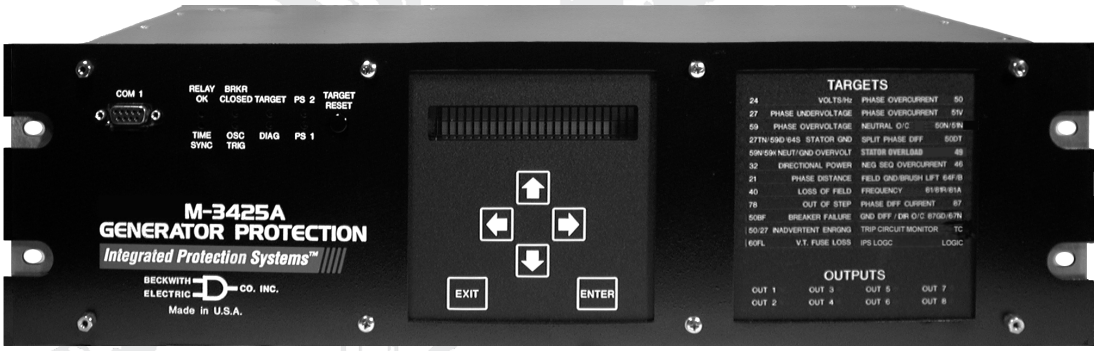
BECKWITH ELECTRIC CO. INC.

PROTECTION

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)**

Industry Leader Since 1969
Made in the USA

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, ΔV and ΔF 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†
	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	±0.1 Ω or 5% (±0.5 Ω or 5%)
	Offset #1,#2,#3	-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 #1,#2,#3	0° to 90°	1°	±1°
	Load Encroachment Blinder #1,#2,#3			
	Angle	1° to 90°	1°	±1°
	R Reach	0.1 to 100 Ω		
	Time Delay #1,#2,#3	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Out-of-Step Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Overcurrent Supervision	0.1 to 20 A (0.02 to 4 A)	0.1 A 0.01 A	±0.1 A or ±2% ±0.02 A or ±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%	±1%
	Time Delay #1, #2	30 to 8160 Cycles	1 Cycle	±25 Cycles
	Inverse Time			
	Pickup	100 to 200%	1%	±1%
	Characteristic Curves	Inverse Time #1–#4	—	—
	Time Dial: Curve #1	1 to 100	1	±1%
	Time Dial: Curves #2–#4	0.0 to 9.0	0.1	±1%
	Reset Rate	1 to 999 Sec. (from threshold of trip)	1 Sec.	±1 Second or ±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.

	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 Limit	0° to 90°	1°	±1°
25	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.

†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 Undervoltage			
27	Pickup #1, #2, #3	5 to 180 V	1 V	±0.5 V or ±0.5% ±0.8 V or ±0.75%*
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±0.5%**
	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 to +5 Cycles 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%
	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°	—

** 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 ± 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.

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	±1 Second or ±1%
	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 (50 BF-Ph)	**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%)
50 BF (50 BF-N)	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			
50/27	50 **Overcurrent**			
	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%
	When RMS (total Waveform) is selected, timing accuracy is ≤20 cycles 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 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±3%*
	** 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 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±3%*
	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 ±0.5% ±0.8 V or ±0.75%*
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%**
	Input Voltage Select	Phase, Positive or Negative Sequence***		
	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 ±1%
	Positive Seq Voltage Block	5 to 180 V	1 V	±0.5 V or ±0.5%
	Line Side Voltage	V_X or $3V_0$ (calculated)		
	Neutral Overvoltage			
59N	Pickup #1, #2, #3	5.0 to 180.0 V	0.1 V	±0.5 V or ±0.5%
	Time Delay #1, #2, #3	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Neg. Seq. Voltage Inhibit (>)	1.0 to 100.0 %	0.1 %	±0.5 V or ±0.5%
	Zero Seq. Voltage Inhibit (<)	1.0 to 100.0 %	0.1 %	±0.5 V or ±0.5%
	Zero Seq. Voltage Selection	$3V_0$ or V_X		
	20 Hz Injection Mode	Enable/Disable		
	Multi-purpose Overvoltage			
59X	Pickup #1, #2	5 to 180 V	1 V	±0.5 V or ±0.5%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

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

*** When RMS (total waveform) is selected, timing accuracy is ≤20 cycles or ± 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 ± 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.*

The 59D function has a cutoff voltage of 0.5 V for 3rd 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.

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

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†
	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 ±1%
	Three Phase VT Fuse Loss Detection	Enable/Disable		
	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 15.0 (IEEE curves)	0.1 0.01 0.01	±3 Cycles or ±5%
	Directional Element			
	Max Sensitivity Angle (MSA)	0 to 359°	1°	
	Polarizing Quantity	$3V_0$ (calculated), V_N or V_X		
	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%

**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 $3I_0$ (calculated) or I_N (Residual CT).

If 87GD is enabled, 67N with I_N (Residual CT) operating current 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†
	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%
	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%
	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	

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.*

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.*

**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†
	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	
	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			
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^2T		
	Preset Accumulators Phase A, B, C	0 to 50,000 kA Cycles	1 kA Cycle	

**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.

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†
	Trip Circuit Monitoring			
TC	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.

	Nominal Settings			
	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†
	Field Ground Protection			
64F	Pickup #1, #2	5 to 100 KΩ	1 KΩ	±10% or ±1KΩ
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	$\pm(\frac{2}{IF}+1)$ 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	$\pm(\frac{2}{IF}+1)$ 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.

	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. 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:	±0.5 V or ±0.5%, whichever is greater ±0.8 V or ±0.75%, whichever is greater (when both RMS and Line-Ground to Line-Line are selected)
Current:	5 A rating, ±0.1 A or ±3%, whichever is greater 1 A rating, ±0.02 A or ±3%, whichever is greater
Power:	±0.01 PU or ±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:	±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 55Hz 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 ≥ 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.

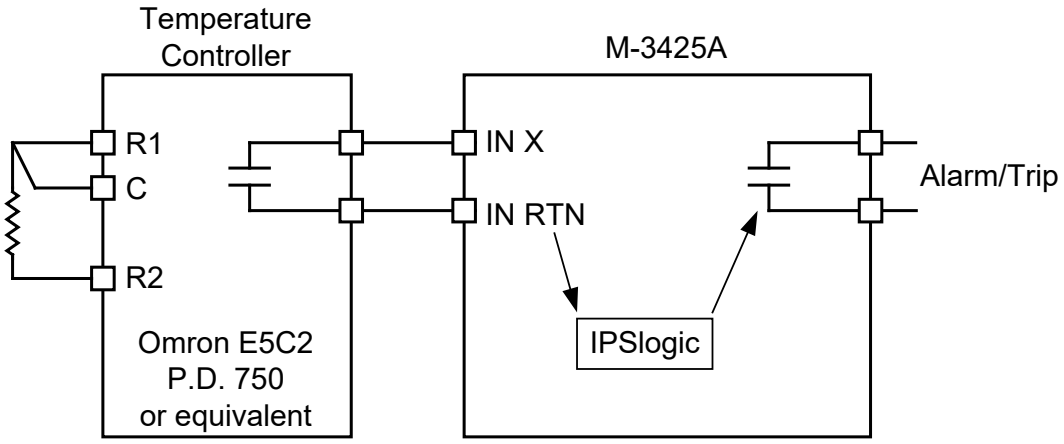


Figure 1 Typical Temperature Controller Monitoring Application

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 μs, 500 ohms impedance, three surges at 1 every 5 seconds

Insulation Resistance

IEC 60255-5 > 100 Megaohms

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 C37.90.1-1989	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk oscillatory applied between each independent circuit 5,000 V pk Fast Transient applied to each independent circuit to earth 5,000 V pk Fast Transient applied between each independent circuit
ANSI/IEEE C37.90.1-2002	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk oscillatory applied between each independent circuit 4,000 V pk Fast Transient burst applied to each independent circuit to earth 4,000 V pk Fast Transient burst applied between each independent circuit

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

Radiated Susceptibility

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

Output Contacts

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 No. 14	6 A break at 120 Vac, 50/60 Hz 0.5 A break at 48 Vdc, 24 VA 0.3 A break at 125 Vdc, 37.5 VA 0.2 A break at 250 Vdc, 50 VA

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, -20° C
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.

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

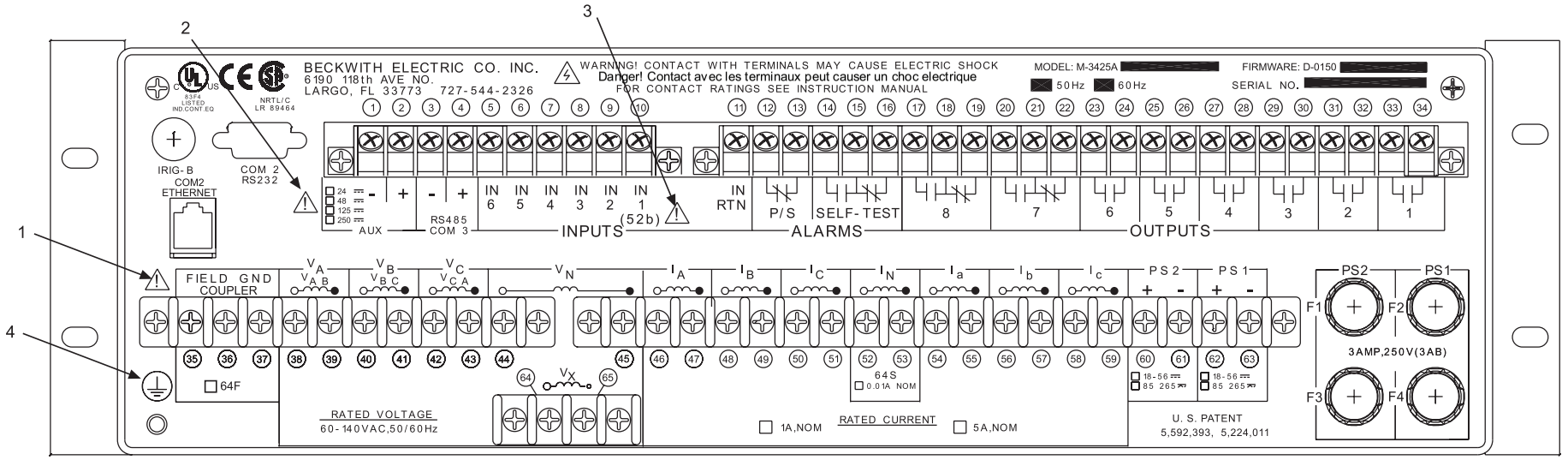


Figure 2 External Connections (Without Optional Expanded I/O)

■**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

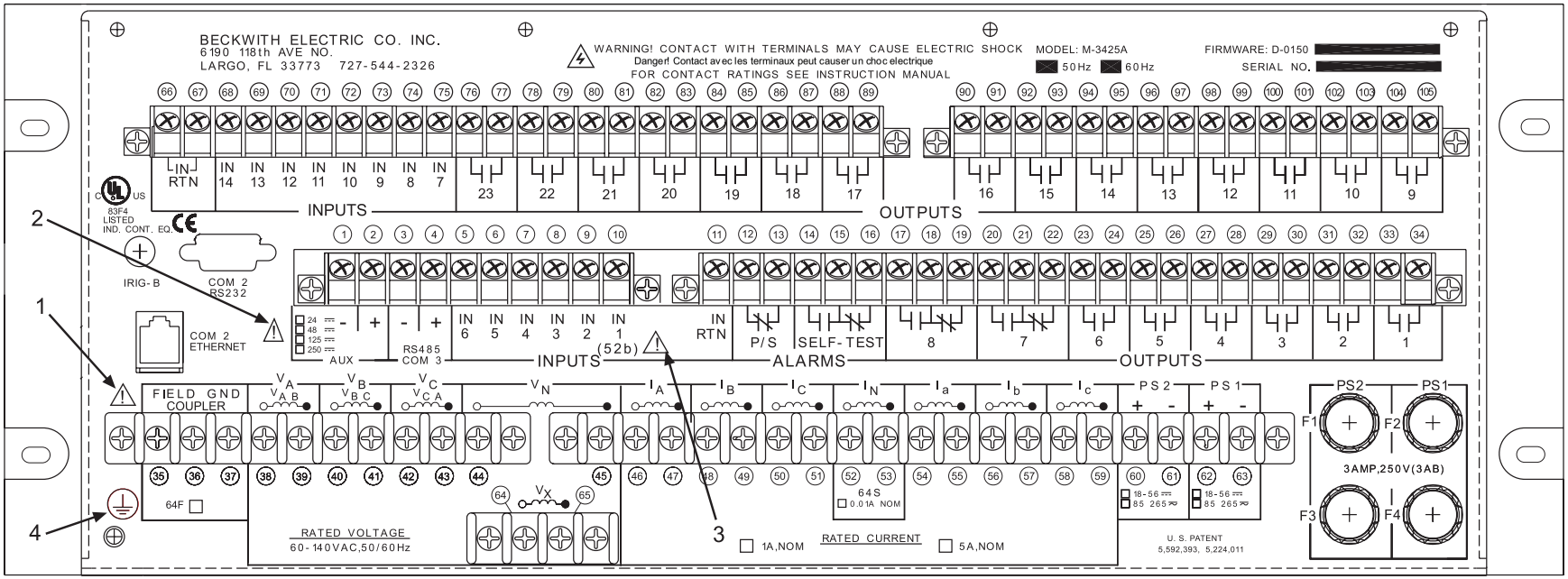


Figure 3 External Connections (With Optional Expanded I/O)

■ **NOTES**:

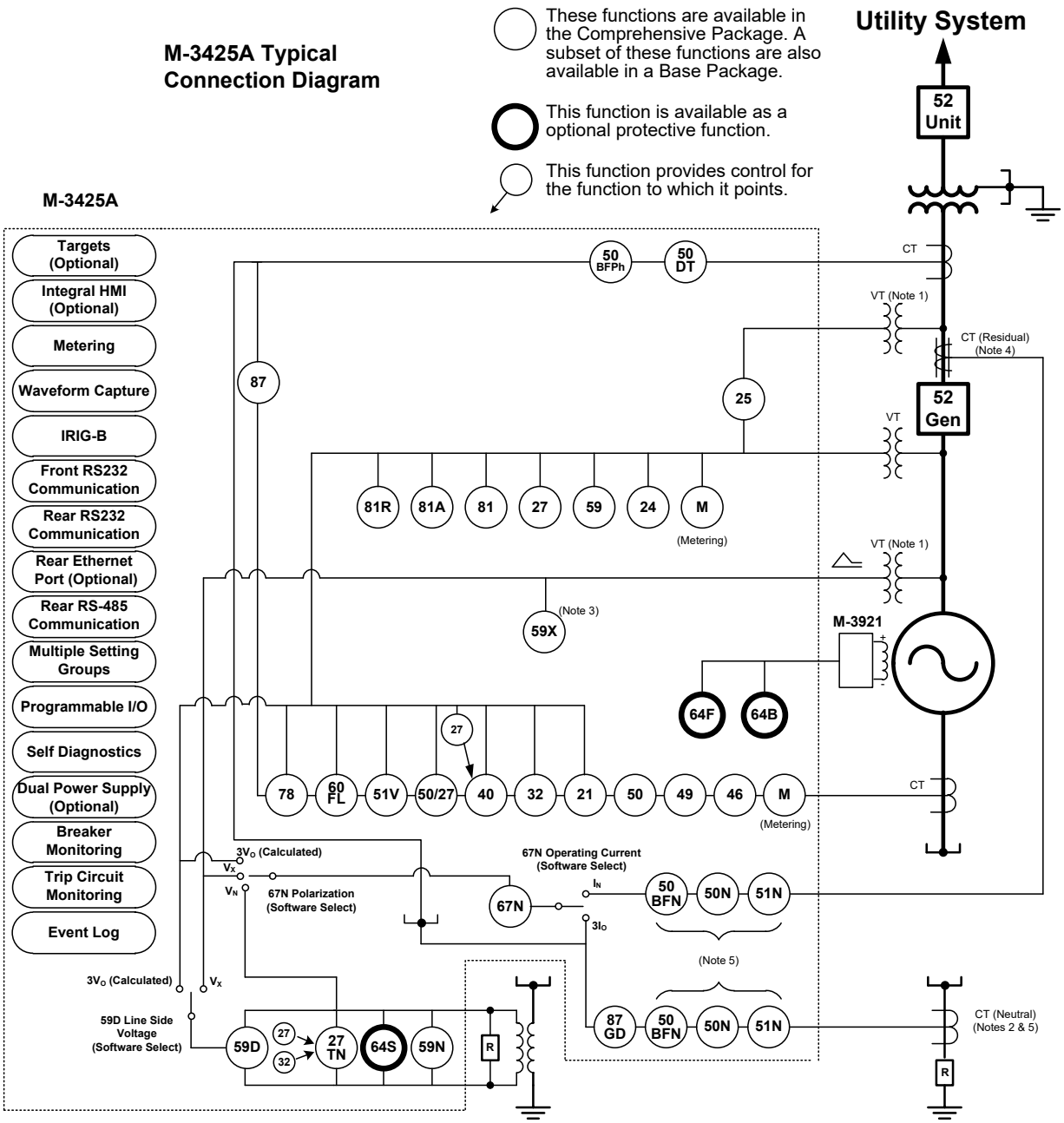
1. See M-3425A Instruction Book Section 4.4, System Setpoints, subsection for 64B/F Field Ground Protection.
2. Before making connections to the Trip Circuit Monitoring input, see M-3425A Instruction Book Section 5.5, Circuit Board Switches and Jumpers, for the information regarding setting Trip Circuit 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.



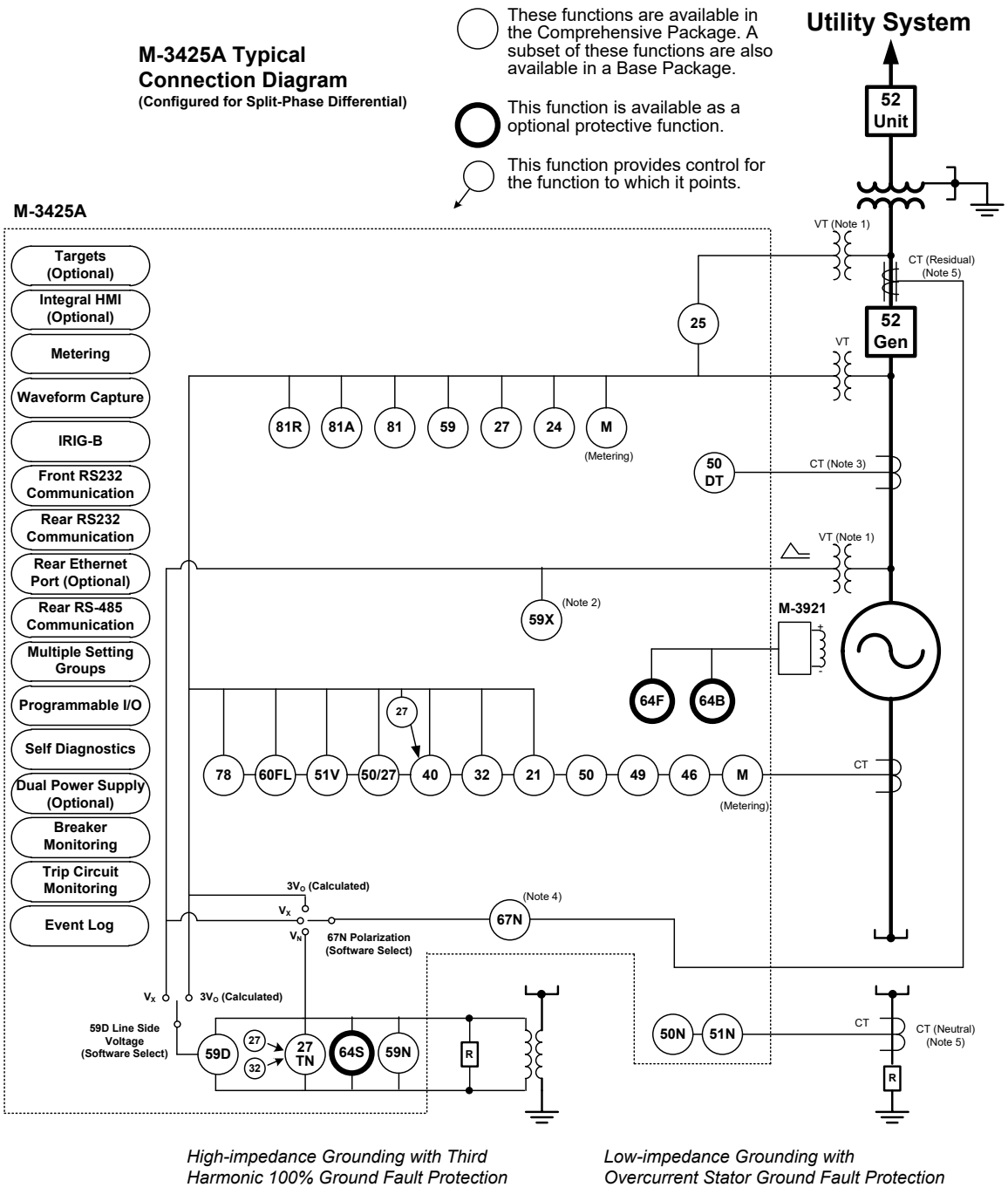
High-impedance Grounding with Third Harmonic 100% Ground Fault Protection

Low-impedance Grounding with Ground Differential and Overcurrent Stator Ground Fault Protection

■ **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)



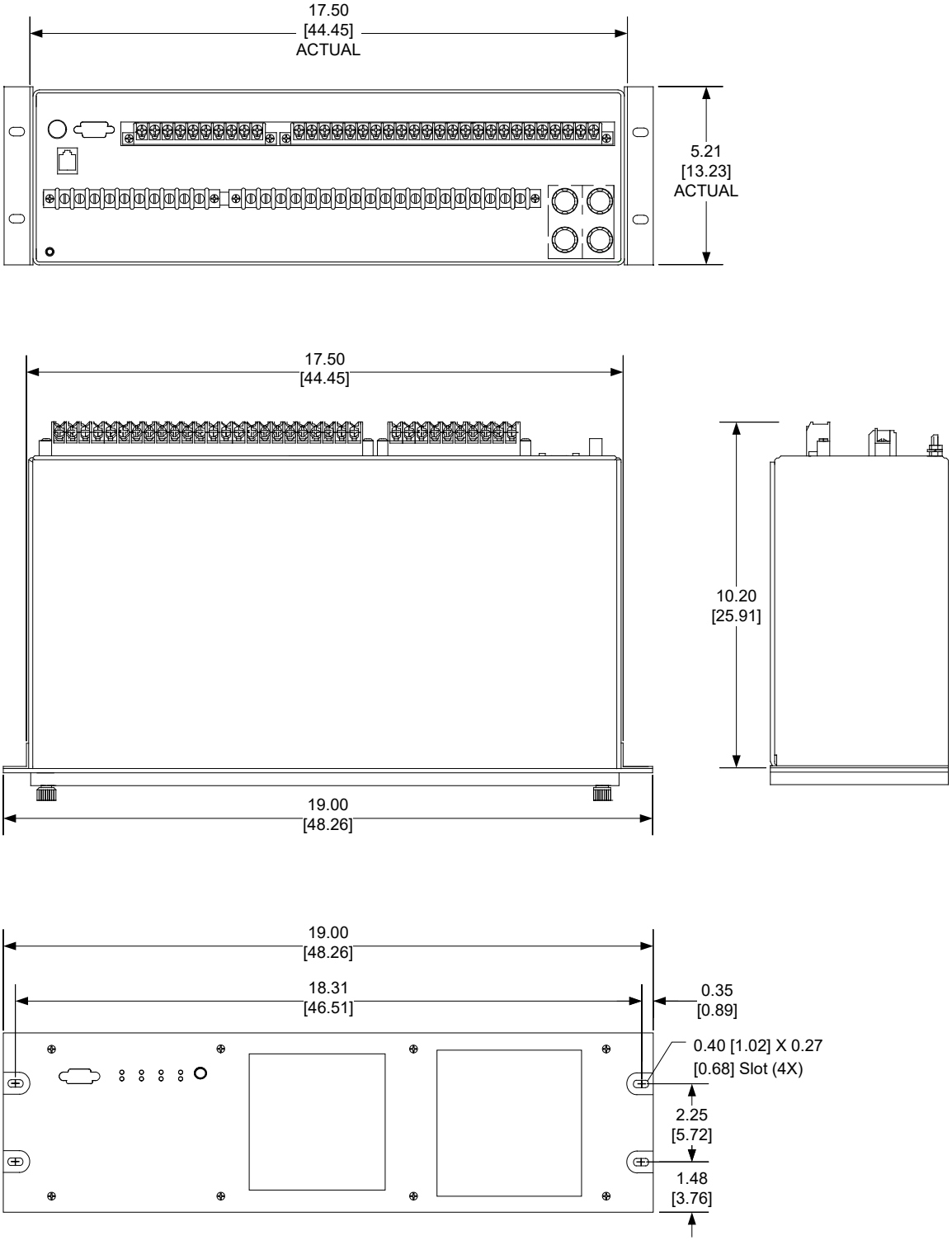
High-impedance Grounding with Third Harmonic 100% Ground Fault Protection

Low-impedance Grounding with Overcurrent Stator Ground Fault Protection

■ **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)

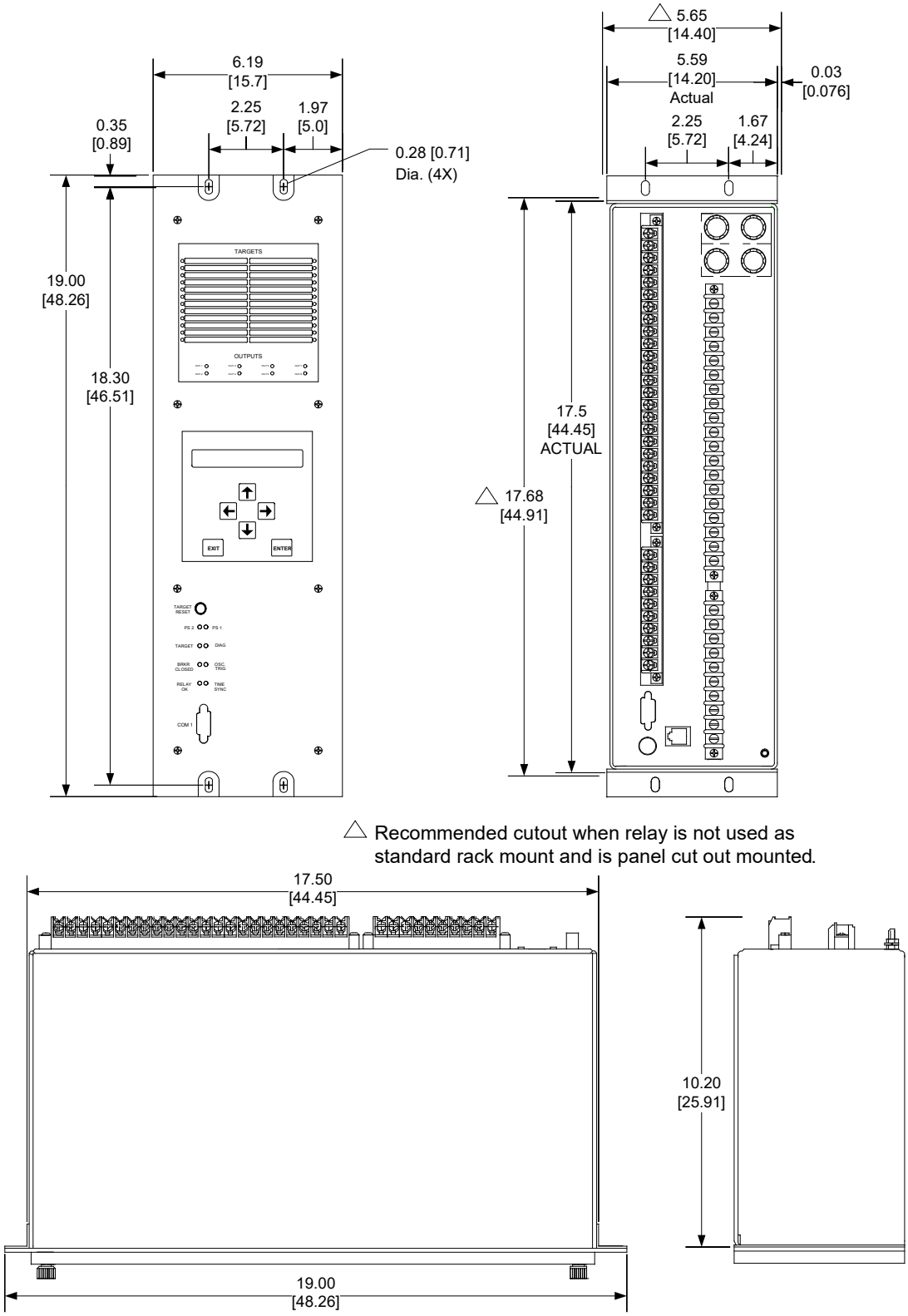


Standard 19" Horizontal Mount Chassis

■**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)

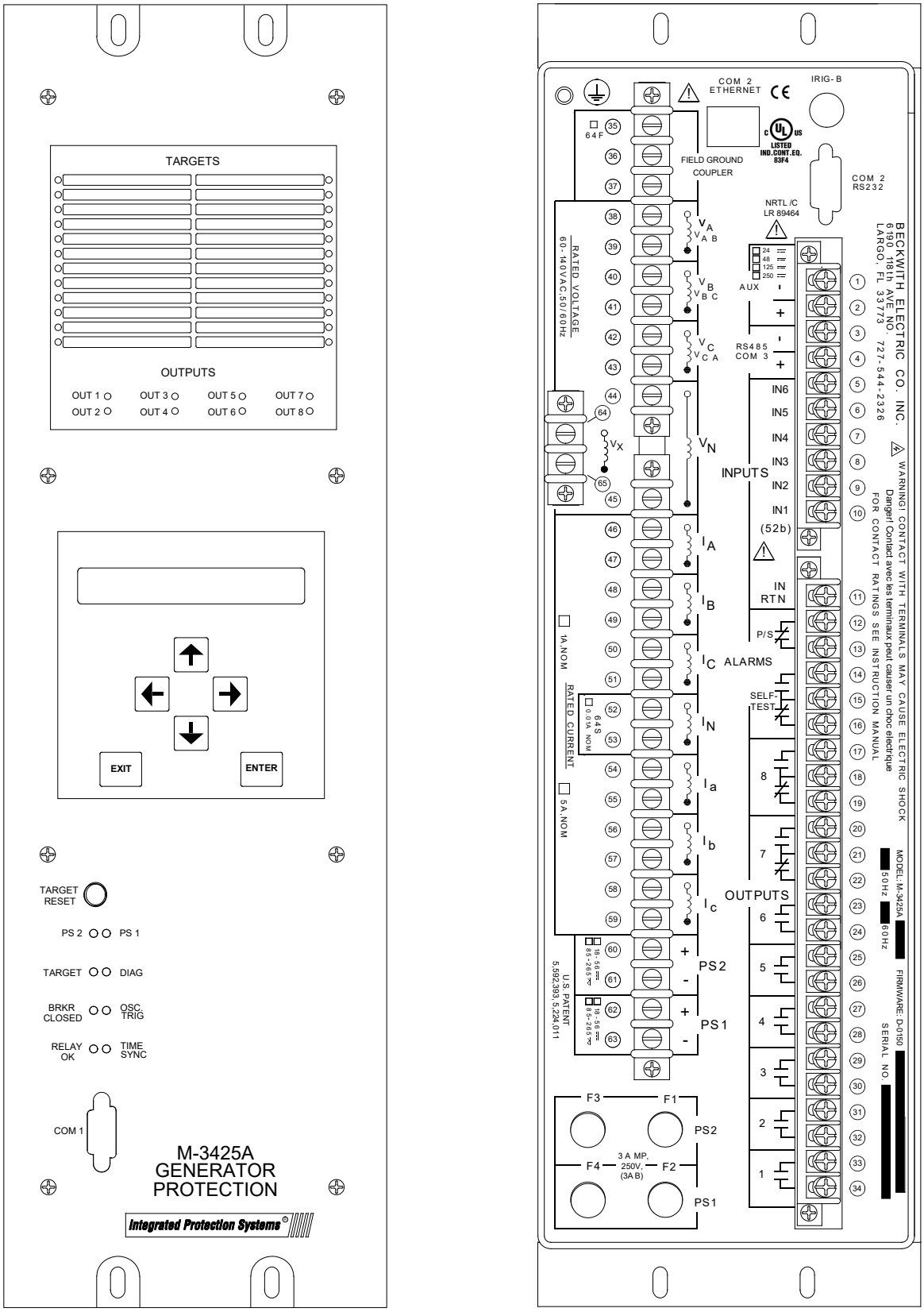
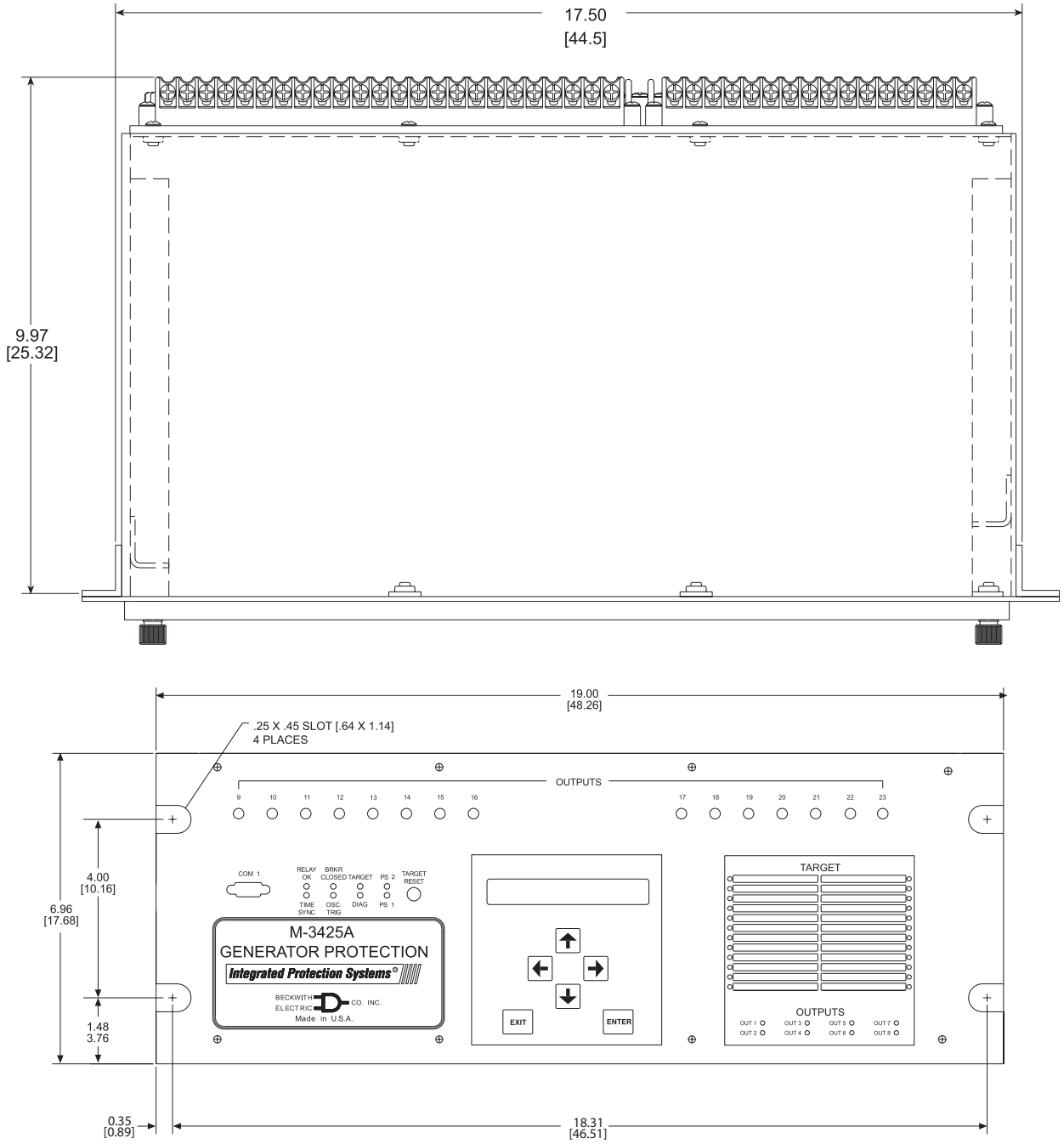


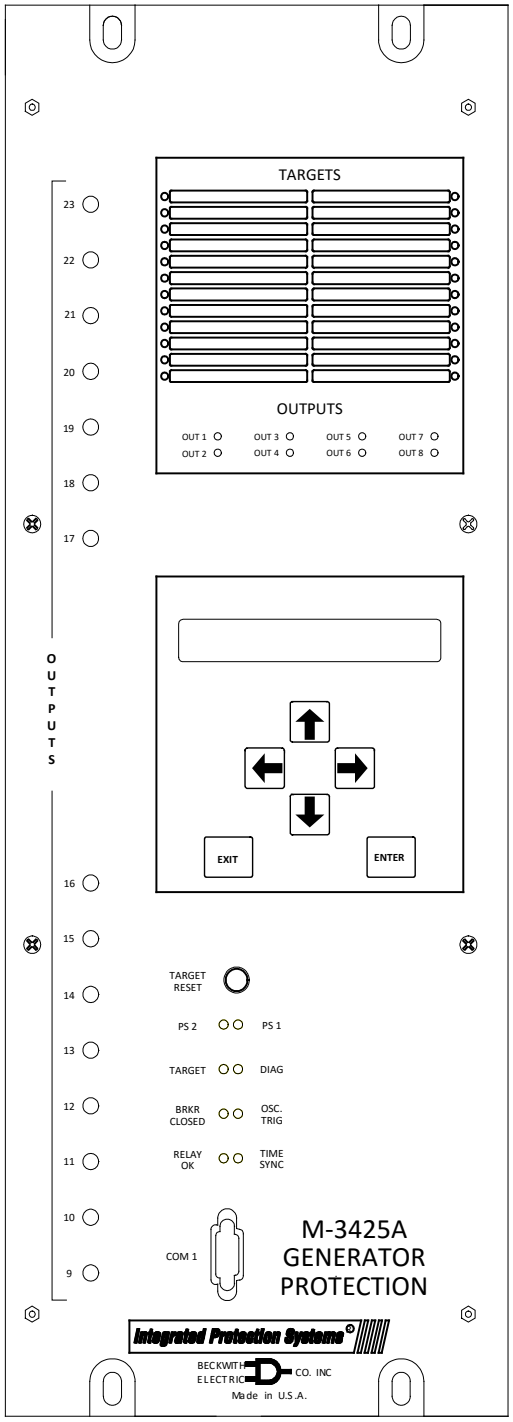
Figure 8 M-3425A Vertical Unit Layout

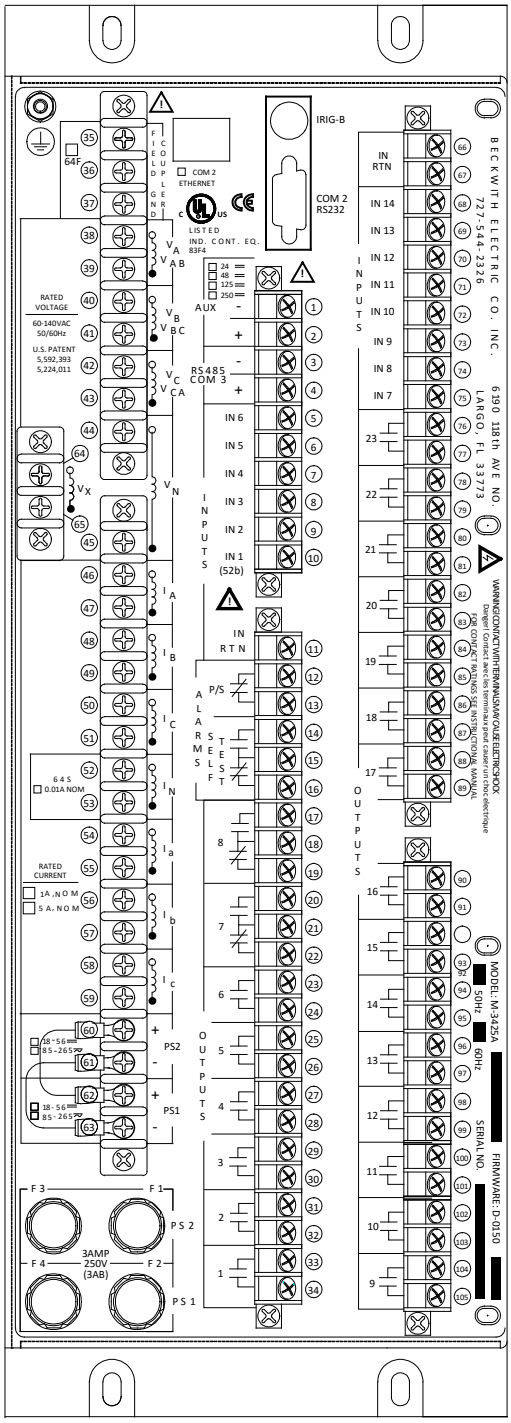


■**NOTES**: 1. Dimensions in brackets are in centimeters.

2. See Instruction Book Chapter 5 for Mounting and Cutout information.

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





■**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

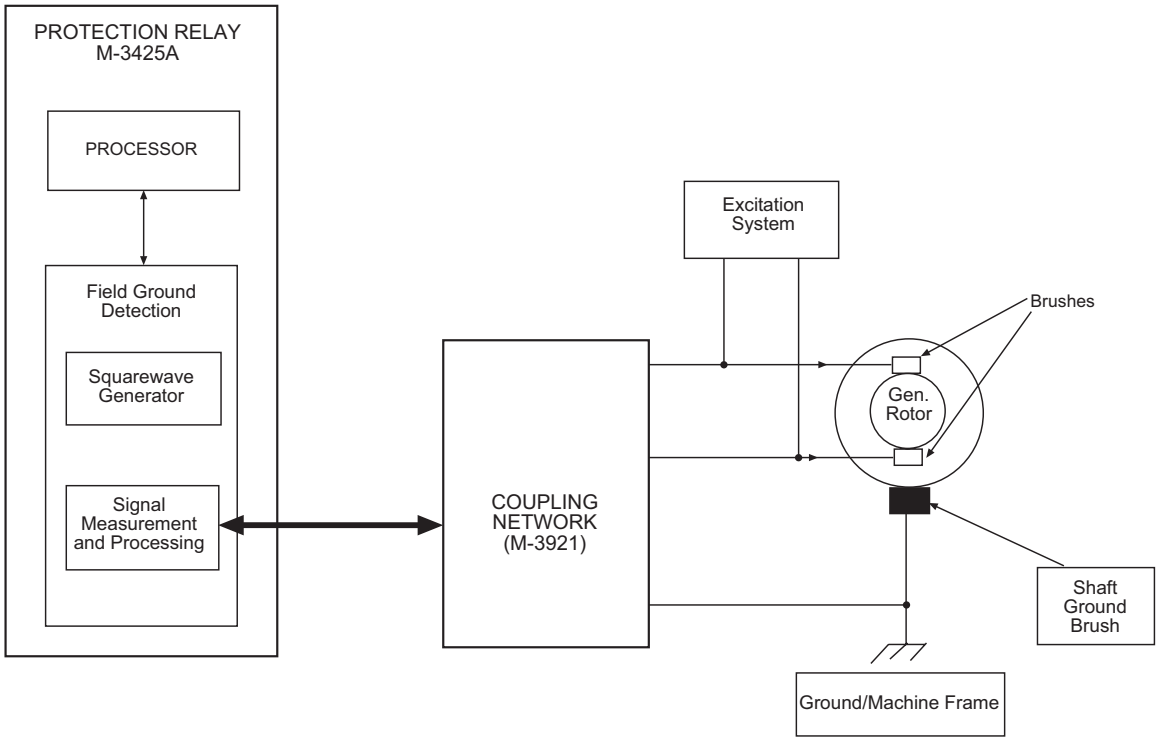


Figure 11 Field Ground Protection Block Diagram

■ **NOTES**:

1. The above circuit measures insulation resistance (R_f) between rotor field winding and ground (64F).
2. Relay injects ± 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 μs, 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 C37.90.1-1989	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk applied between each independent circuit 5,000 V pk Fast Transient applied to each independent circuit to earth 5,000 V pk Fast Transient applied between each independent circuit
ANSI/IEEE C37.90.1-2002	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk applied between each independent circuit 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 C37.90.2	25-1000 Mhz @ 35 V/m

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

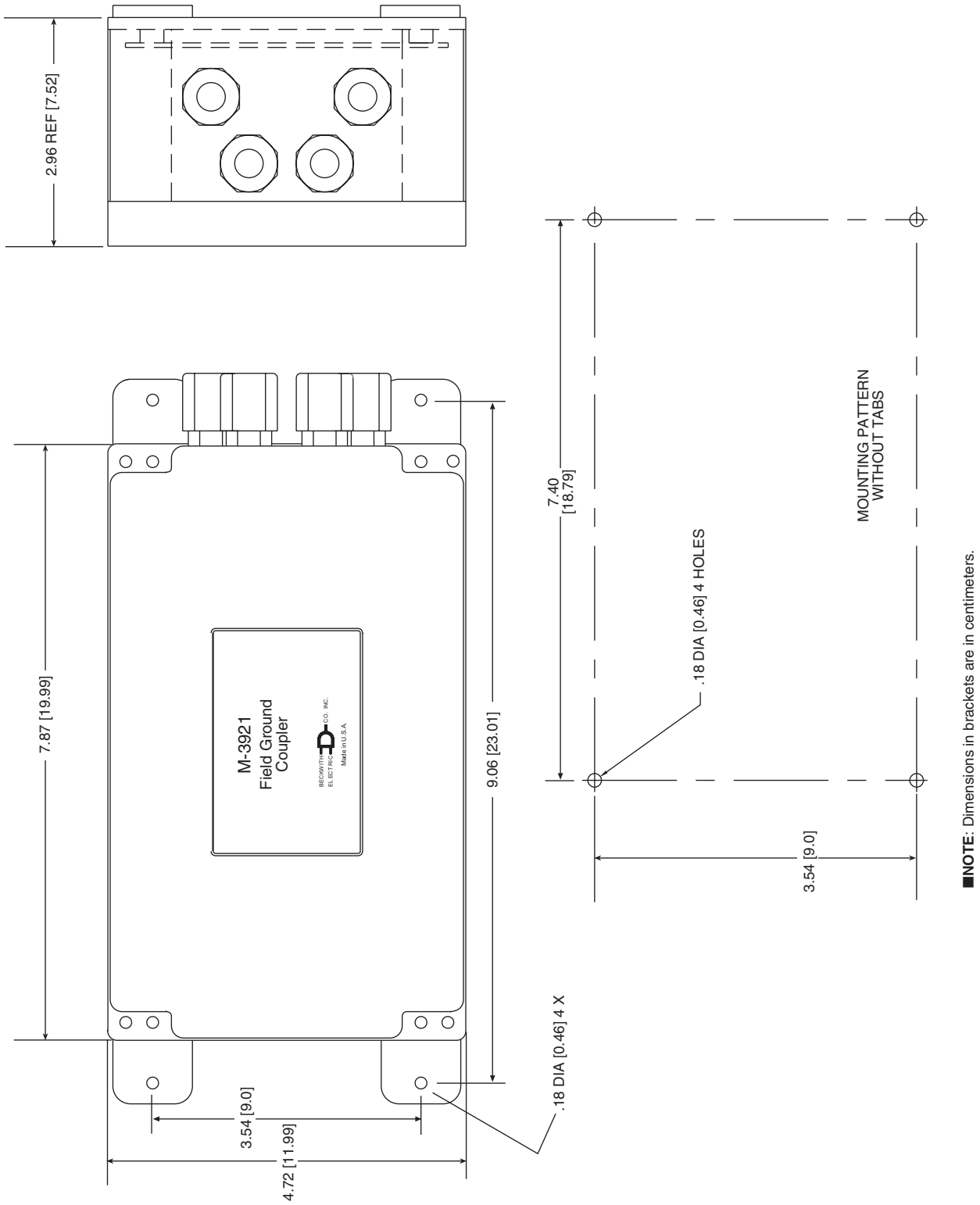


Figure 12 M-3921 Field Ground Coupler Mounting Dimensions

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:

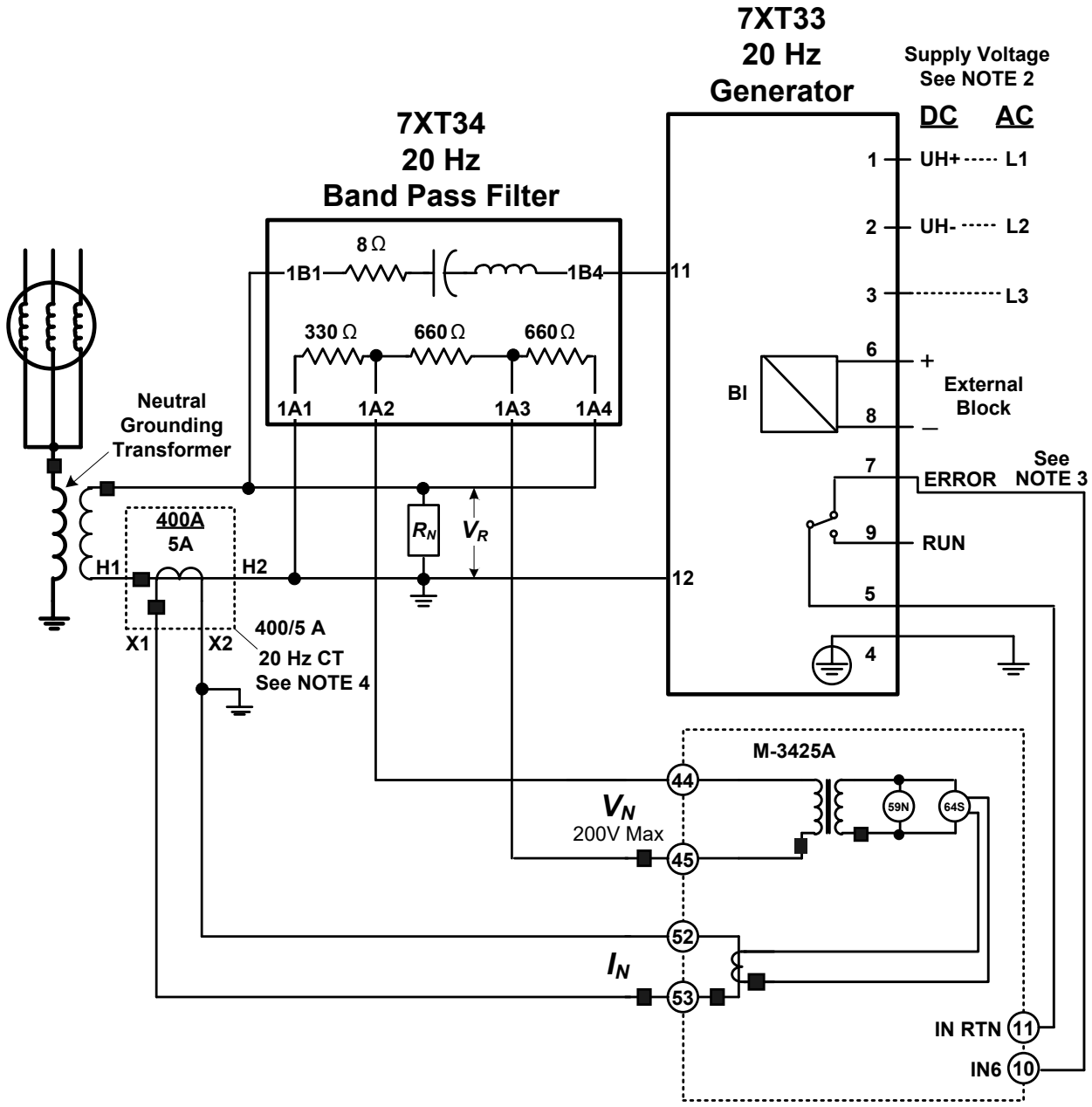
- 20 Hz Signal-generator (BECO Surface Mount/Flush Part No. 430-00426)(Siemens 7XT33)
- Band-pass filter (BECO Surface Mount/Flush Part No. 430-00427)(Siemens 7XT34)
- 20 Hz Measuring Current Transformer, 400/5 A CT (BECO Part No. 430-00428) (ITI-CTW3-60-T50-401)

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 ≤ 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.

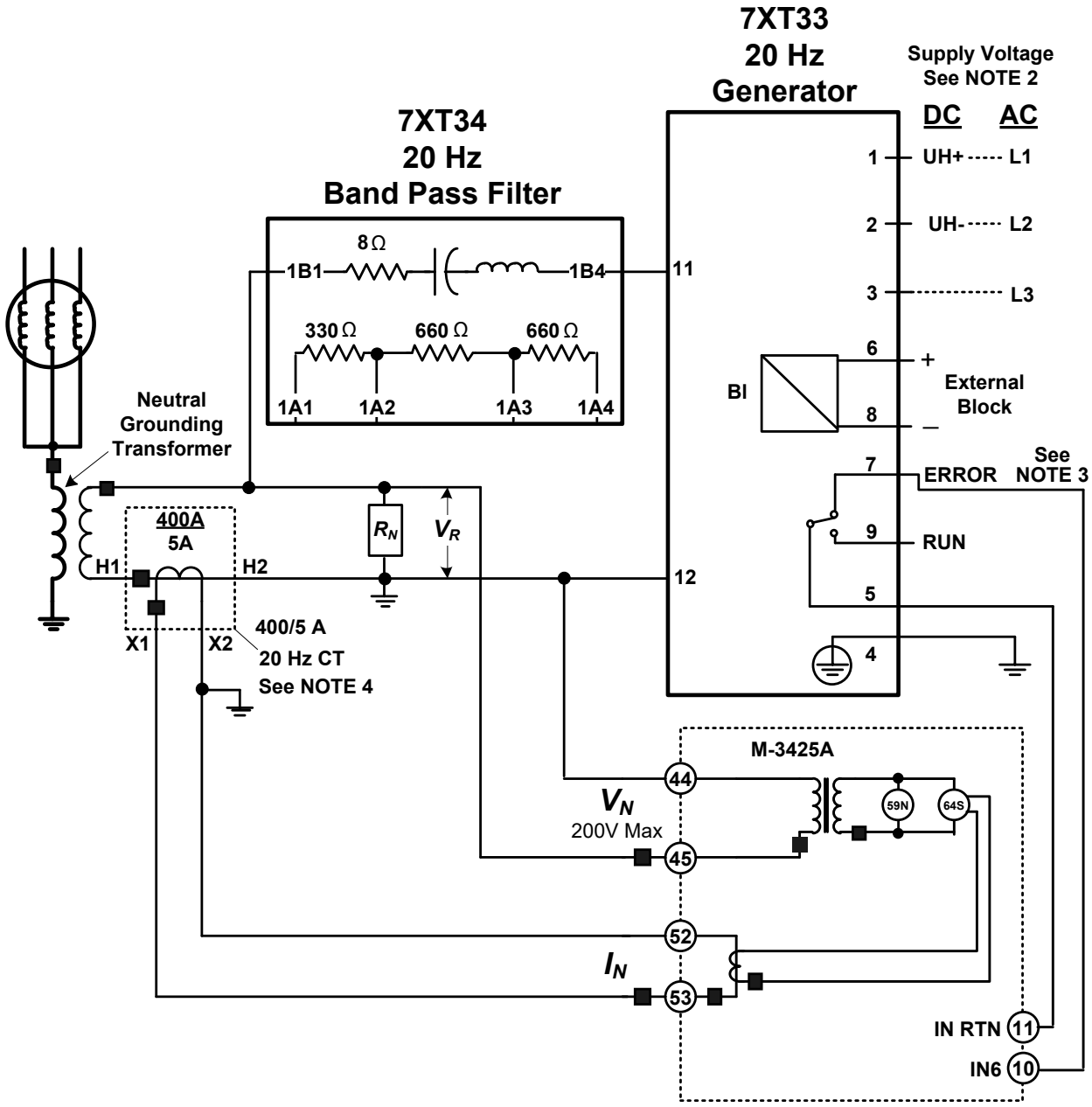
The 59N function (90 to 95%) should also be used in conjunction with 64S protection to provide backup protection.



■**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 impendance ≤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 ±10 %, rectangular; 20 Hz ± 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} ≥ DC 19 V, U_{low} ≤ DC 10 V
– For control voltages	110 V 125 V 220 V 250 V	DC 88 V: U_{high} ≥ DC 88 V, U_{low} ≤ DC 44 V
Permissible voltage, continuous		300 Vdc

Life Contact

Connections (5, 7 and 9)

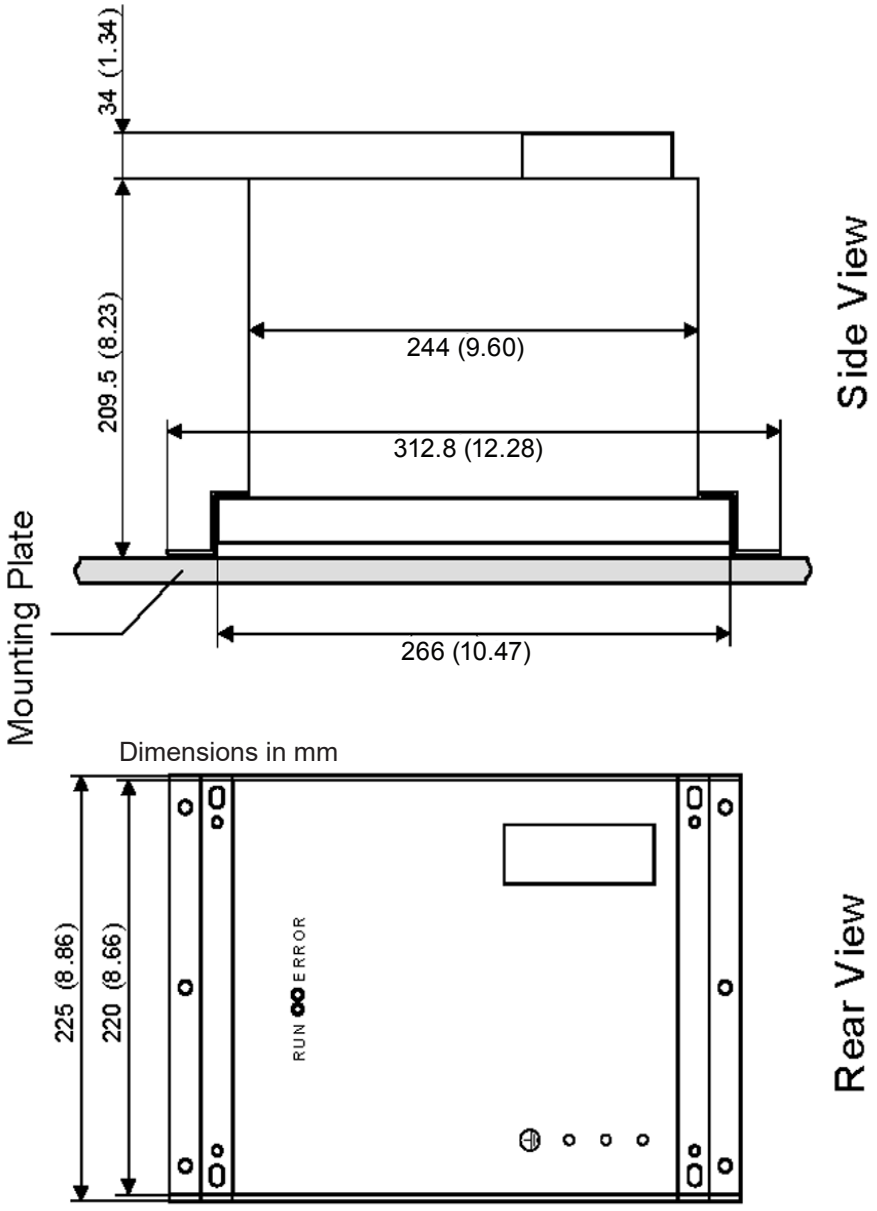
Switching capacity	MAKE	30W/VA
	BREAK	20 VA 30 W resistance load 25 W @ L/R ≤ 50 ms
Switching voltage		DC 24 V to DC 250 V AC 24 to AC 230 V
Permissible current		1 A permanent

Permissible Ambient Temperatures

R_L describes the load resistance at the Band Pass output.

with R_L <5 Ohm	≤55^{0}C or ≤131^{0}F
with R_L >5 Ohm	≤70^{0}C or ≤158^{0}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 ≤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

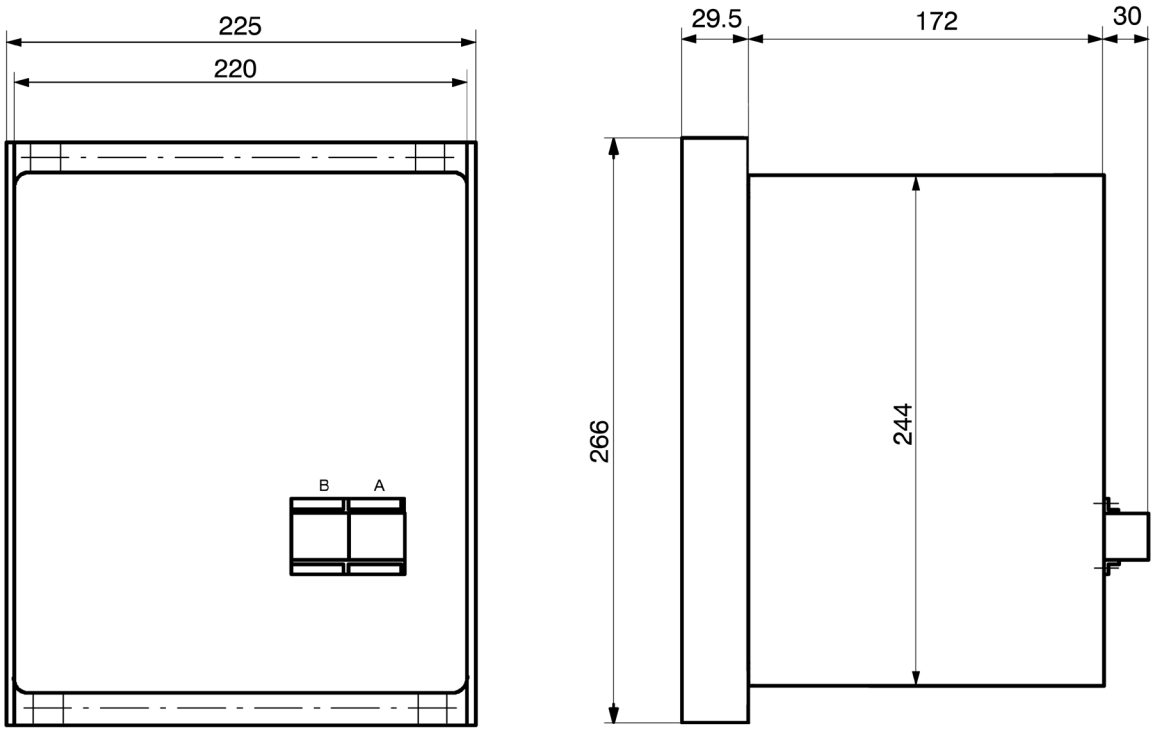
Load Capability of the Voltage Divider Circuit

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 Ω burden	≤40^{0}C or ≤ 104^{0}F
with R_L >5 Ω burden	≤55^{0}C or ≤ 131^{0}F

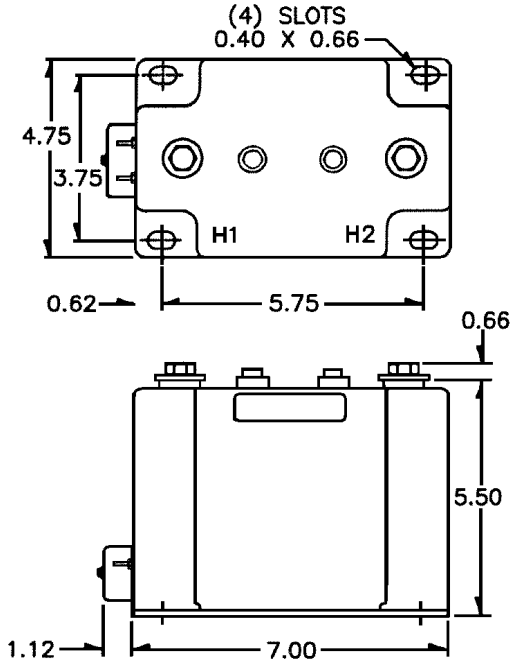
■**NOTE**: The device may produce up to 75 W power losses during service. In order to prevent heat pockets, the dissipation of the losses must not be restricted. The minimum clearance above and below the device to other units or walls is 100 mm or 4 inches. In cubicles, the device shall be installed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

This Page Left Intentionally Blank

BECKWITH ELECTRIC CO., INC.
6190 - 118th Avenue North • Largo, Florida 33773-3724 U.S.A.
PHONE (727) 544-2326 • FAX (727) 546-0121
marketing@beckwithelectric.com
www.beckwithelectric.com
ISO 9001:2008

800-3425A-SP-13MC1 02/17
Printed in U.S.A.