

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), Sync Check (25), 100% Stator Ground Fault Protection by low frequency injection (64S) and Expanded I/O (15 additional Output Contacts and 8 additional Control/Status Inputs)**

*Made With Pride by
Beckwith Electric Company
in the United States of America*

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.
- 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

- Sync Check with Phase Angle, ΔV and ΔF with dead line/dead bus options (25)
- 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 supplied with the 64S option:
 - 20 Hz signal generator (430-00426)
 - Band-pass Filter (430-00429)
 - 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)
- M-3820D 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 $+70^{\circ}\text{C}$
- Sequence of Events Log
- Trip Circuit Monitoring
- Breaker Monitoring
- Four Setpoint Groups

Optional Features

- Redundant power supply
- M-3925A Target Module
- M-3931 Human-Machine Interface (HMI) Module
- RJ45 Ethernet port utilizing MODBUS over TCP/IP and BECO2200 over TCP/IP protocols
- RJ45 Ethernet port utilizing IEC 61850 Protocol
- M-3801D IPSplot® PLUS Oscillograph Analysis Software
- Expanded I/O (15 additional outputs and 8 additional inputs)

PROTECTIVE FUNCTIONS

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

Volts / Hz				
24	Definite Time			
	Pickup #1, #2	100 to 200%	1%	$\pm 1\%$
	Time Delay #1, #2	30 to 8160 Cycles	1 Cycle	± 25 Cycles
	Inverse Time			
	Pickup	100 to 200%	1%	$\pm 1\%$
	Characteristic Curves	Inverse Time #1-#4	—	—
	Time Dial: Curve #1	1 to 100	1	
	Time Dial: Curves #2-#4	0.0 to 9.0	0.1	
	Reset Rate	1 to 999 Sec. (from threshold of trip)	1 Sec.	$\pm .02$ Sec. 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 120 V.

Phase Undervoltage				
27	Pickup #1, #2, #3	5 to 180 V	1 V	± 0.5 V or $\pm 0.5\%$ ± 0.8 V or $\pm 0.75\%^*$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	± 1 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 ≤ 20 cycles or $\pm 1\%$.

†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†
Third-Harmonic Undervoltage, Neutral				
27 TN	Pickup #1, #2	0.10 to 14.00 V	0.01 V	±0.1 V or ±1%
	Positive Sequence Voltage Block	5 to 180 V	1 V	±0.5 V or ±0.5%
	Forward Under Power Block	0.01 to 1.00 PU	0.01 PU	±0.01 PU or ±2%
	Reverse Under Power Block	-1.00 to -0.01 PU	0.01 PU	±0.01 PU or ±2%
	Lead Under var Block	-1.00 to -0.01 PU	0.01 PU	±0.01 PU or ±2%
	Lag Under var Block	0.01 to 1.00 PU	0.01 PU	±0.01 PU or ±2%
	Lead Power Factor Block	0.01 to 1.00	0.01	±0.03 PU or ±3%
	Lag Power Factor Block	0.01 to 1.00	0.01	±0.03 PU or ±3%
	High Band Forward Power Block	0.01 to 1.00 PU	0.01 PU	±0.01 PU or ±2%
	Low Band Forward Power Block	0.01 to 1.00 PU	0.01 PU	±0.01 PU or ±2%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
Directional Power				
32	Pickup #1, #2, #3	-3.000 to +3.000 PU	0.001 PU	±0.002 PU or ±2%
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	+16 Cycles or ±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.

Loss of Field (dual-zone offset-mho characteristic)				
40	Circle Diameter #1, #2	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 #1, #2	-50.0 to 50.0 Ω (-250.0 to 250.0 Ω)	0.1 Ω	±0.1 Ω or ±5% (±0.5 Ω or ±5%)
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Time Delay with Voltage Control #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Voltage Control (positive sequence)	5 to 180 V	1 V	±0.5 V or ±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†
Negative Sequence Overcurrent				
46	Definite Time			
	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%
	Inverse Time			
	Pickup	3 to 100%	1%	±0.5 % of 5 A (±0.5% of 1 A)
	Time Dial Setting ($K = I_2^{2t}$)	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	—

Pickup is based on the generator nominal current setting.

Stator Overload Protection				
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%

Instantaneous Phase Overcurrent				
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.

Breaker Failure				
50 BF	Pickup			
	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.

Definite Time Overcurrent				
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†
Instantaneous Neutral Overcurrent				
50N	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.

Inadvertent Energizing				
50	Overcurrent			
50/27	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%)
27	Undervoltage			
	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%

Inverse Time Neutral Overcurrent				
51N	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) 0.85 to 1.15 (IEEE curves)	0.01 0.01	

* For IEC Curves the timing accuracy is ±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.

Inverse Time Phase Overcurrent, with Voltage Control or Voltage Restraint				
51V	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	
		0.85 to 1.15 (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 ±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†
Phase Overvoltage				
59	Pickup #1, #2, #3	5 to 180 V	1 V	± 0.5 V or $\pm 0.5\%$ ± 0.8 V or $\pm 0.75\%^*$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	± 1 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 +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 ± 1 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.

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

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.

Neutral Overvoltage				
59N	Pickup #1, #2, #3	5.0 to 180.0 V	0.1 V	± 0.5 V or $\pm 0.5\%$
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	± 1 Cycle or $\pm 1\%$

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

Multi-purpose Overvoltage				
59X	Pickup #1, #2	5.0 to 180.0 V	0.1 V	± 0.5 V or $\pm 0.5\%$
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	± 1 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.

VT Fuse-Loss Detection				
60 FL	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 $\pm 1\%$
	Three Phase VT Fuse Loss Detection	Enable/Disable		

†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†
Residual Directional Overcurrent				
67N	Definite Time*			
	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%
	Inverse Time*			
	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 11 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±5%
Directional Element				
	Max Sensitivity Angle (MSA)	0 to 359°	1°	
	Polarizing Quantity	3V _o (calculated), V _N or V _x		

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

V_x polarization cannot be used if 25 function is enabled.

3V_o polarization can only be used with line-ground VT configuration.

Operating current for 67N can be selected as 3I_o (calculated) or I_N (Residual CT).

If 87GD is enabled, 67N with I_N (Residual CT) operating current will not be available.

Out of Step (mho characteristic)				
78	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%
Frequency				

81	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.

†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†
Frequency Accumulation				
81A	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.

Rate of Change of Frequency				
81R	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%

Phase Differential Current				
87	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	+1 to -2 Cycles or ±1%

*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 $I_A I_B I_C$.

Ground (zero sequence) Differential Current				
87 GD	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_C)	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.

†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†
IPSlogic™				

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

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

Trip Circuit Monitoring				
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TC	Time Delay	1 to 8160 Cycles	1 Cycle	± 1 Cycle or ± 1%
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The AUX input is provided for monitoring the integrity of the trip circuit. This input can be used for nominal trip coil voltages of 24 V dc, 48 V dc, 125 V dc and 250 V dc.

Nominal Settings				
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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†
Sync Check				
(25D)	Dead Check			
	Dead Voltage Limit	0 to 60 V	1 V	±0.5 V or ±0.5%
	Dead Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or 1%
(25S)	Sync Check			
	Phase Angle Window	0° to 90°	1°	±1°
	Upper Voltage Limit	60 to 140 V	1 V	±0.5 V or ±0.5%
	Lower Voltage Limit	40 to 120 V	1 V	±0.5 V or ±0.5%
	Delta Voltage Limit	1.0 to 50.0 V	0.1 V	±0.5 V or ±0.5%
	Delta Frequency Limit	0.001 to 0.500 Hz	0.001 Hz	±0.0007 Hz or ±5%
	Sync Check Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±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.

Field Ground Protection				
(64F)	Pickup #1, #2	5 to 100 K Ω	1 K Ω	±10% or ±1K Ω
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±($\frac{2}{f_F} + 1$) Sec.
	Injection Frequency (IF)	0.10 to 1.00 Hz	0.01 Hz	
(64B)	Brush Lift-Off Detection (measuring control circuit)			
	Pickup	0 to 5000 mV	1 mV	
	Time Delay	1 to 8160 Cycles	1 Cycle	±($\frac{2}{f_F} + 1$) Sec.

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

Figure 10, 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 11, M-3921 Field Ground Coupler Mounting Dimensions.

100% Stator Ground Protection by low frequency injection				
(64S)	Total Current Pickup	2 to 75 mA	0.1 mA	±2 mA or ±10%
	Real Component of Total Current Pickup	2 to 75 mA	0.1 mA	±2 mA or ±10%
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle* or ±1%

An external Low Frequency Generator, Band Pass Filter and Current Transformer are required for this function. Figure 12, 64S Function Component Connection Diagram, illustrates a typical 100% Stator Ground Protection by Low Frequency Injection application. Hardware dimensional and mounting information is illustrated in Figures 13, 14 and 15.

59D and 27TN function should be disabled when the 64S function is enabled. 59N may be applied when this function is enabled.

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

†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.

■ **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:	± 0.5 V or $\pm 0.5\%$, whichever is greater ± 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, ± 0.1 A or $\pm 3\%$, whichever is greater 1 A rating, ± 0.02 A or $\pm 3\%$, whichever is greater
Power:	± 0.01 PU or $\pm 2\%$ of VA applied, whichever is greater
Frequency:	± 0.02 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models) ± 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.

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 M-3820D IPScom Communications Software.

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 V ac, 50/60 Hz, or nominal 110/125/220/250 V dc. Operates properly from 85 V ac to 265 V ac and from 80 V dc to 312.5 V dc. Withstands 300 V ac or 315 V dc for 1 second. Nominal burden 40 VA at 120 V ac/125 V dc.

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

An optional redundant power supply is available for units that are purchased without the 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. Burden (nominal) 46 VA @ 120 V ac.

Sensing Inputs

Five Voltage Inputs: Rated for a nominal voltage of 50 V ac to 140 V ac 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 V ac.

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 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 V dc 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 ANSI/IEEE C37.90-1989 for tripping. Make 30 A for 0.2 seconds, carry 8 A, break 6 A at 120 V ac, break 0.5 A at 48 V dc; 0.3 A, 125 V dc; 0.2 A, 250 V dc with L/R=40 mSec.

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 and an Ethernet port (optional). The communications protocol implements serial, byte-oriented, asynchronous communication, providing the following functions when used with the Windows™-compatible M-3820D IPScom® Communications Software. MODBUS and BECO 2200 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.

IRIG-B

The M-3425A Generator Protection Relay can accept either modulated or demodulated 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 (optional)

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

Target Module (optional)

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.

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 V ac, 50/60 Hz, or 220/240 V ac 50/60 Hz or 24 V dc.

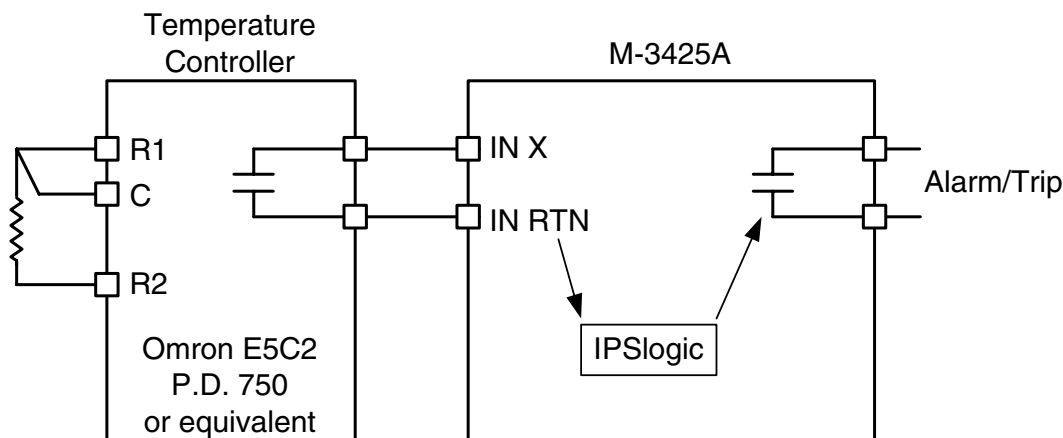


Figure 1 Typical Temperature Controller Monitoring Application

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.

Tests and Standards

The relay complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

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

Impulse Voltage

IEC 60255-5	5,000 V pk, +/- polarity applied to each independent circuit to earth
	5,000 V pk, +/- polarity applied between each independent circuit
	1.2 by 50 μ 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

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

Atmospheric Environment

Temperature

IEC 60068-2-1 Cold, -20° C

IEC 60068-2-2 Dry Heat, +70° C

IEC 60068-2-3 Damp Heat, +40° C @ 93% RH

Mechanical Environment

Vibration

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

IEC 60255-21-2 Shock Response Class 1, 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.

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.

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.

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 five year warranty from date of shipment.

Specification subject to change without notice.

External Connections

M-3425A external connection points are illustrated in Figures 2 and 3.

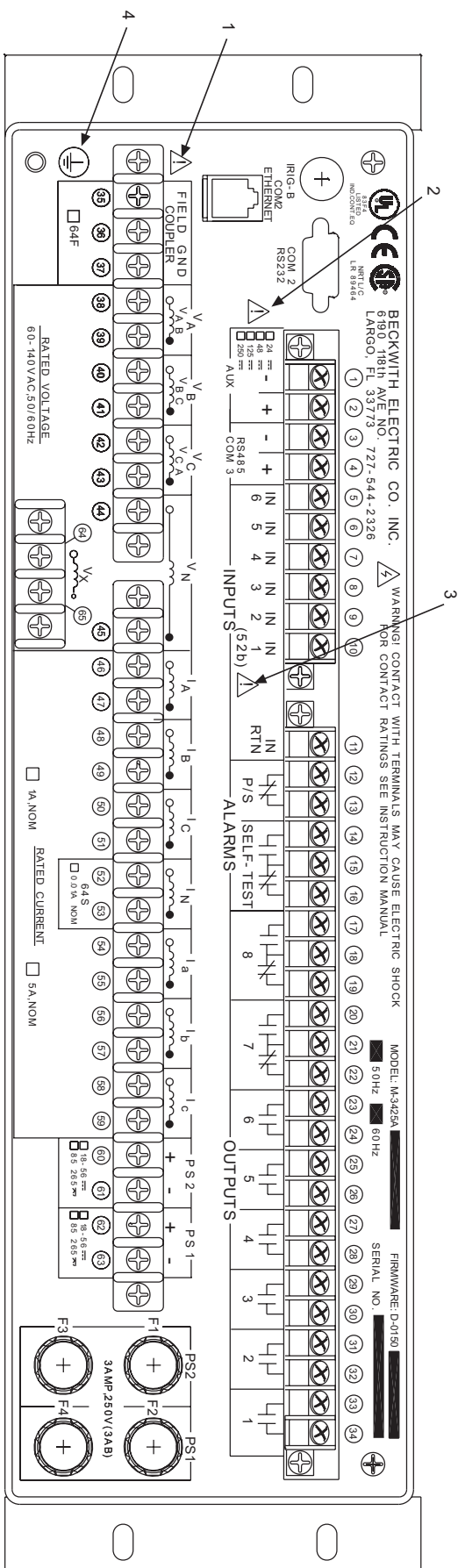


Figure 2 External Connections (Without Optional Expanded I/O)

NOTES:

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. **WARNING: 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.**

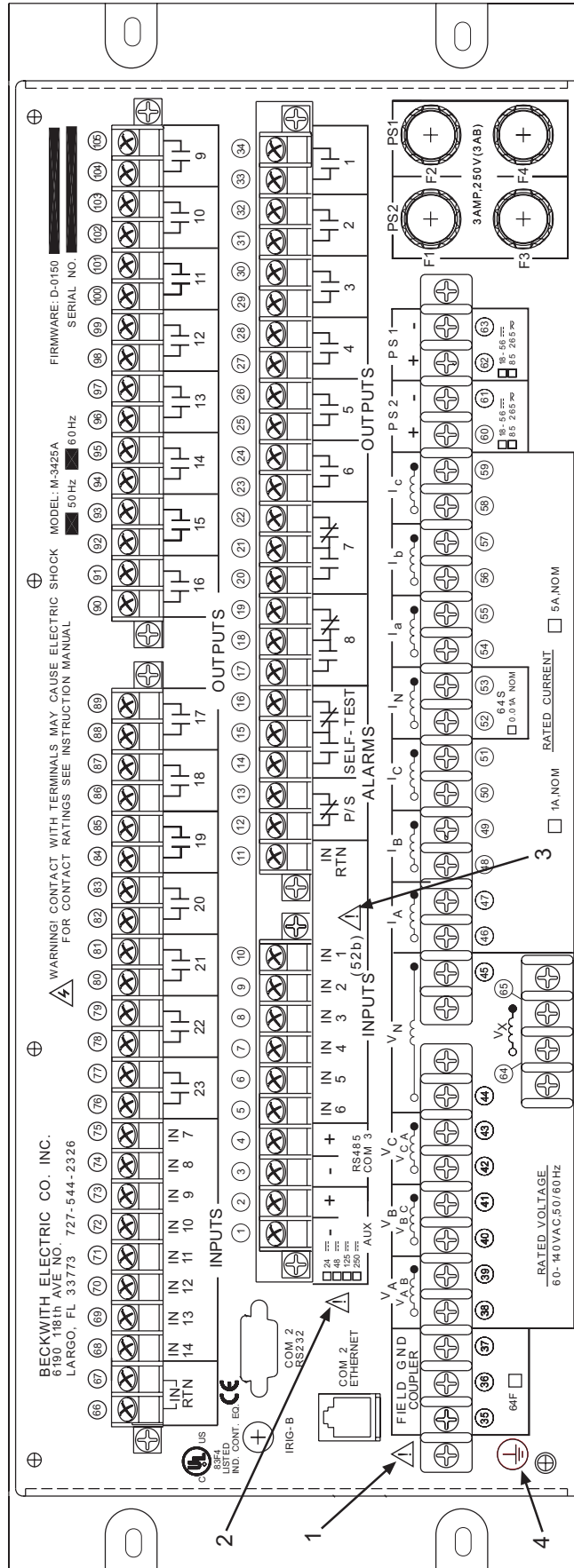
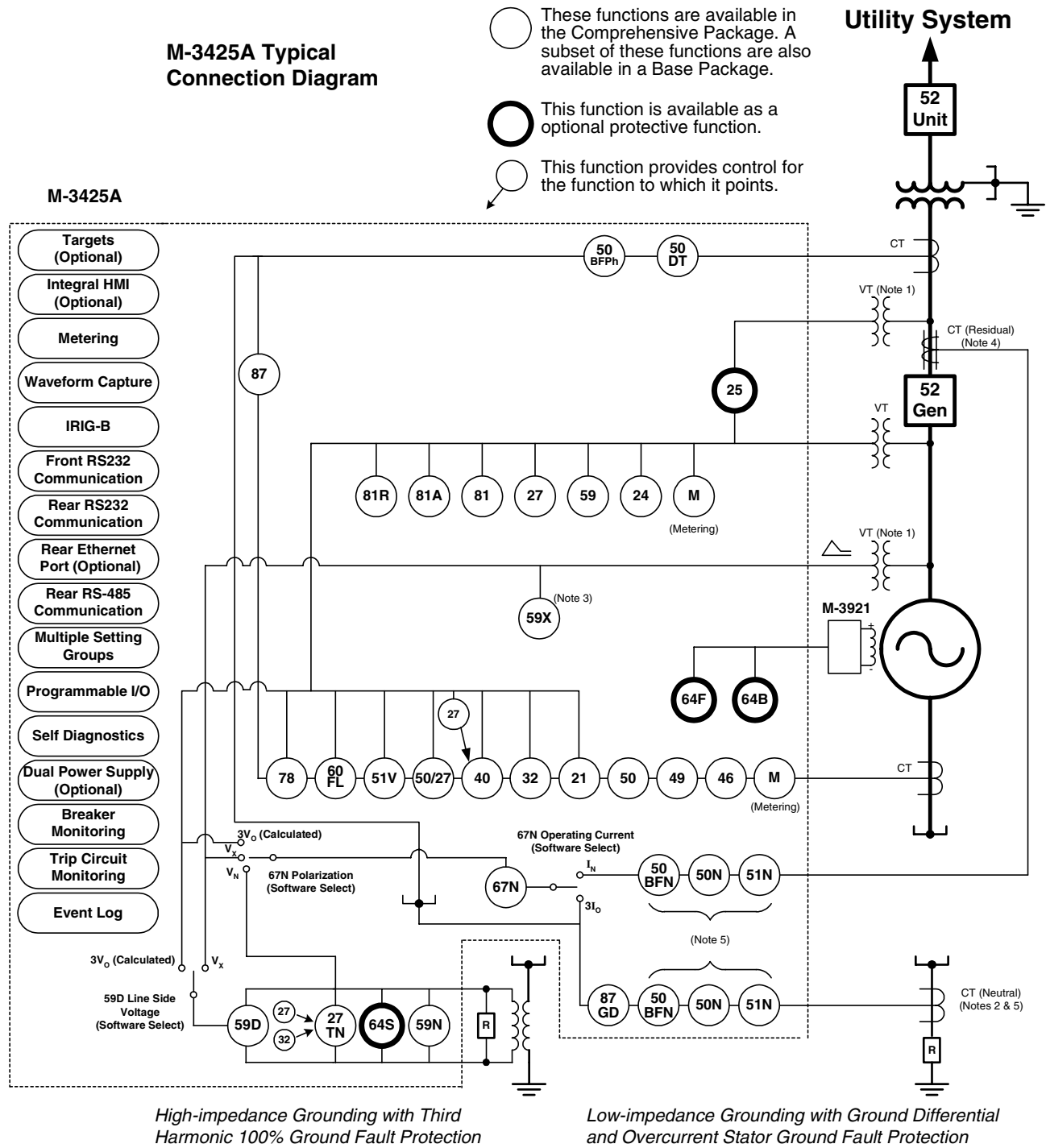


Figure 3 External Connections (With Optional Expanded I/O)

NOTES:

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. **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.**
4. **WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**

M-3425A Typical Connection Diagram



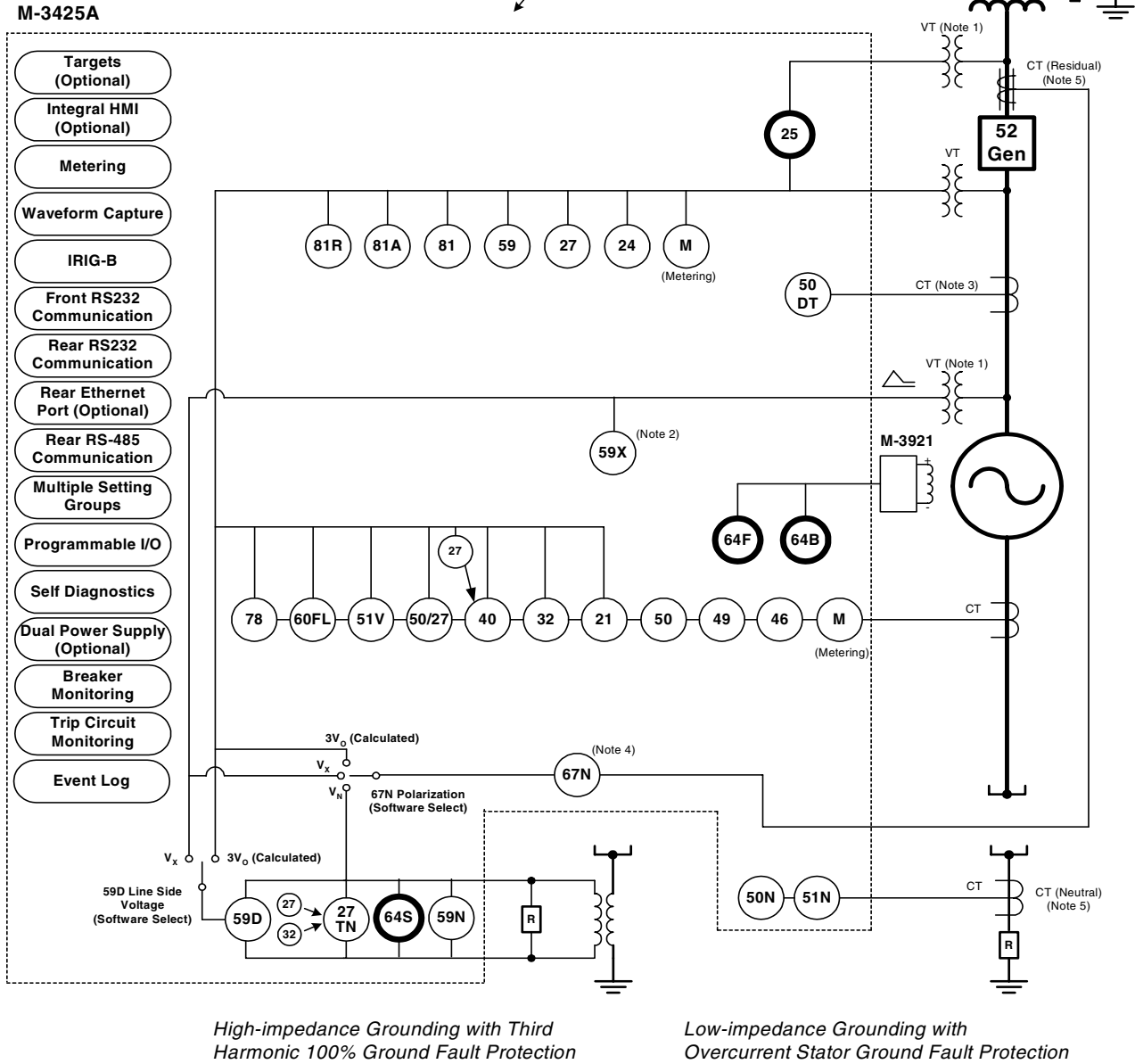
NOTES:

- When 25 function is enabled, 59X, 59D with V_x and 67N with V_x are not available, and vice versa.
- When 67N function with I_N (Residual) operating current is enabled, 87GD is not available, and vice versa.
- When VT source is used as a turn-to-turn fault protection device (See M-3425A Instruction Book, Chapter 2, Application, for additional 59X applications.)
- The current input I_N can be connected 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 One-Line Functional Diagram (Configured with Phase Differential)

M-3425A Typical Connection Diagram (Configured for Split-Phase Differential)

-  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 an optional protective function.
-  This function provides control for the function to which it points.

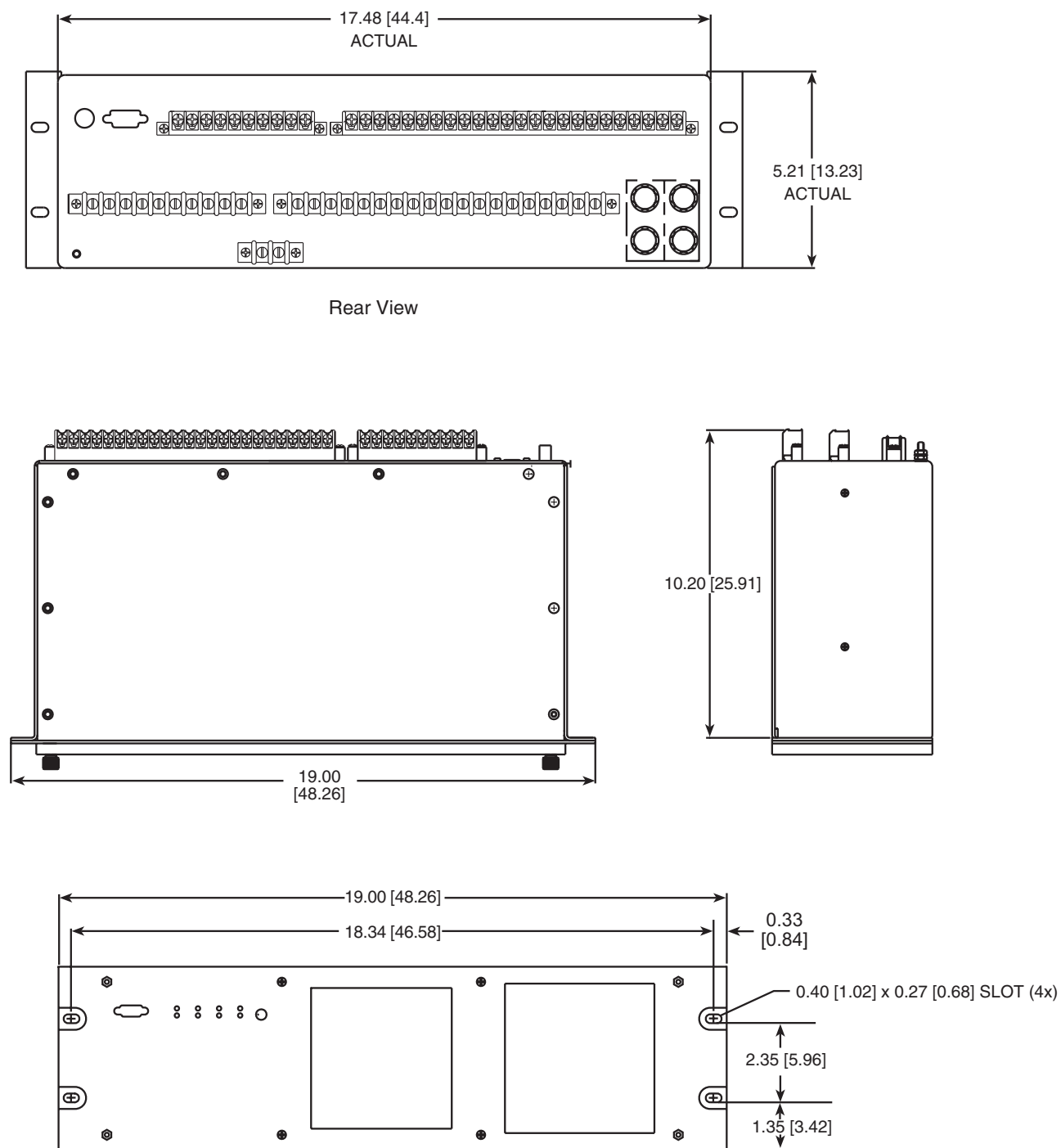


NOTES:

1. When 25 function is enabled, 59X, 59D with V_x and 67N with V_x are not available, and vice versa.
2. When used as a turn-turn fault protection device.
3. CTs are connected for split-phase differential current.
4. 67N operating current can only be selected to I_N (Residual) for this configuration.
5. The current input (I_N) can be connected either from neutral current or residual current.
6. 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 5 One-Line Functional Diagram (configured for split-phase differential)

M-3425A Generator Protection Relay



Standard 19" Horizontal Mount Chassis

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

Figure 6 Horizontal Mounting Dimensions (Without Expanded I/O)

■ **NOTE:** Panels for vertical mounting are available (See Figure 8).

M-3425A Generator Protection Relay

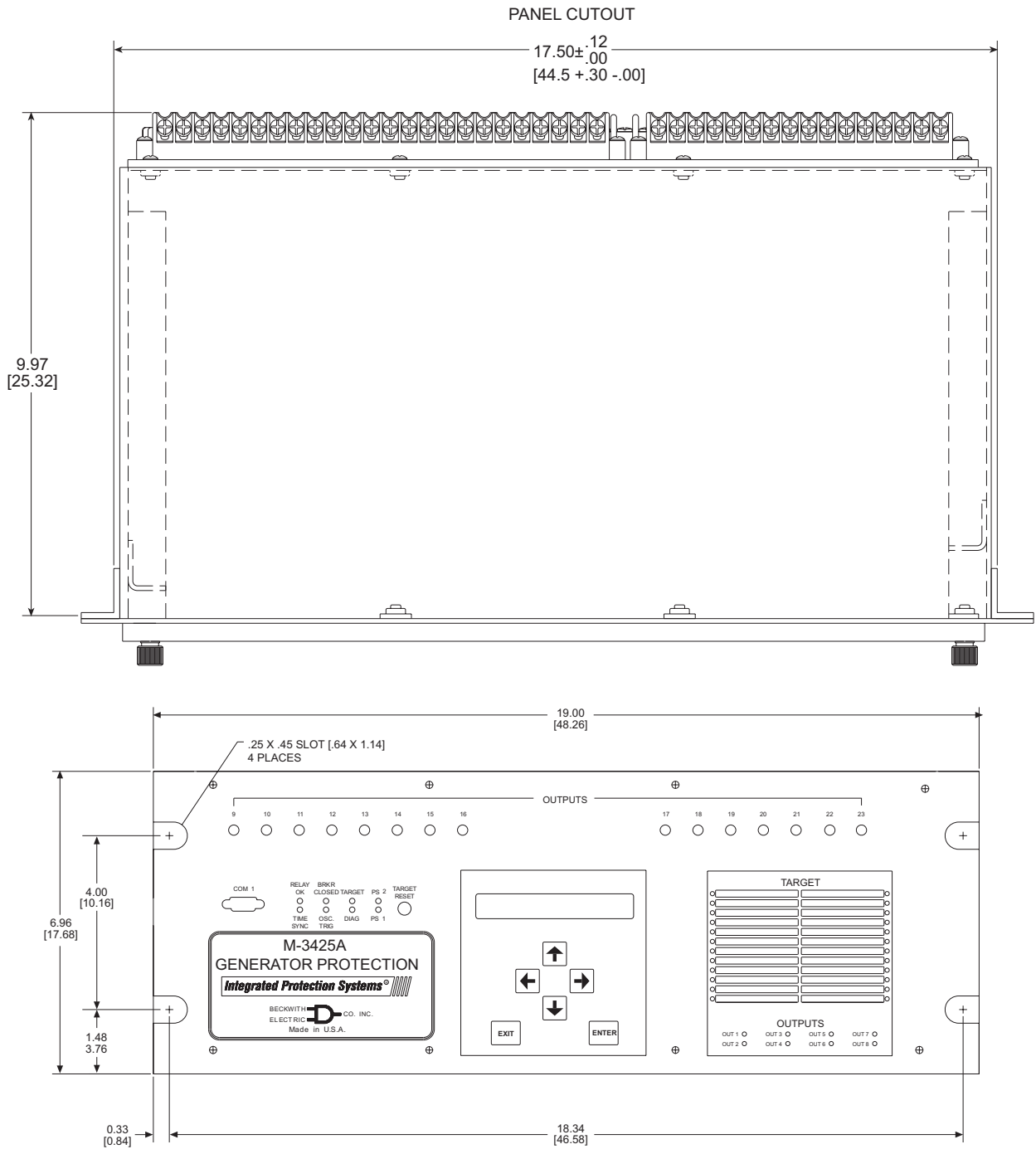
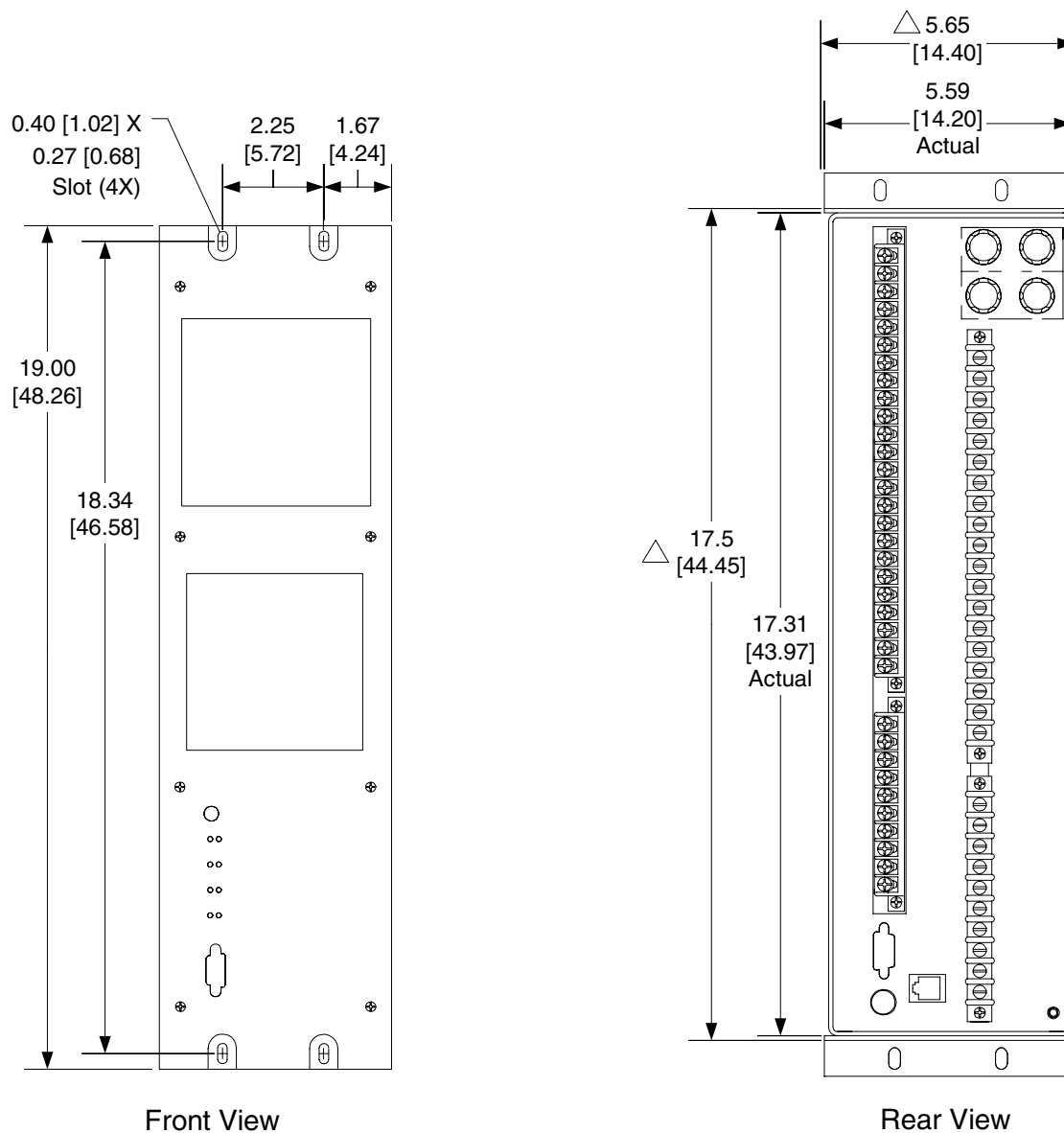


Figure 7 Horizontal Mounting Dimensions (With Expanded I/O)



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

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

Optional Vertical Mount Chassis

■ **NOTES:**

1. When mounted vertically, the target module will be located at the top and all front-panel text will be horizontally aligned. Consult Beckwith Electric Co. for details.
2. Expanded I/O not available on vertical mount chassis model.

Figure 8 Vertical Mounting Dimensions (Without Expanded I/O)

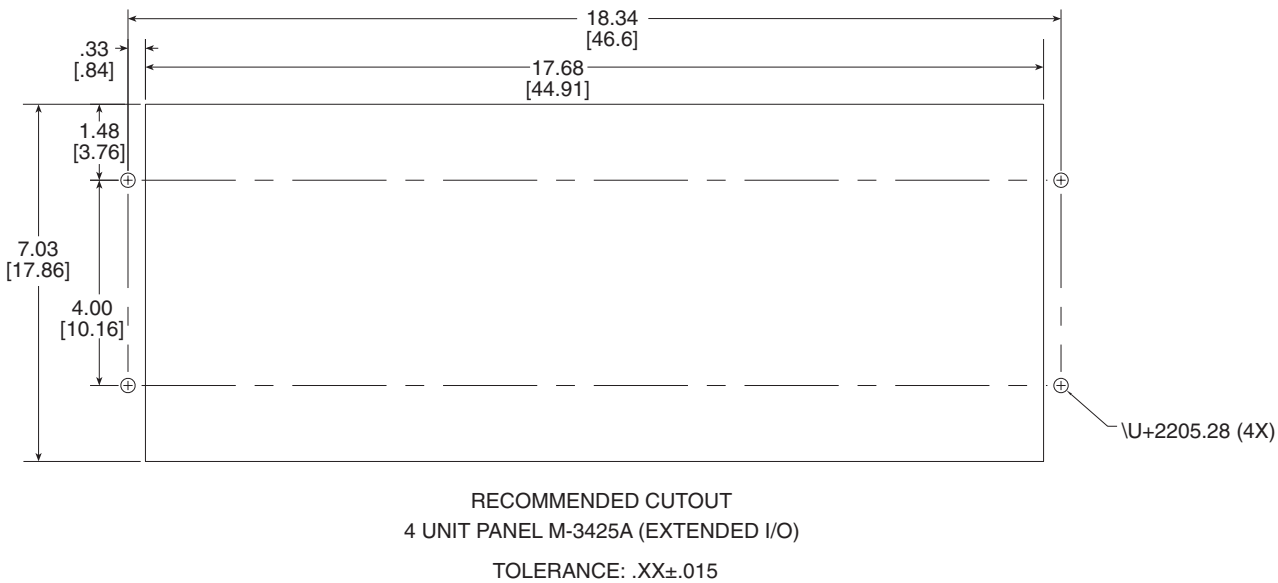
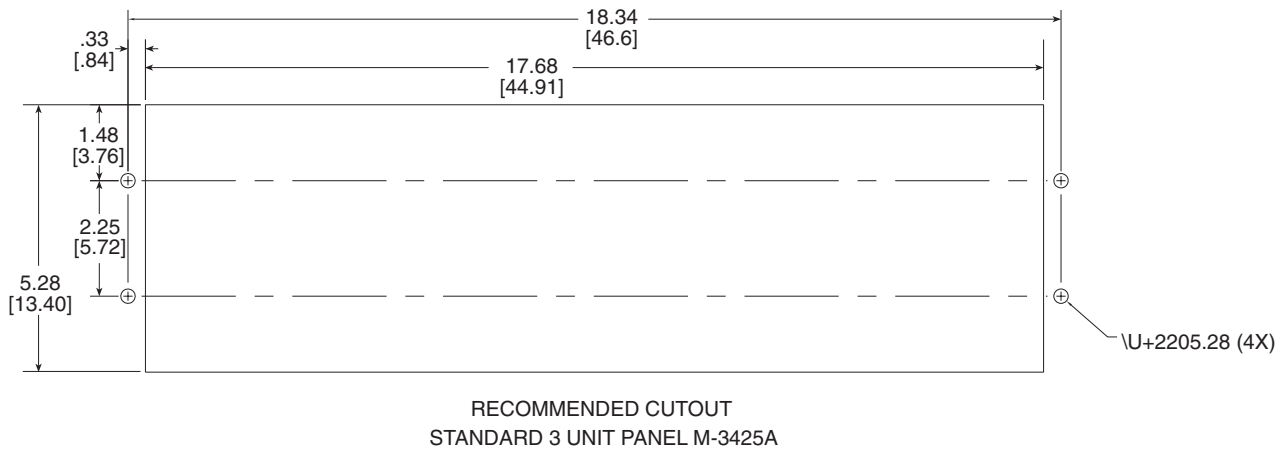


Figure 9 M-3425A Panel Mount Cutout Dimensions

M-3921 Field Ground Coupler

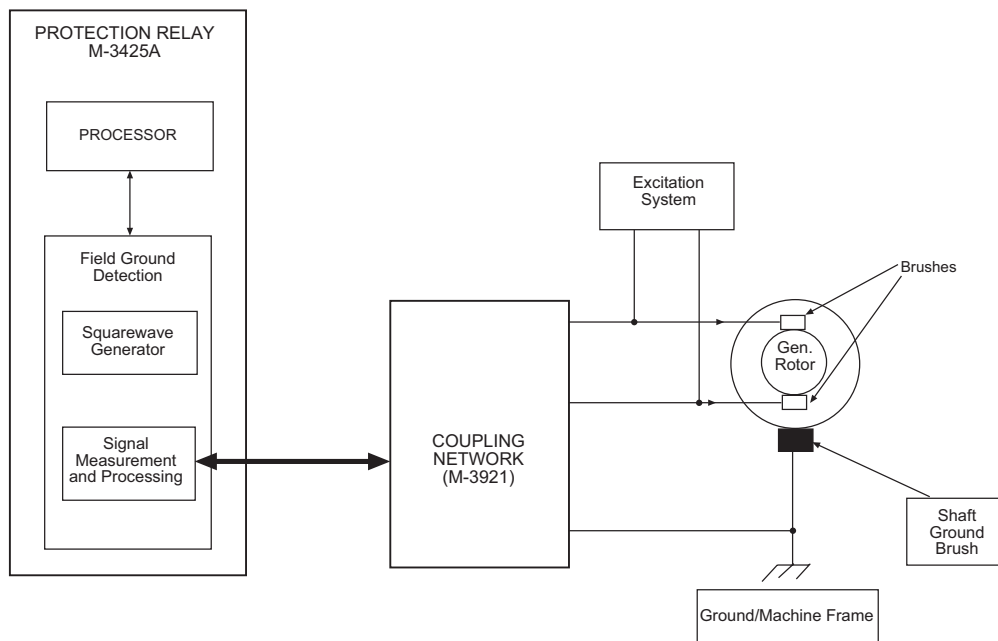


Figure 10 Field Ground Protection Block Diagram

■ NOTES:

1. The above circuit measures insulation resistance (R_f) between rotor field winding and ground (64F).
2. Relay injects ± 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 V dc, continuous
- 1500 V dc, 1 minute

Operating Temperature: -20° to $+70^{\circ}$, 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

4 kV ac for 1 minute, all terminals to case

Impulse Voltage

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

Electrical Interference

Electrostatic Discharge Test

IEC 61000-4-2 Class 4 (8 kV)—point contact 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

■ **NOTE:** See also M-3425A Surge Withstand Capability test standards, ANSI/IEEE C37.90.2-2002.

Radiated Susceptibility

ANSI/IEEE 25-1000 Mhz @ 20 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 1, IEC IPC-65

M-3425A Generator Protection Relay

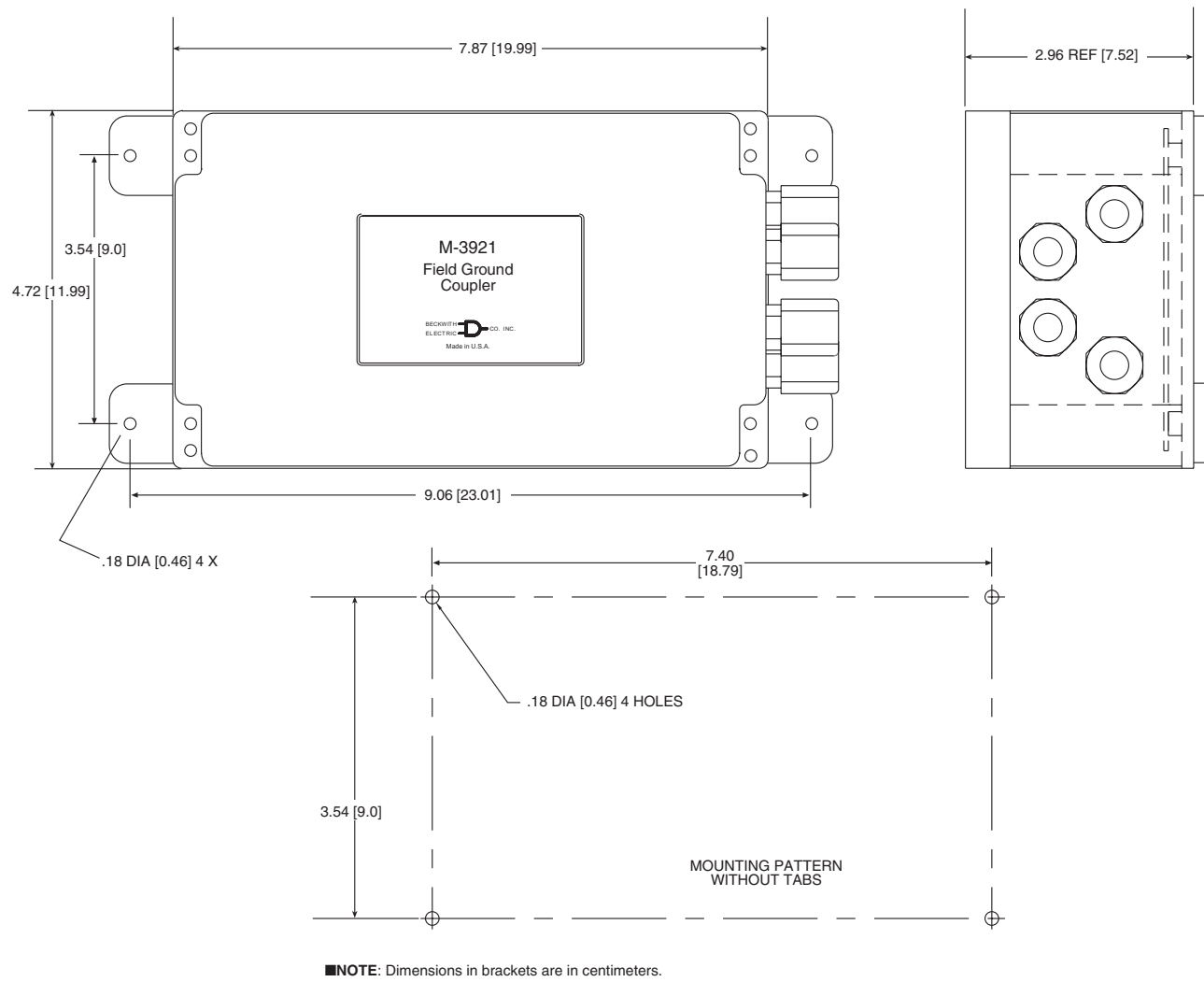


Figure 11 M-3921 Field Ground Coupler Mounting Dimensions

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:

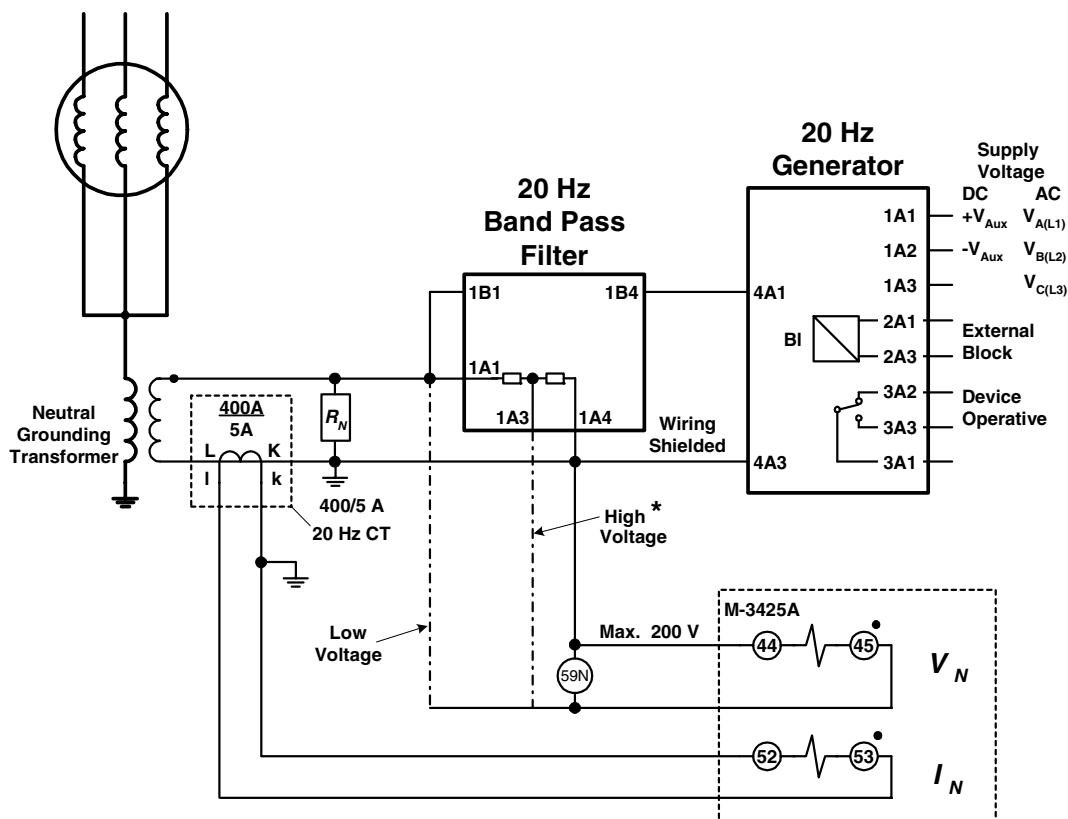
- 20 Hz Signal-generator (BECO Part No. 430-00426) (Siemens 7XT33)
- Band-pass filter. (BECO Part No. 430-00427) (Siemens 7XT34)
- 20 Hz Measuring Current Transformer, 400/5 A CT (BECO Part No. 430-00428) (ITI-CTW3-60-T50-401)

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 ≤ 200 V ac (the voltage generator may be bypassed if the expected 50/60 Hz voltage during a phase-to-ground fault of the generator is ≤ 200 V.) The 20Hz current is also connected to the I_N input of the M-3425A, through the 20Hz 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. When a ground fault occurs anywhere on the generator stator windings the 20 Hz current will increase. The 64S function will issue a trip signal after a set time delay when the measured 20 Hz current exceeds the pickup current.

For cases where the Load Resistor (R_N) is small, the Undervoltage Inhibit should not be enabled, as the voltage will be small.

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



* For applications with a transformer secondary rating that will result in 50/60 Hz phase ground fault voltages >200 V ac, use the "High Voltage" connection for the 59N Function.

Figure 12 64S Function Component Connection Diagram

20 Hz Signal Generator Function Specifications

Auxiliary Voltage

Rated auxiliary voltage U_H ac	3x (100/110 V ac), 50/60 Hz	1x (110 to 230 V ac), 50/60 Hz
Permissible variations ac	80 to 130 V ac	80 to 265 V ac

OR

Rated auxiliary voltage U_H dc	110 to 220 V dc
Permissible Variations dc	88 to 253 V dc

Permissible consumption at 8 W impedance ≤ 110 VA

20 Hz Output Voltage

Connections (4A1-4A3)

Output Voltage approx. 25 V rectangular; 20 Hz ± 0.2 Hz

Load Capability, continuous 75 VA

■ **NOTE:** If the input voltage is slowly increased, appearance of the output voltage may last up to 1 minute.

Binary Input for Blocking

Connections (2A1-2A3)

Permissible voltage, continuous 300 V dc

Alarm Relay

Connections (3A1-3A3)

Switching capacity MAKE/BREAK 20W/VA

Switching voltage for ≤ 30 s 250 V dc

Permissible current MAKE 5A

Permissible current BREAK 1A

Test Voltage

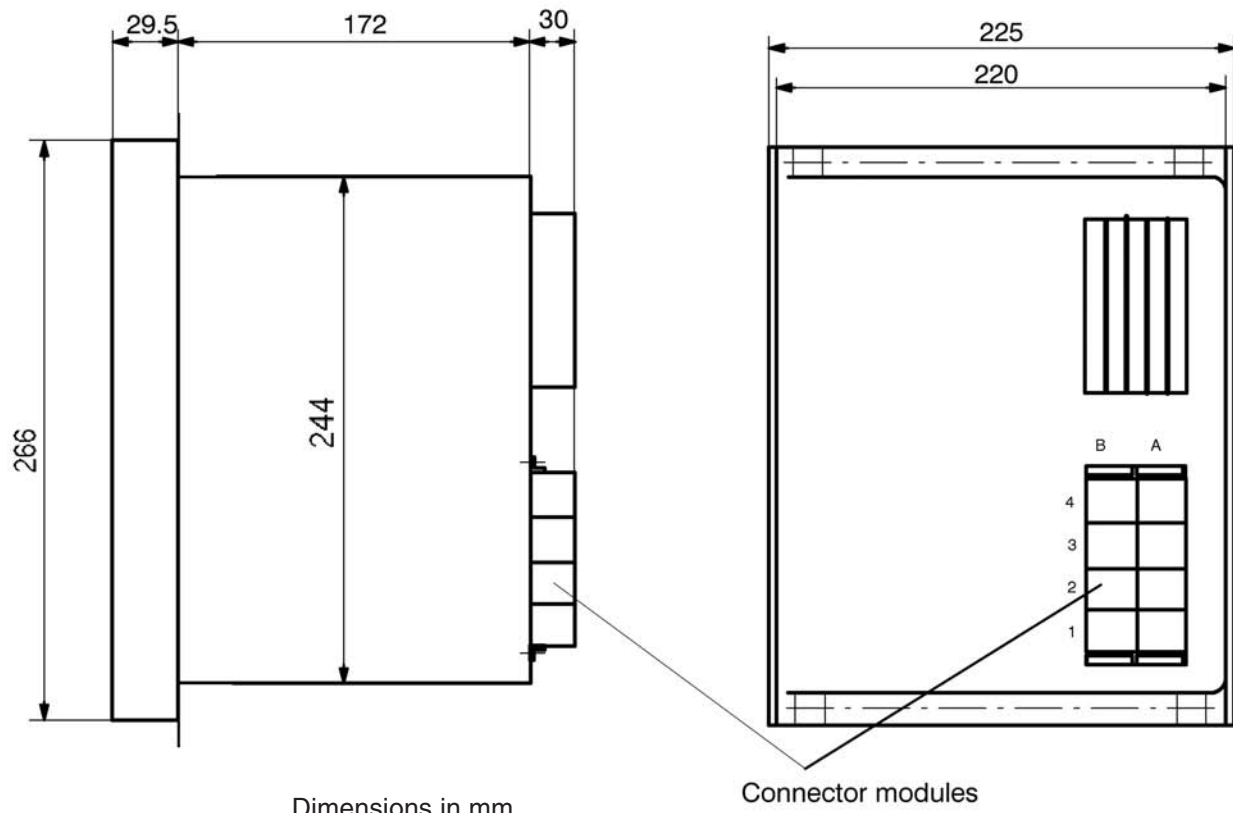
2.8 kV dc

Permissible Ambient Temperatures

with $R_L < 5$ W burden $\leq 40^\circ\text{C}$ or $\leq 104^\circ\text{F}$

with $R_L > 5$ W burden $\leq 55^\circ\text{C}$ or $\leq 131^\circ\text{F}$

■ **NOTE:** The device may produce up to 20 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.



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

Figure 13 20Hz 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 ≤ 30 s 550 V ac

Frequency of superimposed ac voltage ≥ 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 ≤ 30 s 50 V ac

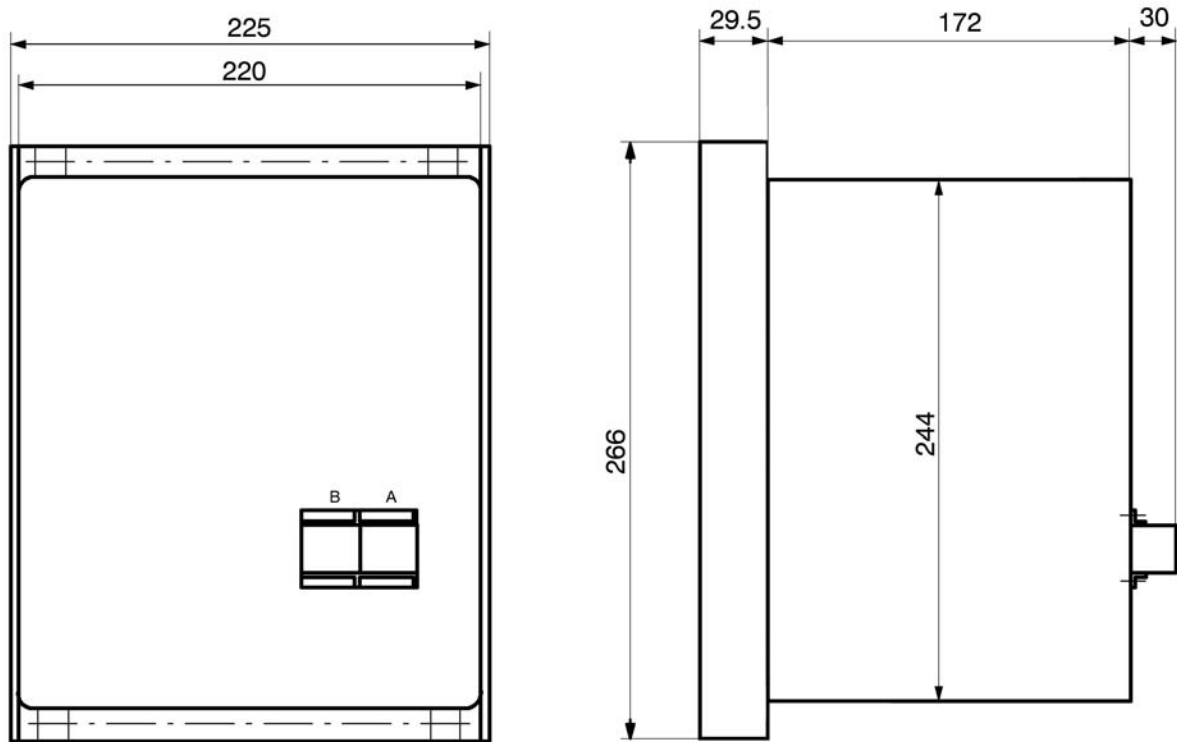
Test Voltage 2.8 kV dc

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 14 Band-pass Filter Dimensions

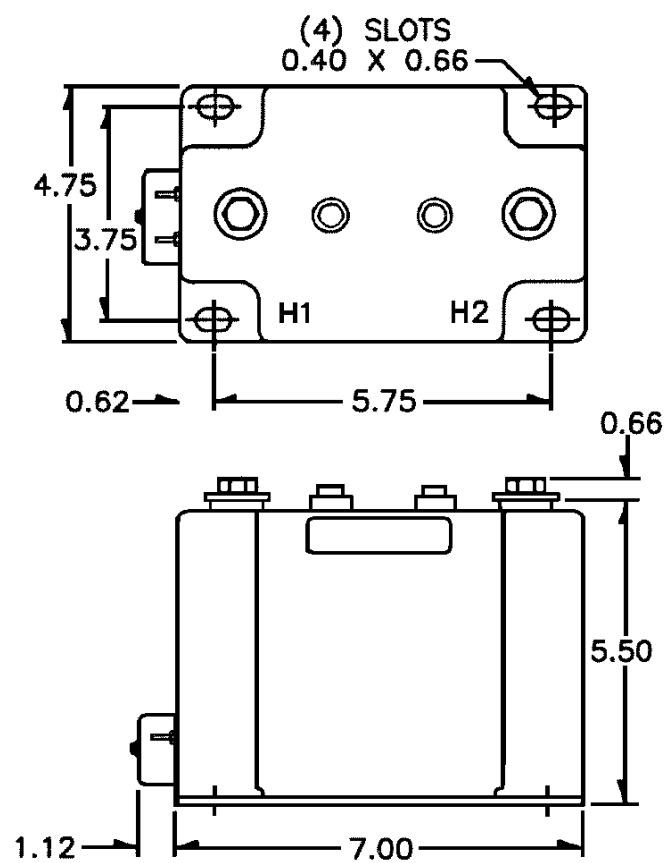


Figure 15 20 Hz Measuring Current Transformer 400-5 A CT

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