 5.8 Activating Initial Local Communications).
7. Select "Relay/Setup/Set Date/Time" from the menu bar. IPScom will display the "Date/Time Dialog Screen".
8. Verify that "Start Clock" is displayed, then proceed as follows:
  - a. If "Start Clock" is displayed, then select "Save" and go to Step 9.
  - b. If "Stop Clock" is displayed, then select "Stop Clock" and then select "Save".
9. Close communications with the unit by selecting "Comm" from the menu bar and then select "Exit".
10. Disconnect the null modem cable and then remove power from the unit. The unit can now be placed in storage.

Storage of the M-3425A greater than five years may require replacement of the lithium battery prior to placing the unit in service. Contact Beckwith Electric Customer Service for replacement procedure.

# F

## HMI Menu Flow

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## F.1 HMI Menu Overview

Appendix F illustrates the Human Machine Interface (HMI) menu flow that is presented on the M-3931 Human-Machine interface module.

### Key to Input Data

- A. All heavily bordered  screens are MENU screens which have horizontal choices (made with right - left arrows).
- B. Gray boxes  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.
- C. The Up/Down arrows only adjust value or letter (lower/upper case) inputs; they do not move within the menus or between menu displays.
- D. 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.
- E. 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.
- F. Pressing **EXIT** at any time will exit the display screen to the last screen containing a horizontal choice. (Return to the preceding menu).

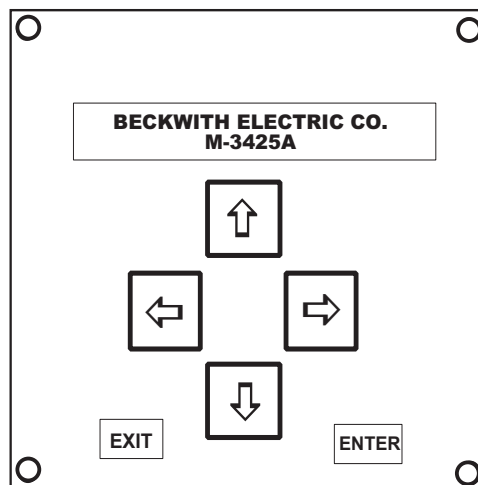


Figure F-1 M-3931 Human-Machine Interface Module

- G. 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.

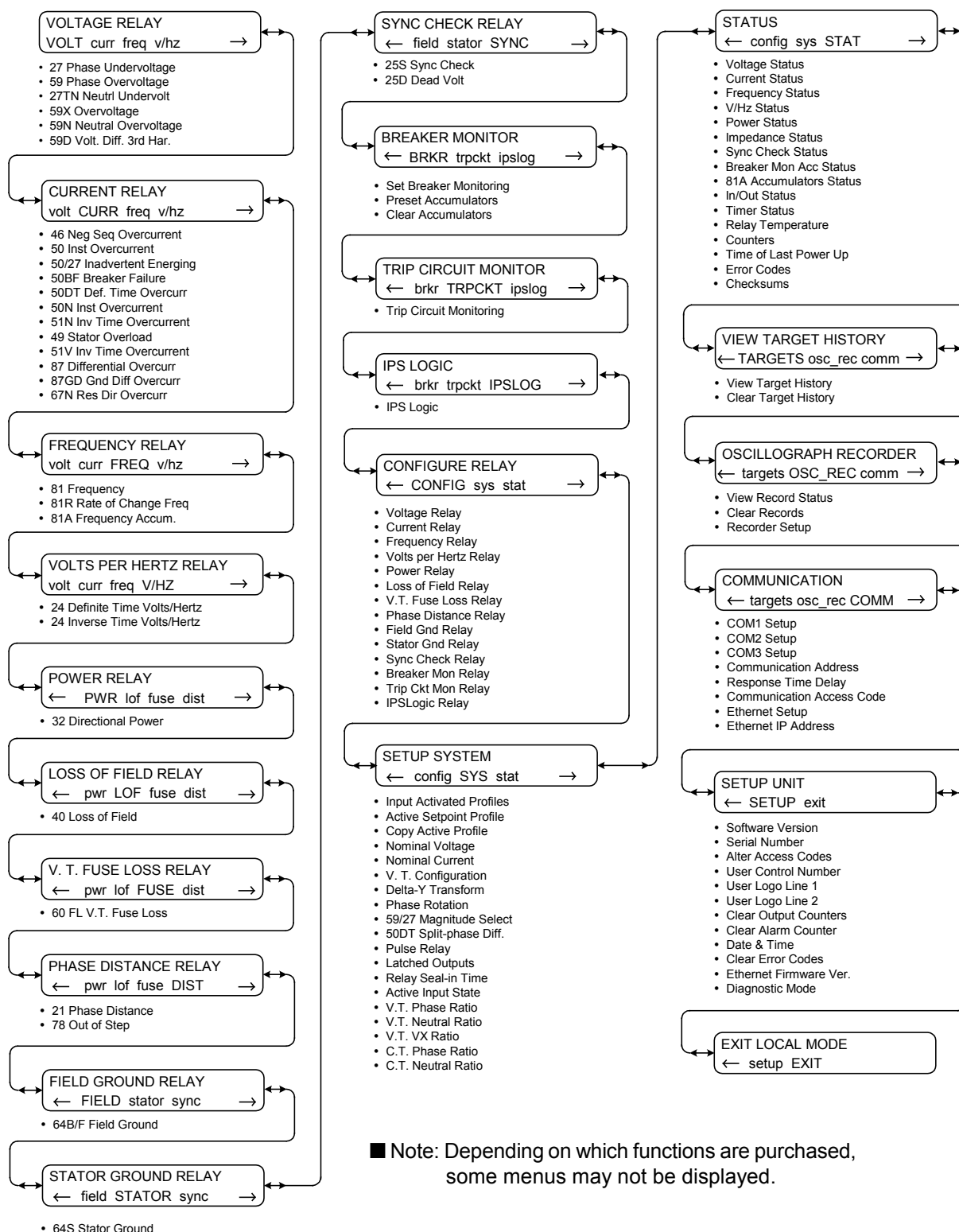


Figure F-2 HMI Menu Flow Overview

F.2 HMI Menu Flow

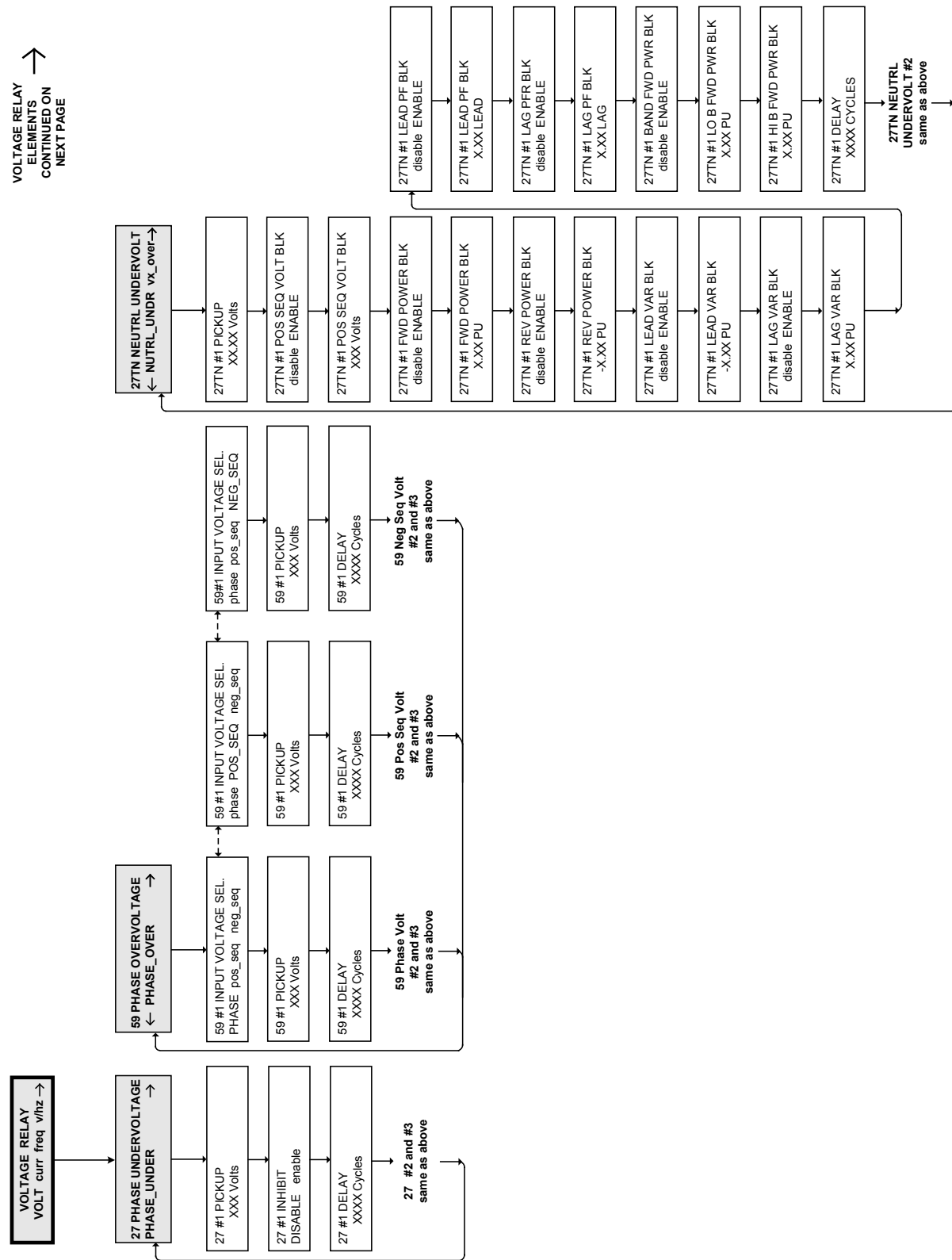


Figure F-3 Voltage Relay Menu Flow

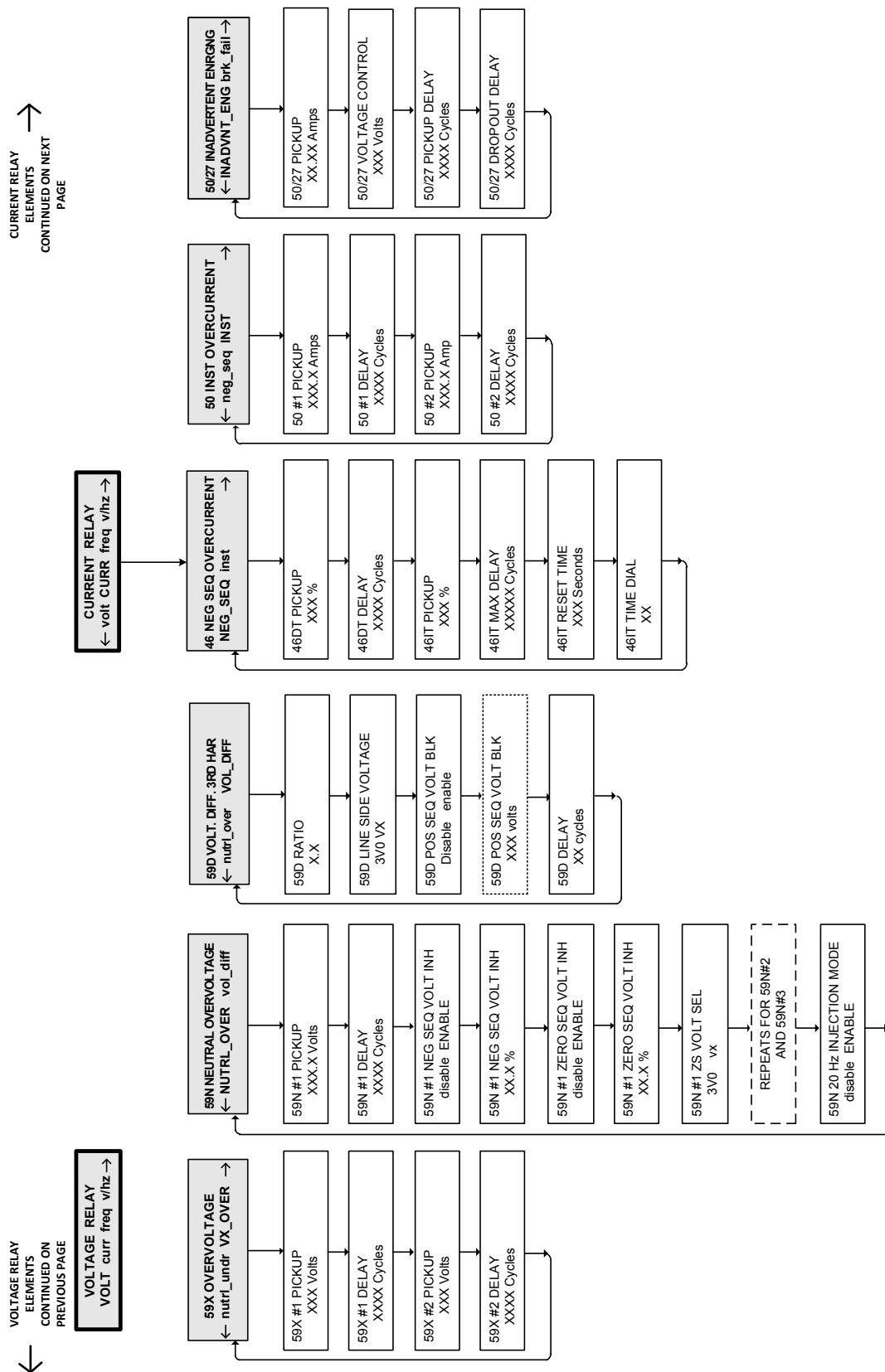


Figure F-4 Current Relay Menu Flow (Page 1 of 2)

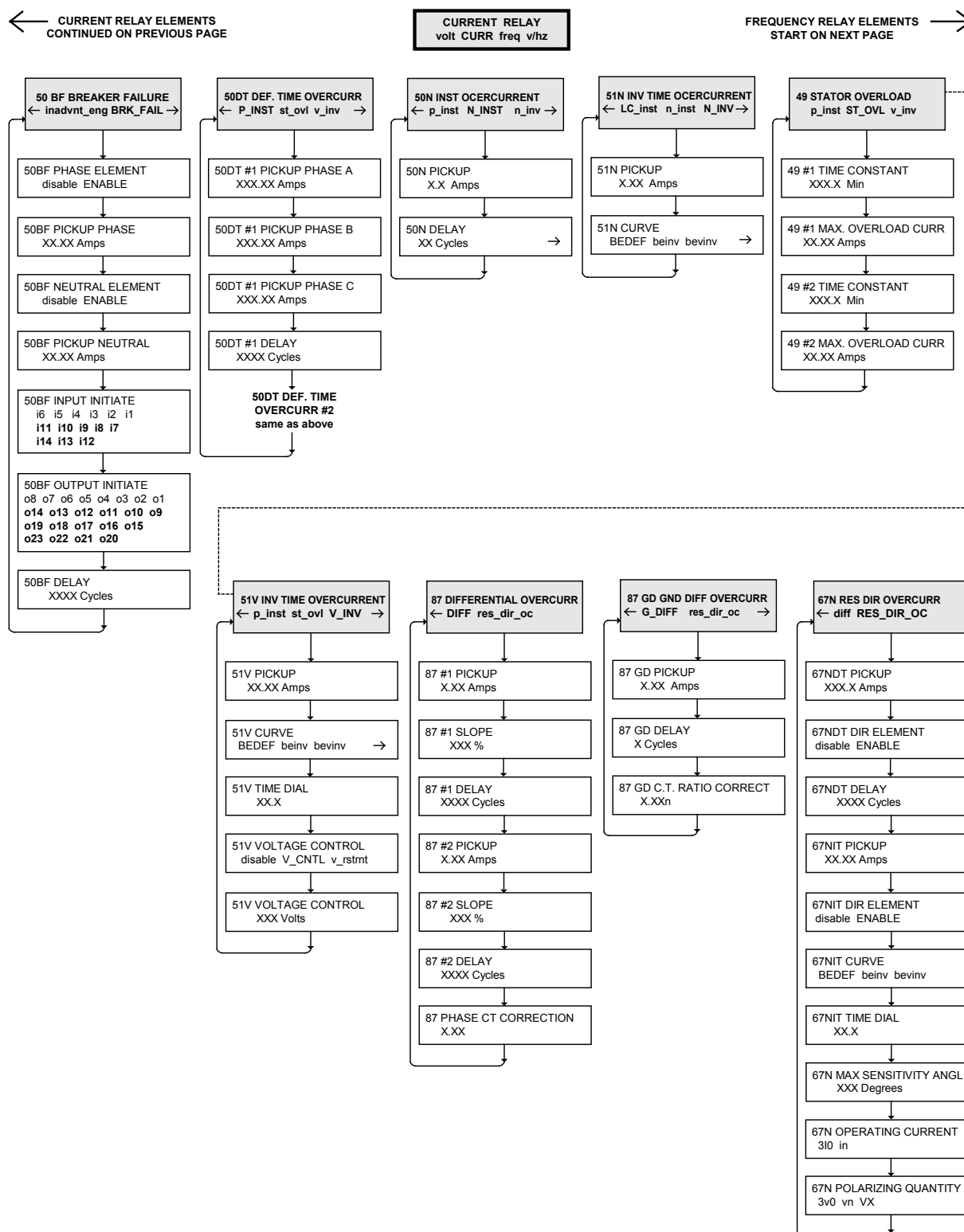


Figure F-4 Current Relay Menu Flow (Page 2 of 2)

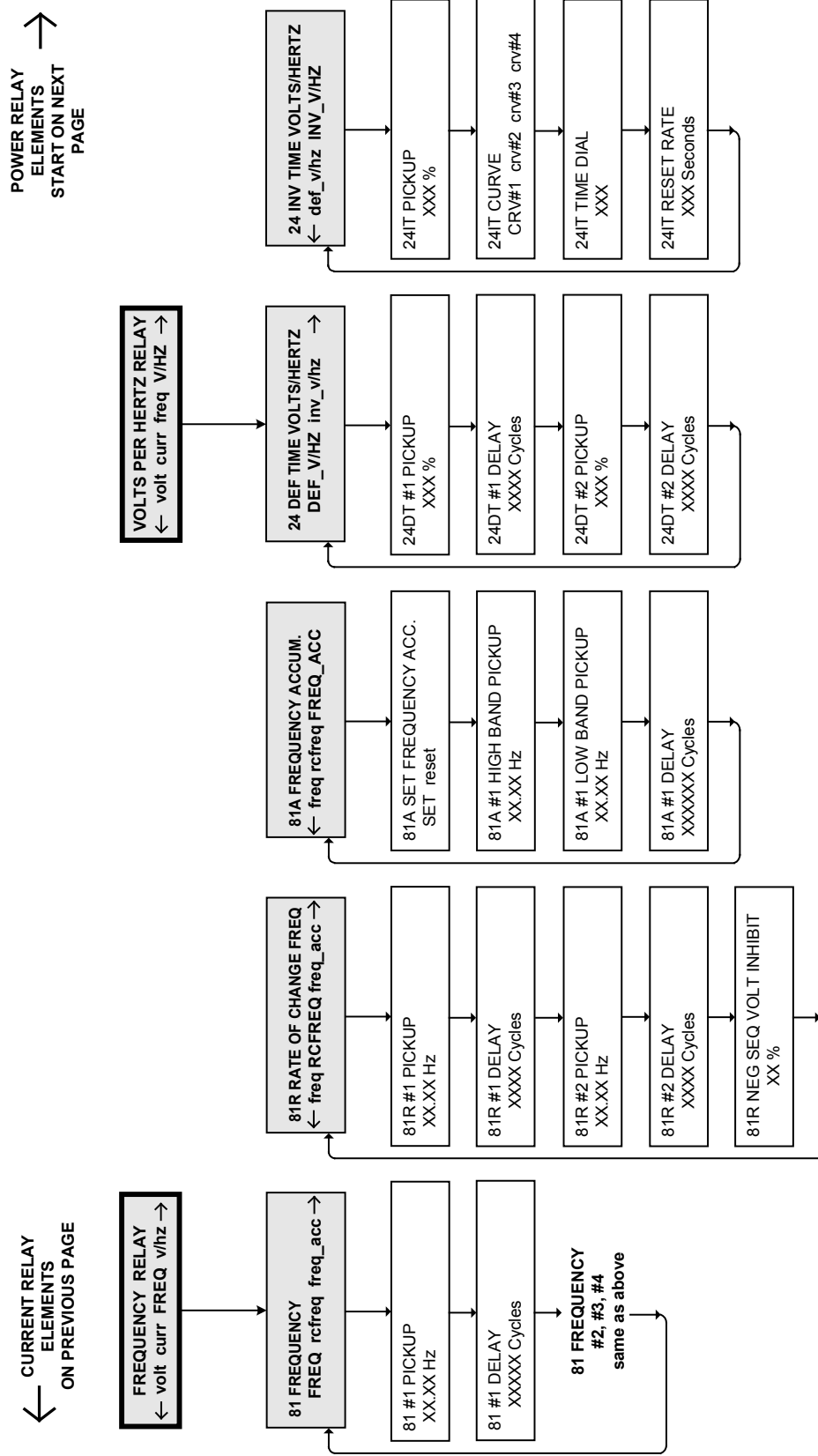


Figure F-5 Frequency Relay, Volts Per Hertz Relay Menu Flow

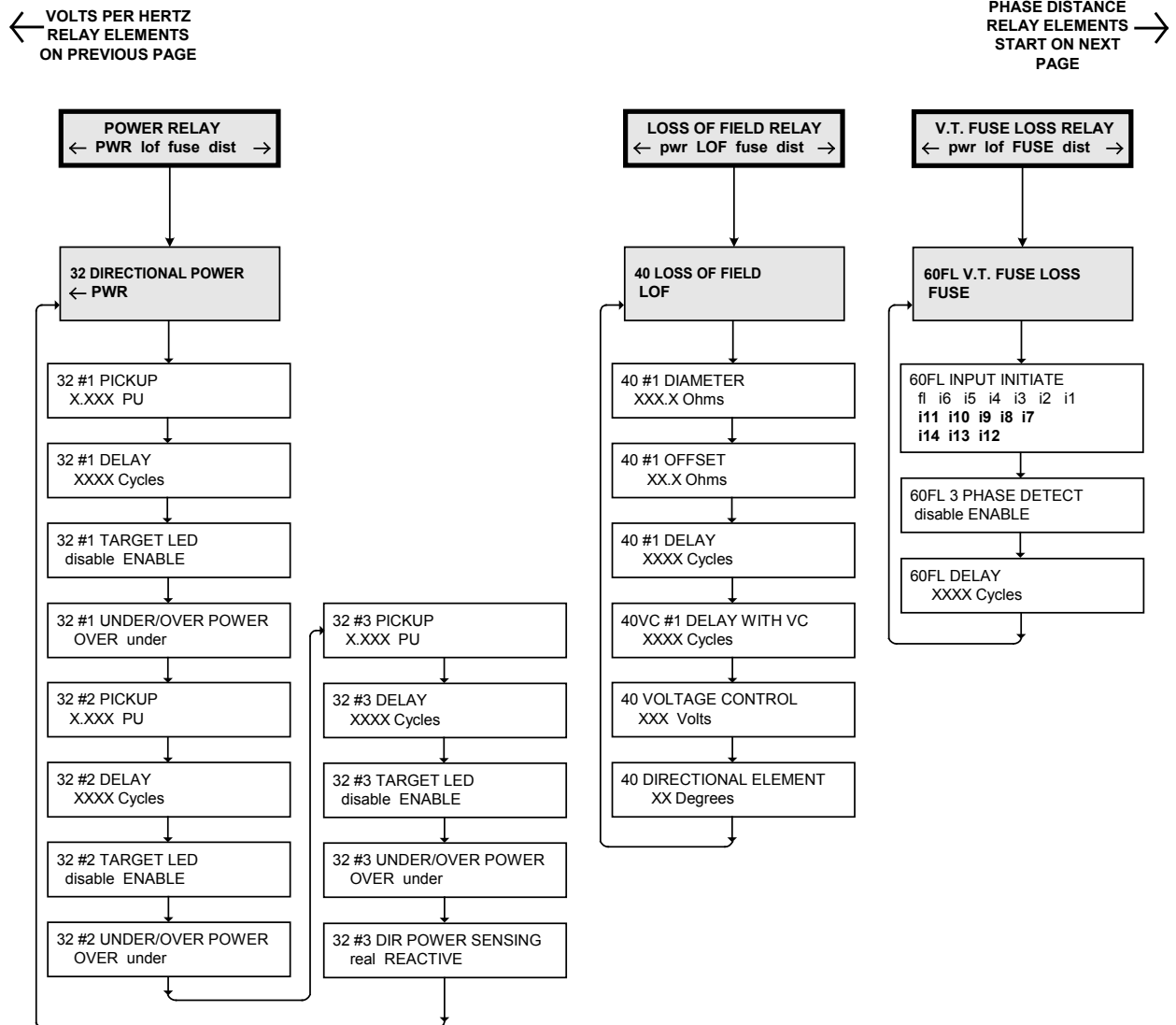


Figure F-6 Power Relay, Loss of Field Relay and V.T. Fuse Loss Relay Menu Flow



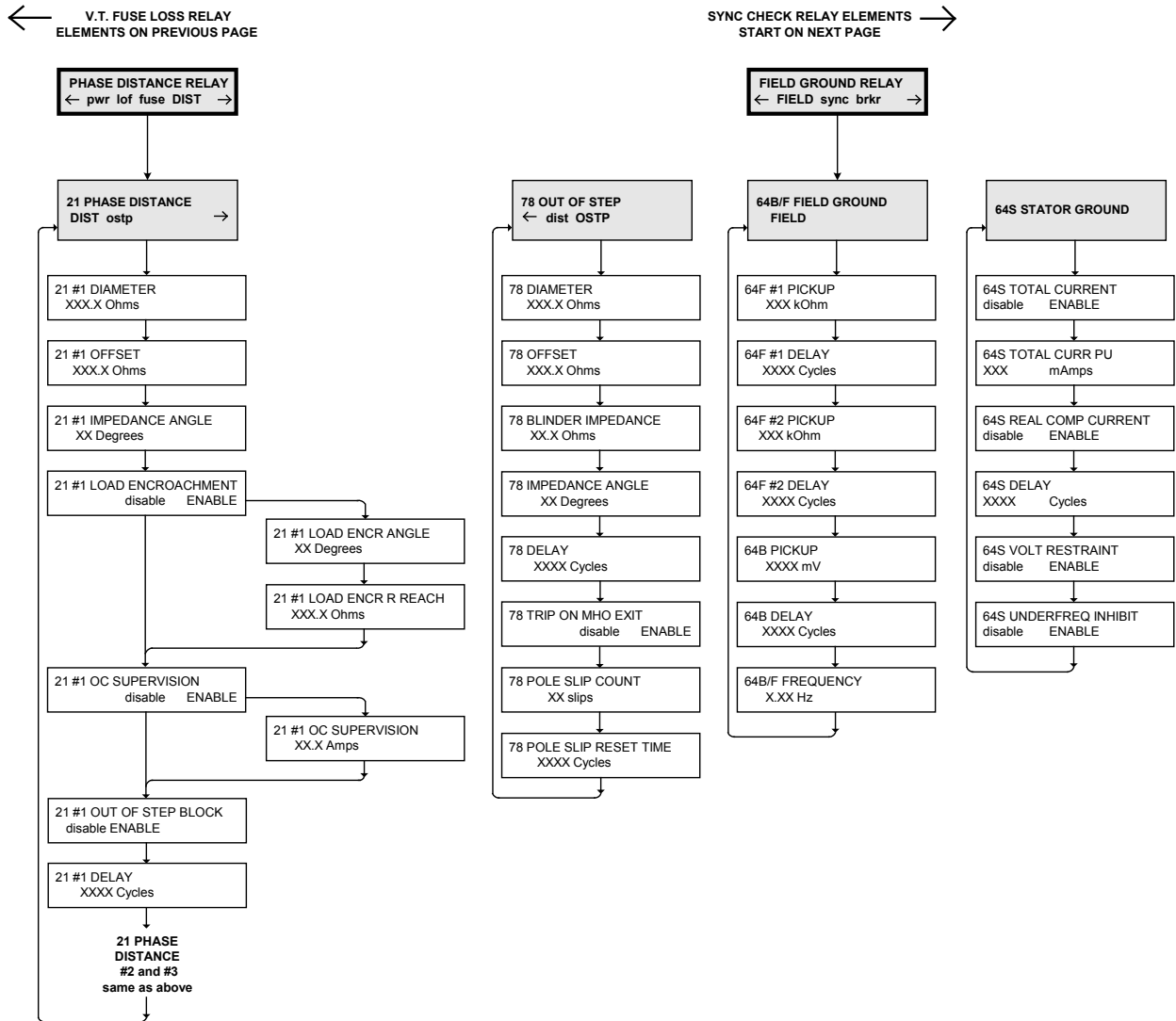


Figure F-7 Phase Distance and Field Ground Relay Menu Flow

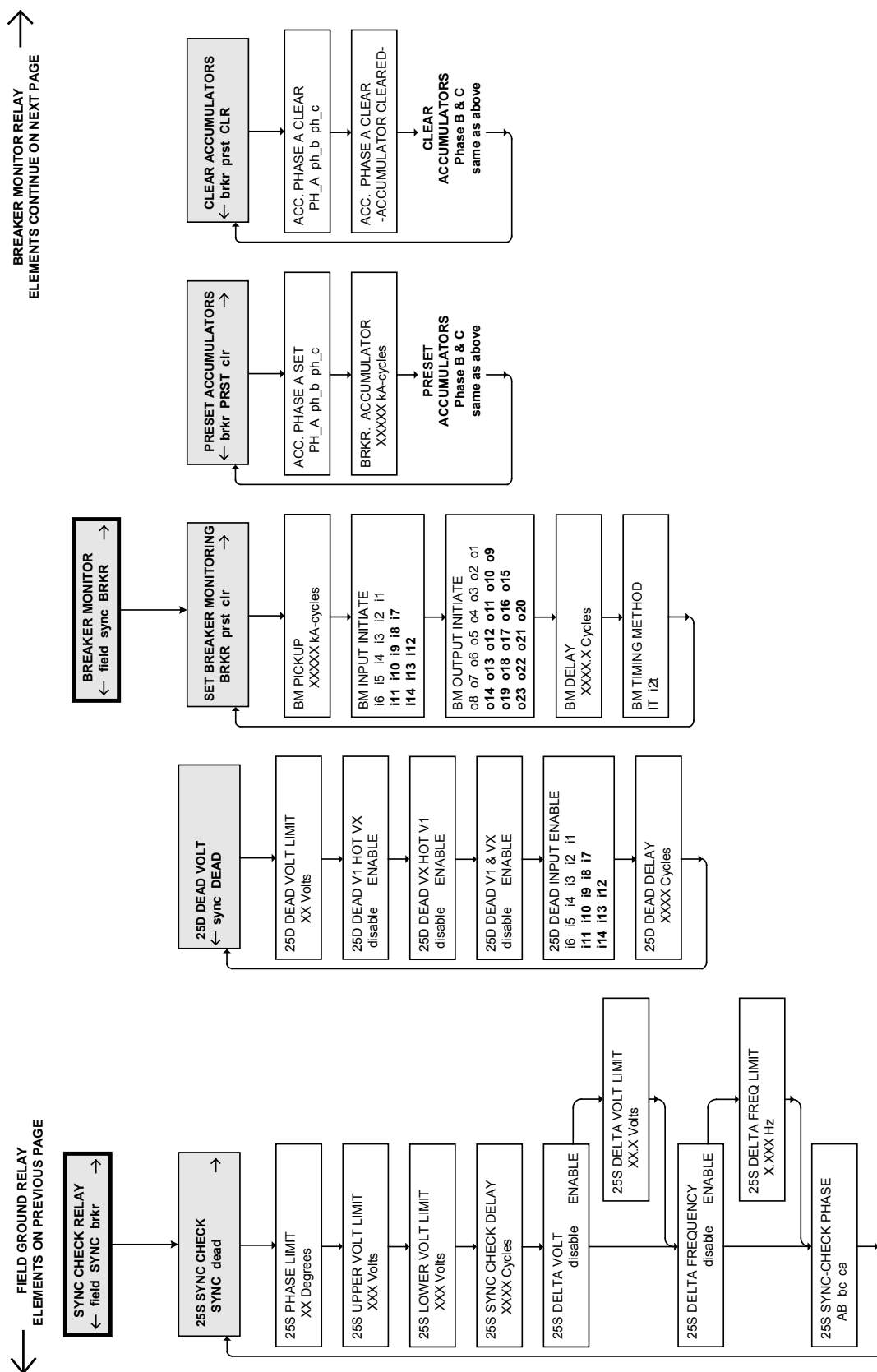


Figure F-8 Sync Check Relay and Breaker Monitor Menu Flow

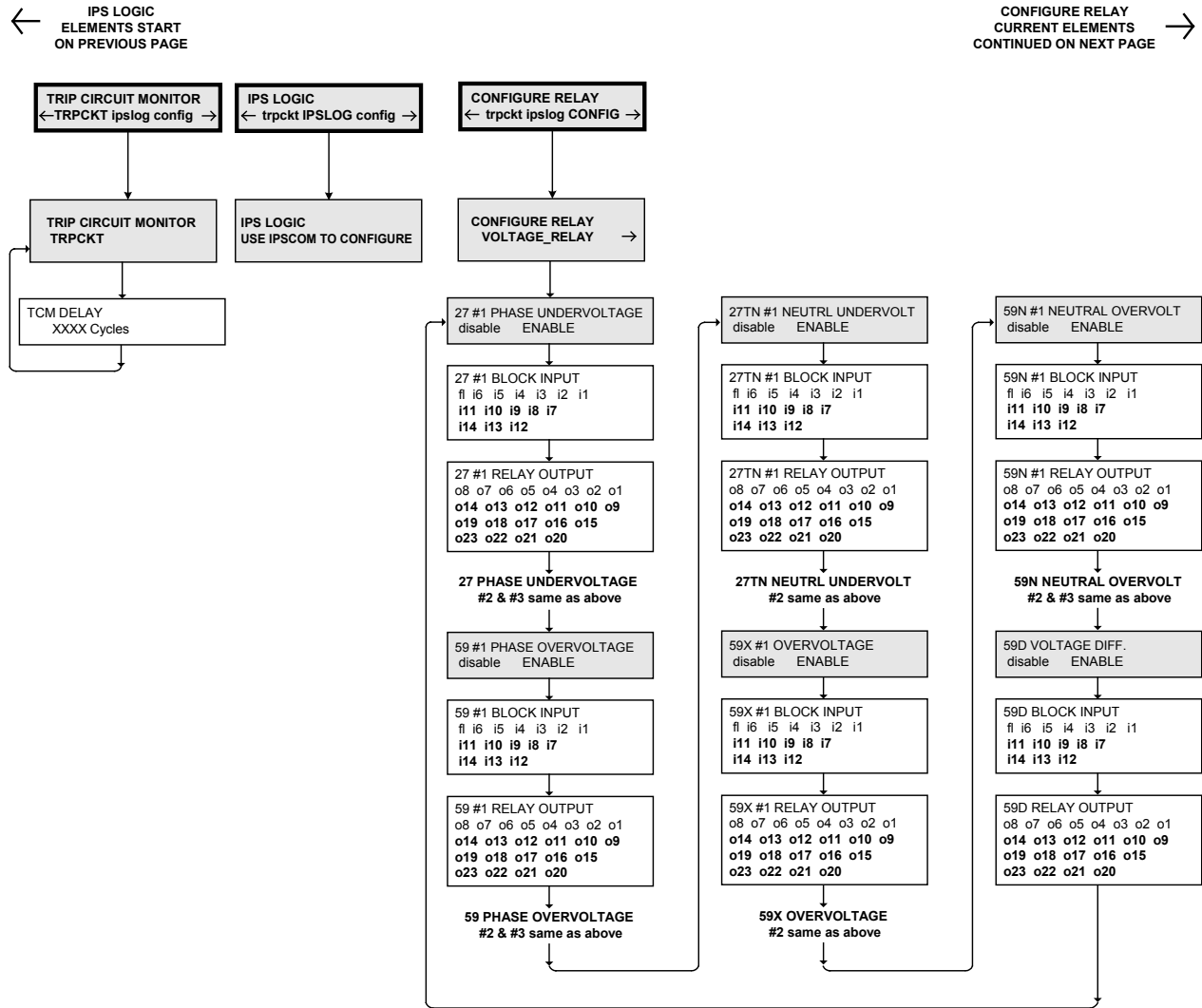


Figure F-9 Configure Relay Menu Flow (1 of 5)

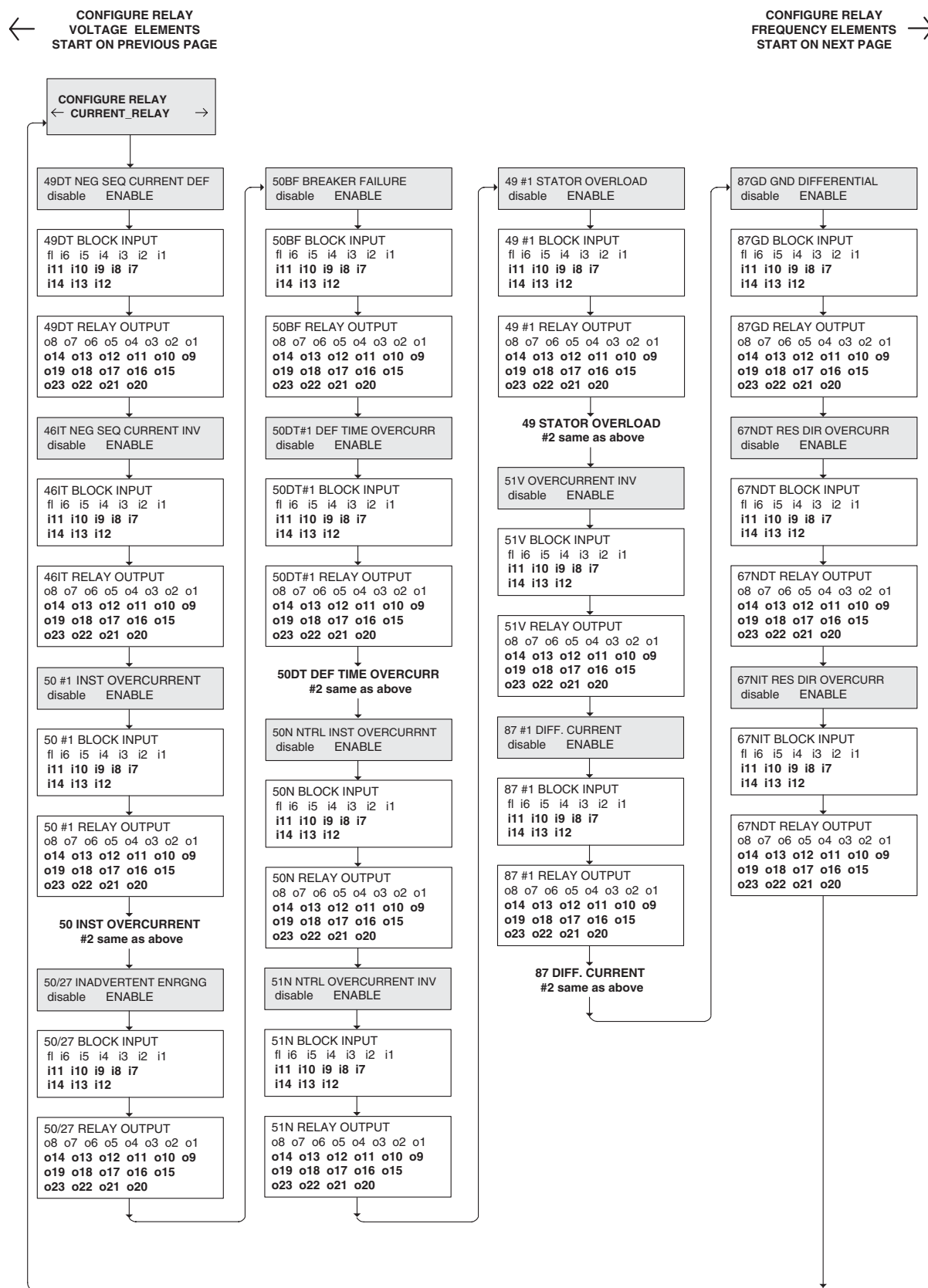


Figure F-9 Configure Relay Menu Flow (2 of 5)

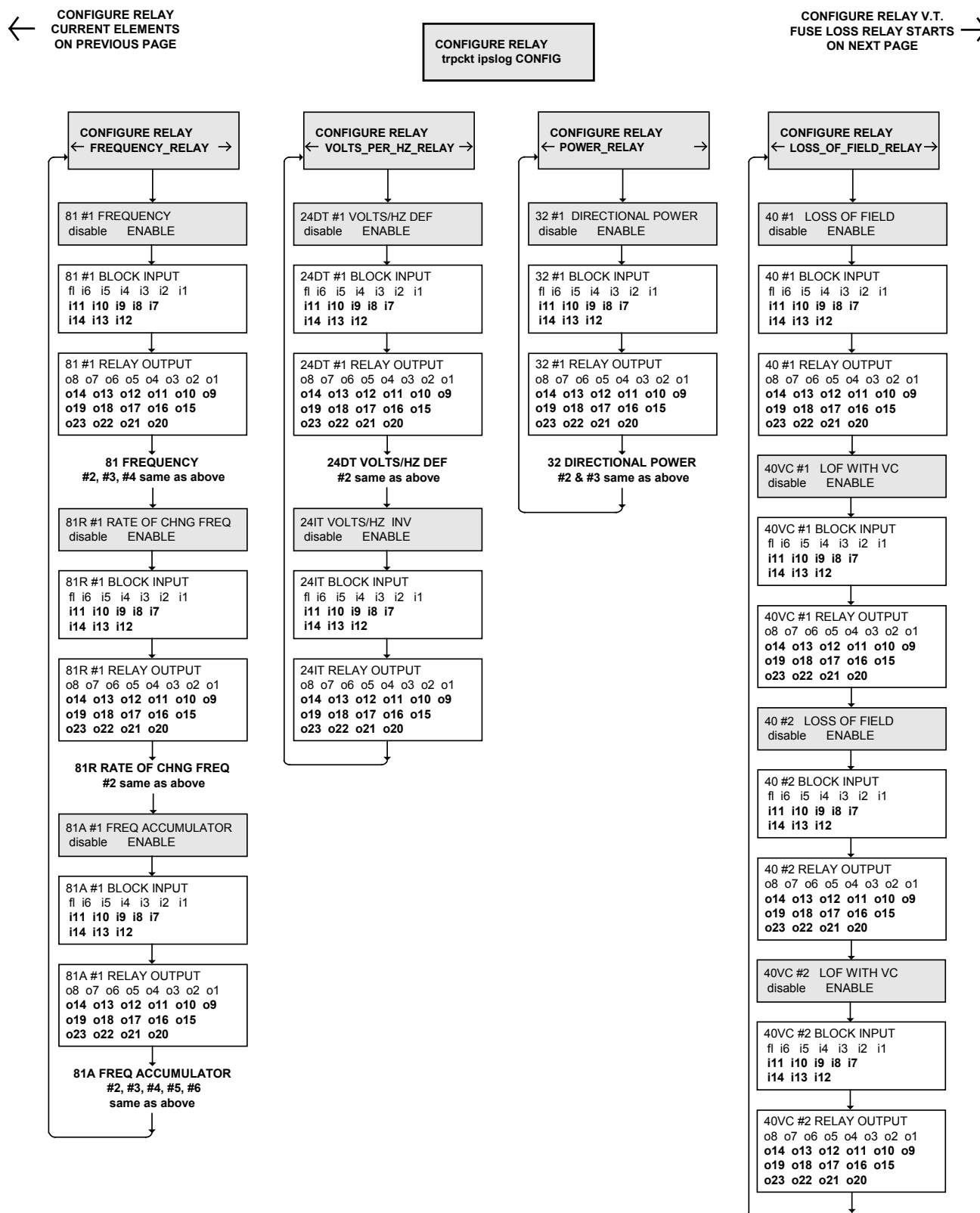


Figure F-9 Configure Relay Menu Flow (3 of 5)

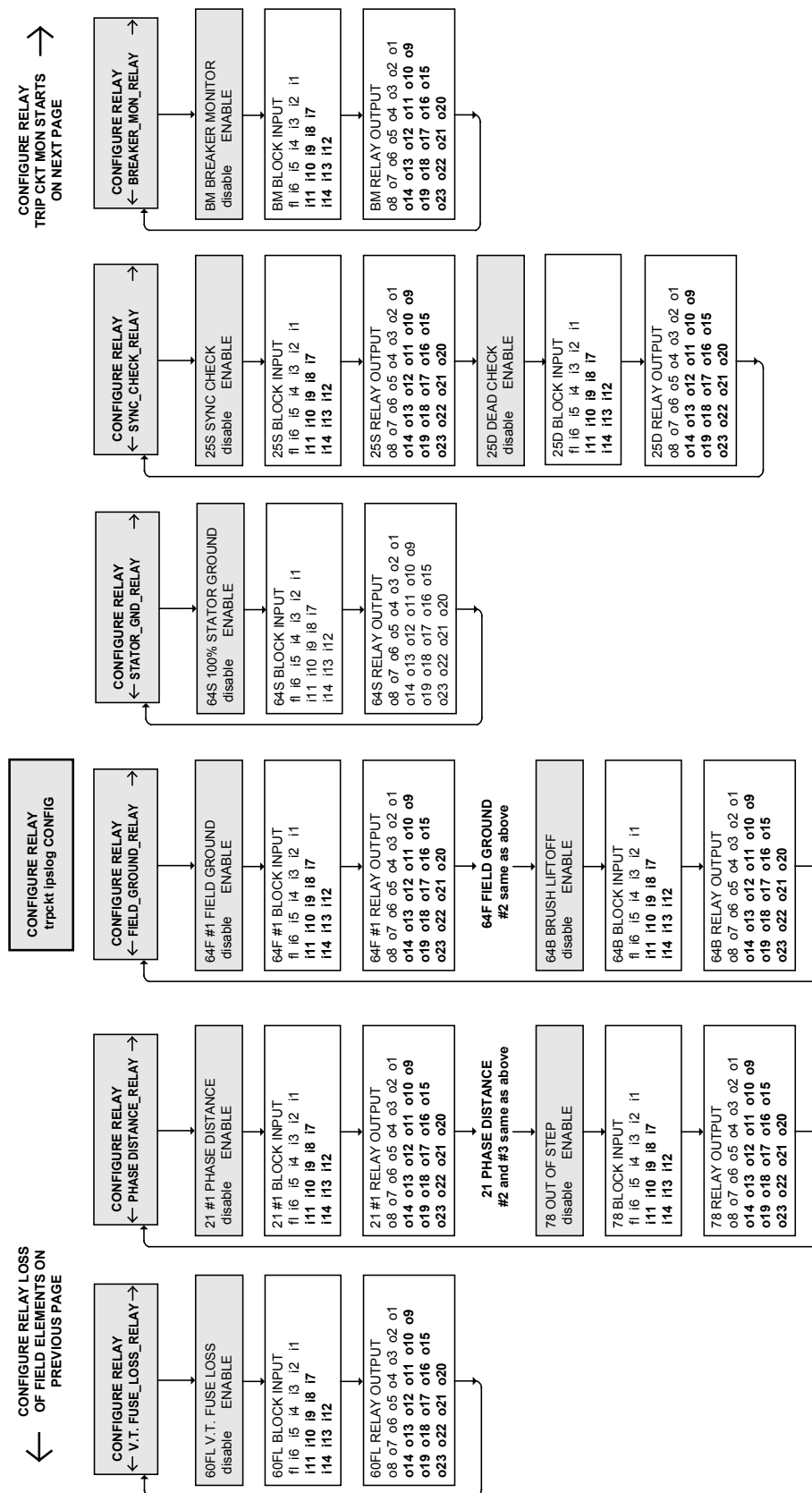


Figure F-9 Configure Relay Menu Flow (4 of 5)

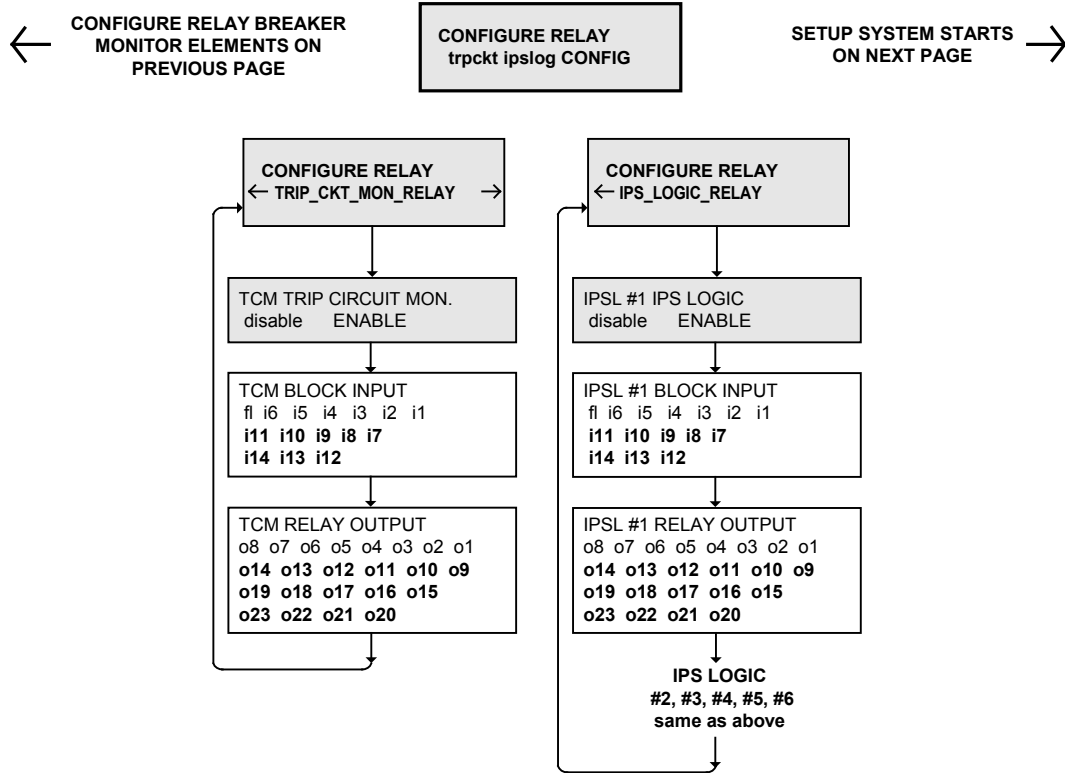


Figure F-9 Configure Relay Menu Flow (5 of 5)

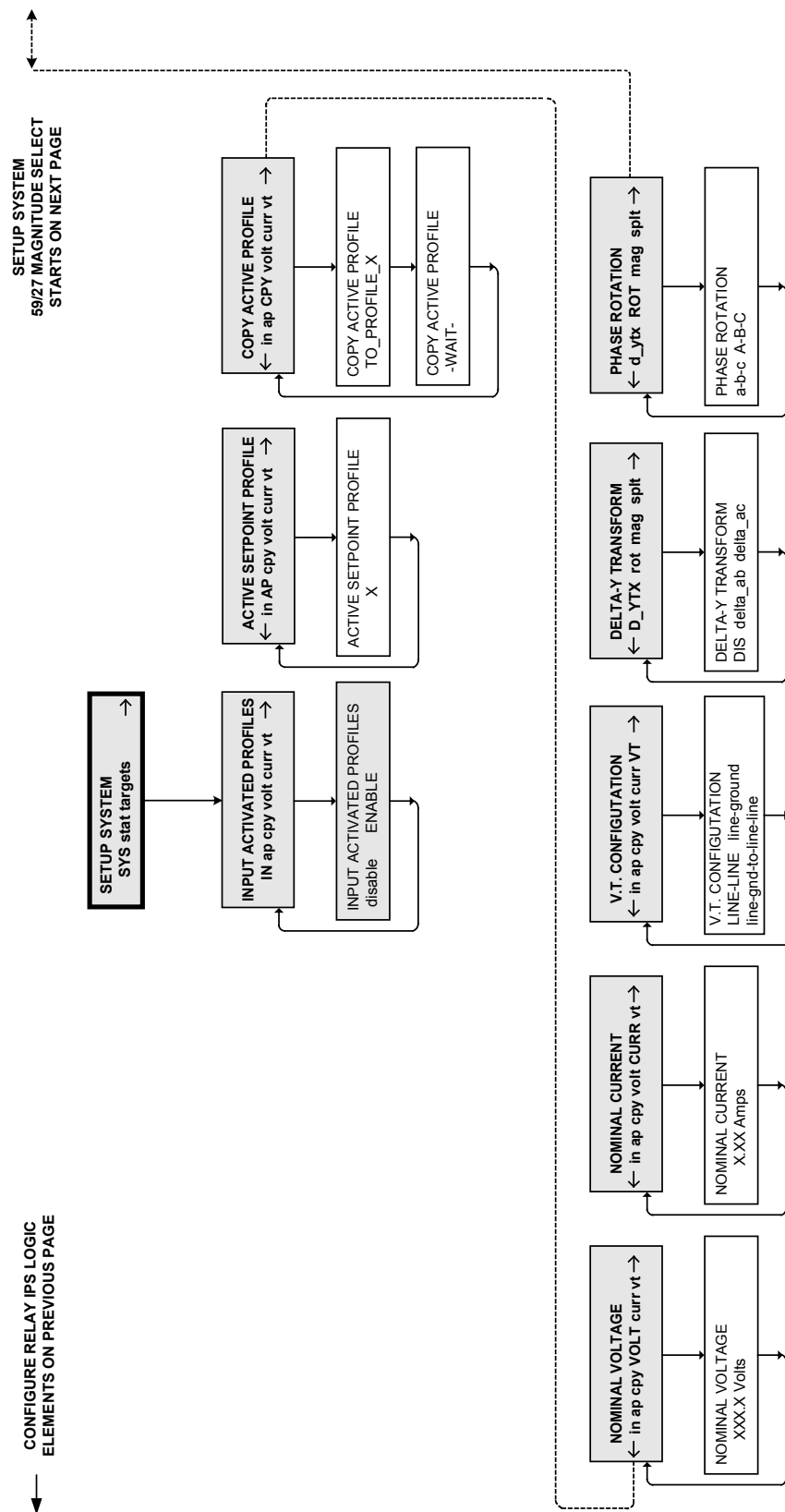


Figure F-10 Setup System (1 of 2)



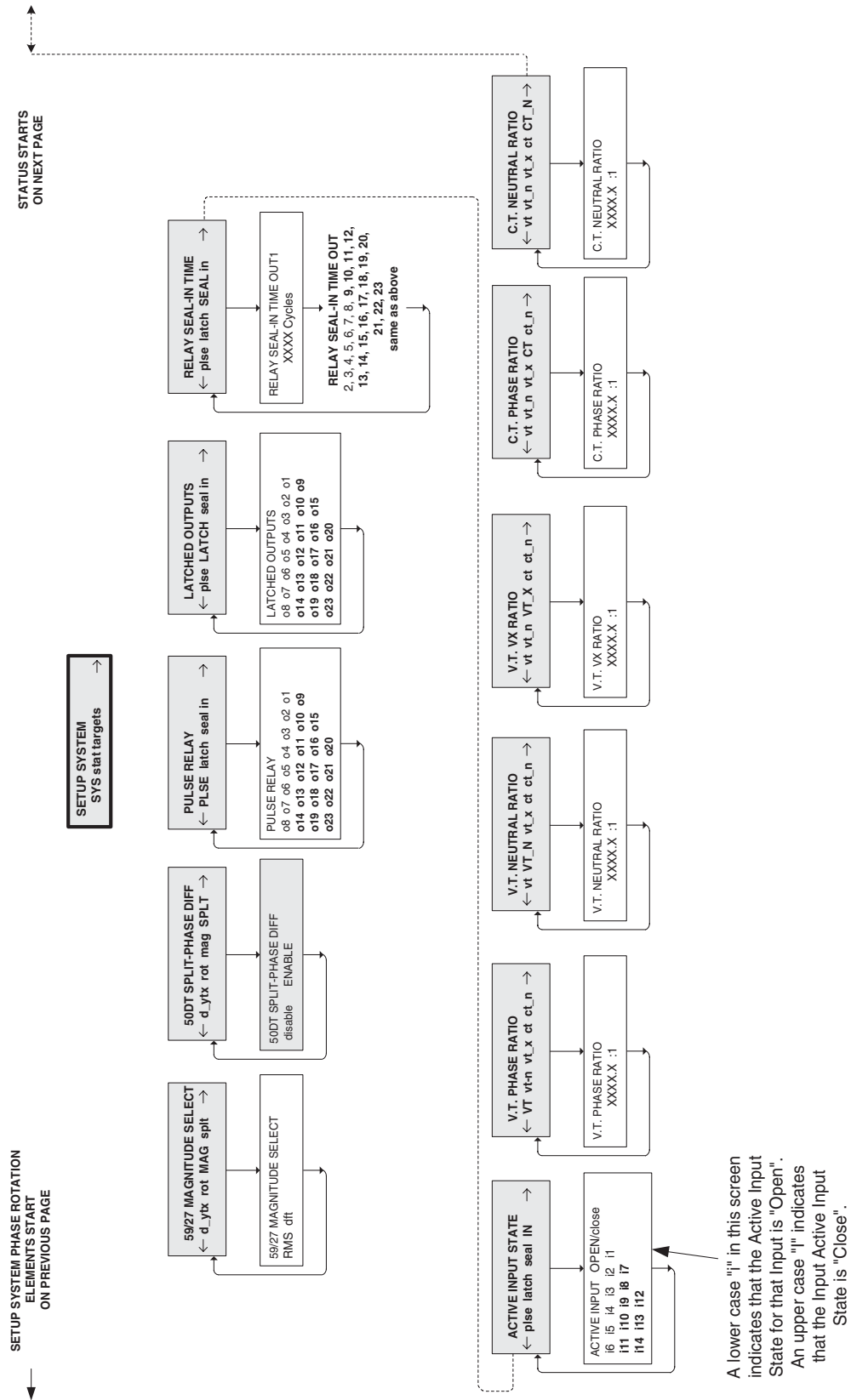


Figure F-10 Setup System (2 of 2)

RELAY STATUS CONTINUES  
ON NEXT PAGE →

←  
SETUP SYSTEM ELEMENTS  
ON PREVIOUS PAGE

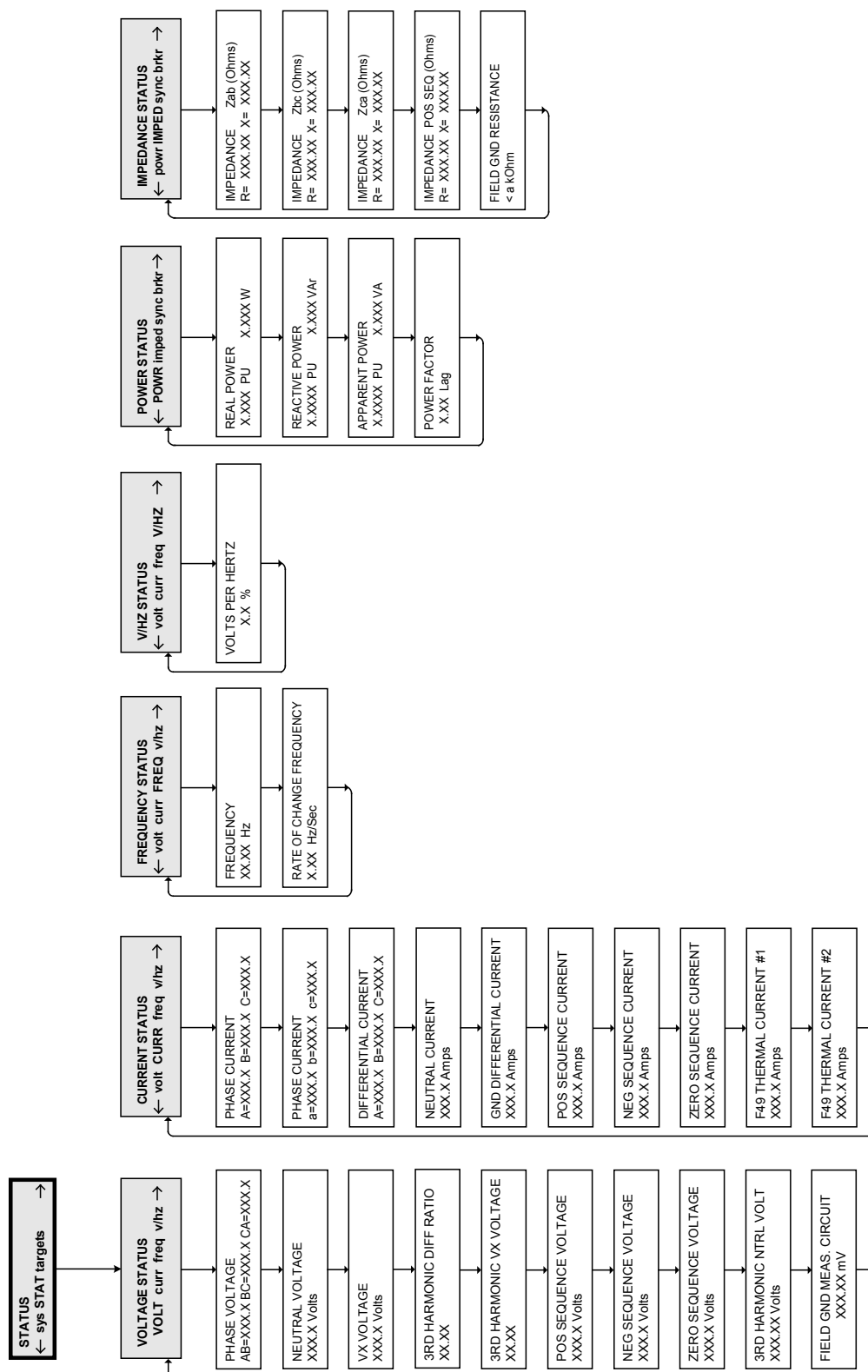


Figure F-11 Status (1 of 3)

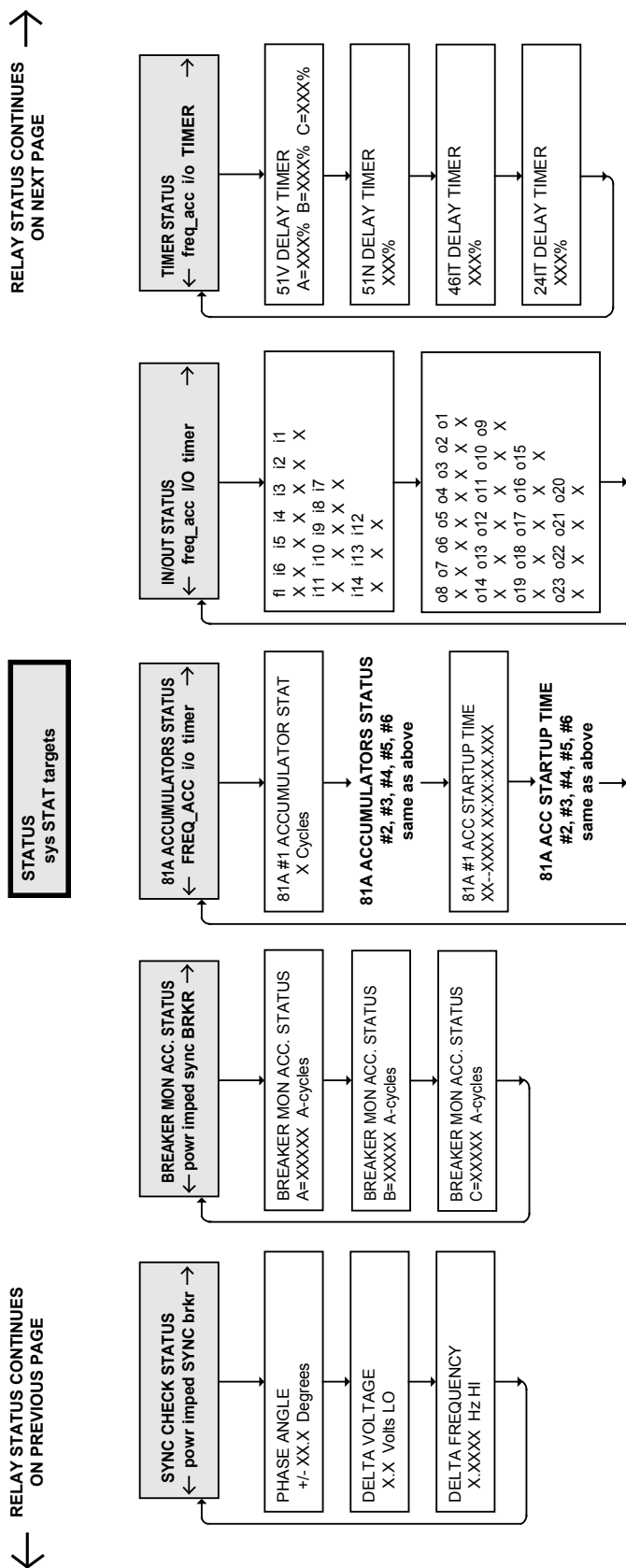


Figure F-11 Status (2 of 3)

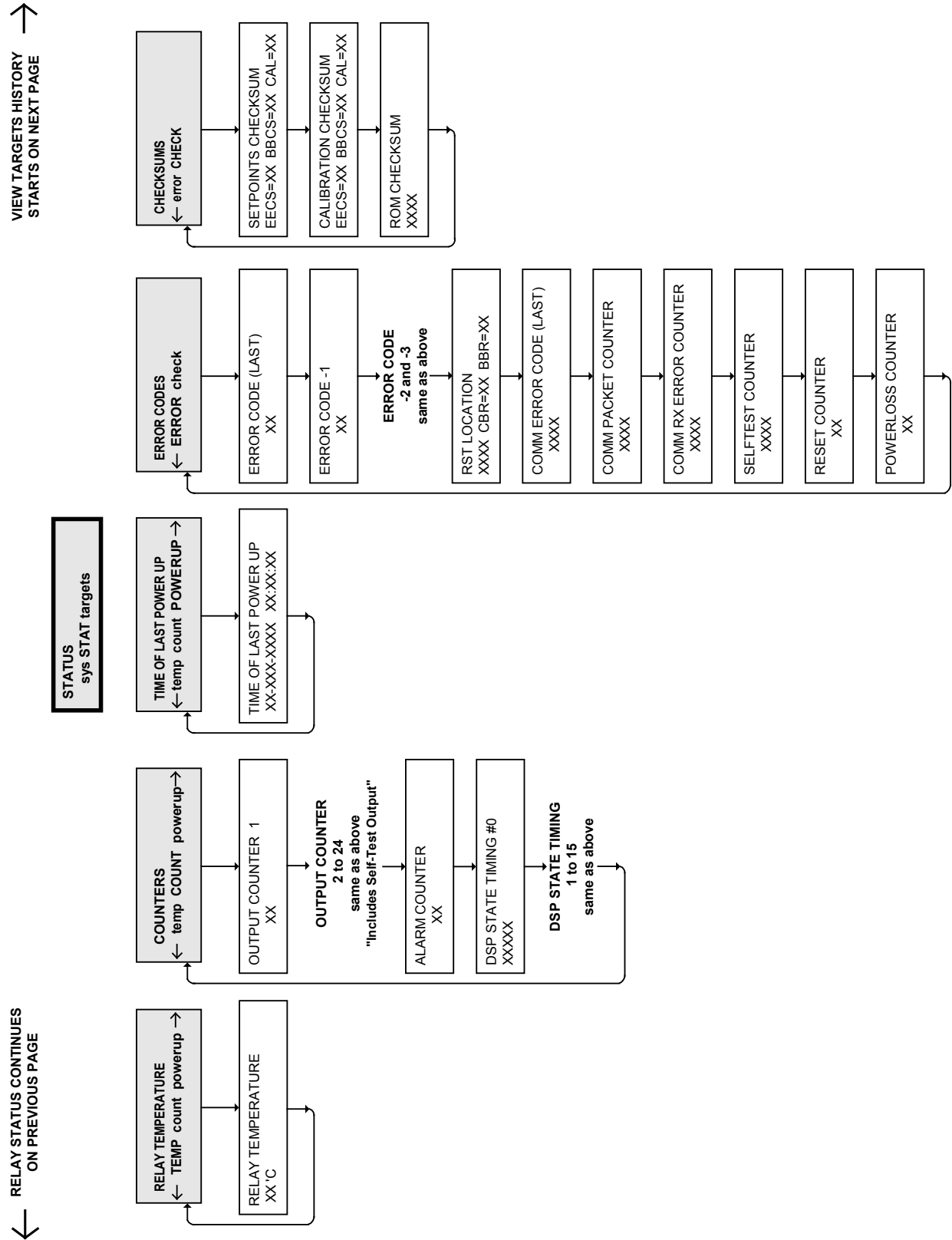


Figure F-11 Status (3 of 3)

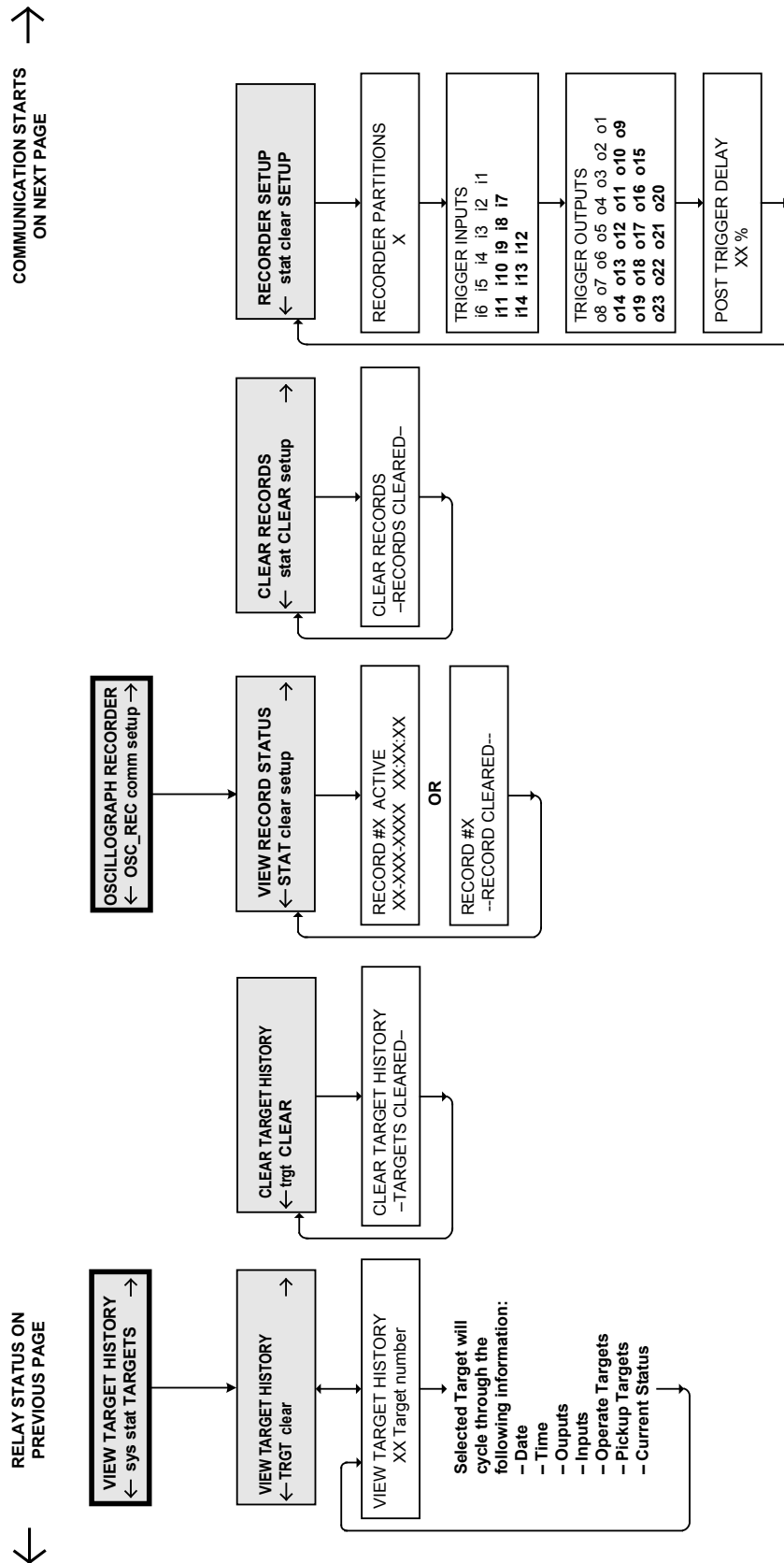


Figure F-12 View Target History and Oscillograph Explorer

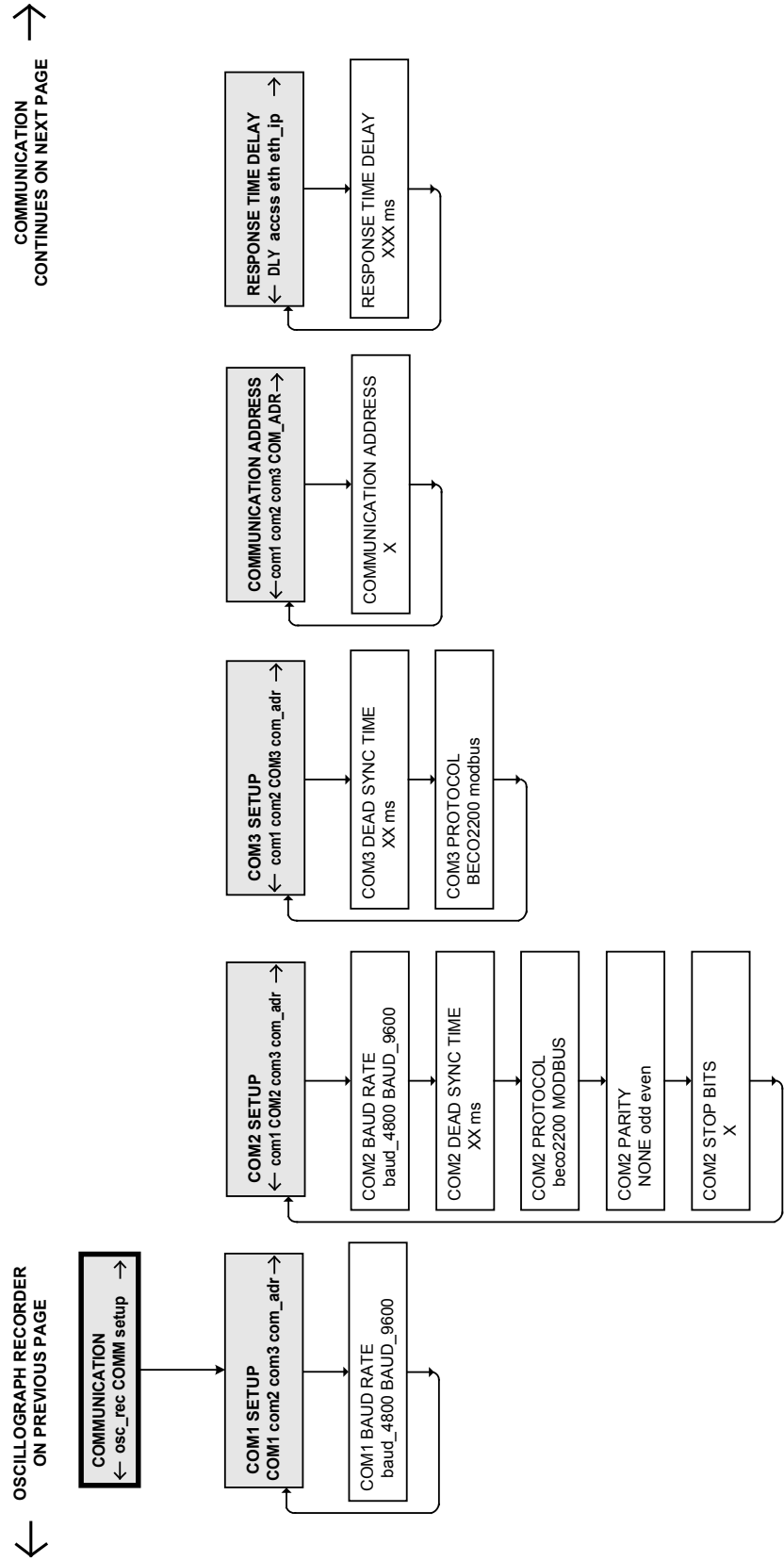


Figure F-13 Communication (1 of 2)

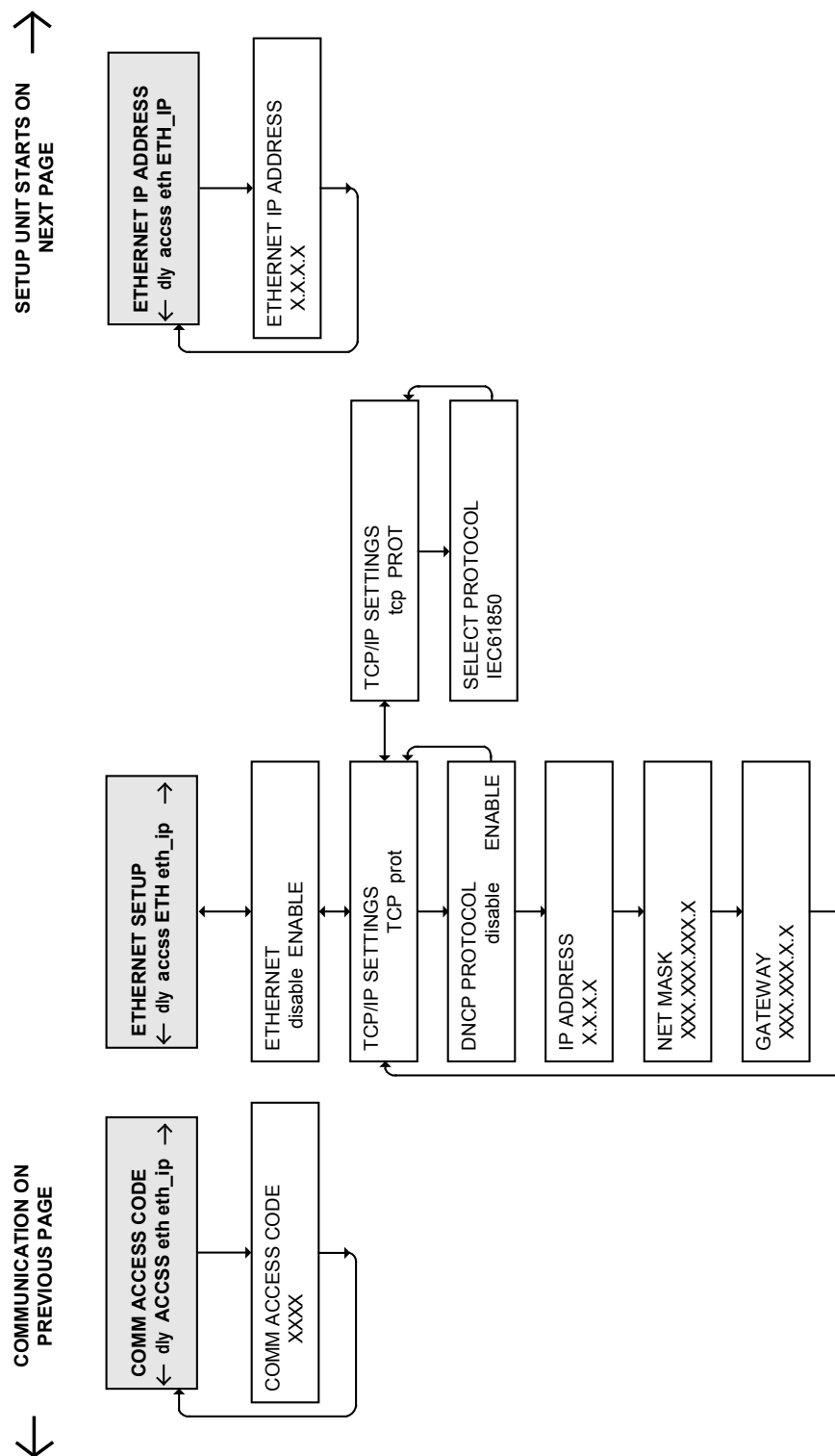


Figure F-13 Communication (2 of 2)

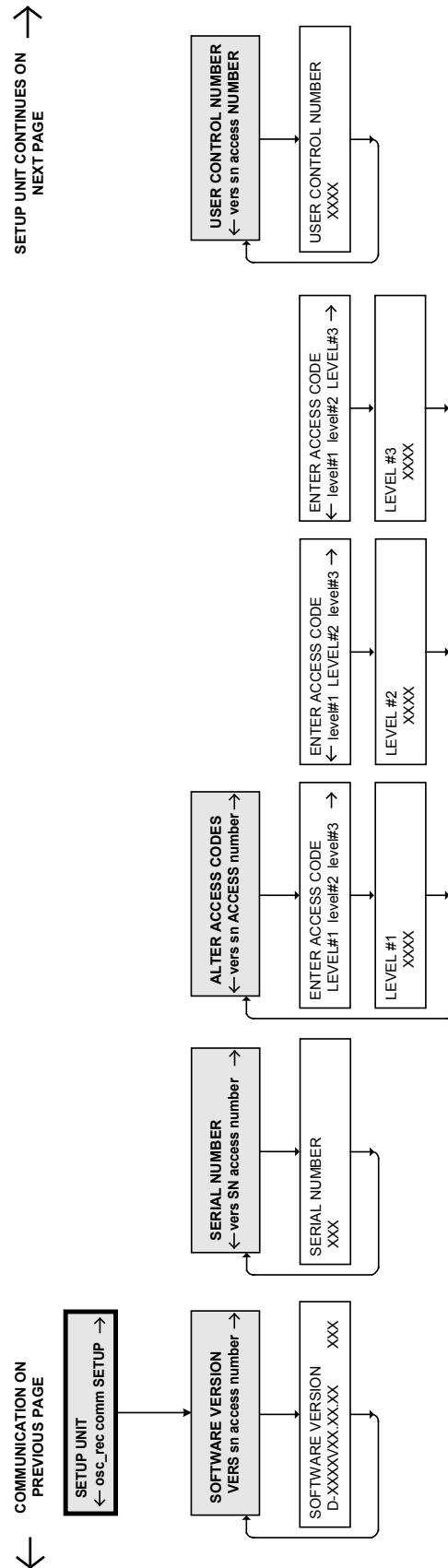


Figure F-14 Setup Unit (1 of 2)



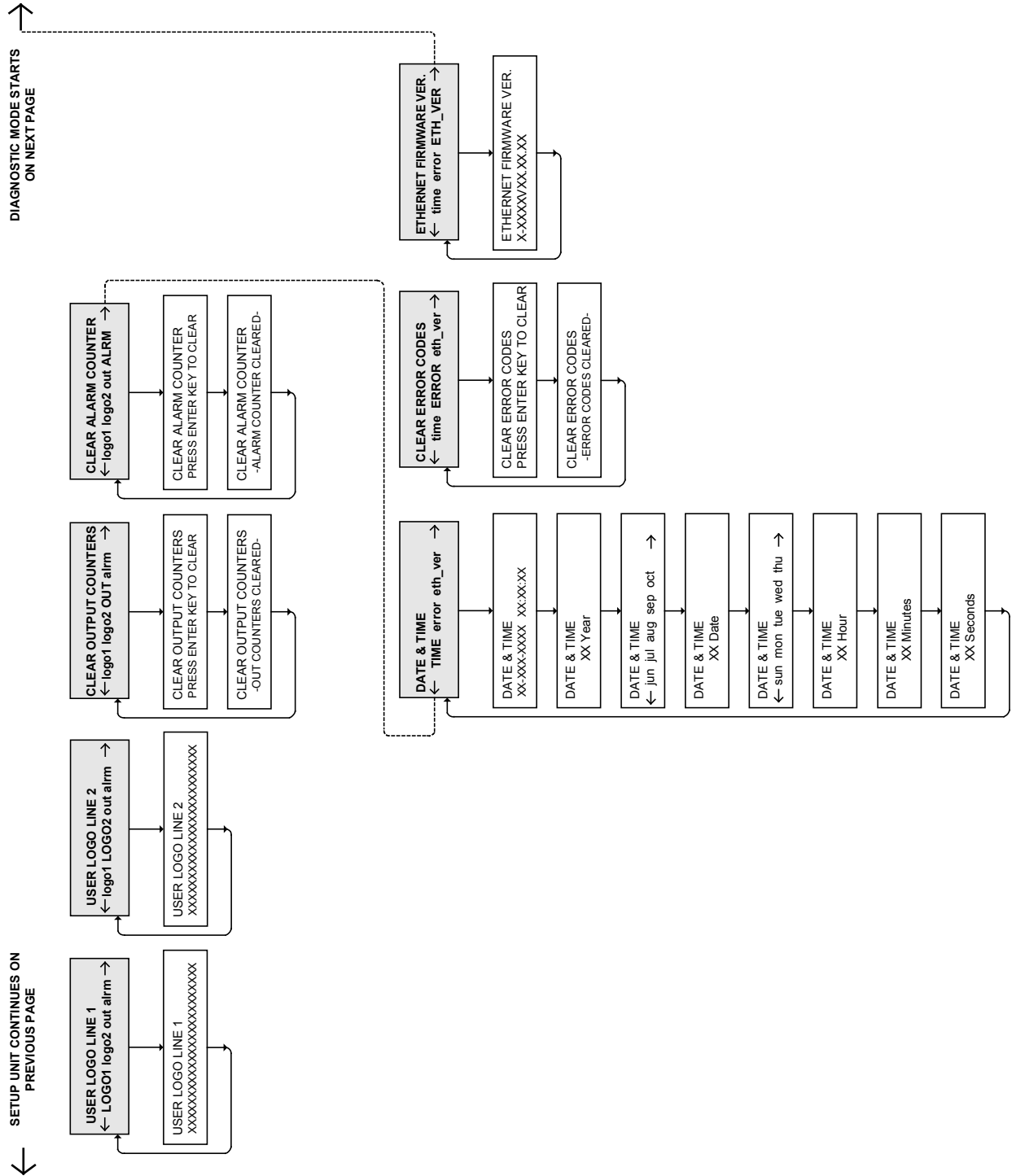


Figure F-14 Setup Unit (2 of 2)

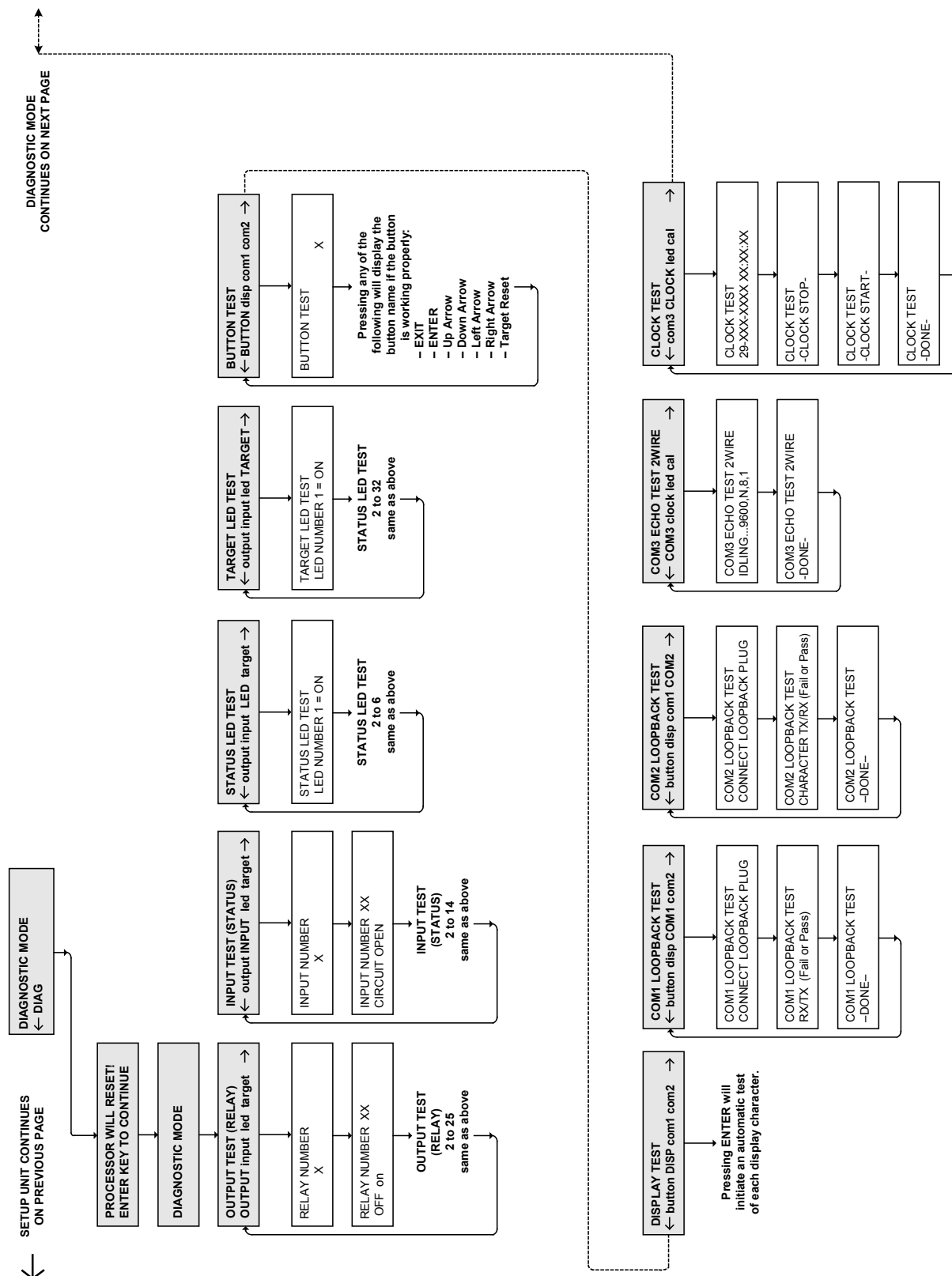
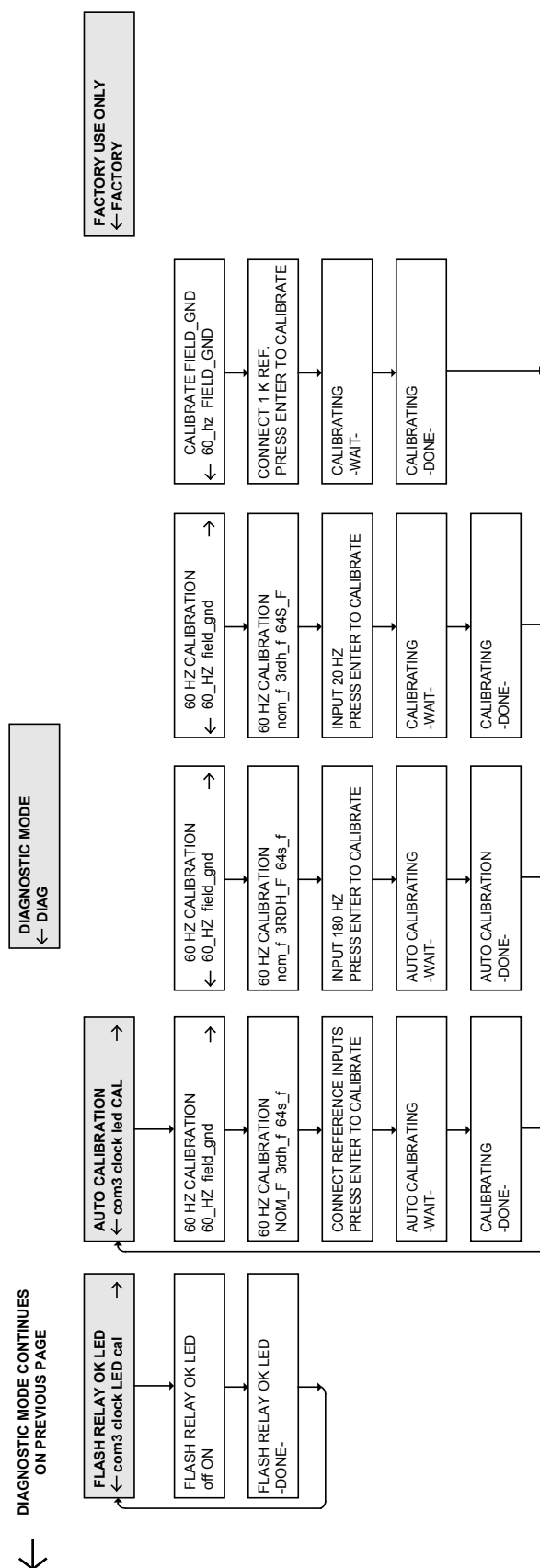


Figure F-15 Diagnostic Mode (1 of 2)



*Figure F-15 Diagnostic Mode (2 of 2)*

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## Declaration of Conformity

**DECLARATION OF CONFORMITY**  
( in accordance to ISO/IEC 17050-1:2004 )

No. M-3425A

**Manufacturer's Name:** Beckwith Electric CO, INC.  
**Manufacturer's Address:** 6190 118th Avenue North  
Largo, FL 33773-3724

The manufacturer hereby declares under our sole responsibility that the M-3425A product conforms to the following product standard as of January 14<sup>th</sup>, 2004 in accordance to Directive 2004/108/EC for equipment incorporated into stationary installations:

**BS EN 50263:2000**

**Electromagnetic compatibility ( EMC )**  
**Product standard for measuring relays and protection equipment**

**Electromagnetic Emissions: EN 60255-25:2000**

**Conducted 150 kHz to 30MHz**  
**Radiated 30MHz to 1000MHz**  
**Class A Limits**

**Electromagnetic Immunity**

**1 MHz Disturbance**  
EN 60255-22-1:1988  
( ANSI C37.90.1:2002 )

**Electrostatic Discharge 8kV Contact; 15kV Air**  
EN 60255-22-2:1997

**Radiated RF 80MHz to 1000MHz 10V/m, 80% AM ( 1kHz )**  
EN 60255-22-3:2001

**Fast Transients 5ns/50ns Bursts @ 5kHz for 15ms 300ms for 1 min.**  
**2kV power supply lines and earth 2kV signal data and control lines**  
EN 60255-22-4:2002

**Surge 1Kv Line to Line coupling, 2Kv Line to Earth coupling power supply lines 12Ω source impedance**  
EN 61000-4-5:1995

**Conducted RF 150KHz to 80MHz 10V emf**  
EN 60255-22-6:2001

**Power frequency magnetic field immunity test**  
**30 A/m continuous**  
EN 61000-4-8:1994

**Voltage dips, short interruptions and voltage variations immunity tests**  
EN 61000-4-11:1994

**EN 61010-1: 2001 Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1. General requirements European Safety Directive**

**Manufacturers Contact:**  
Engineering Manager  
6190 118<sup>th</sup> Ave North  
Largo, FL 33773-3724  
Tel ( 727 ) 544-2326

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## 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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**ISO 9001:2008**