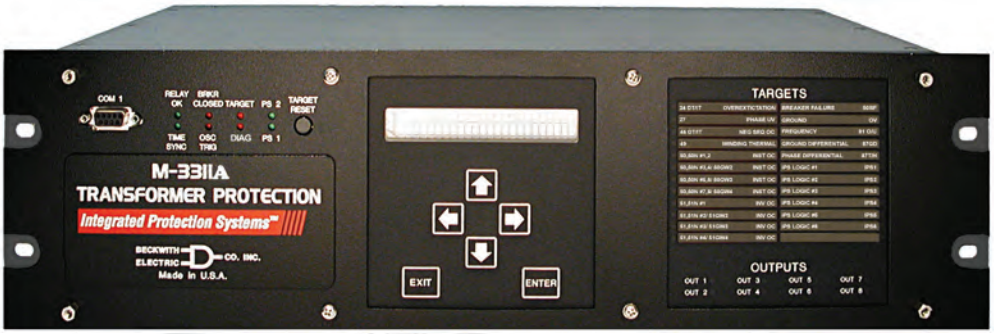
Transformer Protection M-3311A

Integrated Protection System®



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

- **For Transformers of All Sizes:**
  - **2, 3 or 4 winding Transformers for Transmission and Distribution applications**
  - **Generator-Transformer Unit Overall Differential**
  - **Unit Protection of Other Electrical Apparatus and certain Bus Arrangements (including those with a transformer in the zone)**
- **Additional Applications: System Backup Protection, Load Shedding (voltage and frequency), Bus Protection, and individual Breaker Failure Protection for each winding input**
- **Available voltage configurations include zero, two or four voltage inputs**
- **Ground Differential configurations include one, two or three current inputs**
- **Optional Ethernet Connection and Expanded I/O**
- **Optional Voltage Package includes, 24 Volts/Hz Overexcitation, 27 Phase Undervoltage, 59G Ground Overvoltage and 81O/U Over/Under Frequency**

Industry Leader Since 1969
Made in the USA

Standard Protective Functions

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

Optional Voltage Protection Package

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

Standard Features

- Eight programmable outputs and six programmable inputs
- Oscillographic recording
- Through-Fault Monitoring
- 8-target storage
- Real time metering of measured and calculated parameters, including demand currents
- Two RS-232 and one RS-485 communications ports
- Standard 19" rack-mount design
- Removable printed circuit board and power supply
- 50 and 60 Hz models available
- 1 or 5 A rated CT inputs available
- S-3300 IPScom® Communications Software
- IRIG-B time synchronization
- Sequence of Events Log
- Breaker Monitoring
- Multiple Setpoint Groups
- Trip Circuit Monitoring
- Includes MODBUS and DNP 3.0 protocols
- Summing Currents from multiple sources for 49, 50, 51, 50N, 51N, 87 GD and Through Fault functions

Optional Features

- Redundant Power Supply
- M-3911A Target Module
- M-3931 Human-Machine Interface (HMI) Module
- M-3801D IPSplot® *Plus* Oscillograph Analysis Software
- RJ45 Ethernet port utilizing MODBUS over TCP/IP, BECO 2200 over TCP/IP, IEC 61850 or DNP 3.0 protocol
- Expanded I/O (8 additional outputs and 12 additional inputs)
- Standard and Expanded I/O Models available in vertical panel mount
- Close Circuit Monitoring on Expanded I/O units

STANDARD PROTECTIVE FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Negative Sequence Overcurrent			
46	**46W2/46W3/46W4**			
	Definite Time			
	Pickup	0.10 to 20.00 A (0.02 to 4.00 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±1%
	Inverse Time			
	Pickup	0.50 to 5.00 A (0.10 to 1.00 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curves	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves/IEEE		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±5%
	Winding Thermal Protection			
49	Time Constant	1.0 to 999.9 minutes	0.1 minutes	
	Maximum Overload Current	1.00 to 10.00 A	0.01 A	±0.1 A or ±2% (0.2 to 2.00 A)
	Winding Select	Sum1, Sum2, W1, W2, W3, or W4		
	Instantaneous Phase Overcurrent			
50	**1-8**			
	Pickup	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Breaker Failure			
50 BF	**50BFW1/50BFW2/50BFW3/50BFW4**			
	Pickup (phase)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Pickup (residual)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±2%
	Instantaneous Ground Overcurrent			
50G	**50GW2/50GW3/50GW4**			
	Pickup #1, #2	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%

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

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Instantaneous Residual Overcurrent			
50N	**1-8**			
	Pickup	1.0 to 100.0 A	0.1 A (0.2 to 20.0 A)	±0.1 A or ±3% (±0.02 A or ±3%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Inverse Time Phase Overcurrent			
51	**1-4**			
	Pickup	0.50 to 12.00 A	0.01 A (0.10 to 2.40 A)	±0.1 A or ±3% (±0.02 A or ±3%)
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0	0.1 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	±3 Cycles or ±3% 0.01 0.1

Two or three of the windings may be summed together.

	Inverse Time Ground Overcurrent			
51G	**51GW2/51GW3/51GW4**			
	Pickup	0.50 to 12.00 A	0.01 A (0.10 to 2.40 A)	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0	0.1 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	±3 Cycles or ±3% 0.01 0.1
	Inverse Time Residual Overcurrent			
51N	**1-4**			
	Pickup	0.50 to 6.00 A	0.01 A (0.10 to 1.20 A)	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Very Inverse/Extremely Inverse IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse IEEE Moderately Inverse/Very Inverse/Extremely Inverse		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±5%
	Current Selection	Sum1, Sum2, W1, W2, W3, W4		

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

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

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

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

	Ground Differential			
87 GD	**87GDW2/87GDW3/87GDW4**			
	Pickup #1, #2	0.2 to 10.00 A	0.01 A (0.04 to 2.00 A)	±0.1 A or ±5% (±0.02 A or ±5%)
	Time Delay #1, #2	1 to 8160 Cycles*	1 Cycle	–1 to +3 Cycles or ±1%
	$3I_O$ Current Selection	Sum1, Sum2, W2**, W3**, W4**		
	Directional Element	Disable/Enable		
	CT Ratio Correction (R_c)	0.10 to 7.99	0.01	

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

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

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

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	IPSlogic			
IPS	IPSlogic uses element pickups, element trip commands, control/status input state changes, output contact close signals with programmable logic array to develop schemes.			
	Reset/Dropout Delay #1–#6	0 to 65500 Cycles	1 Cycle	±1 Cycle or ±1%
	Time Delay #1–#6	1 to 65500 Cycles	1 Cycle	±1 Cycle or ±1%
	Trip (Aux Input) Circuit Monitor			
TCM	**Trip Circuit Monitor**			
	TCM Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	TCM Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

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

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

	Breaker Monitoring			
BM	Pickup	1 to 50,000 kA Cycles	1 kA Cycles or kA^2 Cycles	± 1 kACycles or kA^2 Cycles or kA^2 Cycles
	Time Delay	0.1 to 4095.9 Cycles	0.1 Cycles	±1 Cycle or ±1%
	Timing Method	IT or I^2T		
	Preset Accumulators Phase A, B, C	0 to 50,000 kA Cycles	1 kA Cycle	

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

The per-phase values are added to an accumulated total for each phase, and then compared to a user-programmed threshold value. When the threshold is exceeded in any phase, the relay can set a programmable output contact.

The accumulated value for each phase can be displayed.

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

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

STANDARD PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
	Through Fault			
TF	Through Fault Current Threshold	1.0 to 100.0 A (0.2 to 20.0 A)	0.1A	±0.1A or ±5% (±0.02A or ±5%)
	Through Fault Count Limit	1 to 65535	1	—
	Cumulative I^2T Limit	1 to 1000000(kA^2 Cycles)	1	±1.0 kA Cycles or kA^2 Cycles
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Current Selection	Sum1, Sum2, W1, W2, W3 or W4	—	—
	Nominal Settings			
	Nominal Voltage	60.0 to 140.0 V	0.1 V	—
	VT Configuration	V_A, V_B, V_C, V_{AB}, V_{BC}, V_{CA}, V_G		
	Phase Rotation	ABC/ACB	—	—
	Number of Windings	2, 3, or 4		
	Transformer/CT Connection	Standard IEEE/IEC or Custom Connections		

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

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

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

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

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

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

OPTIONAL VOLTAGE PROTECTION PACKAGE

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

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

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

	Phase Undervoltage			
27	Pickup #1, #2*, #3*	5 to 140 V	1 V	±0.5 V
	Inhibit Setting	5 to 140 V	1 V	±0.5 V
	Time Delay	1 to 8160 Cycles	1 Cycle	–1 to +3 Cycles or ±1%

This function is applicable only when phase voltage input is applied.
*** Elements #2 and #3 are not available in four winding applications.*

	Phase Overvoltage			
59	**1-3**			
	Pickup	5 to 180 V	1 V	±0.5 V or ±0.5%
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Input Voltage Selection	Phase, Positive Sequence, Negative Sequence		

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

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

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

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

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

OPTIONAL VOLTAGE PROTECTION PACKAGE

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

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

Configuration Options

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

M-3311A Configuration Options		
Windings	**Ground Inputs**	**Voltage Inputs**
Two	One	Zero
		Two
		Four
Three	Two	Zero
		Two
		Four
Four	Three	Zero
		Two

Multiple Setpoint Profiles (Groups)

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

Metering

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

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

Metering accuracies are:

Voltage: ±0.5 V or ±0.5%, whichever is greater (range 0 to 180 V ac)

Current: 5 A rating, ±0.1 A or ±3%, whichever is greater (range 0 to 14 A)
1 A rating, ±0.02 A or ±3%, whichever is greater (range 0 to 2.8 A)

Power: ±0.01 PU or ±2% of VA applied, whichever is greater

Frequency: ±0.1 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)

Volts/Hz: ±1%

Oscillographic Recorder

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

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

Sequence of Events Log

The Sequence Events Log records predefined relay events. The Sequence of Events Log includes 512 of the most recently recorded relay events. The events and the associated data is available for viewing utilizing the S-3300 IPScom Communications Software. The sequence of events log is stored in RAM and will be erased if power to the relay is removed.

Through Fault Recorder

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

Target Storage

A total of 8 targets can be stored. This information includes the function(s) operated, the function(s) picked up, input/output contact status, time stamp, phase and ground currents. The sequence of events log is stored in RAM and will be erased if power to the relay is removed.

Calculations

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

Power Input Options

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

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

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

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

Sensing Inputs

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

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

Control/Status Inputs

The control/status inputs, INPUT1 through INPUT6, can be programmed to block any of the relay functions, trigger the oscillographic recorder, select a setpoint group, or to operate one or more outputs. The control/status inputs are designed to be connected to dry contacts and are internally wetted, with a 24 V dc power supply. To provide breaker status LED indication on the front panel, the INPUT1 status input contact must be connected to the 52b breaker status contact. The minimum current value to initiate/pickup an input is $\geq$25 mA.

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

Output Contacts

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

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

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

Breaker Monitoring

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

IPSlogic

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

Target/Status Indicators and Controls

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

Communication

Communication ports include rear RS-232 and RS-485 ports, a front RS-232 port and a rear IRIG-B port (Ethernet port optional). The communications protocol implements serial, byte-oriented, asynchronous communication, providing the following functions when used with the Windows™-compatible S-3300 IPScom® Communications Software.

- Interrogation and modification of setpoints
- Time-stamped trip target information for the 8 most recent events
- Real-time metering of all measured and calculated quantities, real-time monitoring of percentage differential characteristics, and vector displays of compensated and uncompensated phasors.
- Downloading of recorded oscillographic data
- Downloading of Through-Fault Event Log
- Downloading Sequence of Events
- MODBUS and DNP3.0 protocols are supported
- The optional Ethernet port can be purchased with MODBUS over TCP/IP, BECO2200 over TCP/IP, DNP 3.0 protocol or with the IEC 61850 protocol

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

IRIG-B

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

HMI Module (optional)

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

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

I/O Expansion Module (optional)

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

Target Module (optional)

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

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

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

Tests and Standards

The relay complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

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

Impulse Voltage

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

Insulation Resistance

IEC 60255-5 > 100 Megaohms

Electrical Environment

Electrostatic Discharge Test

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

Fast Transient Disturbance Test

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

Surge Withstand Capability

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

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

Output Contacts

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

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, –20° C
IEC 60068-2-2	Dry Heat, +70° C
IEC 60068-2-3	Damp Heat, +40° C @ 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, 0.5 g Shock Withstand Class 1, 15.0 g Bump Endurance Class 1, 10.0g

Compliance

cULus-Listed per 508 – Industrial Control Equipment

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

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

External Connections

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

Physical

Without Optional I/O Expansion Module

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

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

Approximate Weight: 16 lbs (7 kg)

Approximate Shipping Weight: 25 lbs (11.3 kg)

With Optional I/O Expansion Module

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

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

Approximate Weight: 19 lbs (8.6 kg)

Approximate Shipping Weight: 26 lbs (11.8 kg)

Recommended Storage Parameters

Temperature: 5° C to 40° C

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

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

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

Patent & Warranty

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

Specification subject to change without notice.

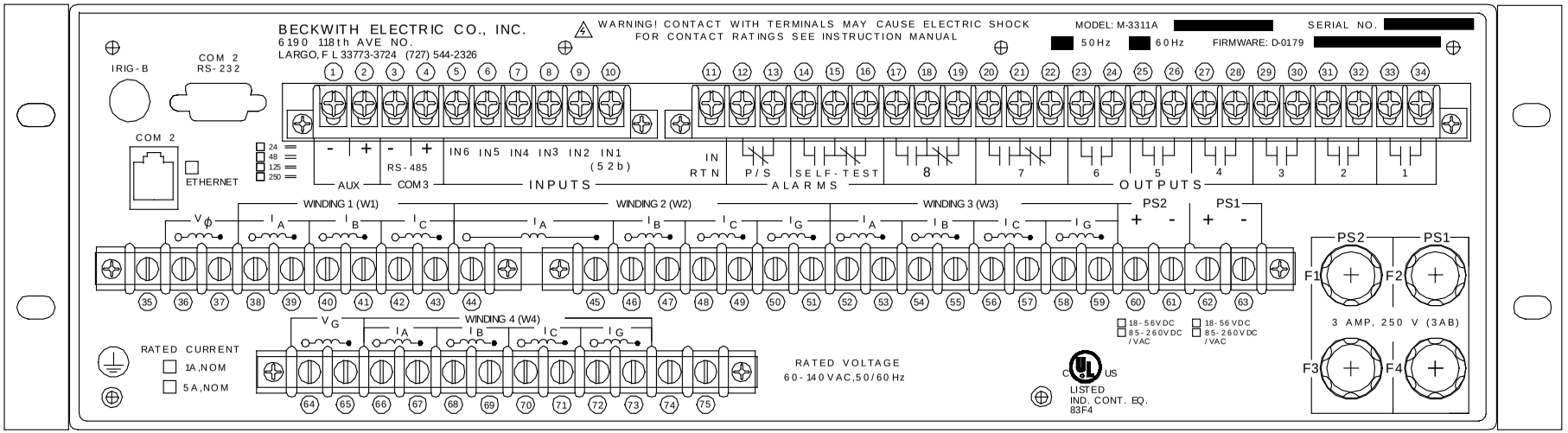


Figure 1 Typical External Connections (See Instruction Book Chapter 5, for Details)

■NOTES:

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

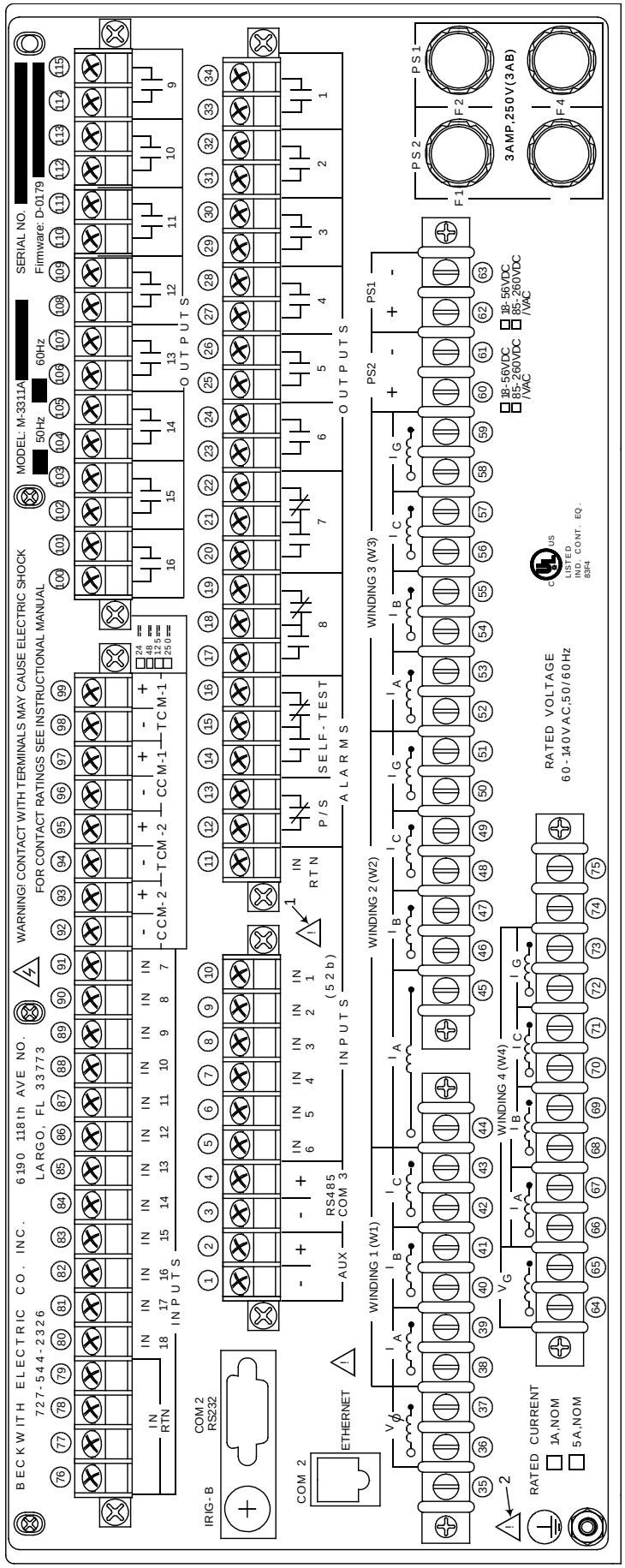


Figure 2 Typical External Connections With Optional Extended I/0 (See Instruction Book Chapter 5, for Details)

■NOTES:

1. **● 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.
2. **● WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.**

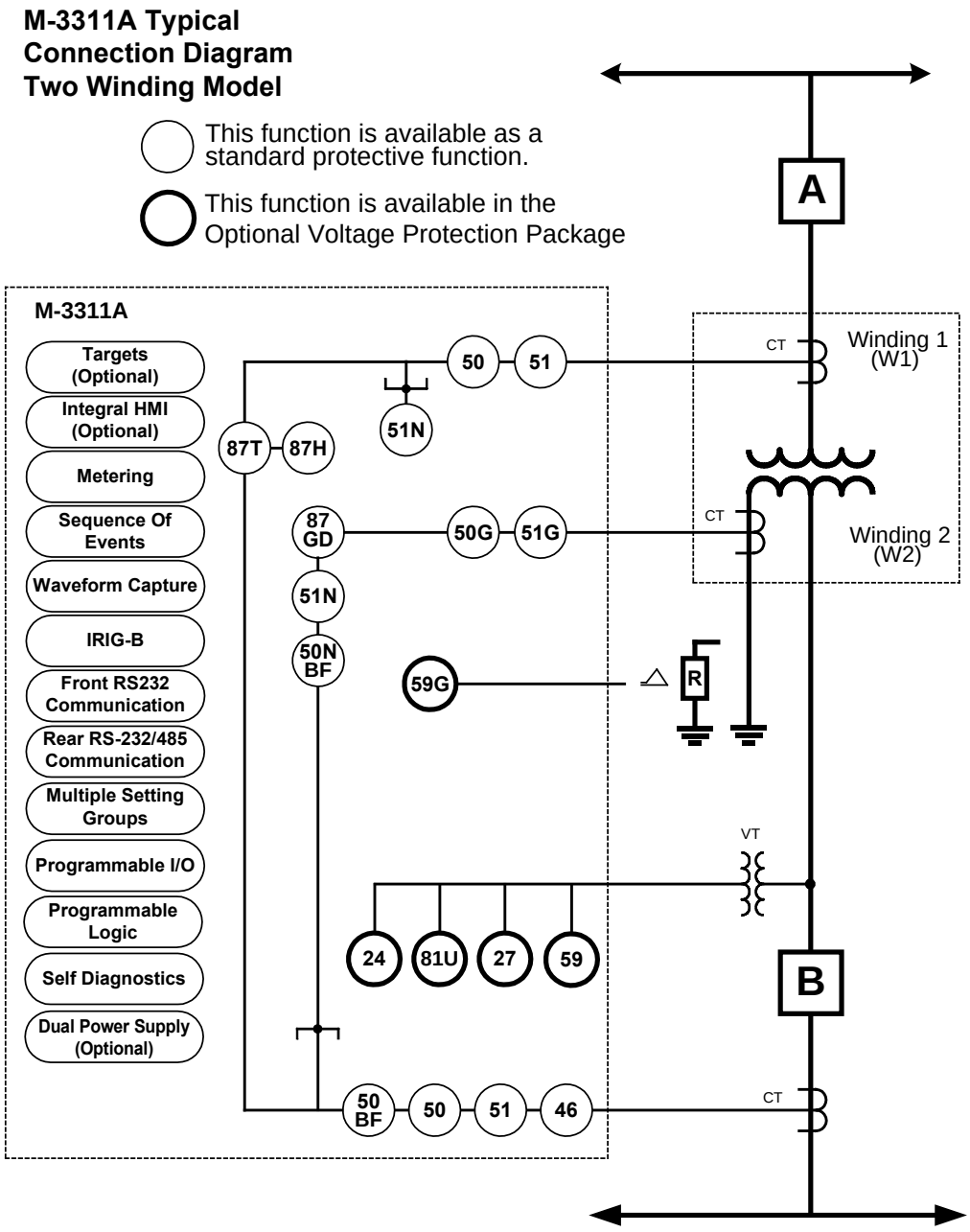
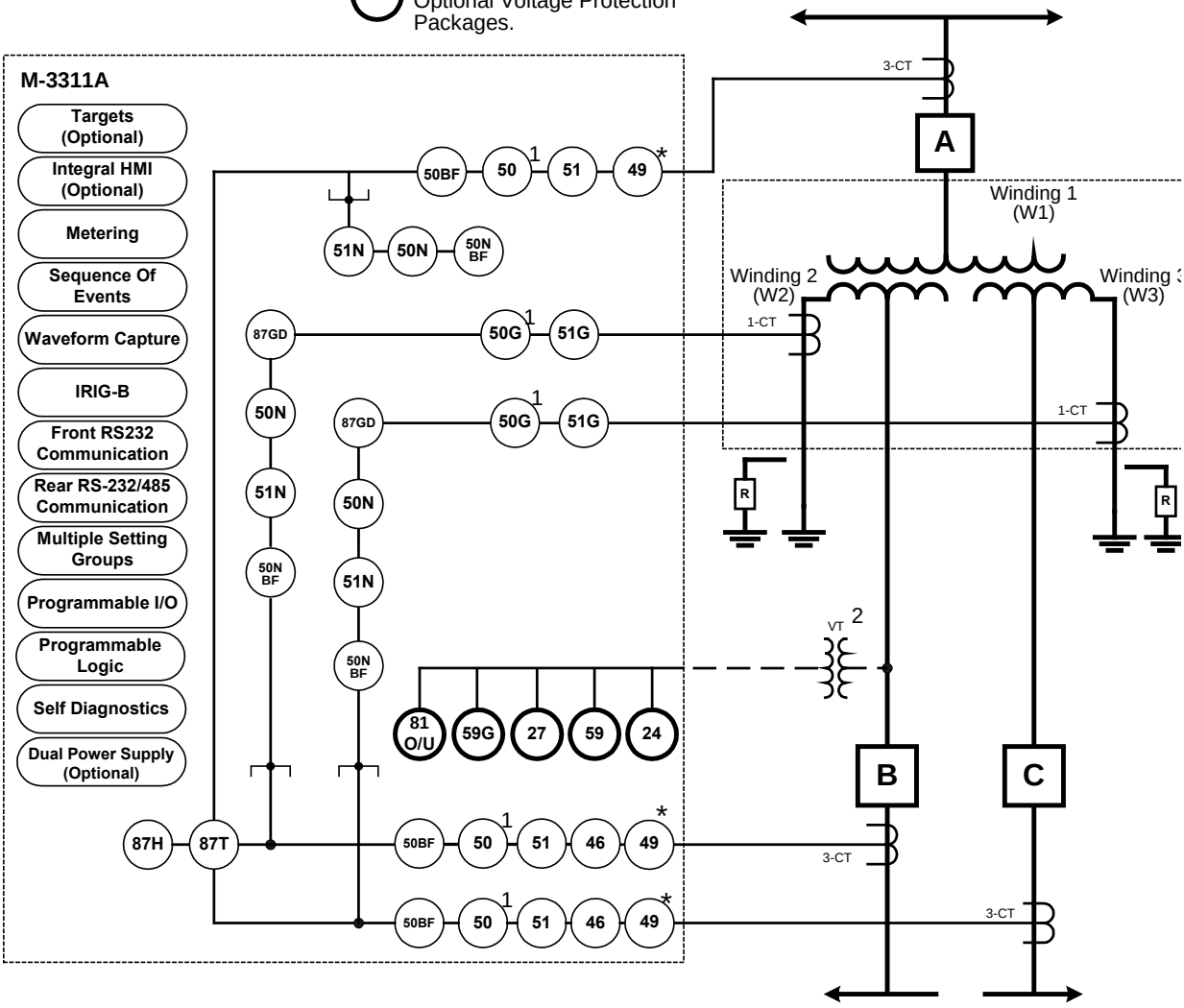


Figure 3 M-3311A (Two Winding-Two or Four Voltage Inputs) Typical One-Line Function Diagram

M-3311A Typical Connection Diagram Three Winding Model

This function is available as a standard protective function.

This function is available in the Optional Voltage Protection Packages.

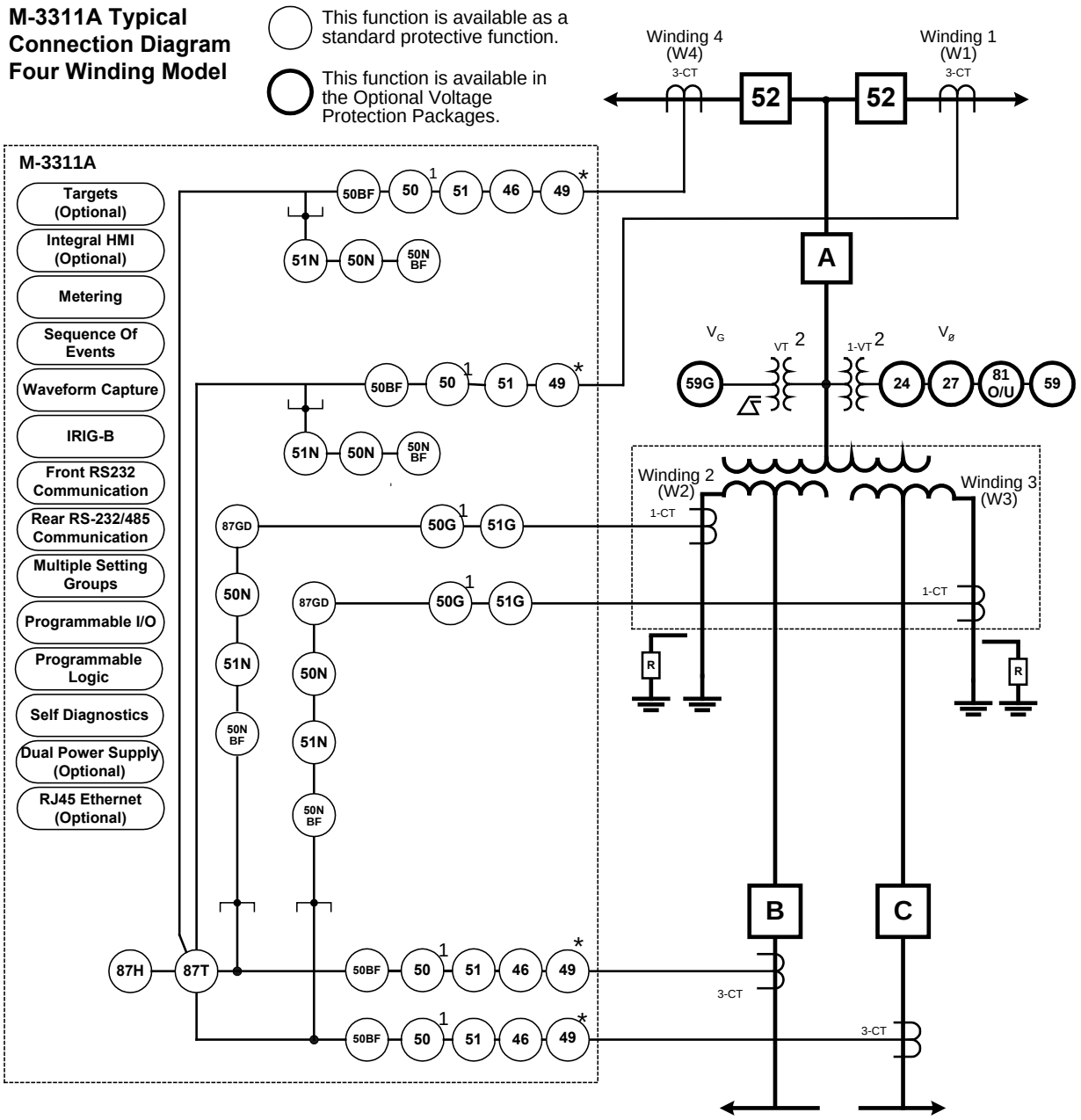


* 49 Function can only be enabled in one winding.

■NOTES:

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

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



* 49 Function can only be enabled in one winding.

■NOTES:

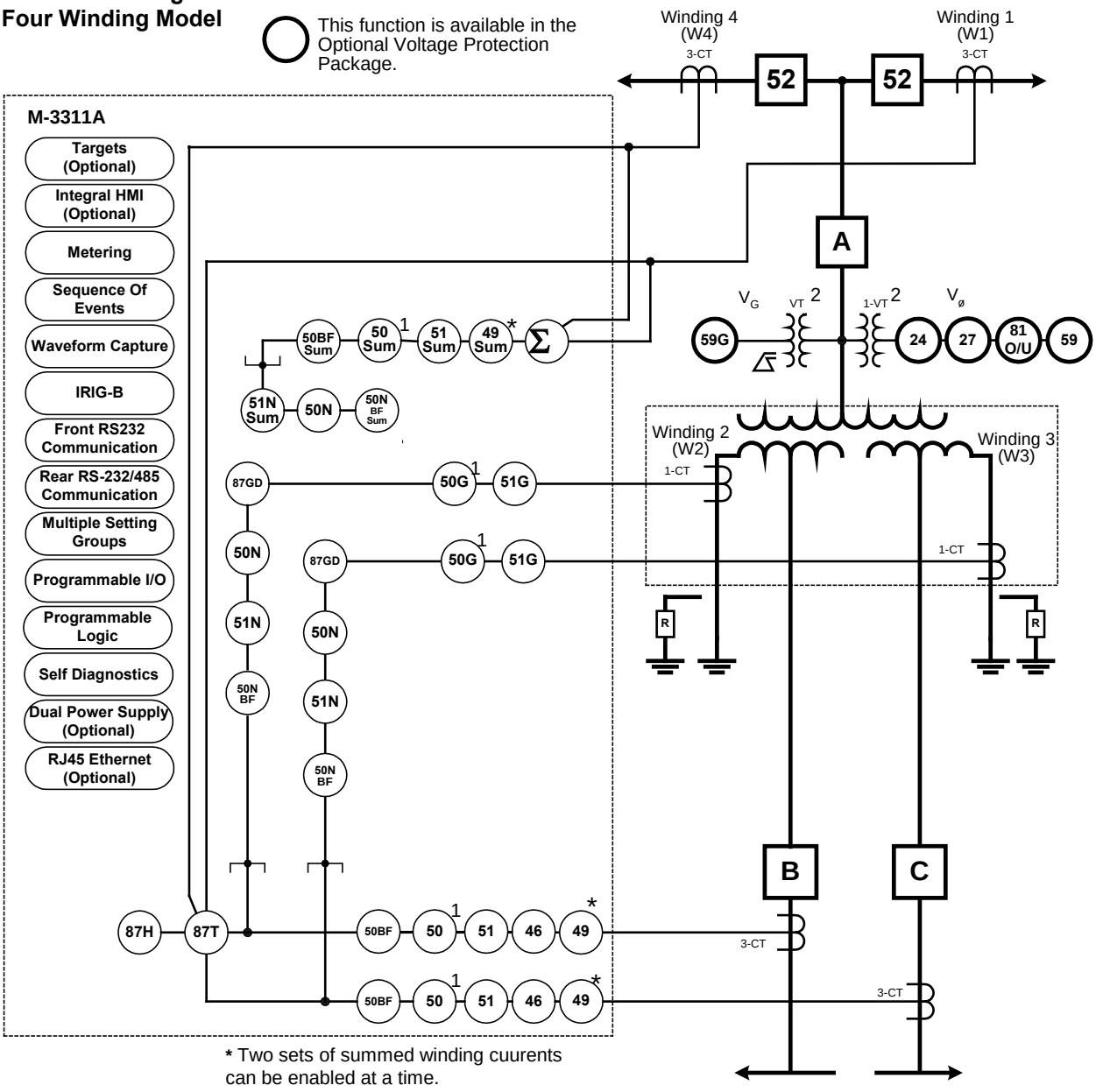
1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
2. Two voltage inputs are available in the 4-winding model of the M-3311A. These are a phase voltage Vϕ use for the 59, 81O/U, 27, and 24 Functions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

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

M-3311A Typical Connection Diagram Four Winding Model

This function is available as a standard protective function.

This function is available in the Optional Voltage Protection Package.



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

* 49 Function can only be enabled in one winding.

■NOTES:

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

Figure 6 Typical M-3311A (Four Winding-Two Voltage Inputs) Summing Currents One Line Functional Diagram

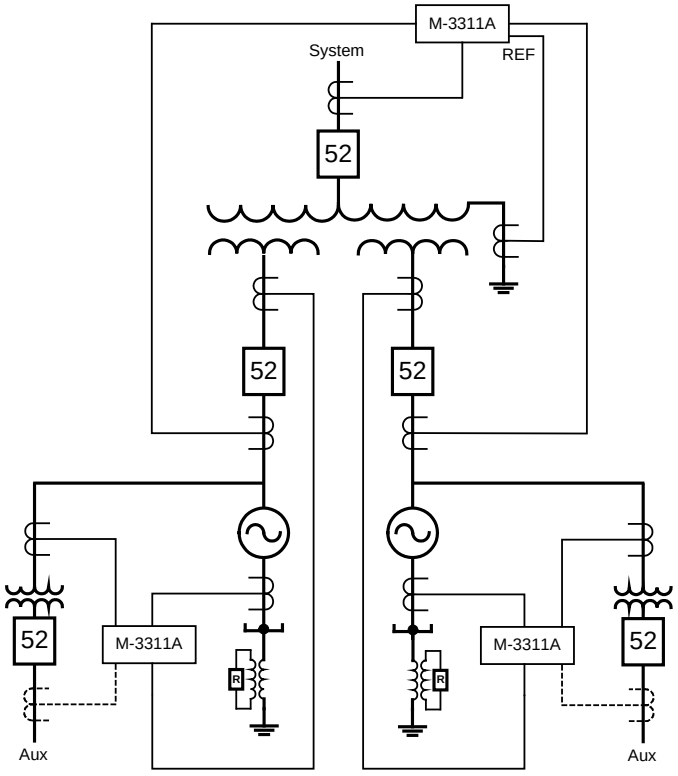


Figure 7 Dual Generator Power Plant Differential Zone of Protection

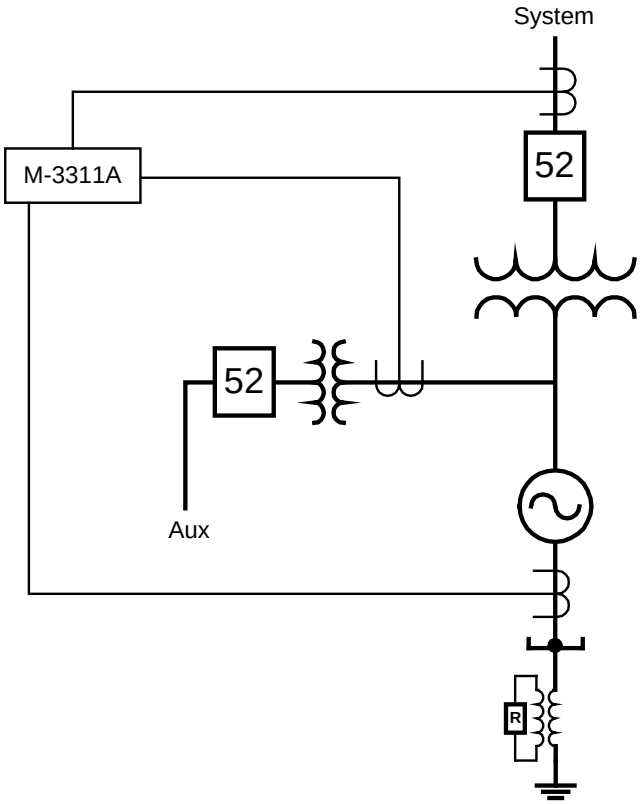


Figure 8 Generator Plant Overall Differential Zone of Protection

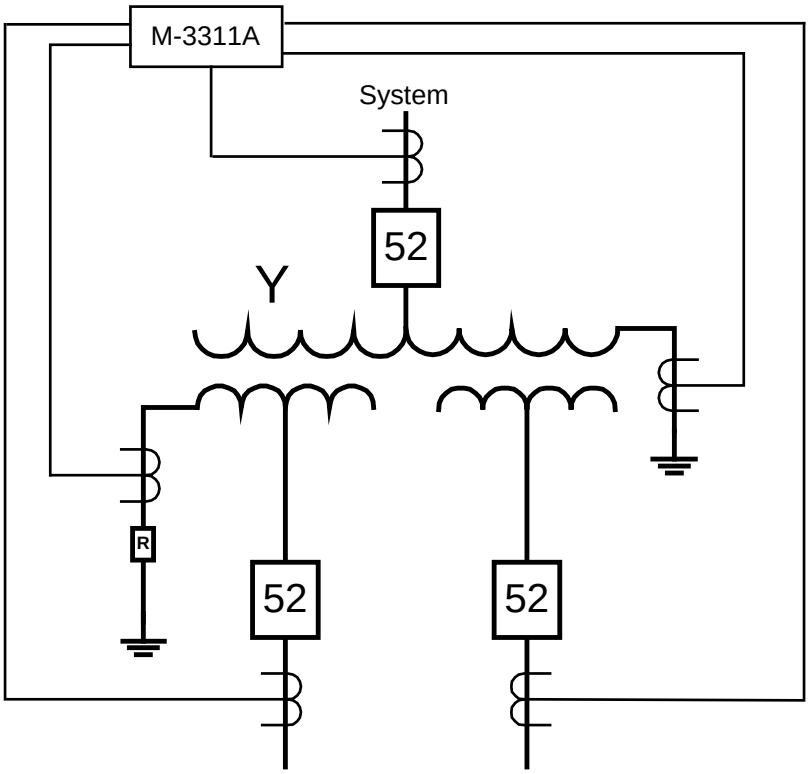


Figure 9 Three Winding Transformer with High Impedance Ground

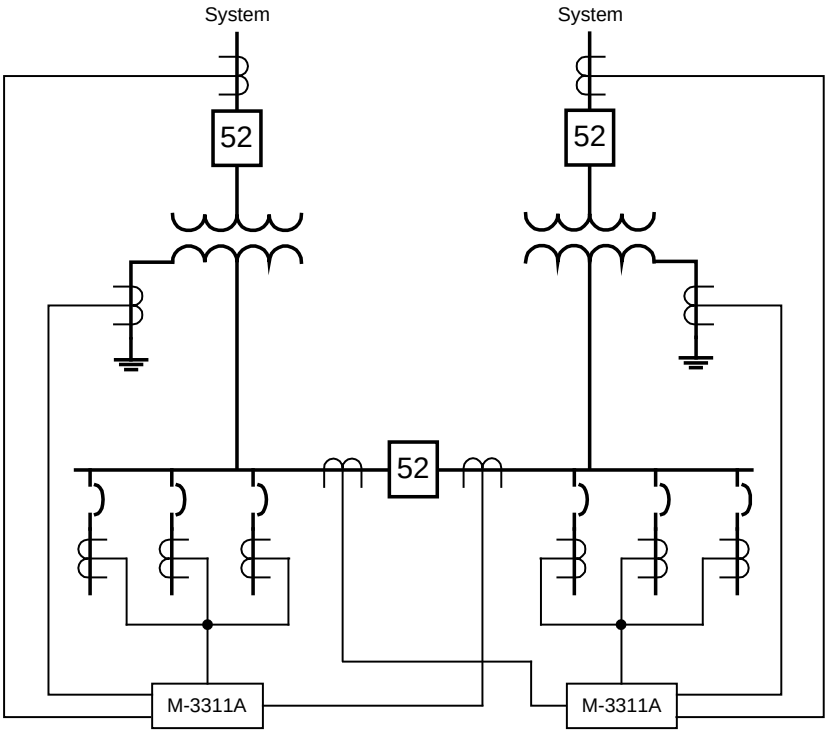
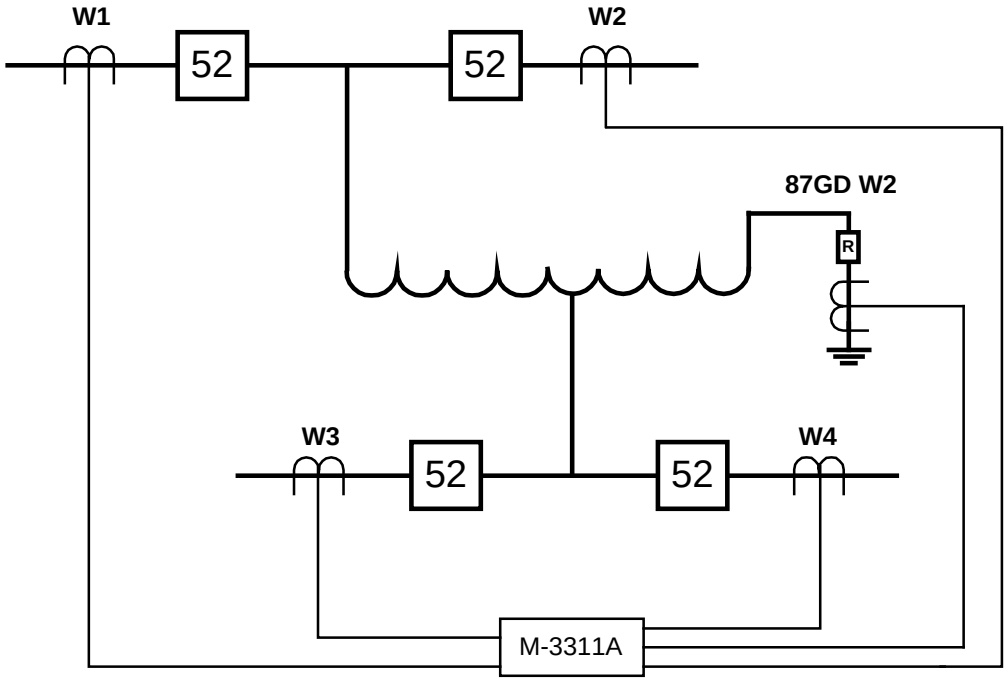


Figure 10 Dual Bank Distribution Substation



■ **NOTES:**

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

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

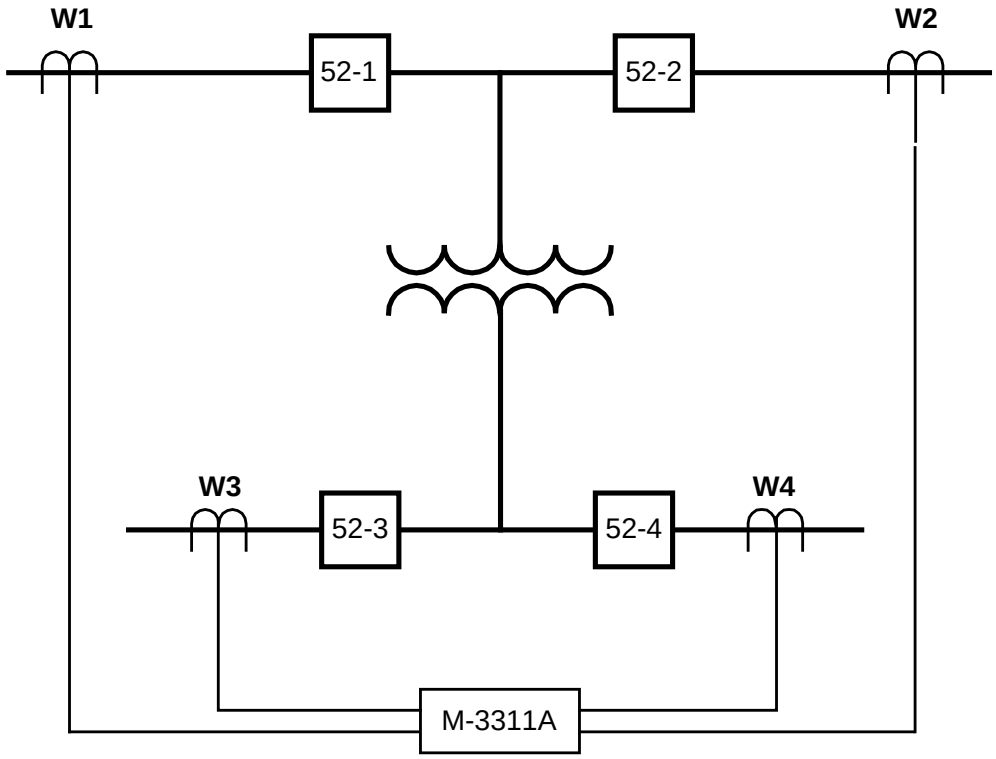
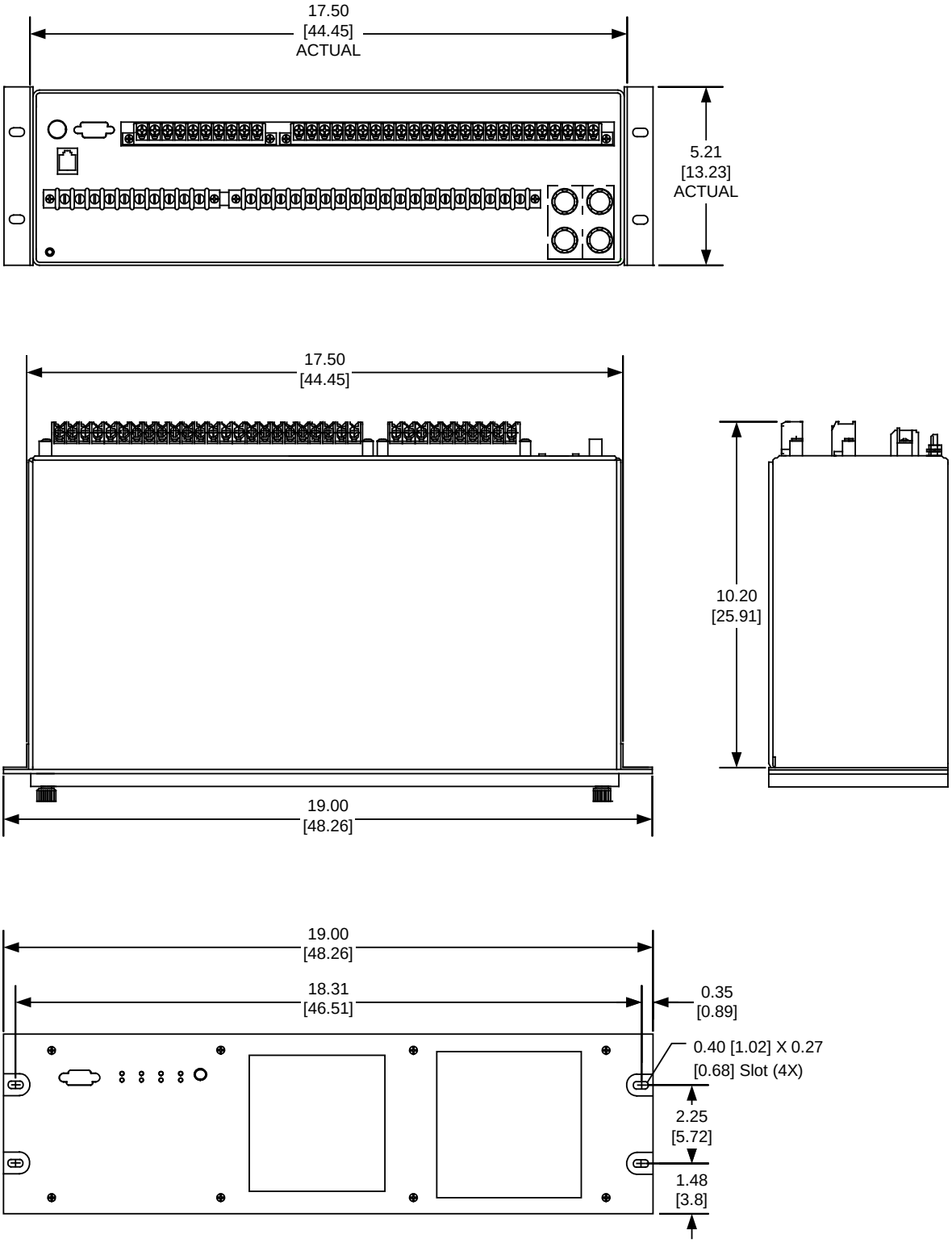


Figure 12 Two Winding Transformer with Two Circuit Breakers on High and Low Sides

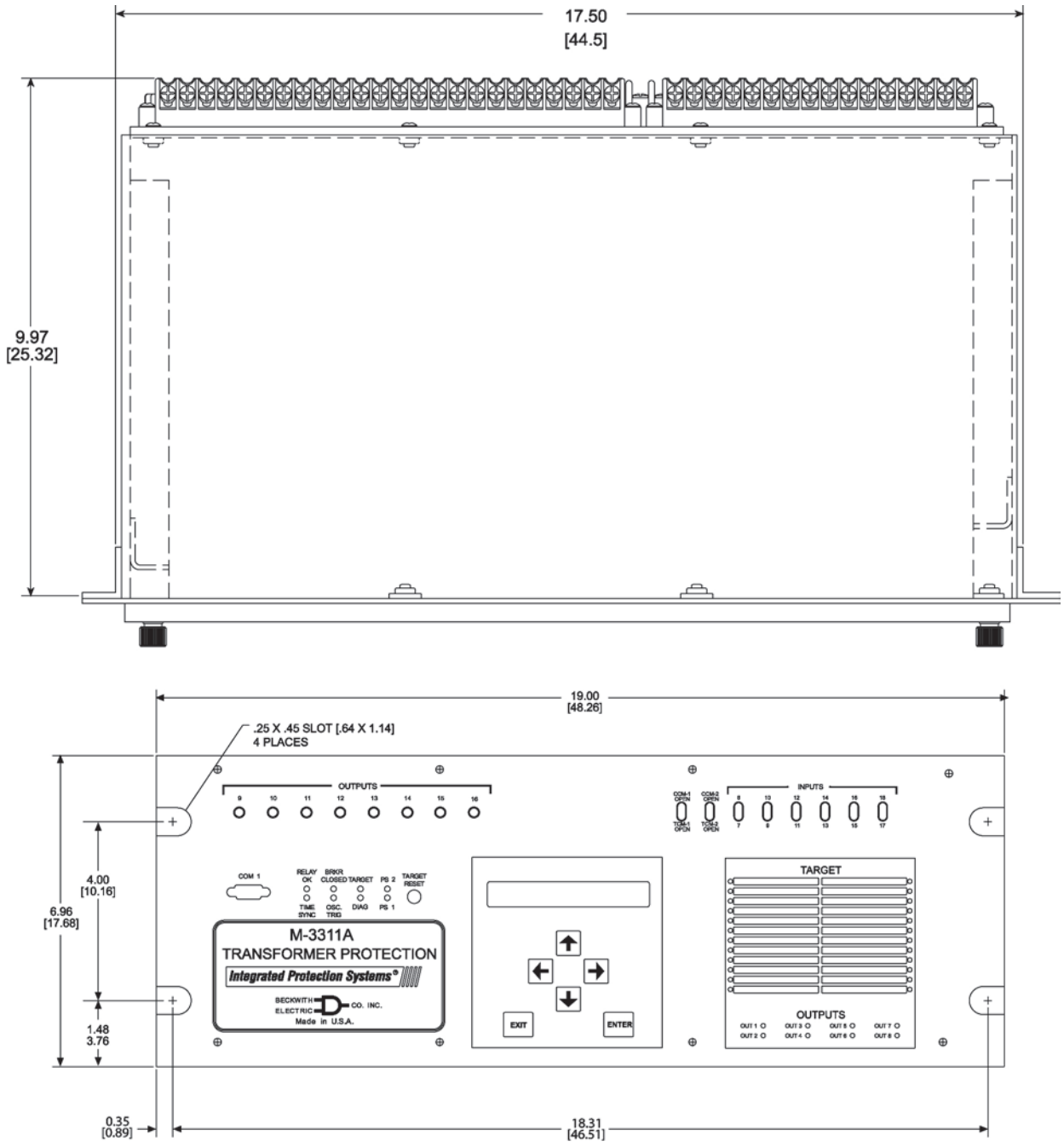


Standard 19" Horizontal Mount Chassis

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

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

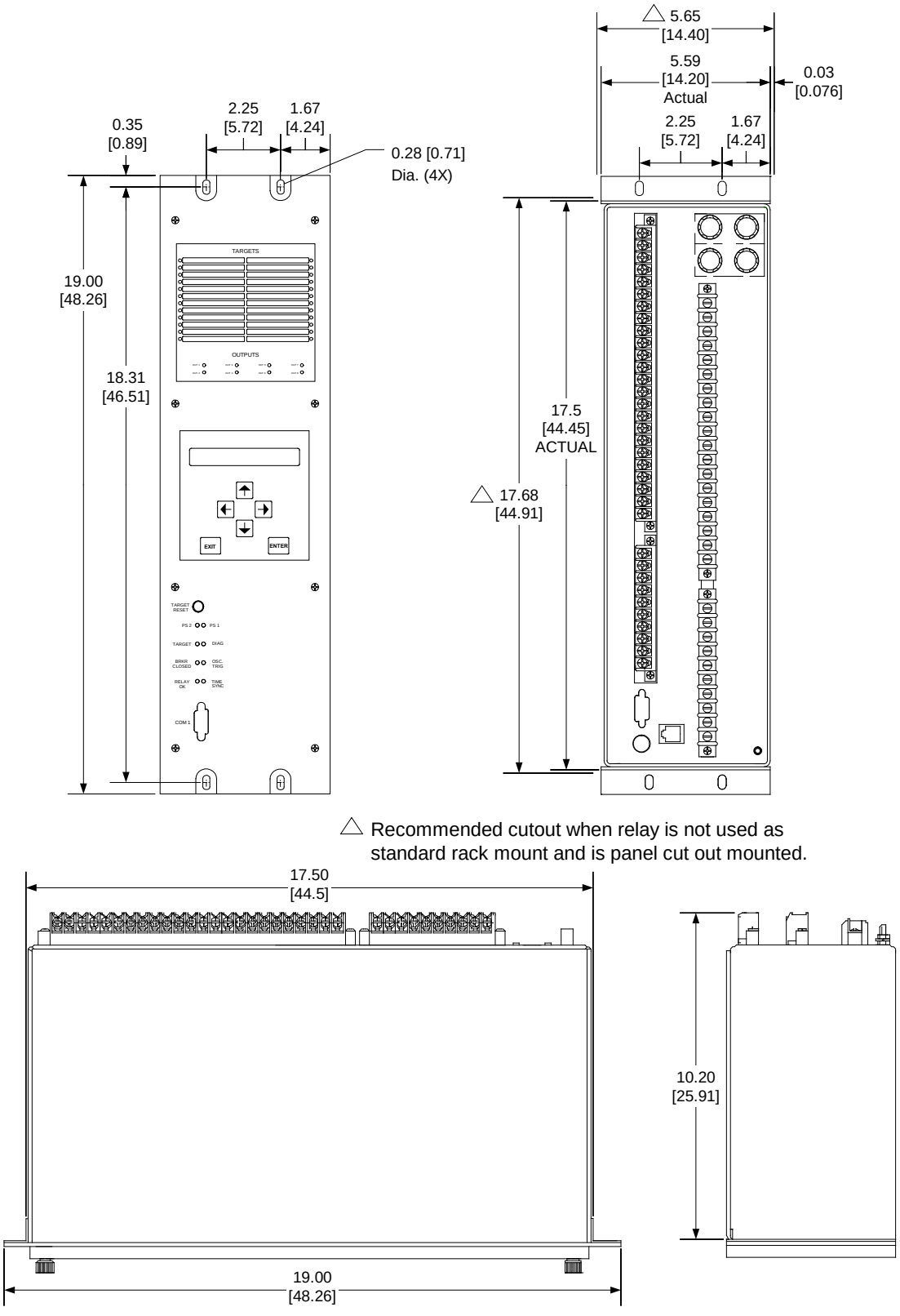
Figure 13 Horizontal Unit Dimensions Without Expanded I/O (H1)



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

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

Figure 14 Horizontal Unit Dimensions With Expanded I/O



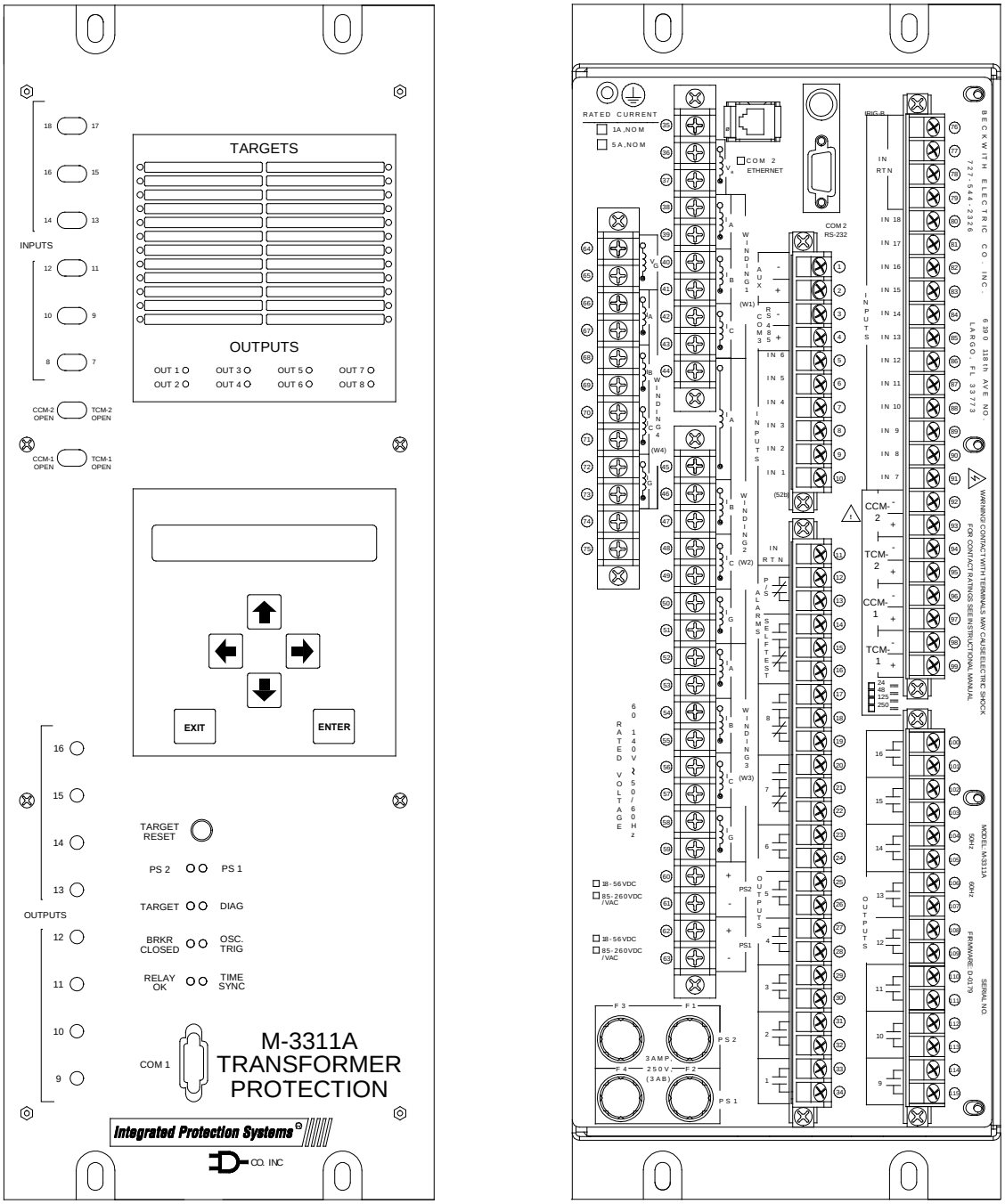
△ Recommended cutout when relay is not used as standard rack mount and is panel cut out mounted.

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

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

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

Figure 15 Vertical Unit Dimensions (H2)



■**NOTES**: 1. The M-3311A Expanded I/O vertical panel is the same physical size as the M-3311A Expanded I/O horizontal panel. See Figure 14 for dimensions.

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

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

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800-3311A-SP-06MC1 06/11