# BECKWITH BECKWITH

### **Transformer Protection** M-3311A

Integrated Protection System®



- For Transformers of All Sizes:
  - Two-, Three- or Four-winding Transformers for Transmission and Distribution applications
  - Generator-Transformer Unit Overall Differential
  - Unit Protection of Other Electrical Apparatus and certain Bus Arrangements (including those with a transformer in the zone)
- Additional Applications: System Backup Protection, Load Shedding (voltage and frequency), Bus Protection, and individual Breaker Failure Protection for each winding input
- Available voltage configurations include zero, two or four voltage inputs
- Ground Differential configurations include one, two or three current inputs
- Optional Ethernet Connection and Expanded I/O
- Optional Voltage Package includes, 24 Volts/Hz Overexcitation, 27 Phase Undervoltage, 59G Ground Overvoltage and 810/U Over/Under Frequency



#### **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<sup>®</sup>

#### **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 (810/U)

#### **Standard Features**

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

#### **Optional Features**

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

Device Number	Function	Setpoint Ranges	Increment	Accuracy <sup>†</sup>
	Negative Sequence	Overcurrent		
	46W2/46W3/46W4			
40	<b>Definite Time</b> 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%
	<b>Inverse Time</b> 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 Inve	erse/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 Pro	otection		
	Time Constant	1.0 to 999.9 minutes	0.1 minutes	
49	Maximum Overload Currer	nt 1.00 to 10.00 A (0.2 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±3%)
	Winding Select	Sum1, Sum2, W1, W2, W3	, or W4	
	Instantaneous Phase	e Overcurrent		
50	1-8			
50	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	50BFW1/50BFW2/50BFV	V3/50BFW4		
<b>B</b> F	Pickup (phase)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
	Pickup (residual)	0.10 to 10.00 A	0.01 A	±0.1 A or ±2%
	Time Delay	1 to 8160 Cycles	1 Cycle	-1 to +3 Cycles or ±2%
	Instantaneous Grou	nd Overcurrent		
	50GW2/50GW3/50GW4			
(50G)	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%

#### STANDARD PROTECTIVE FUNCTIONS

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

Two or three of the windings may be summed together.

	Inverse Time Ground (	Dvercurrent		
	51GW2/51GW3/51GW4			
(51G)	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Ve IEC Inverse/Very Inverse/Extra IEEE Moderately Inverse/Very	ery Inverse/Ext emely Inverse/ v Inverse/Extre	remely Inverse /Long Time Inverse mely Inverse
	Time Delay	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±3%
	Inverse Time Residual	Overcurrent		
	1-4			
(51N)	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Beco Definite Time/Inverse/Ve IEC Inverse/Very Inverse/Extra IEEE Moderately Inverse/Very	ery Inverse/Ext emely Inverse/ v Inverse/Extre	remely Inverse ′Long Time Inverse mely Inverse
	Time Delay	0.5 to 11.0 0.05 to 1.10 (IEC curves) 0.5 to 15.0 (IEEE curves)	0.1 0.01 0.1	±3 Cycles or ±3%
	Current Selection	Sum1, Sum2, W1, W2, W3, W	/4	

Device Number	Function	Setpoint Ranges	Increment	Accuracy <sup>†</sup>
	Instantaneous Residual	Overcurrent		
07	87H			
01	Pickup	5.0 to 20.0 PU	0.1 PU	±0.1 PU or ±3%
	Time Delay	1 to 8160 Cycles	1 Cycle	-1 to +3 Cycles or ±1%
	87T			
	Pickup	0.10 to 1.00 PU	0.01 PU	±0.02 PU or ±5%
	Percent Slope #1	5 to 100%	1%	±1%
	Percent Slope #2	5 to 200%	1%	±1%
	Slope Break Point	1.0 to 4.0 PU	0.1 PU	_
	Even Harmonics Restraint (2nd and 4th)	5 to 50%	1%	±1% or ±0.1 A
	5th Harmonic Restraint	5 to 50%	1%	±1% or ±0.1 A
	Pickup at 5th Harmonic Restraint	0.10 to 2.00 PU	0.01 PU	±0.1 PU or ±5%
	CT Tap W1/W2/W3/W4	1.00 to 100.00 (0.2 to 20)	0.01	_

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

	Ground Differential			
87	87GDW2/87GDW3/87GDW	4		
GD)	Pickup #1, #2	0.2 to 10.00 A (0.04 to 2.00 A)	0.01 A	±0.1 A or ±5% (±0.02 A or ±5%)
	Time Delay #1, #2	1 to 8160 Cycles*	1 Cycle	-1 to +3 Cycles or ±1%
	3I <sub>0</sub> Current Selection	Sum1, Sum2, W2**, W3**,	W4**	
	Directional Element	Disable/Enable		
	CT Ratio Correction (R <sub>c</sub> )	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.

Device Number	Function	Setpoint Ranges	Increment	Accuracy <sup>†</sup>	
	IPSIogic				
	<b>PS</b> ) IPSlogic uses element pickups, element trip commands, control/status input state characterized output contact close signals with programmable logic array to develop schemes.				
$\bigcirc$	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			
	Trip Circuit Monitor				
	TCM Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%	
	TCM Dropout Time Delav	1 to 8160 Cvcles	1 Cvcle	±1 Cvcle or ±1%	

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

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

	Breaker Monitoring			
(BM)	Pickup	1 to 50,000 kA Cycles or kA² Cycles	1 kA Cycles or kA <sup>2</sup> Cycles	± 1 kA Cycles or kA <sup>2</sup> Cycles
$\bigcirc$	Time Delay	0.1 to 4095.9 Cycles	0.1 Cycles	±1 Cycle or ±1%
	Timing Method	IT or I²T		
	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.

Device Number	Function	Setpoint Ranges	Increment	Accuracy <sup>†</sup>	
	Through Fault				ľ
TF	Through Fault Current Threshold	1.0 to 100.0 A (0.2 to 20.0 A)	0.1 A	±0.1 A or ±5% (±0.02 A or ±5%)	
$\bigcirc$	Through Fault Count Limit	1 to 65535	1	-	
	Cumulative <i>I</i> <sup>2</sup> T Limit	1 to 1000000 (kA² Cycles)	1	±1.0 kA Cycles or kA <sup>2</sup> Cycles	
	Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%	
	Current Selection	Sum1, Sum2, W1, W2, W3	or W4	-	
	Nominal Settings				Ī
	Nominal Voltage VT Configuration	60.0 to 140.0 V V <sub>A</sub> , V <sub>B</sub> , V <sub>C</sub> , V <sub>AB</sub> , V <sub>BC</sub> , V <sub>CA</sub> , V	0.1 V G	_	
	Phase Rotation	ABC/ACB	_	_	
	Number of Windings	2, 3, or 4			
	Transformer/CT Connection	Standard IEEE/IEC or Cust	om 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.

#### **OPTIONAL VOLTAGE PROTECTION PACKAGE**

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

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

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

	Phase Undervoltage			
	Pickup #1, #2*, #3*	5 to 140 V	1 V	±0.5 V
27	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			
<b>E0</b>	1-3			
29	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	e, Negative Sec	luence
	Ground Overvoltage			
	Pickup #1, #2, #3*	5 to 180 V	1 V	±0.5 V or ±0.5%
(59G)	Time Delay #1, #2, #3*	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
	Zero Sequence Voltage**	$V_{G}$ or $3V_{0}$ (Only for Two-	/Three-Winding	js, Four Voltage Inputs)

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

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

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

#### **OPTIONAL VOLTAGE PROTECTION PACKAGE (***cont.***)**

Device Number	Function	Setpoint Ranges	Increment	Accuracy <sup>†</sup>
	Overfrequency/Underfr	equency		
(81 (0/U)	Pickup #1, #2, #3, #4	55.00 to 65.00 Hz 45.00 to 55.00 Hz*	0.01 Hz	±0.1 Hz
$\underline{\bigcirc}$	Time Delay #1,#2,#3,#4	2 to 65,500** Cycles	1 Cycle	-1 to +3 Cycles or ±1%

Accuracy applies to 60 Hz models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. \* This range applies to 50 Hz nominal frequency models.

\*\* For 65,500 cycles, time delay setting phase voltage must be greater than 35 Vac.

This function is applicable only when phase voltage of at least 27 Vac input is applied.

#### Trip and Close Circuit Monitor (Expanded I/O Units)

	(M:
(10	~

Trip Circuit Monitor			
TCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
<b>Close Circuit Monitor</b>			
CCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

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

#### **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 Vac)
Current:	5 A rating, ±0.1 A or ±3%, whichever is greater (range 0 to 14 A) 1 A rating, ±0.02 A or ±3%, whichever is greater (range 0 to 2.8 A)
Power:	±0.01 PU or ±2% of VA applied, whichever is greater
Frequency:	±0.1 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)
Volts/Hz:	±1%

#### **Oscillographic Recorder**

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

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

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

#### **Sequence of Events Log**

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

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

#### **Through Fault Recorder**

In addition to the Even Recorder, the M-3311A also has a separate Through Fault Recorder, which records Through Faults. Each through fault record contains the serial number of the fault, duration of the event, maximum RMS fault current magnitude for each phase during the fault, I<sup>2</sup>t 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<sup>2</sup>t for each phase since last reset (up to 256 records).

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

#### **Target Storage**

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

#### **Calculations**

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

#### **Power Input Options**

Nominal 110/120/230/240 Vac, 50/60 Hz, or nominal 110/125/220/250 Vdc. UL rating, 85 Vac to 265 Vac and from 80 Vdc to 288 Vdc. Burden 20 VA at 120 Vac/125 Vdc. Withstands 300 Vac or 300 Vdc for 1 second.

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

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

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

#### **Sensing Inputs**

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

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

#### **Control/Status Inputs**

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

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

#### **Output Contacts**

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

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

The eight output contacts (six form 'a' and two form 'c'), the power supply alarm output contact (form 'b'), the self-test alarm output contact (form 'c') and the optional 8 I/O Expansion Module output contacts (form 'a') are all rated per IEEE C37.90/UL (See Tests and Standards section for details).

#### **Breaker Monitoring**

The Breaker Monitoring function calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current (selected as I<sup>2</sup>t 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<sup>®</sup> 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<sup>™</sup>-compatible S-3300 IPScom<sup>®</sup> Communications Software.

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

#### **Optional Ethernet Port**

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

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

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

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

#### IRIG-B

The M-3311A accepts either modulated (B-122) using the BNC Port or demodulated (B-002) using the RS-232 Port IRIG-B time clock synchronization signals. The IRIG-B time synchronization information is used to correct the local calendar/clock and provide greater resolution for target and oscillograph time tagging.

#### **HMI Module**

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

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

#### **Target Module**

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

#### I/O Expansion Module (optional)

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

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

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

#### **Tests and Standards**

The relay complies with the following type tests and standards:

#### **Voltage Withstand**

#### **Dielectric Withstand**

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

- 1,500 Vdc for 1 minute applied between IRIG-B to each independent circuit
- 1,500 Vdc for 1 minute applied between RS-485 to each independent circuit

#### Impulse Voltage

IEC 60255-27 5,000 V pk, +/- polarity applied to each independent circuit to earth 5,000 V pk, +/- polarity applied between each independent circuit 1.2 by 50 μs, 500 ohms impedance, three surges at 1 every 5 seconds

#### Insulation Resistance

IEC 60255-27 > 10 G Ω

#### Voltage Interruptions Immunity

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

#### **Electrical Environment**

#### Electrostatic Discharge Test

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

#### Fast Transient Disturbance Test

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

#### **Emissions**

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

#### Surge Withstand Capability

IEEE C37.90.1- 1989	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk oscillatory applied between each independent circuit 5,000 V pk Fast Transient applied to each independent circuit to earth 5,000 V pk Fast Transient applied between each independent circuit
IEEE C37.90.1- 2012	2,500 V pk-pk oscillatory applied to each independent circuit to earth 2,500 V pk-pk oscillatory applied between each independent circuit 4,000 V pk Fast Transient burst applied to each independent circuit to earth 4,000 V pk Fast Transient burst applied between each independent circuit

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

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

#### Radiated Susceptibility

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

#### **Output Contacts**

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

#### **Atmospheric Environment**

#### Temperature

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

#### **Mechanical Environment**

#### Vibration

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

#### Compliance

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

#### **External Connections**

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

#### **Physical**

#### Without Optional I/O Expansion Module

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

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

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

Approximate Weight: 16 lbs (7 kg)

Approximate Shipping Weight: 25 lbs (11.3 kg)

#### With Optional I/O Expansion Module

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

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

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

Approximate Weight: 19 lbs (8.6 kg)

Approximate Shipping Weight: 26 lbs (11.8 kg)

#### **Recommended Storage Parameters**

**Temperature**: 5° C to 40° C

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

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

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

#### **Disposal and Recycling**

#### Disposal of E-Waste for Beckwith Electric Products

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

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

#### **Patent & Warranty**

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

#### **Trademarks**

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

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





## ■ NOTES:

- 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) <del>.</del> -
- To comply with UL listing requirements, terminal block connections must be made with #22–12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector. Wire insulation must be rated at 75°C minimum. Terminal block connections 1 through 34 must be tightened to 12 in-lbs torque. Terminal block connections 35 through 75 must be tightened to 8.0 in-lbs, minimum, 9.0 in-lbs, maximum torque. Over torquing may result in terminal damage. сi
- 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. *с*і.
- All relays are shown in the de-energized state, and without power applied to the relay 4
- The power supply relay (P/S) is energized when the power supply is functioning properly. ы. С
- self-test relay is energized when the relay has performed all self-tests successfully. The . 0

-17-





# ■ NOTES:

- 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) <del>.</del> -
- To comply with UL listing requirements, terminal block connections must be made with #22-12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector. Wire insulation must be rated at 75°C minimum. Terminal block connections 1 through 34 and 76 through 115 must be tightened to 12 in-lbs torque. Terminal block connections 35 through 75 must be tightened to 8.0 in-lbs, minimum, 9.0 in-lbs, maximum torque. Over torquing may result in terminal damage. с,
- ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common and terminals 80 through 91 with 76 through 79 common) because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the unit с.
- All relays are shown in the de-energized state, and without power applied to the relay 4
- The power supply relay (P/S) is energized when the power supply is functioning properly. ы. С
- The self-test relay is energized when the relay has performed all self-tests successfully . 0



#### M-3311A Typical Connection Diagram Two Winding Model

\* Available with Four Voltage option and VT Config = LG

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



\* Available with 4 Voltage option and VT Config = LG

† 49 Function can only be enabled in one winding.

**NOTE:** All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.

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



\* 49 Function can only be enabled in one winding.

#### **NOTES:**

- 1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.

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



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

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

#### NOTES:

- 1. All 50 and 50G functions may be applied instantaneous or definite time, and are multiple (2) elements, each with individual pickup and time delay setpoints.
- Two voltage inputs are available in the four-winding model of the M-3311A. These are a phase voltage Vφ use for the 59, 81O/U, 27, and 24 Functions and the V<sub>G</sub> 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  $3I_0$  current is the sum of W1, W2, W3 and W4 currents.

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



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







Standard 19" Horizontal Mount Chassis

#### NOTES:

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

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



#### **NOTES:**

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

Figure 14 Horizontal Unit Dimensions With Expanded I/O



#### **NOTES:**

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

Figure 15 Vertical Unit Dimensions (H2)



#### NOTES:

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

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

This Page Left Intentionally Blank

This Page Left Intentionally Blank

### **BECKWITH ELECTRIC**

6190 118th Avenue North • Largo, Florida 33773-3724 U.S.A. PHONE (727) 544-2326 beckwithelectricsupport@hubbell.com www.beckwithelectric.com ISO 9001:2015



A proud member of the Hubbell family.