Instruction Book

M-3311A Transformer Protection Relay

BECKWITH ELECTRIC CO. INC.
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
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

<table>
<thead>
<tr>
<th>Device Number</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>Negative Sequence Overcurrent</td>
<td>46W2/46W3/46W4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Definite Time</td>
<td>Pickup</td>
<td>0.10 to 20.00 A</td>
<td>0.01 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02 to 4.00 A)</td>
<td></td>
<td>0.01 A or ±3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
</tr>
<tr>
<td>50</td>
<td>Inverse Time</td>
<td>Pickup</td>
<td>0.50 to 5.00 A</td>
<td>0.01 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.10 to 1.00 A)</td>
<td></td>
<td>0.01 A or ±3%</td>
</tr>
<tr>
<td></td>
<td>Characteristic Curves</td>
<td>Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves/IEEE Time Dial Setting</td>
<td>0.05 to 1.10</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current Dial Setting</td>
<td>0.5 to 11.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Winding Thermal Protection</td>
<td>Time Constant</td>
<td>1.0 to 999.9 minutes</td>
<td>0.1 minutes</td>
</tr>
<tr>
<td>50</td>
<td>Instantaneous Phase Overcurrent</td>
<td>1-8</td>
<td>1.0 to 100.0 A</td>
<td>0.1 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.2 to 20.0 A)</td>
<td></td>
<td>0.01 A or ±3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
</tr>
<tr>
<td></td>
<td>Breaker Failure</td>
<td>Pickup (phase)</td>
<td>0.10 to 10.00 A</td>
<td>0.01 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02 to 2.00 A)</td>
<td></td>
<td>0.01 A or ±2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pickup (residual)</td>
<td>0.10 to 10.00 A</td>
<td>0.01 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02 to 2.00 A)</td>
<td></td>
<td>0.01 A or ±2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
</tr>
<tr>
<td>50</td>
<td>Instantaneous Ground Overcurrent</td>
<td>50GW2/50GW3/50GW4</td>
<td>1.0 to 100.0 A</td>
<td>0.1 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.2 to 20.0 A)</td>
<td></td>
<td>0.01 A or ±3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
</tr>
</tbody>
</table>

¹Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.
### STANDARD PROTECTIVE FUNCTIONS (cont.)

<table>
<thead>
<tr>
<th>Device Number</th>
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<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Instantaneous Residual Overcurrent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-8</td>
<td>Pickup 1-8</td>
<td>1.0 to 100.0 A</td>
<td>0.1 A</td>
<td>± 0.1 A or ±3% (± 0.02 A or ± 3%)</td>
</tr>
<tr>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
<td>± 2 Cycles or ± 1%</td>
</tr>
<tr>
<td></td>
<td>Current Selection</td>
<td>Sum1, Sum2, W1, W2, W3, W4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Inverse Time Phase Overcurrent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-4</td>
<td>Pickup 1-4</td>
<td>0.50 to 12.00 A</td>
<td>0.01 A</td>
<td>± 0.1 A or ±3% (± 0.02 A or ± 3%)</td>
</tr>
<tr>
<td></td>
<td>Characteristic Curve</td>
<td>Beco Definite Time/Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE Moderately Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Dial Setting</td>
<td>0.5 to 11.0</td>
<td>0.1</td>
<td>± 3 Cycles or ± 3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05 to 1.10 (IEC curves)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 to 15.0 (IEEE curves)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Inverse Time Ground Overcurrent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51GW2/51GW3/51GW4</td>
<td>Pickup 51GW2</td>
<td>0.50 to 12.00 A</td>
<td>0.01 A</td>
<td>± 0.1 A or ±3% (± 0.02 A or ± 3%)</td>
</tr>
<tr>
<td></td>
<td>Characteristic Curve</td>
<td>Beco Definite Time/Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE Moderately Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Dial Setting</td>
<td>0.5 to 11.0</td>
<td>0.1</td>
<td>± 3 Cycles or ± 3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05 to 1.10 (IEC curves)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 to 15.0 (IEEE curves)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Inverse Time Residual Overcurrent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-4</td>
<td>Pickup 1-4</td>
<td>0.50 to 6.00 A</td>
<td>0.01 A</td>
<td>± 0.1 A or ±3% (± 0.02 A or ± 3%)</td>
</tr>
<tr>
<td></td>
<td>Characteristic Curve</td>
<td>Beco Definite Time/Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC Inverse/Very Inverse/Extremely Inverse/Long Time Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE Moderately Inverse/Very Inverse/Extremely Inverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Dial Setting</td>
<td>0.5 to 11.0</td>
<td>0.1</td>
<td>± 3 Cycles or ± 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05 to 1.10 (IEC curves)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 to 15.0 (IEEE curves)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current Selection</td>
<td>Sum1, Sum2, W1, W2, W3, W4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.
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<th>Increment</th>
<th>Accuracy†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Phase Differential Current</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87H</td>
<td>Pickup</td>
<td>5.0 to 20.0 PU</td>
<td>0.1 PU</td>
<td>± 0.1 PU or ± 3%</td>
</tr>
<tr>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
<td>−1 to +3 Cycles or ± 1%</td>
</tr>
<tr>
<td>87T</td>
<td>Pickup</td>
<td>0.10 to 1.00 PU</td>
<td>0.01 PU</td>
<td>± 0.02 PU or ± 5%</td>
</tr>
<tr>
<td></td>
<td>Percent Slope #1</td>
<td>5 to 100%</td>
<td>1%</td>
<td>± 1%</td>
</tr>
<tr>
<td></td>
<td>Percent Slope #2</td>
<td>5 to 200%</td>
<td>1%</td>
<td>± 1%</td>
</tr>
<tr>
<td></td>
<td>Slope Break Point</td>
<td>1.0 to 4.0 PU</td>
<td>0.1 PU</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Even Harmonics Restraint (2nd and 4th)</td>
<td>5 to 50%</td>
<td>1%</td>
<td>± 1% or ± 0.1 A</td>
</tr>
<tr>
<td></td>
<td>5th Harmonic Restraint</td>
<td>5 to 50%</td>
<td>1%</td>
<td>± 1% or ± 0.1 A</td>
</tr>
<tr>
<td></td>
<td>Pickup at 5th Harmonic Restraint</td>
<td>0.10 to 2.00 PU</td>
<td>0.01 PU</td>
<td>± 0.1 PU or ± 5%</td>
</tr>
<tr>
<td></td>
<td>CT Tap W1/W2/W3/W4</td>
<td>1.00 to 100.00 (0.2 to 20)</td>
<td>0.01</td>
<td>—</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>87GD</th>
<th>87GDW2/87GDW3/87GDW4</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup #1, #2</td>
<td>0.2 to 10.00 A</td>
<td>0.01 A</td>
<td>± 0.1 A or ± 5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.04 to 2.00 A)</td>
<td></td>
<td>(± 0.02 A or ± 5%)</td>
<td></td>
</tr>
<tr>
<td>Time Delay #1, #2</td>
<td>1 to 8160 Cycles*</td>
<td>1 Cycle</td>
<td>−1 to +3 Cycles or ± 1%</td>
<td></td>
</tr>
<tr>
<td>3I₀ Current Selection</td>
<td>Sum1, Sum2, W2**, W3**, W4**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directional Element</td>
<td>Disable/Enable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Ratio Correction (R₀)</td>
<td>0.10 to 7.99</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The Time Delay should not be less than 2 cycles. This function is selectable as either directional or non-directional. If 3I₀ 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.)

**IPSlogic**

IPSlogic uses element pickups, element trip commands, control/status input state changes, output contact close signals with programmable logic array to develop schemes.

<table>
<thead>
<tr>
<th>Device</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reset/Dropout Delay #1–#6</td>
<td>0 to 65500 Cycles</td>
<td>1 Cycle</td>
<td>± 1 Cycle or ±1%</td>
</tr>
<tr>
<td></td>
<td>Time Delay #1–#6</td>
<td>1 to 65500 Cycles</td>
<td>1 Cycle</td>
<td>± 1 Cycle or ±1%</td>
</tr>
</tbody>
</table>

**Trip (Aux Input) Circuit Monitor**

Trip Circuit Monitor

<table>
<thead>
<tr>
<th>Device</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TCM Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
<td>± 1 Cycle or ±1%</td>
</tr>
<tr>
<td></td>
<td>TCM Dropout Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
<td>± 1 Cycle or ±1%</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Device</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pickup</td>
<td>1 to 50,000 kA Cycles or kA² Cycles</td>
<td>1 kA Cycles or kA² Cycles</td>
<td>± 1 kACycles or kA² Cycles</td>
</tr>
<tr>
<td></td>
<td>Time Delay</td>
<td>0.1 to 4095.9 Cycles</td>
<td>0.1 Cycles</td>
<td>± 1 Cycle or ±1%</td>
</tr>
<tr>
<td></td>
<td>Timing Method</td>
<td>I¹T or I²T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preset Accumulators Phase A, B, C</td>
<td>0 to 50,000 kA Cycles</td>
<td>1 kA Cycle</td>
<td></td>
</tr>
</tbody>
</table>

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.)

<table>
<thead>
<tr>
<th>Device Number</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy(^\d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through Fault</td>
<td>1.0 to 100.0 A</td>
<td>0.1 A</td>
<td>± 0.1 A or ± 5%</td>
</tr>
<tr>
<td></td>
<td>Current Threshold</td>
<td>(0.2 to 20.0 A)</td>
<td></td>
<td>(± 0.02 A or ± 5%)</td>
</tr>
<tr>
<td></td>
<td>Through Fault Count Limit</td>
<td>1 to 65535</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Cumulative (I^2T) Limit</td>
<td>1 to 1000000 (kA(^2) Cycles)</td>
<td>1</td>
<td>± 1.0 kA Cycles or kA(^2) Cycles</td>
</tr>
<tr>
<td></td>
<td>Time Delay</td>
<td>1 to 8160 Cycles</td>
<td>1 Cycle</td>
<td>± 1 Cycle or ± 1%</td>
</tr>
<tr>
<td></td>
<td>Current Selection</td>
<td>Sum1, Sum2, W1, W2, W3 or W4</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

#### Nominal Settings

- **Nominal Voltage**: 60.0 to 140.0 V
- **VT Configuration**: VA, VB, VC, VAB, VBC, VCA, VG
- **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.

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\(^\d\)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 |
|               | 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.    | ±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.

| Device Number | Function                      | Setpoint Ranges | Increment | Accuracy
|---------------|-------------------------------|-----------------|-----------|-----------
|               | Phase Undervoltage             |                 |           |           |
|               | 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.

| Device Number | Function                      | Setpoint Ranges | Increment | Accuracy
|---------------|-------------------------------|-----------------|-----------|-----------
|               | Phase Overvoltage              |                 |           |           |
|               | 1-3                            | 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 |

| Device Number | Function                      | Setpoint Ranges | Increment | Accuracy
|---------------|-------------------------------|-----------------|-----------|-----------
|               | Ground Overvoltage             |                 |           |           |
|               | Pickup #1, #2, #3*             | 5 to 180 V      | 1 V       | ±0.5 V or ±0.5% |
|               | Time Delay #1, #2, #3*         | 1 to 8160 Cycles | 1 Cycle  | ±1 Cycle or ±1% |
|               | Zero Sequence Voltage**        | Vₐ or 3V₀ (Only for 2/3 Windings, 4 Voltage Inputs) |

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

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

** This setting is only functional in 2/3 winding applications with firmware version V02.03.01 and later.

†Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.
### OPTIONAL VOLTAGE PROTECTION PACKAGE

<table>
<thead>
<tr>
<th>Device Number</th>
<th>Function</th>
<th>Setpoint Ranges</th>
<th>Increment</th>
<th>Accuracy(^\d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overfrequency/Underfrequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pickup #1, #2, #3, #4</td>
<td>55.00 to 65.00 Hz</td>
<td>0.01 Hz</td>
<td>± 0.1 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45.00 to 55.00 Hz*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Delay #1, #2, #3, #4</td>
<td>2 to 65,500** Cycles</td>
<td>1 Cycle</td>
<td>−1 to +3 Cycles or ± 1%</td>
</tr>
</tbody>
</table>

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)

**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%

**Close Circuit Monitor**

- 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.

\(^\d\)Select the greater of these accuracy values. Values in parentheses apply to 1 A CT secondary rating.
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.

<table>
<thead>
<tr>
<th>Windings</th>
<th>Ground Inputs</th>
<th>Voltage Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>One</td>
<td>Zero</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two</td>
</tr>
<tr>
<td>Three</td>
<td>Two</td>
<td>Zero</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Four</td>
</tr>
<tr>
<td>Four</td>
<td>Three</td>
<td>Zero</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two</td>
</tr>
</tbody>
</table>

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:** $\pm 0.5 \text{ V or } \pm 0.5\%$, whichever is greater (range 0 to 180 Vac)
- **Current:**
  - 5 A rating, $\pm 0.1 \text{ A or } \pm 3\%$, whichever is greater (range 0 to 14 A)
  - 1 A rating, $\pm 0.02 \text{ A or } \pm 3\%$, whichever is greater (range 0 to 2.8 A)
- **Power:** $\pm 0.01 \text{ PU or } \pm 2\%$ of VA applied, whichever is greater
- **Frequency:** $\pm 0.1 \text{ Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)}$
- **Volts/Hz:** $\pm 1\%$

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. UL rating, 85 V ac to 265 V ac and from 80 V dc to 288 V dc. Burden 20 VA at 120 V ac/125 V dc. Withstands 300 V ac or 300 V dc 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 $I^2t$ 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 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 (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 60255-27
- 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 GΩ

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
- Level 4 (15 kV)–air discharge

Fast Transient Disturbance Test

IEC 61000-4-4
- Level 4 (4 kV, 5 kHz)

Emissions

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

Surge Withstand Capability

IEEE
- C37.90.1-1989
- 2,500 V pk-pk oscillatory applied to each independent circuit to earth
- 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
- 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  80-1000 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 (–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% RH – 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, 10.0g

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

Product Safety  – IEC 60255-27, CAT III, Pollution Degree 2
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 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-3311A Generator Protection Relay is covered by a ten-year warranty from date of shipment.

*Specification subject to change without notice.*
### 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 #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.**

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.
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 #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.

3. 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.

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/O (See Instruction Book Chapter 5, for Details)
Figure 3  M-3311A (Two Winding-Two or Four Voltage Inputs) Typical One-Line Function Diagram
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.

**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*
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 $V_{\phi}$ use for the 59, 81O/U, 27, and 24 Functions and the $V_o$ 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.

### M-3311A

- Targets (Optional)
- Integral HMI (Optional)
- Metering
- Sequence Of Events
- Waveform Capture
- IRIG-B
- Front RS232 Communication
- Rear RS-232/485 Communication
- Multiple Setting Groups
- Programmable I/O
- Programmable Logic
- Self Diagnostics
- Dual Power Supply (Optional)
- RJ45 Ethernet (Optional)

<table>
<thead>
<tr>
<th>50 Sum</th>
<th>51 Sum</th>
<th>49 Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>50N</td>
<td>50N</td>
<td>50N</td>
</tr>
<tr>
<td>50N</td>
<td>50N</td>
<td>50N</td>
</tr>
<tr>
<td>50N</td>
<td>50N</td>
<td>50N</td>
</tr>
</tbody>
</table>

* Two sets of summed winding currents 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 \( V_\phi \) 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 3Io 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
**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)*
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)
WARNING

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

DANGER! HIGH VOLTAGE

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

PERSONNEL SAFETY PRECAUTIONS

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

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

Always Ground the Equipment

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

Do NOT operate in an explosive environment

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

Keep away from live circuits

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

Exercise care during installation, operation, & maintenance procedures

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

Do not modify equipment

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

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

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

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

1.1 Instruction Book Contents

This instruction book includes six Chapters and seven Appendices.

Chapter 1: Introduction
Chapter One summarizes the devices’ capabilities, introduces the instruction book contents and describes the application of an M-3311A.

Chapter 2: Operation
Chapter Two provides the necessary instructions regarding operation of the M-3311A. Manual operation of the M-3311A is accomplished by utilizing either the unit’s front panel controls and indicators, which include the M-3931 Human Machine Interface (HMI) and M-3911A Status Module or through the S-3300 IPScom(TM) Communications and Oscillographic Analysis Software.

Chapter 3: IPScom
Chapter 3 provides a description of each element of the S-3300 IPScom Communications Software. The IPScom menu structure and commands are described in detail for each feature and function.

Chapter 4: System Setup and Setpoints
Chapter Four is designed for the person(s) responsible for the direct setting and configuration of the system. It describes the procedures for entering all required data into the M-3311A. Included in this chapter are functional and connection diagrams for a typical application for the system; and describes the configuration process for the unit (choosing active functions), output contact assignment and input blocking designation. It also illustrates the definition of system quantities and equipment characteristics required by the M-3311A, and describes the individual function settings.

Chapter 5: Installation
The person or group responsible for the installation of the M-3311A will find herein all mechanical information required for physical installation, equipment ratings, and all external connections in this chapter. For reference, the Three-Line Connection Diagrams are repeated from Chapter 4, System Setup and Setpoints. Further, a commissioning checkout procedure is outlined to check the external CT and VT connections. Additional tests which may be desirable at the time of installation are described in Chapter 6, Testing.
Chapter 6: Testing
This chapter provides step-by-step test procedures for each function, as well as diagnostic mode and auto-calibration procedures.

Appendix A: Configuration Record Forms
This Appendix supplies a set of forms to record and document the settings required for the proper operation of the M-3311A.

Appendix B: Communications
This Appendix describes communication port signals and various topologies and equipment required for remote communication.

Appendix C: Self-Test Error Codes
This Appendix lists all the error codes and their definitions.

Appendix D: Inverse Time Curves
This appendix contains a graph of the four families of Inverse Time Curves for V/Hz applications, the four standard and the four IEC overcurrent curves. Also included are three IEEE inverse time curves.

Appendix E: Layup and Storage
This Appendix provides the recommended storage parameters, periodic surveillance activities and layup configuration.

Appendix F: HMI Menu Flow
This Appendix includes the M-3311A HMI Flow diagrams to aide the user in navigating the menu system.

Appendix G: Index
This Appendix includes the Index for the M-3311A Instruction Book.

1.2 M-3311A Transformer Protection Relay
The M-3311A Transformer Protection Relay, is a microprocessor-based unit that uses digital signal processing technology to protect a high voltage transformer from internal winding faults, system faults (Through Faults), abnormal voltage and frequency, negative sequence current, overloading, and overexcitation (V/Hz) disturbances. The M-3311A also provides system wide protection by implementing breaker failure, load shedding, bus fault and digital feeder relay backup protection capability.

The available M-3311A Transformer Protective Functions are listed in Table 1-1. The nomenclature follows the standards of ANSI/IEEE Std. C37.2, Standard Electric Power Systems Device Function Numbers where applicable.

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

The M-3931 Human Machine Interface (HMI) Module allows the user to access the following features and functions from the M-3311A front panel using a menu-driven, 2 line by 24 character alphanumeric display:

**Settings**
- Enter Comm settings
- Set Access Codes
- Set User Control Number
- Set display User Lines 1 and 2
- Set Date/Time

**Functions**
- Clear Alarm Counter
- Enter Diagnostic Mode
- Clear Error Codes

**Status**
- Metering of various quantities, including voltage, current, frequency and phase-angle
- I/O Status
- Alarm Counter
- M-3311A Unit Last Power Up Date and Time
- M-3311A Unit Firmware Version and Serial Number
- Error Codes
- Checksums
### Standard Functions Description

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<td>46W2, 3, 4</td>
<td>Negative Sequence Overcurrent</td>
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<tr>
<td>49</td>
<td>Winding Thermal Protection (W1 or W2 or W3)</td>
</tr>
<tr>
<td>50 1-8</td>
<td>Instantaneous Phase Overcurrent</td>
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<td>50BFW1, 2, 3, 4</td>
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<td>87GDW2, 3, 4</td>
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### Optional Functions Description

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<td>59G</td>
<td>Ground Overvoltage</td>
</tr>
<tr>
<td>81O/U</td>
<td>Over/Under Frequency</td>
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</table>

*Two Close Circuit Monitor inputs are available with Expanded I/O models.

**One Trip Circuit Monitor input available on Standard I/O models and two available on Expanded I/O modes.

---

**Table 1-1  M-3311A Device Functions**

The relay provides storage of time-tagged target information for the 8 most recent trip events. Also included are self-test, self-calibration and diagnostic capabilities. The M-3911A Target Module LEDs are used to provide a detailed visual indication of function operation for the most recent event.

The M-3311A retains up to 311 cycles of oscillograph waveform data assign able to up to 24 events with selectable post-trigger delay. This data can be downloaded and analyzed using the M-3801D IPSplot™ PLUS Oscillograph Analysis Software.

The unit is powered from a wide range switch mode power supply. An optional redundant power supply is available for units without the Expanded I/O. When expanded I/O option is selected, the unit includes the second power supply.

The M-3311A includes self-test, auto calibration, and diagnostic capabilities, in addition to IRIG-B time-sync capability for accurate time-tagging of events.

---

**Communication Ports**

The M-3311A includes three physical communication ports. If the optional RJ45 Ethernet port is purchased, then COM2 is not available:

- **COM1**, located on the relay front panel, is a standard 9-pin RS-232 DTE-configured port. COM1 is used to locally set and interrogate the relay using a portable computer.
- **COM2**, located on the rear of the relay, is a standard 9-pin RS-232 DTE-configured port. When the optional RJ45 Ethernet Port is enabled, COM2 port is disabled for communications. The demodulated IRIG-B may still be used via the COM2 Port when ethernet is enabled.
  - The RJ45 Ethernet port uses a 10Base-T type connection that accepts an RJ45 connector using CAT5 twisted pair cable. The Ethernet port can support MODBUS over TCP/IP, BECO2200 over TCP/IP, DNP 3.0 or IEC 61850. The IP address can be obtained automatically when using the DHCP protocol if enabled, or a static IP address can be manually entered, using the HMI.
- **COM3**, located on the rear terminal block of the relay, is an RS-485 communications port.

The relay may be remotely set and interrogated utilizing either a hard-wired RS-232 serial connection or modem (COM2 when activated as RS-232, or COM3), or when purchased, the ethernet connection (RJ45 activated).

Detailed information regarding the use of the relay communications ports is provided in Appendix B, Communications, as well as Chapter 3, IPScom®.

The system may be remotely set and interrogated utilizing either a hard-wired RS-232 serial connection or modem (COM2 when activated as RS-232, or COM3), or when purchased, the ethernet connection (RJ45 activated).
S-3300 IPScom Communications Software
Each M-3311A unit includes the S-3300 IPScom Communications Software. The IPScom communications software runs on an IBM PC compatible computer running under Windows 2000 or later, providing remote access to the relay using either direct serial connection or modem. IPScom provides the following communication functions:

- Setpoint interrogation and modification
- Real-time metering and I/O status monitoring
- Stored target interrogation
- Recorded oscillographic data downloading
- Real time Phasor display

See Chapter 3, IPScom for an overview of IPScom features.

1.3 Accessories

M-3911A Target Module
The optional target modules shown in Figures 1-1 and 1-2 include 24 individually labeled TARGET LEDs to target the operation of the functions on the front panel. Eight individually labeled OUTPUT LEDs will be illuminated as long as any output is picked up.

![Figure 1-1 Typical 2/3 Winding M-3911A Target Module](image)

![Figure 1-2 Typical 4 Winding M-3911A Target Module](image)
M-3933/M-0423 Serial Communication Cables
The M-3933 cable is a 10-foot RS-232 cable for use between the M-3311A rear panel (COM2) port and a modem. This cable includes a DB25 (25-pin) connector (modem) and a DB9 (9-pin) at the relay end.

The M-0423 cable is a 10-foot null-modem RS-232 cable for direct connection between a PC and the M-3311A front panel COM1 port, or the rear COM2 port. This cable includes a DB9 (9-pin) connector at each end.

M-3931 Human-Machine Interface (HMI) Module
The optional HMI module shown in Figure 1-3, provides a means to interrogate the relay and to input settings, access data, etc. directly from the front of the relay. Operation of the module is described in detail in Section 2.1, Front Panel Controls and Indicators.

![Figure 1-3 M-3931 Human-Machine Interface (HMI) Module](image-url)

M-3949 Redundant Low Voltage Power Supply
Redundant 24/48 V dc supply (For Non-Expanded I/O units).

M-3948 Redundant High Voltage Power Supply
Redundant 110/250 V dc supply (For Non-Expanded I/O units).

M-3801D IPSplot™ Plus Oscillograph Analysis Software
The IPSplot™ Plus Oscillograph Analysis Software runs in conjunction with IPScom software on any IBM PC-compatible computer running Windows 2000 or later, to enable the plotting and printing of waveform data downloaded from the M-3311A Transformer Protection Relay.

M-3933/M-0423 Serial Communications Cable
The M-3933 cable is a 10-foot straight-through RS-232 modem cable for use between the relay’s rear-panel (COM2) port and a modem. This cable has a DB25 (25-pin) connector (modem) and a DB9 (9-pin) at the M-3311A end.

The M-0423 cable is a 10-foot null-modem RS-232 cable for direct connection between a PC and the relay’s front-panel COM1 port or the rear COM2 port. This cable has DB9 (9-pin) connectors at each end.
This chapter contains information that describes the operation of the M-3311A Transformer Protection Relay. See Chapter 4 for System Setup, Configuration and Setpoint information. M-3311A operation from either IPScom or HMI includes the following:

- **Front Panel Controls and Indicators**
- **Status Monitoring**
  - Voltage, Current, Frequency and Volts/Hz Monitoring
  - Input/Output Status
  - Timer Status
  - Counter Status (Input, Output, Alarm)
  - Time of Last Power Up
  - Error Codes
  - Checksum
- **Demand**
  - Demand Currents
  - Maximum Demand Current
  - Clear Maximum Demand Current
- **Target History**
  - View Target History
  - Clear Target History
- **Oscillograph Recorder**
  - View Recorder Status
  - Retrieve Records
  - Trigger Oscillograph
  - Clear Records
- **Miscellaneous**
  - Software Version
  - Serial Number
  - Alter User Access Codes
  - Clear Output Counters
  - Clear Alarm Counters
  - Reset Counters
  - Clear Error Codes
- **Through Fault Recorder**
  - Retrieve Records
  - View Records
  - Clear Records
- **Sequence of Events Recorder**
  - Retrieve Records
  - View Records
  - Clear Records
2.1 Front Panel Controls and Indicators

This section describes the operation of the M-3311A as a function of the M-3931 Human Machine Interface Module (HMI) and the M-3911A Target Module.

The M-3311A can be interrogated locally with the HMI panel. An integral part of the design is the layout and function of the front panel indicators and controls, illustrated in Figure 2-1.

Alphanumeric Display
The HMI module consists of a 2 x 24-character alphanumeric display. To assist the operator in operating and interrogating the relay locally, the HMI displays menus which guide the operator to the desired function or status value. These menus consist of two lines. The bottom line lists lower case abbreviations of each menu selection with the chosen menu selection shown in uppercase. The top menu line provides a description of the chosen menu selection.

Screen Blanking
The display will automatically blank after exiting from the Main Menu, or from any screen after five (5) minutes of unattended operation. To wake up the display, the user must press any key except EXIT.

Arrow Pushbuttons
The left and right arrow pushbuttons are used to choose among the displayed menu selections. When entering values, the left and right arrow pushbuttons are used to select the digit (by moving the cursor) of the displayed setpoint that will be increased or decreased by the use of the up and down pushbuttons.

The up and down arrow pushbuttons increase or decrease input values or change between upper and lower case inputs. If the up or down pushbutton is pressed and held when adjusting numerical values, the speed of increment or decrement is increased.

If the up or down arrow pushbutton is held in the depressed position when adjusting numerical values, the speed of the increment or decrement is increased, after a small delay.

EXIT Pushbutton
The EXIT pushbutton is used to exit from a displayed screen and move up the menu tree. Any changed setpoint in the displayed screen will not be saved if the selection is aborted using the EXIT pushbutton.

ENTER Pushbutton
The ENTER pushbutton is used to choose a highlighted menu selection, to replace a setting or other programmable value with the currently displayed value, or to move down within the menu tree.

RELAY OK LED
The Green RELAY OK LED is controlled by the unit's microprocessor. A flashing RELAY OK LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated to indicate proper program cycling.

Time Sync LED
The green TIME SYNC LED illuminates to indicate that the IRIG-B time signal is being received and validated.

Breaker Closed (BRKR CLOSED) LED
The red BRKR CLOSED LED illuminates when the breaker status input (52b) is open.

Diagnostic LED (DIAG)
The diagnostic LED flashes upon the occurrence of a detectable self-test error. The LED will flash the Error Code Number. For example, for error code 32, the LED will flash 3 times, followed by a short pause, and then 2 flashes, followed by a long pause, and then repeat. For units equipped with the HMI, the Error Code Number is also displayed on the screen.
Power Supply (PS1) and (PS2) LEDs
The green power LED indicator (for the appropriate power supply) will be illuminated whenever power is applied to the unit and the power supply is functioning properly. Power supply PS2 is available as an option, for units without expanded I/O.

Target LED
When a condition exists that causes the operation of Outputs 1 through 8 (1 through 16 for units with expanded I/O), the TARGET LED will illuminate, indicating a relay operation. The TARGET LED will remain illuminated until the condition causing the trip is cleared, and the operator presses the TARGET RESET pushbutton.

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

M-3911A Target Module and Target Reset Pushbutton
For units equipped with the optional M-3911A Target Module, additional targeting information is available. The Target module includes an additional 24 target LEDs, and 8 output status LEDs. LEDs corresponding to the particular operated function as well as the present state of the outputs are available.

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

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

Figure 2-1  M-3311A Front Panel
2.2 Operation (HMI/PC)

The purpose of this section is to describe the steps that are necessary to interrogate the M-3311A utilizing either the optional M-3931 HMI or a PC running S-3300 IPScom Communications software through COM1 the front RS-232 serial port. These instructions assume that the following conditions exist:

- The unit is energized from an appropriate power supply.
  See Chapter 5, Installation, Section 5.3, External Connections, for power supply connection details.
- For PC communications, IPScom is installed on the host PC.
  See Chapter 5, Installation, Section 5.6, IPScom Communications Software Installation, if IPScom is not installed.
- For PC communication, initial PC communication has been established with the unit.
  If this is the first attempt to establish communications with the unit, then see Chapter 5, Installation, Section 5.7, Activating Initial Local Communications.

HMI Operation Overview
Whenever power is applied to the unit the Power On Self Test sequence is initiated (Figure 2-2).

Default Message Screens
When the M-3311A is energized and unattended, the user logo lines are blank.

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

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

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

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

---

**Figure 2-2** Screen Message Menu Flow

---

<table>
<thead>
<tr>
<th>POWER ON SELFTESTS XXXXXXXXXXXXXXXXXXXXXXX</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER ON SELFTESTS PASS</td>
<td>NO</td>
</tr>
</tbody>
</table>

**Power On Relay Sequence**

- Trip Recorded
- Target 03-Jan-2007 09:00:00:000
- Target 02
- Target 27 POS SEQ UNDervoltage
- Target M-3311A
- Volt Curr Freq V/Hz Ext

**Figure 2-3** Access Code Menu Flow

---

**To Do:**

- Enter Access Code
- Access Denied!
- Level #X Access Granted!
VOLTAGE RELAY
VOLT curr freq v/hz
2/3 Winding
- 27 Phase Undervoltage
- 59 Phase Overvoltage
- 56G Ground Overvoltage
4 Winding
- 27 Phase Undervoltage
- 56G Ground Overvoltage

CURRENT RELAY
volt CURN freq v/hz
- 46 Negative Sequence Overcurrent
- 50 Instantaneous Overcurrent
- 51 Instantaneous Phase Overcurrent
- 50G Instantaneous Ground Overcurrent
- 51G Instantaneous Ground Overcurrent
- 50N Instantaneous Residual Overcurrent
- 51N Instantaneous Residual Overcurrent
- 87 Phase Differential Overcurrent
- 87G Ground Differential Overcurrent
- 50BF Breaker Failure

FREQUENCY RELAY
volt curr FREQ v/hz
- 61 Over/Under Frequency

VOLTS PER HERTZ RELAY
volt curr freq V/HZ
- 24 Define Time Volts/Hertz
- 24 Inverse Time Volts/Hertz

IPS LOGIC
IPS brkr thflt tcm
- IPSlogic

BREAKER MONITORING
ips BRKR thflt tcm
- Set Breaker Monitoring
- Breaker ACC. Status
- Preset Accumulators
- Clear Accumulators

THROUGH FAULT
ips brkr THFLT tcm
- Through Fault

TRIP CIRCUIT MONITORING
ips brkr thflt TCM
- Trip Circuit Monitoring

CONFIGURE RELAY
config sys STAT dmd
- Voltage Relay
- Current Relay
- Frequency Relay
- Volts/Hertz Relay
- IPSlogic
- Breaker Monitor
- Through Fault
- TCM Monitor

SETUP SYSTEM
config SYS stat dmd
- 2/3 Winding
  - Input Activated Profile
  - Active Setpoint Profile
  - Copy Active Profile
  - Number of F87 Windings
  - Wind Summing
  - XPMCT Connection
  - Phase Rotation
  - Relay Seal-In Time
  - Active Input State
  - V.T.x Ratio
  - V.T.y Ratio
  - Nominal Voltage
  - Nominal Current
  - V.T. Configuration
  - Power Windings
  - Phase Voltage Option
  - V5 Voltage Option
  - W1 C.T. Ratio
  - W2 C.T. Ratio
  - W2 G.C. Ground Ratio
  - W3 C.T. Ratio
  - W4 C.T. Ratio

4 Winding
- Input Activated Profile
- Active Setpoint Profile
- Copy Active Profile
- Nominal Voltage
- V.T. Configuration
- Number of Windings
- Wind Summing
- Custom XPMCT Connection
- Phase Rotation
- Relay Seal-In Time
- Active Input State
- V.T.x Ratio
- V.T.y Ratio
- V.T.g Ground Ratio
- W1 C.T. Ratio
- W2 C.T. Ratio
- W2 G.C. Ground Ratio
- W3 C.T. Ratio
- W3 G.C. Ground Ratio
- W4 C.T. Ratio
- W4 G.C. Ground Ratio

STATUS
config sys STAT dmd
- Voltage Status
- Current Status
- Frequency Status
- Volts/Hertz Status
- Power Meter (2/3 Winding Only)
- Input/Output Status
- Trip Circuit Input
- Timer Status
- Counters
- Time of Last Power Up
- Error Codes
- Checksum

DEMAND
config sys stat DMD
- Demand Status
- Demand Interval
- Maximum Demand Status
- Clear Maximum Demand

VIEW TARGET HISTORY
targets OSC_REC comm
- View Target History
- Clear Target History

OSCILLOGRAPH RECORDER
targets OSC_REC comm
- View Record Status
- Clear Records
- Recorder Setup

COMUNICATION
targets osc_rec COMM
- COM1 Setup
- COM2 Setup
- COM3 Setup
- Communication Address
- Response Time Delay
- Communication Access Code
- Ethernet Setup
- Ethernet IP Address

SETUP UNIT
- Software Version
- ETH Firmware Version
- Serial Number
- Alter Access Codes
- User Control Number
- User Logo Line 1
- User Logo Line 2
- Clear Output Counters
- Clear Alarm Counter
- Date & Time
- Clear Error Codes
- Diagnostic Mode

- Output Test (Relay)
- Input Test (Status)
- Status LED Test
- Target LED Test
- Button Test
- Display Test
- COM1 Loopback Test
- COM2 Loopback Test
- COM3 Echo Test
- Clock Test
- Flash Relay OK LED
- Auto Calibration
- Factory Use Only

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

Figure 2-3 Main HMI Menu Flow
Level 3 Access: provides access to all M-3311A configuration functions and settings.

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

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

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

Status Monitoring (From Relay Front Panel)
The HMI menu categories for monitored values are:

- **Voltage Status** (V, B, C and V or V.phase voltages)
- **Current Status** (Secondary)
  - Phase Currents, W — W
  - Ground Current, W2 — W4
  - Restraint Current (PU), Phase A/B/C
  - Differential Current Fund. (PU), Phase A/B/C
  - Differential Current (PU), 2nd, 4th and 5th Harmonic
  - Ground Differential Current, W2 — W4
  - Positive Sequence Current, W1 — W4
  - Negative Sequence Current, W1 — W4
  - Zero Sequence Current, W1 — W4
  - Function 49 Thermal Current, Phase A/B/C
- **Frequency Status**
- **Volts/Hz Status**
- **Power Meter** (2/3 Winding)
  - Real Power (PU, Watts)
  - Reactive Power (PU, VAr)
  - Apparent Power (PU, VA)
  - Power Factor
- **I/O Status** (Input and Output Contacts)
- **Trip Circuit Monitor**
- **Timer Status**
- **Counter Status** (Output, Alarm)
- **Time of Last Power Up**
- **Error Codes**
- **Checksums** (Setpoints, Calibration, ROM)

To access the STATUS menu and begin monitoring, proceed as follows:

1. Press the ENTER pushbutton.
2. If Level Access is active, the following is displayed:
   
   ![ENTER ACCESS CODE 0](image)

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

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

   c. Go to Step 4.
3. If Level Access is not Active, then the following will be displayed:

   ![VOLTAGE RELAY VOLT curr freq v/hz](image)

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

   ![STATUS config sys STAT dmd](image)

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

   ![VOLTAGE STATUS VOLT curr freq v/hz](image)

6. Press the Right or Left arrow pushbutton until the desired parameter is selected (upper case), then press ENTER. The HMI will display the selected parameter.

7. Press the ENTER pushbutton to move down within the STATUS menu to the desired category. To exit a specific category and continue to the next menu category, press the EXIT pushbutton.
Status Monitoring (From IPScom)

**PRIMARY METERING AND STATUS**

To access the PRIMARY METERING AND STATUS parameters utilizing IPScom®, select Monitor/Primary Metering and Status from the IPScom Main Screen drop down menu. IPScom will display the Primary Metering & Status dialog screen (Figures 2-4 and 2-5) which include the following PRIMARY parameters:

- Voltage ($V_A$, $V_B$, $V_C$ and $V_G$ or $V_Ø$ phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)
- Power (PU) Real, Reactive and Apparent (2/3 Winding)

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets

Path: Monitor / Primary Metering & Status

*Figure 2-4  Primary Metering & Status Screen (2/3 Winding)*
**Path:** Monitor / Primary Metering & Status

![Primary Metering & Status Screen (4 Winding)](image)

*Figure 2-5  Primary Metering & Status Screen (4 Winding)*
SECONDARY METERING AND STATUS
To access the SECONDARY METERING AND STATUS parameters utilizing IPScom®, select Monitor/Secondary Metering and Status from the IPScom Main Screen drop down menu.

Monitor/Secondary Metering and Status
The Secondary Metering & Status screen (Figures 2-6 and 2-7) include the following SECONDARY parameters:

- Voltage ($V_A, V_B, V_C$ and $V_G$ or $V_Ø$ phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current ($W_1 — W_4$)
- Ground Current ($W_2 — W_4$)
- Positive Sequence Current ($W_1 — W_4$)
- Negative Sequence Current ($W_1 — W_4$)
- Zero Sequence Current ($W_1 — W_4$)
- Differential Current (PU), (Phase A/B/C)
- Restrayment Current (PU), (Phase A/B/C)
- Ground Differential Current ($W_2 — W_4$)
- Power (PU) Real, Reactive and Apparent (2/3 Winding)

Also included on the Secondary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets

![Secondary Metering & Status Screen](image)

Path: Monitor / Secondary Metering & Status

Figure 2-6 Secondary Metering & Status Screen (2/3 Winding)
Path: Monitor / Secondary Metering & Status

*Figure 2-7  Secondary Metering & Status Screen (4 Winding)*
**Metering II**

To access the Metering II parameters utilizing IPScom®, select Monitor/Metering II from the IPScom Main Screen drop down menu.

**Monitor/Metering II**

The Metering II screen (Figures 2-8 and 2-9) includes the following parameters:

- 2nd, 4th and 5th Harmonic Differential Currents (PU), (Phase A/B/C)
- Thermal Currents (Phase A/B/C) for W1 or W2 or W3 or W4

Also included on the Metering II screen are:

- Breaker Monitor Accumulators (Phase A/B/C) Winding 1, 2, 3, & 4 (A Cycles)
- Demand Phase Currents, Winding 1, 2, 3, & 4
- Demand Ground Currents, Winding 2, 3, & 4
- Through Fault Counter
- Cumulative Through Currents (kA² Cycles)

---

**Figure 2-8** Metering II Screen (2/3 Winding)
**Path:** Monitor / Metering II

*Figure 2-9  Metering II Screen (4 Winding)*
Demand Status
Monitored Primary Demand values include:
• Winding 1, 2, 3, & 4 Phase Currents
• Winding 2, 3, and 4 Ground Current

Maximum Demand Current
Maximum values include time-tagged values for all the above quantities.

Demand Interval
Time integrated primary metering values, based on the chosen demand integration interval (15 min, 30 min, or 60 min), as well as the time-tagged peak readings are available for viewing.

Demand (From Relay Front Panel)
The HMI menu items for Demand are:
• Demand Currents
• Demand Interval (See Chapter 4, System Setup and Setpoints)
• Maximum Demand Current
• Clear Maximum Demand Current

To access the DEMAND CURRENTS, proceed as follows:
1. Press the ENTER pushbutton.
2. If Level Access is active, the following is displayed:
   ENTER ACCESS CODE
   0
   a. Input the required Access Code, then press ENTER.
   b. If the proper Access Code has been entered, the HMI will return:
      LEVEL # (1,2 or 3)
      Access Granted!
      VOLTAGE RELAY
      VOLT curr freq v/Hz
   c. Go to Step 4.
3. If Level Access is not Active, then the following will be displayed:
   VOLTAGE RELAY
   VOLT curr freq v/Hz

4. Press the Right arrow pushbutton until the following is displayed:
   DEMAND config sys stat DMD

5. Press the ENTER pushbutton, the following will be displayed:
   DEMAND STATUS
   STAT int mstat clear

6. Press ENTER. The HMI will display W1 Demand Phase Current.
   W1 DEMAND PHASE CURRENT
   X.XX X.XX X.XX A

7. Press the ENTER pushbutton to view W2, W3 and W4 Demand Phase Current values. To exit a specific winding and continue to the next DEMAND CURRENT menu category, press the EXIT pushbutton.

To access the MAXIMUM DEMAND CURRENT, proceed as follows:
1. Press the ENTER pushbutton.
2. If Level Access is active, the following is displayed:
   ENTER ACCESS CODE
   0
   a. Input the required Access Code, then press ENTER.
   b. If the proper Access Code has been entered, the HMI will return:
      LEVEL # (1,2 or 3)
      Access Granted!
      VOLTAGE RELAY
      VOLT curr freq v/Hz
   c. Go to Step 4.
3. If you are already in the **DEMAND STATUS** menu, then go to Step 5.

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

   ![VOLTAGE RELAY
   VOL curr freq v/hz]

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

   ![DEMAND
   config sys stat DMD]

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

   ![DEMAND STATUS
   STAT int mstat clear]

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

   ![MAXIMUM DEMAND STATUS
   stat int MSTAT clear]

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

   ![W1 MAX IA X.XXX Amp
   DD-MM-YYYY hh:mm:ss]

9. Continuing to press the **ENTER** pushbutton will display the "B" and "C" Phase Values for W1 and then display the W2, W3 and W4 values.

   To exit a specific winding and continue to the next **DEMAND CURRENT** menu category, press the **EXIT** pushbutton.

To access the **CLEAR MAXIMUM DEMAND CURRENT**, proceed as follows:

1. Press the **ENTER** pushbutton.

2. If Level Access is active, the following is displayed:

   ![ENTER ACCESS CODE
   0]

   a. Input the required Access Code, then press **ENTER**.

   b. If the proper Access Code has been entered, the HMI will return:

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

   ![VOLTAGE RELAY
   VOL curr freq v/hz]

   c. Go to Step 5.

3. If you are already in the **DEMAND STATUS** menu, then go to Step 5.

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

   ![VOLTAGE RELAY
   VOL curr freq v/hz]

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

   ![DEMAND
   config sys stat DMD]

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

   ![DEMAND STATUS
   STAT int mstat clear]

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

   ![CLEAR MAXIMUM DEMAND
   stat int mstat CLEAR]

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

   ![CLEAR MAXIMUM DEMAND
   PRESS ENTER KEY TO CLEAR]

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

   ![CLEAR MAXIMUM DEMAND
   — MAX VALUES CLEARED —]

   To exit a specific winding and continue to the next **DEMAND CURRENT** menu category, press the **EXIT** pushbutton.
Demand Status (From IPScom)

Demand Currents
To display Demand Currents select Monitor/Metering II. IPScom® will display the Metering II screen (Figures 2-8 or 2-9). The Metering II screen includes the following Demand Currents:
- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current

Max Demand Status
To display Max Demand Status values select Relay/Demand Status. IPScom will display the Demand Status screen (Figure 2-10).

The Demand Status screen includes the following information:
- Max Demand Current values for Winding 1, 2, 3, & 4 Phase Currents
- Max Demand Current values for Winding 2, 3, and 4 Ground Current
- Date and Time of each Max Phase current event

The Demand Status dialog screen also includes the capability to reset individual or reset all Max Demand Status values.

VIEW TARGET HISTORY
Detailed information about the cause of the last 32 operations is retained in the unit’s memory for access through the alphanumeric display from the VIEW TARGET HISTORY menu.

To access the VIEW TARGET HISTORY feature, proceed as follows:
1. Press the ENTER pushbutton.
2. If Level Access is active, the following is displayed:

   ENTER ACCESS CODE

   a. Input the required Access Code, then press ENTER.

Path: Relay / Demand Status

Figure 2-10 Demand Status Screen
b. If the proper Access Code has been entered, the HMI will return:

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

VOLTAGE RELAY
VOLT curr freq v/hz

c. Go to Step 4.

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

VOLTAGE RELAY
VOLT curr freq v/hz

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

VIEW TARGET HISTORY
TARGETS osc_rec comm

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

VIEW TARGET HISTORY
TRGT clear

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

VIEW TARGET HISTORY
X Target Number

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

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

VIEW TARGET HISTORY
TRGT clear

To access the CLEAR TARGET HISTORY feature, proceed as follows:

1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

ENTER ACCESS CODE
0

a. Input the required Access Code, then press ENTER.

b. If the proper Access Code has been entered, the HMI will return:

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

VOLTAGE RELAY
VOLT curr freq v/hz

c. Go to Step 4.

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

VOLTAGE RELAY
VOLT curr freq v/hz

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

VIEW TARGET HISTORY
TARGETS osc_rec comm

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

VIEW TARGET HISTORY
TRGT clear

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

VIEW TARGET HISTORY
trgt CLEAR

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

VIEW TARGET HISTORY
— TARGETS CLEARED —

8. To exit press the EXIT pushbutton.
View Target History (From IPScom)

View Targets

To View Targets select Relay/Targets/View. IPScom™ will display the View Targets screen (Figure 2-11). The View Targets screen includes the following target information:

- Target Number
- Target Date/Time
- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current
- Active Functions
- Function Status (Picked up/Operated)
- Active Inputs and Outputs

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

Clear Targets

To Clear Targets perform the following:

1. Select Relay/Targets/Clear. IPScom will display the Clear Targets confirmation dialog screen (Figure 2-12).

Figure 2-12 Clear Targets Confirmation Dialog Screen

![Figure 2-11 View Targets Screen](image)
2. Select Yes. IPScom® will display the Clear Targets dialog screen (Figure 2-13).

![Clear Targets Dialog Screen](image)

**Figure 2-13  Clear Targets Dialog Screen**

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

---

### Oscillograph Recorder Data

The Oscillograph Recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded using the communications ports to any Windows™ based computer running the S-3300 IPScom Communications Software. Once downloaded, the waveform data can be examined and printed using the optional M-3801D IPSplot® PLUS Oscillograph Data Analysis Software.

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

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

- **Recorder Partitions:** When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder's memory may be partitioned into 1 to 24 partitions.

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

- **Post-Trigger Delay:** A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pre-trigger data, and 80% post-trigger data.

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

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

---

<table>
<thead>
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<th>Windings 1, 2</th>
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<td>311</td>
</tr>
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<td>122</td>
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*Table 2-1  4 Winding Recorder Partitions*
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<th>3 Windings 2 Voltages</th>
<th>2 Windings 2 Voltages</th>
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<td>18</td>
<td>24</td>
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</tbody>
</table>

*Table 2-2  2/3 Winding Recorder Partitions*
To access the Oscillograph Recorder **VIEW RECORDER STATUS** feature, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:
   
   ![ENTER ACCESS CODE 0]

   a. Input the required Access Code, then press **ENTER**.
   
   b. If the proper Access Code has been entered, the HMI will return:
   
   ![LEVEL #(1,2 or 3)
   Access Granted!](https://example.com/image)

   ![VOLTAGE RELAY
   VOLT curr freq v/hz](https://example.com/image)

   c. Go to Step 4.
3. If Level Access is not active, then the following will be displayed:
   
   ![VOLTAGE RELAY
   VOLT curr freq v/hz](https://example.com/image)

4. Press the Right arrow pushbutton until the following is displayed:
   
   ![OSCILLOGRAPH RECORDER
targets OSC_REC comm](https://example.com/image)

5. Press the **ENTER** pushbutton, the following will be displayed:
   
   ![VIEW RECORDER STATUS
   STAT clear setup](https://example.com/image)

6. Press **ENTER**. The HMI will cycle through and display the following for each active record:
   
   ![RECORD #1 ACTIVE
dd-mmm-yyyy hh:mm:ss:ms](https://example.com/image)

   For those records that are not active the following will be displayed:
   
   ![RECORD #1
   --RECORD CLEARED--](https://example.com/image)

7. To exit press the **EXIT** pushbutton. The display will return to the following:
   
   ![VIEW RECORDER STATUS
   STAT clear setup](https://example.com/image)

To access the Oscillograph Recorder **CLEAR RECORDS** feature, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:
   
   ![ENTER ACCESS CODE 0](https://example.com/image)

   a. Input the required Access Code, then press **ENTER**.
   
   b. If the proper Access Code has been entered, the HMI will return:
   
   ![LEVEL #(1,2 or 3)
   Access Granted!](https://example.com/image)

   ![VOLTAGE RELAY
   VOLT curr freq v/hz](https://example.com/image)

   c. Go to Step 4.
3. If Level Access is not active, then the following will be displayed:
   
   ![VOLTAGE RELAY
   VOLT curr freq v/hz](https://example.com/image)

4. Press the Right arrow pushbutton until the following is displayed:
   
   ![OSCILLOGRAPH RECORDER
targets OSC_REC comm](https://example.com/image)

5. Press the **ENTER** pushbutton, the following will be displayed:
   
   ![VIEW RECORDER STATUS
   STAT clear setup](https://example.com/image)

6. Press the right arrow pushbutton until the following is displayed:
   
   ![VIEW RECORDER STATUS
   stat CLEAR setup](https://example.com/image)
7. Press the **ENTER** pushbutton, the following will be displayed:

![CLEAR RECORDS]

**RECORDS CLEARED**

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

![VIEW RECORDER STATUS]

**stat CLEAR setup**

### Oscillograph Recorder (From IPScom)

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

### Retrieve Oscillograph Records

To retrieve Oscillograph Records perform the following:

1. Select **Relay/Oscillograph/Retrieve**. IPScom® will display the Retrieve Oscillograph Record dialog screen (Figure 2-14).
2. Select the desired oscillograph record.
3. Select the desired File Format, then select **Retrieve**, IPScom will display the **Save As** dialog screen.
4. Input the desired File Name and location, then select **Save**. IPScom will display the Download Status screen (Figure 2-15).

**Figure 2-14 Retrieve Oscillograph Record Dialog Screen**

5. Upon completion of the oscillograph file download, IPScom will display the Download Successful confirmation screen (Figure 2-16).

**Figure 2-15 Oscillograph Record Download Dialog Screen**

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

**Figure 2-16 Oscillograph Download Successful Confirmation Screen**

**Path:** Relay / Oscillograph / Retrieve
**Trigger Oscillograph**

To manually Trigger the Oscillograph perform the following:

1. Select **Relay/Oscillograph/Trigger**. IPScom® will display the Trigger Oscillograph confirmation screen (Figure 2-17).

![Figure 2-17 Trigger Oscillograph Confirmation Screen](image)

2. Select **Yes**, IPScom will display the Oscillograph Successfully Triggered Dialog Screen. (Figure 2-18)

![Figure 2-18 Oscillograph Successfully Triggered Dialog Screen](image)

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

**Clear Oscillograph Records**

To Clear Oscillograph Records perform the following:

1. Select **Relay/Oscillograph/Clear**. IPScom will display the Clear Oscillograph Records confirmation screen (Figure 2-19).

![Figure 2-19 Clear Oscillograph Records Confirmation Screen](image)

2. Select **Yes**, IPScom will display the Clear Oscillograph Records Successfully Cleared Dialog Screen. (Figure 2-20)

![Figure 2-20 Oscillograph Records Successfully Cleared Dialog Screen](image)

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

**OSC to ComTrade**

To convert an Oscillograph file ".osc" to ComTrade format perform the following:

1. Select **Relay/Oscillograph/Osc to ComTrade**. IPScom will display the "Open" dialog screen with a default ".osc" file extension.

2. Select the ".osc" file to convert, then select Open. IPScom will display the convert dialog screen indicating that the .osc file was converted to a .cfg file.
Software Version (Relay Front Panel only)
To determine the software version installed on the relay, proceed as follows:

1. Press the **ENTER** pushbutton.
2. If Level Access is active, the following is displayed:
   
   ![ENTER ACCESS CODE](image)
   
   a. Input the required Access Code, then press **ENTER**.
   
   b. If the proper Access Code has been entered, the HMI will return:
   
   ![LEVEL #(1,2 or 3)
   Access Granted!](image)

   c. Go to Step 4.

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

   ![VOLTAGE RELAY
   VOLT curr freq  v/hz](image)

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

   ![SETUP UNIT
   SETUP](image)

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

   ![SOFTWARE VERSION
   VERS eth sn access](image)

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

   ![SOFTWARE VERSION
   D-0179VXX.YY.ZZ  AAAA](image)

7. To exit press the **EXIT** pushbutton.

Serial Number (Relay Front Panel only)
To determine the serial number of the relay, proceed as follows:

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

   ![ENTER ACCESS CODE](image)

   a. Input the required Access Code, then press **ENTER**.

   b. If the proper Access Code has been entered, the HMI will return:

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

   c. Go to Step 4.

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

   ![VOLTAGE RELAY
   VOLT curr freq  v/hz](image)

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

   ![SETUP UNIT
   SETUP](image)

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

   ![SOFTWARE VERSION
   VERS eth sn access](image)

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

   ![SERIAL NUMBER
   vers eth SN access](image)

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

   ![SERIAL NUMBER
   XXXXXXXXXX](image)

8. To exit press the **EXIT** pushbutton.
Alter Access Codes (From Relay Front Panel)

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

```
ENTER ACCESS CODE
  0
```
   a. Input the required Access Code, then press **ENTER**.
   b. If the proper Access Code has been entered, the HMI will return:

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

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

```
VOLTAGE RELAY
VOLT curr freq v/hz
```
4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```
5. If User Access Codes are to be set, then use the RIGHT arrow pushbutton to select **ALTER ACCESS CODES**. The following will be displayed:

```
ALTER ACCESS CODES
vers eth sn ACCESS
```
6. Press **ENTER**, the following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```
7. Press **ENTER**, the following will be displayed:

```
LEVEL #1 9999
```
8. Input the desired User Access Code as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Access Code.
   c. When the desired Access Code has been input, then press **ENTER**. The following will be displayed:

```
ENTER ACCESS CODE
LEVEL#1 level#2 level#3
```
9. To set User Access Code Level #2 press the RIGHT arrow pushbutton to select LEVEL #2, then press **ENTER** the following will be displayed:

```
LEVEL #2 9999
```
10. Repeat Step 8 to enter the desired Level #2 User Access Code.
11. To set User Access Code Level #3 press the RIGHT arrow pushbutton to select LEVEL #3, then press **ENTER** the following will be displayed:

```
LEVEL #3 9999
```
12. Repeat Step 8 to enter the desired Level #3 User Access Code.
13. Press the **EXIT** pushbutton will return to the previous selection screen:

```
ALTER ACCESS CODES
vers sn ACCESS number
```
Alter User Access Codes (From IPScom)

**Comm Access Codes**

To set the relay Comm Access Code perform the following:

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

1. From the IPScom® Main Screen menu select **Tools/Security/Change Comm Access Code**. IPScom will display the Change Comm Access Code dialog screen (Figure 2-21).

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.

3. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 2-22).

4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-23).

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

The new Comm Access Code will not be in affect until communications have been closed with the relay for approximately 2.5 minutes.

**User Access Codes**

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

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

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

If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed, and all users have full access to all the relay menus. The device is shipped from the factory with the access code feature disabled.
**User Access Codes**
To change the relay User Access Codes perform the following:

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

1. From the IPScom® Main Screen menu select **Tools/Security/Change User Access Code**. IPScom will display the Access Level Code dialog screen (Figure 2-24).

   ![Access Level Code Dialog Screen](image)

   **Figure 2-24 Access Level Code Dialog Screen**

2. Enter a valid Level 3 User Access Code, then select **OK**. IPScom will display the Change User Access Code dialog screen (Figure 2-25).

   ![Change User Access Code Dialog Screen](image)

   **Figure 2-25 Change User Access Code Dialog Screen**

3. Enter the desired New User Access Code (1-9999), then re-enter (confirmation) the New User Access Code.
4. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 2-22).
5. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 2-23).
6. Select **OK**, IPScom will return to the Main Screen.

**System Error Codes, Output and Alarm Counters**
The System Error Codes, Output and Alarm Counters feature provides the user with the ability to view and clear system Error Codes, Processor Resets, Alarm Counters, Power Loss Counter and Output Counters. Also, Checksums can be viewed (IPScom) for Calibration and Setpoints.

**Clear Output Counters (Relay Front Panel)**
To clear Output Counters from the Front Panel perform the following:

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

   ![ENTER ACCESS CODE 0](image)

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

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

   c. Go to Step 4.
3. If Level Access is not active, then the following is displayed:

   ![VOLTAGE RELAY VOLT curr freq v/hz](image)

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

   ![SETUP UNIT](image)

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

   ![SOFTWARE VERSION](image)
6. Press the Right arrow pushbutton until the following is displayed:

```
CLEAR OUTPUT COUNTER
logo1 logo2 OUT alrm
```

7. Press ENTER, the following will be displayed:

```
CLEAR OUTPUT COUNTERS
PRESS ENTER KEY TO CLEAR
```

8. Press ENTER, the following will be displayed:

```
CLEAR ALARM COUNTER
-OUT COUNTERS CLEARED-
```

9. Press EXIT as necessary to return to the main menu.

**Clear Alarm Counters (Relay Front Panel)**

To clear Alarm Counters from the Front Panel perform the following:

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

```
ENTER ACCESS CODE
0
```

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

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

```
VOLTAGE RELAY
VOLT curr freq v/Hz
```

   c. Go to Step 4.
3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq v/Hz
```

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

```
SETUP UNIT
SETUP
```

5. Press ENTER, the following will be displayed:

```
SOFTWARE VERSION
VERS sn access number
```

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

```
CLEAR OUTPUT COUNTER
logo1 logo2 OUT alrm
```

7. Press ENTER, the following will be displayed:

```
CLEAR OUTPUT COUNTERS
PRESS ENTER KEY TO CLEAR
```

8. Press ENTER, the following will be displayed:

```
CLEAR ALARM COUNTER
-ALARM COUNTERS CLEARED-
```

9. Press EXIT as necessary to return to the main menu.

**Clear Error Codes (Relay Front Panel)**

To clear Error Codes from the Front Panel perform the following:

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

```
ENTER ACCESS CODE
0
```

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

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

```
VOLTAGE RELAY
VOLT curr freq v/Hz
```

   c. Go to Step 4.
3. If Level Access is not active, then the following is displayed:

```
VOLTAGE RELAY
VOLT curr freq v/Hz
```

   c. Go to Step 4.
4. Press the Right arrow pushbutton until the following is displayed:

```
SETUP UNIT
SETUP
```

5. Press ENTER, the following will be displayed:

```
SOFTWARE VERSION
VERS eth sn access
```

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

```
CLEAR ERROR CODES
time ERROR diag
```

7. Press ENTER, the following will be displayed:

```
CLEAR ERROR CODES
PRESS ENTER KEY TO CLEAR
```

8. Press ENTER, the following will be displayed:

```
CLEAR ERROR CODES
-ERROR CODES CLEARED-
```

9. Press EXIT as necessary to return to the main menu.

**Resetting Counters (From IPScom)**

**Tools/Counters and Error Codes**

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

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

1. From the IPScom Main Screen menu bar select **Tools/Counters and Error Codes**. IPScom will display the Counters and Error Codes dialog screen (Figure 2-26).

2. Select the desired Error Code, Alarm Counter, Power Loss Counter to be reset, then select **OK**. IPScom will return to the Main Menu.

![Counters and Error Codes Dialog Screen](image)

**Figure 2-26  Counters and Error Codes Dialog Screen**
Through Fault Recorder (From IPScom)

Relay/Through Fault/Retrieve

To download available Through Fault records perform the following:

1. From the IPScom® Main Screen menu select Relay/Through Fault/Retrieve.
   The Through Fault Download screen will display a bar indicating the status of the download. When the download is complete the Save As screen will be displayed with a default ".tfe" file extension.

2. Select the destination folder and name the file, then select Save to save the Through Fault Record or Cancel.

Relay/Through Fault/View

To view available Through Fault records perform the following:

1. From the IPScom Main Screen menu select Relay/Through Fault/View. IPScom will display the View Through Fault Record screen (Figure 2-27).

2. Select Open. IPScom will display the Open screen with a default ".tfe" file extension.

3. Select the location of the ".tfe" files, then select the file to be viewed.

4. Select Open. IPScom will Open the target file in the View Through Fault Record screen.

5. Select Close to return to the IPScom Main screen.

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<th>Start Time</th>
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<td>51831.7</td>
<td>111.68</td>
<td>6.00</td>
<td>A</td>
</tr>
<tr>
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<td>03/10/2007 09:08:01.041</td>
<td>51831.7</td>
<td>110.74</td>
<td>6.00</td>
<td>B</td>
</tr>
<tr>
<td>2</td>
<td>03/10/2007 09:08:01.045</td>
<td>51887.5</td>
<td>111.84</td>
<td>6.01</td>
<td>C</td>
</tr>
</tbody>
</table>

Figure 2-27  View Through Fault Record Screen
Relay/Through Fault/Clear
To Clear the relay Through Fault records perform the following:

1. From the IPScom® Main Screen menu select Relay/Through Fault/Clear. IPScom will display the Clear Through Fault record confirmation screen (Figure 2-28).

![Figure 2-28 Clear Through Fault Record Confirmation Screen](image)

2. Select YES. IPScom will respond with the Through Fault Record Cleared Successfully screen (Figure 2-29).

![Figure 2-29 Through Fault Record Cleared Successfully Screen](image)

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

Relay/Sequence of Events/Retrieve
The Retrieve selection downloads the events from the currently connected relay (events must be retrieved from the relay and stored in a file in order to view them).

To download available Sequence of Events perform the following:

1. From the IPScom Main Screen menu select Relay/Sequence of Events/Retrieve. IPScom will display the Sequence of Events Recorder Download screen (Figure 2-30) and indicate the number of Sequence of Events Recorder Events being downloaded.

![Figure 2-30 Sequence of Events Retrieve/Download Screen](image)

2. When the download is complete the Save As screen will be displayed with a default ".evt" file extension.

3. Select the destination folder and name the file, then select Save to save the Sequence of Events Record or Cancel.
**Relay/Sequence of Events/View**

The Sequence of Events viewer screen includes the commands **Open**, **Close**, **Print Summary**, and **Print**. **Open** opens a saved sequence of events file. **Close** closes the print file. **Print Summary** prints an event summary, and **Print** prints the event report. **Clear** deletes event history from the control.

To view available Sequence of Events Records perform the following:

1. From the IPScom® Main Screen menu select **Relay/Sequence of Events/View**. IPScom will display the View Sequence of Events Record screen (Figure 2-31).
2. Select **Open**. IPScom will display the **Open** screen with a default ".evt" file extension.
3. Select the location of the ".evt" files, then select the file to be viewed.
4. Select **Open**. IPScom will **Open** the target file in the View Sequence of Events Record screen (Figure 2-31).

**Relay/Sequence of Events/Clear**

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

To Clear all Sequence of Events Records perform the following:

1. From the IPScom Main Screen menu select **Relay/Sequence of Events/Clear**. IPScom will display the Clear Sequence of Events Records confirmation screen (Figure 2-32).
2. Select **YES**, IPScom will respond with the Sequence of Events Records Cleared confirmation Screen (Figure 2-33).
3. Select **OK**, IPScom will return to the IPScom Main Screen.
This chapter is designed for the person or group responsible for the operation and setup of the M-3311A. The S-3300 IPScom Communications Software can be used to successfully communicate system settings and operational commands to the M-3311A as well as access the extensive monitoring and status reporting features. Figure 3-3, represents the IPScom Main Screen menu structure. This chapter provides a general overview of each IPScom menu selection and command in the same order as they are displayed in the software program. Those IPScom features and functions that are covered in other sections of this Instruction Book will be noted and referenced.

3.1 IPScom Functional Description

The IPScom installation and establishing initial local communications are covered in Section 5.6, IPScom Communications Software Installation, and Section 5.7, Activating Initial Local Communications.

Selecting the IPScom Program from the Becoware Folder or selecting the IPScom Program Icon (Figure 3-1) from the Desktop will open the program and display the IPScom Main Screen (Figure 3-2).

IPScom Main Screen Menu Bar
The IPScom Main Screen Menu Bar includes (when the program is initially opened) the File, Connect and Help menu selections. This menu bar includes the additional selections; Communication, Monitor, System, Tools and Windows when IPScom is in either the file mode or has open communications established with a relay.

Shortcut Command Buttons
Before IPScom has entered either the file mode or communications have been opened, the new and open shortcut commands are available. When IPScom is in the New File, Existing File, or Communication Mode, the main screen includes the Save, Secondary Metering, Phasor Diagram and Setpoints shortcut command buttons. These shortcuts allow direct access to these functions.

IPScom Main Screen Status Line
The IPScom status line indicates the source of the information that is displayed. Sources include New File, Existing File, Serial Port, TCP/IP or Modem. Also included on the IPScom Main Screen at the bottom, are the Type of Unit IPScom is connected to, the Firmware Version of the unit and Status of the Communication connection, or if not connected, it will indicate that IPScom is in the File Mode.

Figure 3-1 IPScom Program Icon
Figure 3-2  IPScom Main Screen
Figure 3-3  S-3300 IPScom Menu Selection
File Menu

The **File** menu enables the user to create a **New** data file, **Open** a previously created data file, **Close**, **Save**, **Save as** and **Exit** the IPScom® program. The user can also perform **Print** and **Print Preview** of the open file and **Compare** two files.

**File/New Command**
When not connected to a M-3311A, using the **New** command, a new file is established with the New System dialog screen (Figure 3-4). Selecting **Save** allows the new data file to be named by using the **Save** or **Save as**... commands.

**NOTE:** By choosing the **NEW** command, unit and setpoint configuration values are based on factory settings.

**Command Buttons**

**OK** Allows the file to be created using the currently displayed information.

**Cancel** Returns to the IPScom main screen; any changes to the displayed information are lost.

**File/Save and Save As Command**
The **Save** and **Save As...** commands allow saving a file or renaming a file, respectively.

**File/Open Command**
The open command allows opening a previously created data file. With an opened data file, use the System... Setup... menu items to access the setpoint windows.

If communication can be established with a relay, it is always preferred to use the **Read Data From System** command in the System menu to update the PC's data file with the relay data. This file now contains the proper system type information, eliminating the need to set the information manually.

**File/Close Command**
Closes the open file without saving.

**File/Exit Command**
The Exit command quits the IPScom program.
The Connect dialog screens allow selection of the IPScom communication parameters to coordinate with the relay. Selecting “Serial Port” displays the PC Comm Port and device settings (Figure 3-5).

Selecting “TCP/IP” displays the PC TCP/IP and device settings (Figure 3-6) for Ethernet communication. Selecting “Modem” displays a modem dialog screen (Figure 3-7), to establish contact with remote locations. The Modem dialog screen also includes a “Bring up terminal window after dialing” option. When selected, IPScom will open a terminal window (Figure 3-8) to allow modem commands to be sent to the target modem. When communicating by way of a fiber optic loop network, echo cancelling is available by checking the Echo Cancel box. This command masks the sender's returned echo.

If the modem was not used to establish communication (direct connection), select Connect to start. If the relay has a default communication access code of 9999, a message window will be displayed showing Access Level #3 was granted. Otherwise, another dialog screen will be displayed to prompt the user to enter the access code in order to establish communication. Communication/Disconnect discontinues communication.

Communication/Open Terminal Window
Opens the IPScom Terminal Window (Figure 3-8).
Figure 3-7  IPScom Modem Communication Dialog Screen

Figure 3-8  Terminal Window
Monitor Menu
The Monitor Menu provides access to the screens used to monitor relay parameters. Seven submenus are provided: Primary Metering and Status, Secondary Metering and Status, Metering II, Phasor Diagram, Phasor Diagram (87T), Pickup/Timeout Status, and 87T Dual Scope.

Monitor/Primary Metering & Status
The Primary Metering screen (Figures 3-9 and 3-10) allow the user to review the following PRIMARY parameters:

- Voltage ($V_A$, $V_B$, $V_C$ and $V_G$ or $V_O$ phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%) 
- Current ($W_1$ — $W_4$)
- Ground Current ($W_2$ — $W_4$)
- Positive Sequence Current ($W_1$ — $W_4$)
- Negative Sequence Current ($W_1$ — $W_4$)
- Zero Sequence Current ($W_1$ — $W_4$)
- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current ($W_2$ — $W_4$)

Also included on the Primary Metering & Status screen are:

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets

Path: Monitor / Primary Metering and Status

Figure 3-9  Primary Metering Status Screen (2/3 Winding)
Path: Monitor / Primary Metering and Status

Figure 3-10  Primary Metering Status Screen (4 Winding)
Monitor/Secondary Metering & Status

The Secondary Metering and Status screen (Figures 3-11 and 3-12) allow the user to review the following SECONDARY parameters:

- Voltage ($V_A$, $V_B$, $V_C$ and $V_G$ or $V_O$ phase voltages)
- Frequency (Hz)
- Volts Per Hertz (%)
- Current (W1 — W4)
- Ground Current (W2 — W4)
- Positive Sequence Current (W1 — W4)
- Negative Sequence Current (W1 — W4)
- Zero Sequence Current (W1 — W4)

Also included on the Secondary Metering & Status screen are:

- Differential Current (PU), (Phase A/B/C)
- Restraint Current (PU), (Phase A/B/C)
- Ground Differential Current (W2 — W4)

- Inputs
- Outputs
- Breaker Status
- OSC Triggered Status
- Targets

![Secondary Metering Status Screen](image)

**Path:** Monitor / Secondary Metering and Status

*Figure 3-11 Secondary Metering Status Screen (2/3 Winding)*
Path: Monitor / Secondary Metering and Status

*Figure 3-12  Secondary Metering Status Screen (4 Winding)*
Monitor/Metering II

The Metering II screen (Figures 3-13 and 3-14) include the following parameters:

- 2\textsuperscript{nd}, 4\textsuperscript{th} and 5\textsuperscript{th} Harmonic Differential Currents (PU), (Phase A/B/C)
- Thermal Currents (Phase A/B/C) for W1 or W2 or W3 or W4

Also included on the Metering II screen are:

\[\text{NOTE:}\] These parameters are described in their respective sections of this chapter.

- Breaker Monitor Accumulators (Phase A/B/C) Winding 1, 2, 3, & 4 (A Cycles)
- Demand Phase Currents, Winding 1, 2, 3, & 4

Demand Status

Monitored Primary Demand values include:

- Winding 1, 2, 3, & 4 Phase Currents
- Winding 2, 3, and 4 Ground Current

Maximum Demand Current

Maximum values include time-tagged values for all the above quantities.

\[\text{Figure 3-13} \quad \text{Metering II Screen (2/3 Winding)}\]
Path: Monitor / Metering II

Figure 3-14  Metering II Screen (4 Winding)
Monitor/Phasor Diagram

The Phasor Diagram (Figures 3-15 and 3-16) provide the user with the ability to evaluate a reference Phase Angle to Phase Angle data from other windings. The Phasor Diagram also includes a menu that allows the user to select/deselect sources to be displayed and Freeze capability to freeze the data displayed on the Phasor Diagram.

Path: Monitor / Phasor Diagram

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

*Figure 3-15 Phasor Diagram (2/3 Winding)*
**Path:** Monitor / Phasor Diagram

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

*Figure 3-16  Phasor Diagram (4 Winding)*
Monitor/Phasor Diagram (F87T)
The Phasor Diagram (F87T) (Figures 3-17 and 3-18) provide the user with the ability to evaluate compensated and uncompensated 87 Function parameters.

*Figure 3-17  Phasor Diagram (F87T) (2/3 Winding)*
Path: Monitor / Phasor Diagram (F87T)

Figure 3-18  Phasor Diagram (F87T) (4 Winding)
Monitor/Pickup/Timeout Status

The Pickup/Timeout Status screen (Figures 3-19 and 3-20) display the extended status information of relay functions and Input/Output contact information.

Path: Monitor / Pickup/Timeout Status

Figure 3-19 Pickup/Timeout Status (2/3 Winding)

Figure 3-20 Pickup/Timeout Status (4 Winding)
Monitor/87T Dual Slope

The 87T Dual Slope display allows the user to display a graphical representation of the 87T programmable Dual Slope Percentage Restraint Characteristic. See Section 4.4, System Setpoints for detailed information.

Path: Monitor / 87TDual Slope

*Figure 3-21  87T Function Dual Slope Display*
The Relay menu provides access to the screens used to set, monitor, or interrogate the relay. Six submenus are provided: Setup, Demand Status, Targets, Through Fault, Sequence of Events, Oscillograph and Profile as well as two commands, Write File to Relay, and Read Data From Relay.

The Setup submenu includes the Setup System, Relay Setpoints, Set Date & Time, Display I/O Map and Display All Setpoints selections.

Relay/Setup/Setup System

The Setup System selection displays the Setup System dialog screen (Figures 3-22 and 3-23) allowing the user to input the pertinent information regarding the system on which the relay is applied (see Section 4.2, Setup System, for detailed information regarding the specific elements of the Setup System dialog screen).

**NOTE:** Checking the inputs for the Active Input Open parameter designates the “operated” state established by an opening rather than a closing external contact.

**COMMAND BUTTONS**

**Save** When connected to a relay, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information to file and returns to the IPScom Main screen.

**Cancel** Returns to the IPScom Main screen; any changes to the displayed information are lost.
Figure 3-22  Setup System Dialog Screen (2/3 Winding)
Figure 3-23  Setup System Dialog Screen (4 Winding)
**Relay/Setup/Relay Setpoints**

The Relay Setpoints menu selection displays the Relay Setpoints dialog screen (Figures 3-24 and 3-25) from which the individual Function Setting dialog screens can be accessed. Selecting a Function Setting button will display the corresponding function dialog screen (See Figure 3-26 as an example).

![Figure 3-24 Relay Setpoints Dialog Screen (2/3 Winding)](image)

**Figure 3-24  Relay Setpoints Dialog Screen (2/3 Winding)**

![Figure 3-25 Relay Setpoints Dialog Screen (4 Winding)](image)

**Figure 3-25  Relay Setpoints Dialog Screen (4 Winding)**

**COMMAND BUTTONS**

- **Display All**  Opens the All Setpoints Table dialog screen for the specified range of functions.
- **I/O Configure**  Opens the I/O Map dialog screen (Figures 3-28 and 3-29)
- **OK**  Exits the screen and returns to the IPScom® main screen.
**Figure 3-26  Example Function Dialog Screen**

**COMMAND BUTTONS**

**Save**  When connected to a relay, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information and returns to the System Setpoints screen or All Setpoints Table.

**Cancel**  Returns to the System Setpoints screen or All Setpoints Table; any changes to the displayed information are lost.

**Relay/Setup/Set Date & Time**

The **Setup Date & Time** command (Figure 3-27) allows the system date and time to be set, or system clock to be stopped. This dialog screen also displays an LED mimic to identify when the Time Sync is in use (preventing date/time from being changed by user).

The time field in the dialog box is not updated continuously. The time at which the dialog box was opened is the time that is displayed and remains as such. This is true whether the relay is synchronized with the IRIG-B signal or not.

There is a green Time Sync LED mimic in this dialog box (the LED is displayed as different shading on a monochrome monitor). When this LED is green, the relay is synchronized with the IRIG-B signal and the Time field is grayed out, indicating that this field can't be changed. But the Date field can be changed (by editing and selecting **Save**).

When the LED is not blue, the relay is not timesynchronized and therefore, both the Date and Time fields can be changed.

**Figure 3-27  Date/Time Dialog Screen**

**SETUP DATE AND TIME COMMAND BUTTONS**

**Start/Stop**  This toggles between start/stop, the relay clock. 'Stop' pauses, 'Start' resumes.

**Save**  Saves Time and Date settings to the relay when applicable.

**Cancel**  Returns to the IPScom® main window. Any changes to the displayed information is lost.
Relay/Setup/Display/I/O Map

Selecting the I/O Map button displays the I/O Map dialog screen (Figures 3-28 and 3-29), which contain a chart of programmed input and output contacts, in order to allow scrolling through all relay output and blocking input configurations.

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

![I/O Map Screen (2-3 Winding)](image-url)
Figure 3-29  I/O Map Screen (4 Winding)
Relay/Setup/Display All Setpoints

Selecting the **Display All Setpoints** button displays the **All Setpoints** dialog screen (Figures 3-30 and 3-31). This dialog screen contains the settings for each relay function within a single window to allow scrolling through all relay setpoint and configuration values.

The individual Feature and Function selection buttons are described in the applicable sections.

The All Setpoint Table includes Jump Command Buttons which allow the user to jump from a scrolling dialog screen to an individual relay function dialog screen and return to the scrolling dialog screen. All available parameters can be reviewed or changed when jumping to a configuration dialog screen.

![Figure 3-30 Display All Setpoints Screen (2/3 Winding)](image-url)
## M-3311A All Setpoints

### Setup

<table>
<thead>
<tr>
<th>CT Type</th>
<th>5A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Rotation</td>
<td>ABC</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>120 (V)</td>
</tr>
<tr>
<td>Frequency Type</td>
<td>60Hz</td>
</tr>
<tr>
<td>VT Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>V.T. Ground Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W1 Phase Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W2 Phase Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W3 Phase Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W4 Phase Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W2 Ground Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W3 Ground Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>C.T. W4 Ground Ratio</td>
<td>10 (1)</td>
</tr>
<tr>
<td>Demand Timing Method</td>
<td>15 (Minutes)</td>
</tr>
<tr>
<td>Winding Summing 1</td>
<td>W1 W2</td>
</tr>
<tr>
<td>Winding Summing 2</td>
<td>W1 W2</td>
</tr>
</tbody>
</table>

### Transformer/CT Connection (Standard)

<table>
<thead>
<tr>
<th>CT W1</th>
<th>CT W2</th>
<th>CT W3</th>
<th>CT W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

### Select Time

<table>
<thead>
<tr>
<th>Output</th>
<th>30 (Cycles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 2</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 3</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 4</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 5</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 6</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 7</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 8</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 9</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 10</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 11</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 12</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 13</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 14</td>
<td>30 (Cycles)</td>
</tr>
<tr>
<td>Output 15</td>
<td>30 (Cycles)</td>
</tr>
</tbody>
</table>

### I/O Settings

<table>
<thead>
<tr>
<th>Latched Outputs</th>
<th>False Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Inputs (Open)</td>
<td></td>
</tr>
</tbody>
</table>

### 24: Volts/Hz Overexcitation

- 24 DT #1 (Disabled)
- 24 DT #2 (Disabled)
- 24 TT (Disabled)

### 27: Phase Undervoltage

<table>
<thead>
<tr>
<th>Blocking Inputs</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup</td>
<td>105 (V)</td>
</tr>
<tr>
<td>Inhibit</td>
<td>Disabled</td>
</tr>
<tr>
<td>Output</td>
<td>1</td>
</tr>
<tr>
<td>Inhibit Voltage</td>
<td>105 (V)</td>
</tr>
<tr>
<td>Delay</td>
<td>30 (Cycles)</td>
</tr>
</tbody>
</table>

---

**Figure 3-31** Display All Setpoints Screen (4 Winding)
Relay/Demand Status

The Demand Status feature allows the user to access Primary Demand Values. See Chapter 2, Operation for detailed information.

Figure 3-32 Demand Status Dialog Screen (2/3 Winding)

Figure 3-33 Demand Status Dialog Screen (4 Winding)
The **Targets** submenu provides three command options: **View**, **Clear** and **Reset LED**. The **View** command displays the View Targets Dialog Screen (see Figure 3-34). This dialog screen provides detailed data on target events including time, date, function status, phase current values, and IN/OUT contact status at the time of trip. Individually recorded events may be selected and saved to a text file, or be printed out with optional added comments. The **Reset LED** selection is similar to pressing the **Target Reset** button on the relay Front Panel. This command resets current targets displayed on the relay. This command does not reset any target history. The **Clear** command clears all stored target history. See **Chapter 2, Operation** for detailed information.

![View Targets Dialog Screen](image)

**Figure 3-34  View Targets Dialog Screen**
The Through Fault submenu provides three command options: Retrieve, View and Clear. The Retrieve command initiates the retrieval of any Through Faults present in the relay. The View command displays the View Through Fault Record dialog screen (Figure 3-35). This screen provides detailed information about each Through Fault record. The information includes the Record Serial Number, Start Time, Duration, Fault Current, Max Current and Phase. The submenu also includes the Clear command which clears all Through Fault records in the relay. See Chapter 4, System Setup and Setpoints and Chapter 2, Operation, for detailed information.

![View Through Fault Record Screen](image)

**Figure 3-35** View Through Fault Record Screen
The Sequence of Events submenu allows the user to Setup, Retrieve, View and Clear Sequence of Events records. The Setup command displays the Setup Sequence of Events Recorder dialog screen (Figure 3-36). Function Pickup, Trip and Dropout can be selected to initiate the recorder as well as Input Pickup, Output Pickup, Inputs Drop and Outputs Drop. The Retrieve command downloads and saves the record to file (Figure 3-37). The View command displays the View Sequence of Events Record screen (Figure 3-38) which allows the user to open and print Sequence of Events files. The Clear command clears all Sequence of Events records in the relay. See Chapter 4, System Setup and Setpoints and Chapter 2, Operation, for detailed information.

![Setup Sequence of Events Recorder](image)

**Figure 3-36  Sequence of Events Recorder Setup Screen**

![Download](image)

**Figure 3-37  Sequence of Events Recorder Retrieve Screen**
Figure 3-38  View Sequence of Events Recorder Screen
The Oscillograph submenu allows setting and control over the relay's oscillograph recorder. The Setup command allows the user to set the number of partitions and triggering designations to be made (Figure 3-39 and 3-40), Retrieve downloads and save data to a file (Figure 3-41). Trigger sends a command to the relay to capture a waveform. This is the same as issuing a manual oscillograph trigger. Clear erases all existing records. The optional M-3801D IPSplot® PLUS Oscillograph Analysis Software program is required to view the downloaded oscillograph files or the files can be converted to ComTrade format.

See Chapter 4, System Setup and Setpoints and Chapter 2, Operation, for detailed information.
Relay/Profile

CAUTION: If relay is online, be sure to switch the active profile. If the wrong profile is selected, it may cause unexpected operation.

The Profile submenu provides three command options: Switching Method, Select Profile, and Copy Active Profile.

The Switching Method command allows selection of either Manual or Input contact (Figure 3-42). Select Profile allows the user to designate the active profile (Figure 3-43). Copy Active Profile copies the active profile to one of four profiles (user should allow approximately 15 seconds for copying) (Figure 3-44).

See Chapter 4, System Setup and Setpoints for detailed information.
Relay/Write File to Relay

The **Write File to Relay** command sends a predefined setpoint data file to the Relay.

Relay/Read Data From Relay

The **Read Data from Relay** command updates the PC data image with the relay's latest data.

Tools Menu

The **Tools** menu provides the user with access to IPScom® relay support features and functions.

Tools/Security

The Security menu item includes the **Change Comm Access** and **Change User Access** code submenus.


The **Change Comm Access** code selection displays the Change Comm Access Code screen (Figure 3-45) which allows the user to change the Comm Access Code. See Section 4.1, **Unit Setup** for detailed setup instructions.

If additional link security is desired, a communication access code can be programmed. Like the user access codes, if the communication access code is set to 9999 (default), communication security is disabled.

![Figure 3-45 Change Comm Access Code Dialog Screen](image-url)

The **Change User Access Code** selection displays the Access Level Code dialog screen (Figure 3-46). After entering a valid Level 3 Access Code IPScom® will display Figure 3-47 which allows the user to change the relay User Access Code. See Section 4.1, **Unit Setup** for detailed setup instructions.

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

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

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

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

Tools/User Information

The User Information menu selection displays the User Information screen (Figure 3-48) which provides the user with the ability to edit/input the User Logo lines of the HMI display, enter/edit the User Control Number and set the operating mode of the System OK LED. See Section 4.1, **Unit Setup** for detailed setup instructions.
User Control Number
The User Control Number is a user-defined value which can be used for inventory or identification. The unit does not use this value, but it can be accessed through the HMI or the communications interface, and can be read remotely.

System OK LED
The green SYSTEM OK LED is controlled by the unit's microprocessor. A flashing SYSTEM OK LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated.

Tools/Relay Communication
The Relay Communication menu selection provides the user with the ability to change the relay Communication Address (Figure 3-49), set the relay’s COM Port communication parameters (Figure 3-50) and setup the Ethernet Port (Figure 3-51). See Section 4.1, Unit Setup for detailed communication setup instructions.

Tools/Output Test
The Output Test menu selection displays the Output Test screen (Figure 3-53) which provides the user with the ability to test each output relay. See Section 6, Testing for detailed testing instructions.

Tools/Counters and Error Codes
The Counters and Error Codes menu selection displays the Counters and Error Codes screen (Figure 3-54) which provides the user with the ability to view and clear system Error Codes, Alarm Counters, Power Loss Counter and Output Counters. Also, Checksums can be viewed for Calibration and Setpoints. See Chapter 2, Manual Operation for detailed instructions.
Figure 3-52  Output Test Warning Dialog Screen

Figure 3-53  Output Test Dialog Screen

Figure 3-54  Counters and Error Codes Dialog Screen
Tools/Firmware Update
The Firmware Update feature allows the user to perform M-3311A Firmware updates. Firmware update files and instructions are provided by Beckwith Electric.

![Figure 3-55 Firmware Update Warning Dialog Screen](image)

Tools/Calibration Data
The Calibration Data feature allows the user to retrieve calibration data from M-3311A relays. It also allows relay calibration data to be restored to the relay.

![Figure 3-56 Calibration Data Retrieve Dialog Screen](image)

Window Menu
The Window menu enables positioning and arrangement of IPScom® windows so that there is better access to available functions. This feature allows the display of several windows at the same time. Clicking on an inactive yet displayed window activates that window.

![Figure 3-57 Calibration Data Restore Dialog Screen](image)

Help Menu
The Help menu provides two commands. The Contents command initiates a link to a PDF (Portable Document File) version of this instruction book for easy reference. An Adobe Acrobat® reader is required to view this document.

The M-3311A Instruction Book has been indexed to its table of contents. By selecting the ‘Navigator pane’ in Adobe Acrobat Reader, the user can directly access selected topics.

The About command displays IPScom and firmware version.
Chapter four is designed for the person or group responsible for the Unit Setup, Configuration and System Setpoints of the M-3311A Transformer Protection Relay.

Chapter 4 consists of:

- Functional and connection diagrams for a typical application of the relay.
- The Unit Setup Section, which consists of general unit setup information, Communications setup, Oscillograph, Sequence of Events, Through Fault Recorder and Demand Interval setup.
- The Configuration Section provides the definitions of system quantities and equipment characteristics required by the relay which include CT, VT configuration selection and Input and Output assignments.
- A System Setpoints Section which describes the enabling of functions and setpoints, output contact assignments and digital input assignments.

The selection of the M-3311A System Setup parameters and Setpoints can be performed using either the S-3300 IPScom® Communications Software or from the unit’s M-3931 Front Panel Human Machine Interface (HMI), and will be included where applicable.

### 4.1 Unit Setup

**NOTE:** Setup Record Forms are contained in Appendix A. The Setup Record Form tables list the relay parameter settings choices for each feature and function.

#### GENERAL UNIT SETUP

The General Unit setup consists of the setup of the following features and functions:

- Comm Access Code
- User Access Codes
- User Logo Lines
- User Control Number
- OK LED Flash
- Time and Date

#### COMM ACCESS CODE

If additional link security is desired, a communication access code can be programmed. Like the user access codes, if the communication access code is set to 9999 (default), communication security is disabled.
IPScom Comm Access Code Setup
To set the relay Comm Access Code perform the following:

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

1. From the IPScom Main Screen menu select Tools/Security/Change Comm Access Code. IPScom will display the Change Comm Access Code dialog screen (Figure 4-1).

![Figure 4-1 Change Comm Access Code Dialog Screen](image)

2. Enter the desired New Comm Access Code (1-9999), then re-enter (confirmation) the New Access Code.

3. Select Save, IPScom will display an Access Code change Confirmation Screen (Figure 4-2).

![Figure 4-2 Access Code Change Confirmation Screen](image)

4. Select Yes, IPScom will display an Access Code Was Changed Successfuly Confirmation Screen (Figure 4-3).

![Figure 4-3 Access Code Changed Confirmation Screen](image)

5. Select OK, ISScom will return to the Main Screen.

The new Comm Access Code will not be in affect until communications have been closed with the relay for approximately 2.5 minutes.

HMI Comm Access Code Setup
1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

   ![ENTER ACCESS CODE](image)

   a. Input the required Access Code, then press ENTER.

   b. If the proper Access Code has been entered, the HMI will return:

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

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

   ![VOLTAGE RELAY VOLT curr freq v/hz](image)

   a. Go to step 4.

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

   ![COMMUNICATION stat COMM setup](image)
5. Press ENTER, the following will be displayed:

<table>
<thead>
<tr>
<th>COM1 SETUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM1 com2 com3 com_adr</td>
</tr>
</tbody>
</table>

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

| COMM ACCESS CODE dly ACCSS eth eth_ip |

7. Press ENTER, the following will be displayed:

| COMM ACCESS CODE 9999 |

8. Input the desired Comm Access Code as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Comm Access Code digits.
   c. When the desired Comm Access Code has been input, then press ENTER. The following will be displayed:

| COMM ACCESS CODE ACCESS eth eth_ip |


IPScom User Access Code Setup

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

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

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

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

To setup the relay User Access Codes perform the following:

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

1. From the IPScom Main Screen menu select **Tools/Security/Change User Access Code**. IPScom will display the Change User Access Code dialog screen (Figure 4-4).

2. Enter the desired User Access Code(s) (1-9999), then re-enter (confirmation) the desired User Access Code(s).
3. Select **Save**, IPScom will display an Access Code change Confirmation Screen (Figure 4-2).
4. Select **Yes**, IPScom will display an Access Code Was Changed Successfully Confirmation Screen (Figure 4-3).
5. Select **OK**, IPScom will return to the Main Screen.
HMI User Access Codes Setup

1. Press the **ENTER** pushbutton.

2. If Level Access is active, the following is displayed:

   
   **ENTER ACCESS CODE**
   
   0

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

   **LEVEL #1,2 or 3**
   
   Access Granted!

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

   **VOLTAGE RELAY**
   
   **VOLT curr freq v/hz**

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

   **SETUP UNIT**
   
   SETUP

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

   **ALTER ACCESS CODES**
   
   vers eth sn ACCESS

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

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

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

   **LEVEL #1**
   
   9999

8. Input the desired User Access Code as follows:

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

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

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

   **LEVEL #2**
   
   9999

10. Repeat Step 8 to enter the desired Level #2 User Access Code.

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

   **LEVEL #3**
   
   9999

12. Repeat Step 8 to enter the desired Level #3 User Access Code.

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

   **ALTER ACCESS CODES**
   
   vers eth sn ACCESS
USER LOGO LINE

The user logo is a programmable, two-line by 24-character string, which can be used to identify the relay, and which is displayed locally when the unit is idle. This information is also available in IPScom®.

USER CONTROL NUMBER

The User Control Number is a user-defined value which can be used for inventory or identification. The unit does not use this value, however, it can be accessed through the HMI or the communications interface, and can also be read remotely.

SYSTEM OK LED

The green SYSTEM OK LED is controlled by the unit’s microprocessor. A flashing SYSTEM OK LED indicates proper program cycling. The LED can also be programmed to be continuously illuminated indicating proper program cycling.

IPScom User Logo Line, User Control Number, System OK LED Setup and HMI Blanking

To set the relay User Logo Lines, User Control Number, System OK LED and HMI Blanking perform the following:

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

1. From the IPScom Main Screen menu select Tools/User Information. IPScom will display the User Information dialog screen (Figure 4-5).

![User Information Dialog Screen](image)

**Figure 4-5 User Information Dialog Screen**

2. If entering/editing the User Logo lines, then enter the desired User Logo Lines.

3. If changing the User Control Number, then enter the desired User Control Number.

4. If enabling/disabling the System OK LED Flash operation, then select either Enable or Disable.

5. Select Save, IPScom will return to the Main Screen.

HMI User Logo Line Setup

1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

   ENTER ACCESS CODE
   0

   a. Input the required Access Code, then press ENTER.

   b. If the proper Access Code has been entered, the HMI will return:

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

   c. Go to step 4.

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

   VOLTAGE RELAY
   VOLT curr freq v/hz

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

   SETUP UNIT
   SETUP

5. Press ENTER, the following will be displayed:

   SOFTWARE VERSION
   VERS eth sn access

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

   USER LOGO LINE 1
   LOGO 1 logo 2 alrm

7. Press ENTER, the following will be displayed:

   USER LOGO LINE 1
   BECKWITH ELECTRIC CO.
8. Input the desired User Logo Line 1 as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
   b. Press the Right arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 1.
   c. When the desired User Logo Line 1 has been input, then press ENTER. The following will be displayed:

```
USER LOGO LINE 1
-WAIT-
```

9. To enter a User Logo Line 2 press the RIGHT arrow pushbutton once, the following will be displayed:

```
USER LOGO LINE 2
logo 1 LOGO 2 alrm
```

10. Press ENTER, the following will be displayed:

```
USER LOGO LINE 2
 M-3311A
```

11. Input the desired User Logo Line 2 as follows:
   a. Utilizing the Up and Down arrow pushbuttons select the desired first letter/symbol/digit/blank space.
   b. Press the RIGHT arrow pushbutton once, then repeat the previous step as necessary to input the desired User Logo Line 2.
   c. When the desired User Logo Line 2 has been input, then press ENTER. The following will be displayed:

```
USER LOGO LINE 2
-WAIT-
```

```
USER LOGO LINE 2
logo 1 LOGO 2 alrm
```


---

**HMI User Control Number Setup**

1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
0
```

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

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

   c. Go to step 4.

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

```
VOLTAGE RELAY
VOLT curr freq v/hz
```

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

```
SETUP UNIT
SETUP
```

5. Press ENTER, the following will be displayed:

```
SOFTWARE VERSION
vers eth sn ACCESS
```

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

```
USER CONTROL NUMBER
UNUM logo1 logo2 out
```

7. Press ENTER, the following will be displayed:

```
USER CONTROL NUMBER
1
```
8. Input the desired User Control Number as follows:
   a. Utilizing the Up and Down arrow push-buttons select the desired first digit.
   b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired User Control Number.
   c. When the desired User Control Number has been input, then press **ENTER**. The following will be displayed:

   USER CONTROL NUMBER
   UNUM logo1 logo2 out

9. Press **Exit**.

**HMI System OK LED Setup**

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

   ENTER ACCESS CODE
   0

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

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

   VOLTAGE RELAY
   VOLT curr freq v/hz

   c. Go to step 4.
3. If Level Access is not active, then the following is displayed:

   VOLTAGE RELAY
   VOLT curr freq v/hz

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

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

   SETUP UNIT
   ← stat comm SETUP →

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

   SOFTWARE VERSION
   VERS eth sn access →

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

   DIAGNOSTIC MODE
   ← alrm time error DIAG

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

   PROCESSOR WILL RESET!
   ENTER KEY TO CONTINUE

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

8. Press **ENTER**, the relay will reset and DIAGNOSTIC MODE will be temporarily displayed followed by:

   OUTPUT TEST (RELAY)
   OUTPUT input led target →

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

   FLASH SYS OK LED
   com3 clock LED cal →

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

    FLASH SYS OK LED
    off ON
11. Utilizing the Right or Left arrow pushbuttons select either ON or OFF.

12. Press ENTER, the following will be displayed:
   FLASH SYS OK LED
   →DONE←

13. Press ENTER, the following will be displayed:
   FLASH SYS OK LED
   com3 clock LED cal →

14. Press EXIT, the following will be displayed:
   PRESS EXIT TO
   EXIT DIAGNOSTIC MODE

15. Press EXIT, the unit will cycle through the Power Self Tests.

**SYSTEM CLOCK**

This feature allows the user to set the relay internal clock. The clock is used to time stamp system events and oscillograph operations.

The clock is disabled when shipped from the factory (indicated by “80” seconds appearing on the clock) to preserve battery life. If the relay is to be unpowered for an extended length of time, the clock should be stopped (from Diagnostic Mode or IPScom Figure 4-6). If the IRIG-B interface is used, the hours, minutes, and seconds information in the clock will be synchronized with IRIG-B time information every hour.

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

**IPScom Set Date/Time**

To set the relay Date/Time perform the following:

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

1. From the IPScom Main Screen menu select Relay/Setup/Setup Date & Time. IPScom will display the Setup Date/Time dialog screen (Figure 4-6).

   ![Figure 4-6 Setup Date/Time Dialog Screen](image)

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

**HMI SET DATE and TIME**

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

   ![ENTER ACCESS CODE](image)
   a. Input the required Access Code, then press ENTER.
   b. If the proper Access Code has been entered, the HMI will return:

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

   ![VOLTAGE RELAY
   VOLT curr freq v/Hz](image)

   c. Go to step 4.
3. If Level Access is not active, then the following is displayed:

   ![VOLTAGE RELAY
   VOLT curr freq v/Hz](image)
4. Press the RIGHT arrow pushbutton until the following is displayed:

```
SETUP UNIT
stat comm SETUP
```

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

```
DATE & TIME
← TIME error diag
```

6. Press ENTER, the following will be displayed:

```
DATE & TIME
08-Jan-2001 00:00:80
```

7. Press ENTER, the following will be displayed:

```
DATE & TIME
01 Year
```

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

```
DATE & TIME
JAN feb mar apr may →
```

9. Input the desired Month as follows:
   a. Utilizing the Right or Left arrow pushbuttons select the desired Month.
   b. When the desired Month has been selected, then press ENTER. The following will be displayed:

```
DATE & TIME
8 Date
```

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

```
DATE & TIME
SUN mon tue wed thu →
```

11. Input the desired Day as follows:
    a. Utilizing the Right or Left arrow pushbuttons select the desired Day.
    b. When the desired Day has been selected, then press ENTER. The following will be displayed:

```
DATE & TIME
01 Hour
```

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

```
DATE & TIME
13 Minutes
```

13. Input the desired Minutes as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
    b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Minute(s).
    c. When the desired Minutes have been input, then press ENTER. The following will be displayed:

```
DATE & TIME
16 Seconds
```

14. Input the desired Seconds as follows:
    a. Utilizing the Up and Down arrow pushbuttons select the desired first digit.
b. Press the Left arrow pushbutton once, then repeat the previous step as necessary to input the desired Seconds.

c. When the desired Seconds have been input, then press ENTER. The following will be displayed:

```
DATE & TIME
← TIME error diag
```

**COMMUNICATION SETUP**

Communication setup can be accomplished utilizing either IPScom® or the HMI. The Communication setup consists of the setup of the following features and functions:

* COM Port definitions and Device Address
* Ethernet Port Settings
* Installing Modems

**Serial Ports (RS-232)**

Two serial interface ports, COM1 and COM2, are standard 9-pin, RS-232, DTE-configured ports. The front-panel port, COM1, can be used to locally set and interrogate the relay using a temporary connection to a PC or laptop computer. The second RS-232 port, COM2, is provided at the rear of the unit. COM2 is unavailable for communications when the optional ethernet port is enabled. However, the Demodulated IRIG-B may still be used through the COM2 Port when Ethernet is enabled.

**Serial Port (RS-485)**

COM3 located on the rear terminal block of the M-3311A is an RS-485, 2-wire connection. Appendix B, Figure B-3 illustrates a 2-wire RS-485 network.

Individual remote addressing also allows for communications through a serial multidrop network. Up to 32 relays can be connected using the same 2 wire RS-485 communications line.

**Direct Connection**

In order for IPScom to communicate with the relay using direct serial connection, a serial “null modem” cable is required, with a 9-pin connector (DB9P) for the system, and an applicable connector for the computer (usually DB9S or DB25S). Pin-outs for a null modem adapter are provided in Appendix B, Communications.

An optional 10 foot null modem cable (M-0423) is available from the factory, for direct connection between a PC and the relay’s front panel COM port, or the rear COM2 port.

When fabricating communication cables, every effort should be made to keep cabling as short as possible. Low capacitance cable is recommended. The RS-232 standard specifies a maximum cable length of 50 feet for RS-232 connections. If over 50 feet of cable length is required, other technologies should be investigated.

Other communication topologies are possible using the M-3311A Transformer Protection System. An Application Note, “Serial Communication with Beckwith Electric’s Integrated Protection System Relays” is available from the factory or from our website at www.beckwithelectric.com.

**Device Address**

Individual relay Device Addresses should be between 1 and 255. The default Device Address is 1.

**IPScom COM Port Definitions and System’s Communication Address**

To setup the COM Ports and Communication Addresses perform the following:

- **NOTE:** Communication must be established with the target relay for this procedure. The IPSCom installation and establishing initial Local communications are covered in Section 5.6, IPScom Communications Software Installation, and Section 5.7, Activating Initial Local Communications.

1. From the IPScom Main Screen menu select **Tools/Relay Communication.** IPScom will display the Setup Comm Port dialog screen (Figure 4-7).

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

![Setup Comm Port Dialog Screen](image)

**Figure 4-7  Setup Comm Port Dialog Screen**
2. Select the desired COM Port to be setup (1, 2 or 3).

3. Enter the desired "Baud Rate" (1200 to 9600). COM2 and COM3 share the same baud rate (see Section 5.5, Circuit Board Switches and Jumpers).

4. Enter the desired “Parity” (None, odd or even).

5. Enter the desired “Stop Bits” value (1 or 2).

<table>
<thead>
<tr>
<th>Baud Rate</th>
<th>Dead-Sync Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>9600</td>
<td>4 ms</td>
</tr>
<tr>
<td>4800</td>
<td>8 ms</td>
</tr>
<tr>
<td>2400</td>
<td>16 ms</td>
</tr>
<tr>
<td>1200</td>
<td>32 ms</td>
</tr>
</tbody>
</table>

*Table 4-1 Dead-Sync Time*

6. Enter the desired communications Protocol (MODBUS, DNP3.0).

7. Enter the desired “System’s Communication Address” (1 to 255).

8. Enter the desired “Dead Sync Time” (2 to 3000 msec).

   This delay establishes the line idle time to re-sync packet communication. Dead sync time should be programmed based on the channel's baud rate.

9. When the COM Port settings have been entered, then select Save. IPScom will display the COM Port Settings Warning Screen (Figure 4-2).

10. Select OK, IPScom will return to the Main Screen.

   The individual addressing capability of IPScom and the relay allows multiple systems to share a direct or modem connection when connected through COM2 using a communications-line splitter (Figure 4-8). One such device enables 2 to 6 units to share one communications line. Appendix B, Figure B2 illustrates a setup of RS-232 Fiber Optic network.

![Figure 4-8 Setup Comm Port Dialog Screen](image-url)
HMI COM Port Definitions and Device Address

1. Press the **ENTER** pushbutton.

2. If Level Access is active, the following is displayed:

   ENTER ACCESS CODE
   0

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

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

      VOLTAGE RELAY
      VOLT curr freq v/hz

   c. Go to step 4.

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

   VOLTAGE RELAY
   VOLT curr freq v/hz

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

   Communication
   targets osc-rec COMM

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

   COM1 SETUP
   COM1 com2 com3 com_adr

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

   COM1 BAUD RATE
   baud_4800 BAUD_9600

7. Press the Left or Right arrow pushbutton as necessary to select the desired baud rate.

8. Press **ENTER**. If setting up COM1, the screen will return to the beginning of the Comm menu. If setting up COM2 or 3, the following will be displayed:

   COM2 DEAD SYNC TIME
   50 ms

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

      COM2 PROTOCOL
      beco 2200 modbus dnp3

10. Utilizing the Left and Right arrow pushbuttons, select the desired protocol, then press **ENTER**. The following will be displayed:

    COM2 PARITY
    NONE odd even

11. Press the Left or Right arrow pushbutton as necessary to select the desired Parity setting.

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

    COM2 STOP BITS
    1

13. Utilizing the Up or Down arrow pushbuttons select the desired Stop Bits.

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

    COM1 SETUP
    com1 COM2 com3 com_adr

15. Selecting COM 3 will activate the same menu choices as displayed with the selection of COM1/2. Repeat as necessary to setup the remaining COM Ports.
ETHERNET COMMUNICATION SETTINGS

The optional RJ45 Ethernet port can be enabled utilizing either IPScom® from the Ethernet Settings menu or from the HMI Communication menu. When the ethernet port is enabled the COM2 Serial Port is not available for communications. The demodulated IRIG-B may still be used via the COM2 Port when ethernet is enabled.

The following parameters must be set for proper ethernet communication:

DHCP PROTOCOL

ENABLE: If the network server supports the DHCP protocol the network server will assign the IP Address, Net Mask and Gateway Address.

DISABLE: If the network server does not support the DHCP protocol or the user chooses to manually input ethernet settings, then obtain the IP Address, Net Mask and Gateway address from the Network Administrator and enter the settings.

ETHERNET PROTOCOLS

SERCONV: To utilize the BECO2200 protocol over a TCP/IP connection select the SERCONV (BECO2200 TCP/IP) protocol. The IP Address of the relay must be entered in the IPScom Communication screen. Also, ensure that the COM2 protocol is selected to BECO2200 and the baud rate is set to 9600 bps.

The Standard Port Number for the BECO2200 over TCP/IP protocol is 8800. The master device may require the entry of the Standard Port Number.

MODBUS: To utilize the MODBUS protocol over a TCP/IP connection select the MODBUS (MODBUS over TCP/IP) protocol. The IP Address of the relay must be entered in the IPScom Communication screen. Also, ensure that the COM2 protocol is selected to MODBUS, baud rate is set to 9600 bps, 1 stop bit and no parity selected.

The Standard Port Number for the MODBUS over TCP/IP protocol is 502. The master device may require the entry of the Standard Port Number.

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

IPScom Ethernet Port Setup with DHCP

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

1. From the IPScom Main Screen menu select **Tools/Ethernet Setup**. IPScom will display the Setup Ethernet screen (Figure 4-9).

![Figure 4-9 Setup Ethernet Screen](image-url)

2. Select Ethernet Board **Enable**.
3. Select DHCP Protocol **Enable**.
4. Select the desired protocol.
5. Select **Save**. The ethernet board is now configured for use and may be accessed through a network.
6. Ensure that TCP is selected (Upper Case).

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

7. Press ENTER, the following will be displayed:

   ![DHCP PROTOCOL DISABLE enable]

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

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

   ![TCP/IP SETTINGS TCP prot]

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

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

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

    ![SELECT PROTOCOL modbus serconv]
    ![SELECT PROTOCOL IEC 61850]

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

    ![TCP/IP SETTINGS tcp PROT]

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

    ![CONFIGURING ETH...]
System Setup and Setpoints

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

**ETHERNET IP ADDRESS**

XX.XX.XX.XX

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

Then the display will return to the following:

**ETHERNET SETUP**

← access ETH eth_ip

If the ethernet board fails to obtain an IP Address within 15 seconds the following will be displayed (for approximately 2 seconds):

**CONFIGURING ETH...**

**ETH BOARD ERROR**

Contact the Network Administrator to determine the cause of the configuration failure.

**Manual Configuration of Ethernet Board**

1. Ensure that DISABLE is selected (Upper Case).

   * If DISABLE is not selected (Upper Case), then use the Left arrow pushbutton to select DISABLE.

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

   **IP ADDRESS**

   XX.XX.XX.XX

3. Enter the desired IP Address, then press **ENTER**, the following will be displayed:

   **NET MASK**

   XX.XX.XX.XX

4. Enter the desired Net Mask, then press **ENTER**, the following will be displayed:

   **GATEWAY**

   XX.XX.XX.XX

5. Enter the desired Gateway, then press **ENTER**, the following will be displayed:

   **TCP/IP SETTINGS**

   tcp prot

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

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

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

   **SELECT PROTOCOL**

   modbus serconv

   **SELECT PROTOCOL**

   IEC 61850

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

   **TCP/IP SETTINGS**

   tcp PROT

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

   **CONFIGURING ETH...**

   If the ethernet board is successfully configured, then the entered IP Address will be displayed for approximately 2 seconds:

   **ETHERNET IP ADDRESS**

   XX.XX.XX.XX

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

Using IPScom® to interrogate, set or monitor the relay using a modem requires both a remote modem connected at the relay's location and a local modem connected to the computer with IPScom installed.

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

In order to use IPScom to communicate with the relay using a modem, the following must be provided with the relay:

- An external modem (1200 baud or higher), capable of understanding standard AT commands.
- Serial modem cable with 9-pin connector for the relay and the applicable connector for the modem.

Similarly, the computer running IPScom must also have access to a compatible internal or external modem.

Connecting the PC Modem

1. If the computer has an external modem, then use a standard straight-through RS-232 modem cable (M-3933) to connect the computer to the modem.
2. If the computer has an internal modem, then refer to the modem's instruction book to determine which communications port should be selected.
3. Verify that the modem is attached to (if external) or assigned to (if internal) the same serial port as assigned in IPScom.

While IPScom can use any of the 255 serial ports (COM1 through COM255), most computers support only COM1 and COM2.
4. Connect the modem to a telephone line, then energize the modem.

Initializing the PC Modem

1. Verify that the modem is connected as described in “Connecting the PC Modem”.
2. Open IPScom, then select the **Connect/Modem** menu item.

![Modem Dialog Screen](image)

*Figure 4-10 Modem Dialog Screen*
3. IPScom will display the Modem Dialog screen (Figure 4-10).

4. Enter the required information in the Modem Settings section of the screen, then select Connect.

**COMMAND BUTTONS**

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

**Connecting the Local Modem to the Relay**

Setup of the modem attached to the relay may be slightly complicated. It involves programming parameters (using the AT command set), and storing this profile in the modem’s nonvolatile memory.

After programming, the modem will power up in the proper state for communicating with the relay. Programming may be accomplished by using the “Bring Up Terminal Window after dialing” selection (Figure 4-11). Refer to your modem manual for further information.

![Figure 4-11 Terminal Window](image)

**NOTE:** The relay does not issue or understand any modem commands. It will not adjust the baud rate and should be considered a “dumb” peripheral. It communicates with 1 start, 8 data, and 0, 1 or 2 stop bits.

Connect the Modem to the relay as follows:

1. Connect the unit to an external modem by attaching a standard RS-232 modem cable to the appropriate serial communications port on both the unit and the modem.
2. Connect the modem to a telephone line, then energize the modem.

The modem attached to the relay must have the following AT command configuration:

- `E0` No Echo
- `Q1` Don’t return result code
- `&D3` On to OFF DTR, hangup and reset
- `&S0` DSR always on
- `&C1` DCD ON when detected
- `S0=2` Answer on second ring

The following commands may also be required at the modem:

- `&Q6` Constant DTE to DCE
- `N0` Answer only at specified speed
- `W` Disable serial data rate adjust
- `\Q3` Bidirectional RTS/CTS relay
- `&B1` Fixed serial port rate
- `S37` Desired line connection speed

When connected to another terminal device, the Terminal Window allows the user to send messages or commands. Outgoing communications are displayed in the top pane and incoming messages are displayed in the bottom two panes, in ASCII text and HEX format.

There are some variations in the AT commands supported by modem manufacturers. Refer to the hardware user documentation for a list of supported AT commands and direction on issuing these commands.
OSCILLOGRAPH SETUP

The Oscillograph Recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded using the communications ports to any IBM compatible personal computer running the S-3300 IPScom® Communications Software. Once downloaded, the waveform data can be examined and printed using the optional M-3801D IPSplot® PLUS Oscillograph Data Analysis Software and are also available in COMTRADE file format.

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

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

• **Recorder Partitions**: When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder’s memory may be partitioned into 1 to 24 partitions. Table 4-2 illustrates the number of cycles of waveform data per partition with various numbers of windings. When triggered, the time stamp is recorded, and the recorder continues recording for a user-defined period. The snapshot of the waveform is stored in memory for later retrieval using IPScom Communications Software. The OSC TRIG LED on the front panel will indicate a recorder operation (data is available for downloading).

• **Trigger Inputs and Outputs**: The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.

• **Post-Trigger Delay**: A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pretrigger data, and 80% post-trigger data.

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

<table>
<thead>
<tr>
<th>Number of Partition</th>
<th>Windings 1, 2, 3, 4</th>
<th>Windings 1, 2, 3</th>
<th>Windings 1, 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>183</td>
<td>231</td>
<td>311</td>
</tr>
<tr>
<td>2</td>
<td>122</td>
<td>154</td>
<td>207</td>
</tr>
<tr>
<td>3</td>
<td>91</td>
<td>115</td>
<td>155</td>
</tr>
<tr>
<td>4</td>
<td>73</td>
<td>92</td>
<td>124</td>
</tr>
<tr>
<td>5</td>
<td>61</td>
<td>77</td>
<td>103</td>
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<td>6</td>
<td>52</td>
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<td>57</td>
<td>77</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
<td>51</td>
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</tr>
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<td>9</td>
<td>36</td>
<td>46</td>
<td>62</td>
</tr>
<tr>
<td>10</td>
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<tr>
<td>21</td>
<td>16</td>
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<td>23</td>
<td>15</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>24</td>
<td>14</td>
<td>18</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 4-2 4 Winding Recorder Partitions
<p>| Number of | 3 Windings | 2 Windings | 3 Windings | 2 Windings | 3 Windings | 2 Windings |</p>
<table>
<thead>
<tr>
<th>Partitions</th>
<th>4 Winding</th>
<th>4 Voltages</th>
<th>2 Voltages</th>
<th>2 Voltages</th>
<th>Zero Voltage</th>
<th>Zero Voltages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>265</td>
<td>231</td>
<td>311</td>
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<td>377</td>
</tr>
<tr>
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<td>136</td>
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<td>154</td>
<td>207</td>
<td>176</td>
<td>251</td>
</tr>
<tr>
<td>3</td>
<td>102</td>
<td>132</td>
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<td>155</td>
<td>132</td>
<td>188</td>
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<tr>
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<td>81</td>
<td>106</td>
<td>92</td>
<td>124</td>
<td>106</td>
<td>150</td>
</tr>
<tr>
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<td>88</td>
<td>77</td>
<td>103</td>
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<td>107</td>
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<tr>
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<td>51</td>
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<td>77</td>
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<td>16</td>
<td>21</td>
<td>18</td>
<td>24</td>
<td>21</td>
<td>30</td>
</tr>
</tbody>
</table>

*Table 4-3 2/3 Winding Recorder Partitions*
IPScom Setup Oscillograph Recorder

NOTE: Communication must be established with the target relay for this procedure. When not connected to the relay the Save selection does not save the Oscillograph Recorder settings to an open file.

To setup the Oscillograph Recorder perform the following:

1. From the IPScom Main Screen menu select Relay/Oscillograph/Setup. IPScom will display the Setup Oscillograph Recorder dialog screen (Figures 4-12 and 4-13).

2. Select the Number of Partitions.
   The recorder’s memory may be partitioned into 1 to 24 partitions. The relay Oscillograph Recorder memory buffer is fixed and contains room for a finite number of cycles of recorded data. Consider Table 4-2 when determining the number of Oscillograph records, The number of cycles of recorded data is directly related to the number of records selected.

3. Select the desired Trigger Inputs and Trigger Outputs.
   The recorder can be triggered remotely through serial communications using IPScom, or automatically using programmed status inputs or outputs.

4. Select the Post Trigger Delay.
   A post-trigger delay of 5% to 95% must be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before re-arming for the next record. For example, a setting of 80% will result in a record with 20% pre-trigger data, and 80% post-trigger data.

5. Select Save, IPScom will display a save to device Confirmation Screen (Figure 4-2).

6. Select YES, IPScom will return to the Main Screen.

Figure 4-12 Setup Oscillograph Recorder
(2/3 Winding)

Figure 4-13 Setup Oscillograph Recorder
(4 Winding)
HMI Setup Oscillograph Recorder

1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

```
ENTER ACCESS CODE
0
```

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

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

```
VOLTAGE RELAY
VOLT curr freq v/hz
```

c. Go to step 4.

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

```
VOLTAGE RELAY
VOLT curr freq v/hz
```

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

```
OSCILLOGRAPH RECORDER
targets OSC_REC comm
```

5. Press ENTER, the following will be displayed:

```
VIEW RECORDER STATUS
STAT clear setup
```

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

```
OSCILLOGRAPH RECORDER SETUP
stat clear SETUP
```

7. Press ENTER, the following will be displayed:

```
RECORER PARTITIONS
1
```

8. Input the desired number of Recorder Partitions.

9. Press ENTER, the following will be displayed:

```
TRIGGER INPUTS
I6 i5 i4 i3 i2 i1
```

10. Press the Right or Left arrow pushbutton as necessary to select the desired Trigger Input, then press ENTER, the following will be displayed:

```
TRIGGER OUTPUTS
o8 o7 o6 o5 o4 o3 o2 o1
```

11. Press the Right or Left arrow pushbutton as necessary to select the desired Trigger Output, then press ENTER, the following will be displayed:

```
POST TRIGGER DELAY
5 %
```

12. Press the Right or Left arrow pushbutton as necessary to select the desired digit and the Up or Down arrow pushbutton to increment the Post Trigger Relay, then press ENTER, the following will be displayed:

```
OSCILLOGRAPH RECORDER SETUP
stat clear SETUP
```

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

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

To setup the Sequence of Events Recorder perform the following:

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

HMI Setup Through Fault Recorder
The Through Fault Recorder captures separate 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 rest and total \(I^2t\) for each phase since last reset (up to 256 records).

To setup the relay Through Fault recorder perform the following:

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

   ![ENTER ACCESS CODE](image)

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

   | LEVEL #(1,2 or 3) Access Granted! |
   | VOLTAGE RELAY VOLT curr freq v/hz |

   **c.** Go to step 4.
3. If Level Access is not active, then the following is displayed:

   | VOLTAGE RELAY VOLT curr freq v/hz |

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

   | THROUGH FAULT ips brkr THFLT tcm |

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

   | THFLT CURRENT THRESHOLD ___ Amps |

6. Utilizing the Up or Down arrow pushbutton set the Through Fault Current Threshold setting, then press **ENTER**, the following is displayed:

   | THFLT CUM. I^2T LIMIT ___ kA^2-cycles |

7. Utilizing the Up or Down arrow pushbutton set the Through Fault Cumulative \(I^2T\) Limit setting, then press **ENTER**, the following is displayed:

   | THFLT PU OPERATIONS LIM. ___ Records |

8. Utilizing the Up or Down arrow pushbutton set the Through Fault PU Operations Limit setting, then press **ENTER**, the following is displayed:

   | THFLT WINDING SELECT sum1 sum2 w1 w2 w3 w4 |
Figure 4-14  Setup Sequence of Events Recorder Dialog Screen
9. Utilizing the Right or Left arrow pushbutton select the target winding, then press ENTER, the following is displayed:

```
THFLT DELAY ___ Cycles
```

10. Utilizing the Up or Down arrow pushbutton set the Through Fault Time Delay setting, then press ENTER, the following is displayed:

```
THROUGH FAULT tps brkr THFLT tcm
```


**HMI Demand Interval Setup**

The Demand Interval setting determines the demand integration interval (15 min, 30 min or 60 min). Demand time-tagged peak values are stored for display and printing. See Chapter 2, Operation for detailed information.

To setup the DEMAND INTERVAL, proceed as follows:

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

```
ENTER ACCESS CODE 0
```

a. Input the required Access Code, then press ENTER.

b. If the proper Access Code has been entered, the HMI will return:

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

VOLTAGE RELAY
VOLT curr freq v/hz

c. Go to Step 4.

3. Press the ENTER pushbutton, the following will be displayed:

```
VOLTAGE RELAY
VOLT curr freq v/hz
```

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

```
DEMAND config sys stat DMD
```

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

```
DEMAND STATUS
STAT int mstat clear
```

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

```
DEMAND INTERVAL
stat INT mstat clear
```

7. Press ENTER. The HMI will display the following:

```
DEMAND INTERVAL
  15min  30min  60min
```

8. Utilizing the Right or Left arrow pushbutton select the desired Demand Interval, then press ENTER, the following is displayed:

```
DEMAND config sys stat DMD
```

4.2 Setup System

The Setup System consists of defining common information like CT and VT ratios, nominal voltage rating, transformer connections, and which profile is the Active Profile, etc. Values are entered similar to other setpoints. Configuration information is common to all profiles, and should be entered before setpoint and time settings.

When INPUT ACTIVATED PROFILES are disabled, the Active Profile can be selected using the HMI or remote communication. When enabled, the Active profile is selected by the external connections of Input 5 and 6.

2/3 Winding Setup

- INPUT ACTIVATED PROFILES
  - disable ENABLE
- Active setpoint profile
  - 1
- copy active profile
  - TO_PROFILE_1
- NUMBER OF F87 WINDINGS
  - TWO three

Winding Summing

- W1 INCLUDE IN WIN SUM#1
  - no yes
- W2 INCLUDE IN WIN SUM#1
  - no yes
- W3 INCLUDE IN WIN SUM#1
  - no yes
- W1 INCLUDE IN WIN SUM#2
  - no yes
- W2 INCLUDE IN WIN SUM#2
  - no yes
- W3 INCLUDE IN WIN SUM#2
  - no yes

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

<table>
<thead>
<tr>
<th>Input 5</th>
<th>Input 6</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Open</td>
<td>Profile 1</td>
</tr>
<tr>
<td>Closed</td>
<td>Open</td>
<td>Profile 2</td>
</tr>
<tr>
<td>Open</td>
<td>Closed</td>
<td>Profile 3</td>
</tr>
<tr>
<td>Closed</td>
<td>Closed</td>
<td>Profile 4</td>
</tr>
</tbody>
</table>

*Table 4-4  Input Activated Profile Logic*

If INPUT ACTIVATED PROFILES is disabled this screen allows manual selection of the Active Profile using the front panel or through communications.

Allows the user to manually select the Active Profile.

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

Allows the user to select the number of windings used to calculate differential functions.

The disabled winding will be removed from the differential calculation. However, the disabled winding may be utilized for other non-differential protection. See Section 4.6, Transformer Connections, for additional information.
2/3 Winding Setup (Cont’d)

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

If Custom XFM/CT Connection is DISABLED (standard transformer and CT configurations are used), the relay automatically computes the phase and magnitude compensation required for the differential currents.

If Custom XFM/CT Connection is ENABLED, then the HMI will prompt the user to enter Transformer Phase Comp Type and CT PH/Mag Comp Type values for each winding. Zero Seq Comp will also be required to be enabled or disabled for each winding to complete this setting. See Section 4.6, Transformer Connections, for additional information.

| W1 XFM PHASE COMP TYPE | 0 |
| W2 XFM PHASE COMP TYPE | 0 |
| W3 XFM PHASE COMP TYPE | 0 |
| W1 CT PH/MAG COMP TYPE | 0 |
| W2 CT PH/MAG COMP TYPE | 0 |
| W3 CT PH/MAG COMP TYPE | 0 |
| W1 ZERO SEQ COMP | disable enable |
| W2 ZERO SEQ COMP | disable enable |
| W3 ZERO SEQ COMP | disable enable |
2/3 Winding Setup (Cont’d)

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

■ NOTE: When CT connection is chosen as delta, the relay calculates line currents using delta CT currents and the ground currents (for W2 and W3 only). The line currents (not delta currents) are displayed on the status screens (metering). The line currents are also used for 50, 51, and 46 functions.

The Standard configuration requires the CT connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.6, Transformer Connections, for additional information.

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present. The Standard configuration requires the Transformer Winding Connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.5, Transformer Connections, for additional information.
Indicates the phase rotation.

Seal-in time for output relays. Eight individual seal-in delays can be specified for each output relay (OUT1-OUT16 for expanded I/O units).

Selects the active state for the six control/status inputs. When highlighted (upper case), an open circuit activates the input. When lowercase, a closed circuit activates the input (default).

If Pulse Relay operation is selected, output will dropout after the seal-in delay expires, even if the condition which caused the relay to pick up is still out of band. When selected, latching outputs are not available.

If any of the outputs are selected as latched, then after tripping, this output will stay activated, even when the tripping condition is removed. The Latched Output can be reset using the TARGET RESET pushbutton. When selected, Pulse Relay is not available.

If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

**NOTE:** See Figure 4-17 for Relay Setup of outputs (Latched or Pulsed).
2/3 Winding Setup (Cont’d)

VT Phase Ratio

VT Ground/Phase Ratio

The secondary VT voltage when primary voltage is equal to the rated transformer voltage (V trans rated/VT ratio). Range = 60–140 V; Increment 1 V.


If two voltages are enabled, then the Phase Voltage and VG Voltage Options are available.

With two voltage inputs, power measurement and sequence voltage measurement are available. However, the user must select one voltage, Vab in VT Phase config, and Vbc in VT Phase or Grnd config, in both options. (Not the same voltage).

CT Ratios
2/3 Winding Setup (Cont.’d)

CT Ground Ratios

The relay will calculate the W2 and W3 line currents when a delta CT configuration is selected, as follows:

For Delta ab CTs:

Line Current \( I_a = \frac{(I_{ab} - I_{ca} + (I_g/CTCF))/3}{} \)

Line Current \( I_b = \frac{(I_{bc} - I_{ab} + (I_g/CTCF))/3}{} \)

Line Current \( I_c = \frac{(I_{ca} - I_{bc} + (I_g/CTCF))/3}{} \)

where \( I_{ab}, I_{bc}, I_{ca} \) are the currents that enter the relay, and \( I_g \) is the measured ground current.

CTCF is given by

\[
\text{CT Phase Ratio} = \frac{\text{CT Ground Ratio}}{} 
\]
4 Winding Setup

If INPUT ACTIVATED PROFILES is disabled this screen allows manual selection of the Active Profile using the front panel or through communications.

Allows the user to manually select the Active Profile.

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

The secondary VT voltage when primary voltage is equal to the rated transformer voltage \( V_{\text{trans \, rated}} / \text{VT ratio} \). Range = 60–140 V; Increment 1 V.

Indicates VT connection.

Allows the user to select the number of windings used to calculate differential functions.

The disabled winding will be removed from the differential calculation. However, the disabled winding may be utilized for other non-differential protection. See Section 4.6, Transformer Connections, for additional information.

Winding Summing

If INPUT ACTIVATED PROFILES is disabled this screen allows manual selection of the Active Profile using the front panel or through communications.

Allows the user to manually select the Active Profile.

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

The secondary VT voltage when primary voltage is equal to the rated transformer voltage \( V_{\text{trans \, rated}} / \text{VT ratio} \). Range = 60–140 V; Increment 1 V.

Indicates VT connection.

Allows the user to select the number of windings used to calculate differential functions.

The disabled winding will be removed from the differential calculation. However, the disabled winding may be utilized for other non-differential protection. See Section 4.6, Transformer Connections, for additional information.
4 Winding Setup (Cont.’d)

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

If Custom XFM/CT Connection is DISABLED (standard transformer and CT configurations used), the relay automatically computes the phase and magnitude compensation required for the differential currents.

If Custom XFM/CT Connection is ENABLED, then the HMI will prompt the user to enter Transformer Phase Comp Type and CT PH/Mag Comp Type values for each winding. Zero Seq Comp will also be required to be enabled or disabled for each winding to complete this setting. See Section 4.5, Transformer Connections, for additional information.

CUSTOM XFM/CT CONNECTION

disable enable

<table>
<thead>
<tr>
<th>W1 XFM PHASE COMP TYPE</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 XFM PHASE COMP TYPE</td>
<td>0</td>
</tr>
<tr>
<td>W3 XFM PHASE COMP TYPE</td>
<td>0</td>
</tr>
<tr>
<td>W4 XFM PHASE COMP TYPE</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>W1 CT PH/MAG COMP TYPE</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 CT PH/MAG COMP TYPE</td>
<td>0</td>
</tr>
<tr>
<td>W3 CT PH/MAG COMP TYPE</td>
<td>0</td>
</tr>
<tr>
<td>W4 CT PH/MAG COMP TYPE</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>W1 ZERO SEQ COMP</th>
<th>disable enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 ZERO SEQ COMP</td>
<td>disable enable</td>
</tr>
<tr>
<td>W3 ZERO SEQ COMP</td>
<td>disable enable</td>
</tr>
<tr>
<td>W4 Zero Seq Comp</td>
<td>disable enable</td>
</tr>
</tbody>
</table>
4 Winding Setup (Cont.’d)

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

■ NOTE: When CT connection is chosen as delta, the relay calculates line currents using delta CT currents and the ground currents (for W2 and W3 only). The line currents (not delta currents) are displayed on the status screens (metering). The line currents are also used for 50, 51, and 46 functions.

The Standard configuration requires the CT connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.5, Transformer Connections, for additional information.

▲ CAUTION: Changing from a standard Transformer/CT connection to the equivalent custom setting may cause the relay to momentarily trip when current is present.

The Standard configuration requires the Transformer Winding Connection to be defined as Wye, Delta-ab, Delta-ac, Inverse Wye, Inverse Delta-ab, or Inverse Delta-ac. See Section 4.5, Transformer Connections for additional information.
PHASE ROTATION
← PHASE seal in vt →

PHASE ROTATION
a-c-b A-B-C

RELAY SEAL-IN TIME
← conn phase SEAL IN →

RELAY SEAL-IN TIME OUT01
___________ Cycles

RELAY SEAL-IN TIME OUT02
___________ Cycles

RELAY SEAL-IN TIME OUT03
___________ Cycles

RELAY SEAL-IN TIME OUT04
___________ Cycles

RELAY SEAL-IN TIME OUT05
___________ Cycles

RELAY SEAL-IN TIME OUT06
___________ Cycles

RELAY SEAL-IN TIME OUT07
___________ Cycles

RELAY SEAL-IN TIME OUT08
___________ Cycles

ACTIVE INPUT OPEN/CLOSE
i6 i5 i4 i3 i2 I1

PULSE RELAY
08 07 06 05 04 03 02 01

LATCHED OUTPUTS
08 07 06 05 04 03 02 01

Indicates the phase rotation.

Seal-in time for output relays. Eight individual seal-in delays can be specified for each output relay (OUT1-OUT16 for expanded I/O units).

Selects the active state for the six control/status inputs. When highlighted (upper case), an open circuit activates the input. When lowercase, a closed circuit activates the input (default).

If Pulse Relay operation is selected, output will dropout after the seal-in delay expires, even if the condition which caused the relay to pick up is still out of band. When selected, latching outputs are not available.

If any of the outputs are selected as latched, then after tripping, this output will stay activated, even when the tripping condition is removed. The Latched Output can be reset using the TARGET RESET pushbutton. When selected, Pulse Relay is not available.

If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

**NOTE:** See Figure 4-17 for Relay Setup of outputs (Latched or Pulsed).
VT Ratio

VT Ground Ratio

CT Ratios

The relay will calculate the W2, W3 and W4 line currents when a delta CT configuration is selected, as follows:

For Delta ab CTs:
Line Current $I_A = (I_{ab} - I_{ca} + (I_g/CTCF))/3$
Line Current $I_B = (I_{bc} - I_{ab} + (I_g/CTCF))/3$
Line Current $I_C = (I_{ca} - I_{bc} + (I_g/CTCF))/3$

where $I_{ab}$, $I_{bc}$, $I_{ca}$ are the currents that enter the relay, and $I_g$ is the measured ground current.

CTCF is given by

CT Phase Ratio

CT Ground Ratio
Figure 4-15  IPScom® Relay Setup System Dialog Screen (2/3 Winding)
Figure 4-16  IPScom® Relay Setup System Dialog Screen (4 Winding)
If neither Pulsed or Latched Output is enabled, the output contact will default to the normal mode. In this mode, the output contact will stay energized as long as the abnormal condition which caused it to operate persists. After the abnormal condition is cleared, the contact will reset after the programmed seal-in time has elapsed.

**Figure 4-17**  IPScom Selection Screen for Output Settings
Figure 4-18 IPScom Selection Screen for Input Settings
### 4.3 System Diagrams

M-3311A Typical Connection Diagram
Two Winding Model

This function is available as a standard protective function.

This function is available in the Optional Voltage Protection Package

---

**Figure 4-19**  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.

---

**Figure 4-20  M-3311A (Three Winding-Two or Four Voltage Inputs)**

*Typical One-Line Function Diagram*

---

* 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.
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 $V_{\phi}$ used for the 81O/U, 27, and 24 Functions and the $V_{\phi}$ broken delta input voltage used for the 59G function. These voltage inputs are not winding dependent.

*Figure 4-21  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.

**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 \( V_{\text{Ø}} \) use for the 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 4-22  M-3311A (Four Winding-Two Voltage Inputs)  
Summing Currents One-Line Function Diagram*
Figure 4-23  Typical (Two Winding-Two Voltage Inputs) Three-Line Connection Diagram
Figure 4-24  Typical (Two Winding-Four Voltage Inputs) Three-Line Connection Diagram

NOTES:
1. Delta-Wye power transformer shown with Wye-Wye connected CTs (Connected # DABY yy). Other connections are possible.
2. Alternate VT connections (see Instruction Book Chapter 5)
3. Status Inputs and Relay Output are designated.
4. Extra Outputs may be designated for control/supervisory operation.
Figure 4-25  Typical (Three Winding-Two Voltage Inputs) Three-Line Connection Diagram
Figure 4-26  Typical (Three Winding-Four Voltage Inputs) Three-Line Connection Diagram
Figure 4-27  Typical (Four Winding-Two Voltage Inputs) Three-Line Connection Diagram
### 4.4 System Setpoints

**Setpoint Profiles (Setting Groups)**

Up to four setpoint profiles may be used. Each profile contains a function configuration and associated settings. One of the four profiles may be designated as the Active Profile which will contain the parameters that the relay will actively use. Only the Active Profile may be edited.

The **Active Profile** may be designated either manually using the HMI interface, by control/status input activation (input activated profiles enabled, see Table 4-4) or by remote communication.

A **Copy Profile** feature is available that copies an image of the Active Profile to any one of the other three profiles. This feature can speed up the configuration process. Consider, for example, a situation where a breaker will be removed from service. Two profiles will be used: an “In Service” profile (Profile 1) and an “Out of Service” profile (Profile 2).

Profile 2 will be identical to the “In Service” profile, with the exception of the overcurrent settings. Profile 1 is set to be the Active profile, and all setpoints entered. An image of Profile 1 will then be copied to Profile 2 with the Copy Active Profile command. Profile 2 is then selected as the Active Profile and the overcurrent setpoints modified.

▲ **CAUTION:** During profile switching, relay operation is disabled for approximately 1 second.

Utilizing the above feature not only accelerates the configuration process, but also removes the possibility of errors if all setpoints are re-entered manually.

**Configure Relay Data**

The relay is shipped with a certain group of standard functions, including other optional functions, as purchased. Both of these groups define a configurable set of functions. Only members of this set may be enabled/disabled by the end user. (Optional functions not purchased cannot be enabled.)

Functions designated as **DISABLED** are inactive and will not be available for tripping. All menus associated with inactive functions will be unavailable.

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

- Enable/disable function
- Output choices
- Input blocking choices

**Functions**

Configuration of the relay consists of enabling the functions for use in a particular application, designating the output contacts each function will operate, and which control/status inputs will block the function. The choices include eight programmable output contacts (OUT1–OUT8) and six control/status inputs (IN1–IN6)/(OUT1–OUT16 and IN1–IN18 for expanded I/O units).

Control/status inputs may also initiate actions, such as Breaker Failure Initiate, Trigger Oscillograph Recorder, Switch Setpoint Profile, or initiate an IPSLogic function. The control/status inputs and output contacts need to be chosen before configuring the individual functions. Both can be recorded on the Relay Configuration Table in Appendix A, **Forms**.
Special Considerations
Status input IN1 is pre-assigned to be the 52b breaker contact. IN5 and IN6 may be used to select setpoint profiles (with input activated profiles enabled).

Outputs 1–6 and 9–23 are form “a” contacts (normally open), and outputs 7 and 8 are form “c” contacts (center tapped “a” and “b” normally closed) contacts. Output contacts 1–4 contain special circuitry for high-speed operation and pick up 4 ms faster than outputs 5–8. Function 87 outputs are recommended to be directed to OUT1 through OUT4 contacts.

The following functions can be configured using enable/disable output, and status input blocking designations:

+ 24 Volts/Hz Overexcitation: Definite Time #1, #2, Inverse Time
+ 27 Phase Undervoltage
  • 46W2/W3/W4 Negative Sequence Overcurrent: Definite Time, Inverse Time
  • 49 Winding Thermal Protection (W1, W2, W3, W4)
  • 50 Instantaneous Phase Overcurrent, #1, #2, #3, #4, #5, #6, #7, #8
  • 50BFW1/W2/W3/W4 Breaker Failure
  • 50GW2/W3/W4 Instantaneous Ground Overcurrent, #1, #2
  • 50N Instantaneous Residual Overcurrent, #1, #2, #3, #4, #5, #6, #7, #8
  • 51 Inverse Time Phase Overcurrent #1, #2, #3, #4
  • 51GW2/W3/W4 Inverse Time Ground Overcurrent
  • 51N Inverse Time Residual Overcurrent #1, #2, #3, #4
+ 59 Phase Overvoltage, #1, #2, #3
+ 59G Ground Overvoltage, #1, #2
+ 81 Over/Under Frequency: #1, #2, #3, #4
  • 87H Phase Differential Current, High-set
  • 87T Phase Differential Current, Harmonic Restrained Percentage Differential
  • 87GDW2/W3/W4 Ground Differential: #1, #2
  • Through Fault Monitoring
  • TCM Trip Circuit Monitoring
  • BM Breaker Monitoring: W1, W2, W3, W4
  • IPSlogic: #1, #2, #3, #4, #5, #6

(+)= Denotes the Optional Voltage Protection Package Functions
24 Volts/Hz Overexcitation

**NOTE:** Two or four voltage inputs are available for the M-3311A. The Voltage Input can be a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 24 Volts-Per-Hertz (V/Hz) function provides over-excitation protection for the transformer. As the volts per hertz level rises above a generator's limit, leakage flux increases. The leakage flux induces current in the transformer support structure causing rapid localized heating.

In power plant applications, over-excitation can occur due to sudden tripping of the generator as a result of faults and other abnormal conditions.

In Extra High Voltage (EHV) applications, an incorrectly switched line can lead to over-excitation at tapped transformers due to combined capacitance.

In transmission and distribution applications, sudden loss of load or improper capacitor/reactor switching may result in over-excitation.

This function provides two Definite Operating Time setpoints, four families of Inverse Time curves widely used in the industry (see Appendix D, Figures D1 to D4), and a linear reset rate programmable to match specific cooling characteristics of the transformer. The V/Hz function provides reliable measurements of V/Hz for a frequency range of 10–80 Hz.

When applied for generator and unit transformer protection, the first task in setting this relay function is to determine the desired protective levels and times. This can be accomplished by combining the V/Hz limit curves of the transformer and the associated generator on one graph and simplifying the result into one curve to coordinate with the protection.

Example of Transformer limits:

- Full Load V/Hz = 1.05 PU (HV terminals)
- No Load V/Hz = 1.10 PU (HV terminals)

**NOTE:** The curves must be on the same voltage base to be combined on one graph. An example is shown in Figure 4-28, Example of Capability and Protection Curves. The manufacturer of the generator and transformer will provide these over-excitation capability limits.

Depending on these characteristics, they can best be matched by one of the four families of inverse time curves, alone or in conjunction with definite time setpoints. Coordination of capabilities and protection is achieved when the time between the relay operation and the capability limit is sufficient for the breakers to open and de-energize the units. This coordination time is read vertically between the two curves at any given V/Hz value.

Figure 4-28, Example of Capability and Protection Curves, illustrates a composite graph of generator limits, transformer limits, a chosen inverse time curve, inverse time pickup, and definite time setpoint. While inverse time curve selection may provide more selective and sensitive protection, a traditional two-step protection scheme may be realized by using the two definite time functions (24DT #1 and #2), and disabling the inverse (24IT) element.
Figure 4-28  Example of V/Hz Capability and Protection Curves
Definite time setpoint #1 establishes the V/Hz level above which the protection operating time will be fixed at the definite time delay #1 (See Figure 4-28). 100% is equal to nominal voltage at nominal frequency (50/60Hz). See Section 4.2, Configuration.

Delay time #1 establishes the operation time of the protection for all V/Hz values above the level set by definite time setpoint #1. Note that delay time #1 (A.1 in Figure 4-28) must be less than the operating time of the selected inverse curve at the definite time setpoint #1 V/Hz level (A.2 in Figure 4-28). Delay time A.1 becomes the definite minimum time for the inverse curve which prevents misoperation during transients. It is highly recommended that 24DT #1 be enabled along with 24IT function.

Definite time setpoint #2 could be programmed to alarm, alerting the operator to take proper control action to possibly avoid tripping (may be used to trip). Time to operation at any V/Hz value exceeding Definite time setting #2.

As shown in Figure 4-28, the pickup value is the V/Hz value (in %) that the chosen inverse curve begins protective operation. Typical value is 105%.

The appropriate curve family for this protection application is designated by circling the CRV #. These curves are shown in Appendix D, Inverse Time Curves. Note that the operating times are constant above 150% V/Hz values.

The appropriate curve in the family is designated by the associated "K" value of the curve. These are shown in Appendix D, Inverse Time Curves.

After any V/Hz excursion, cooling time must also be taken into account. If the unit should again be subjected to high V/Hz before it has cooled to normal operating levels, damage could be caused before the V/Hz trip point is reached. For this reason, a linear reset characteristic, adjustable to take into account the cooling rate of the unit, is provided. If a subsequent V/Hz excursion occurs before the reset characteristic has timed out, the time delay will pick up from the equivalent point (as a %) on the curve. The value entered here should be the time needed for the unit to cool to normal operating temperature if the V/Hz excursion time was just under the trip time.
Figure 4-29  IPScom® (24) Volts/Hertz Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/24 Volts/HZ Overexcitation

COMMAND BUTTONS

Save          Saves all information to the relay.
Cancel        Returns the user to the previous window; any changes to the displayed information are lost.
### 27 Phase Undervoltage

**NOTE:** Two or four voltage inputs are available for the M-3311A. The Voltage Input can be a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT.

The 27 Undervoltage function may be used to detect any condition causing long term undervoltage. This function is used to shed the transformer load when the power system does not have enough reactive support, similar to the Over/Underfrequency (81O/U) function. The Inhibit setting of this function prevents it from operating during fault conditions.

**NOTE:** Only one 27 Phase Undervoltage element is available in Four Winding applications.

#### 4 Winding

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 PICKUP</td>
<td>108 Volts</td>
</tr>
<tr>
<td>27 INHIBIT</td>
<td>disable ENABLE</td>
</tr>
<tr>
<td>27 INHIBIT</td>
<td>108 Volts</td>
</tr>
<tr>
<td>27 DELAY</td>
<td>30 Cycles</td>
</tr>
</tbody>
</table>

Undervoltage pickup establishes the voltage level below which the function timer will start.

Enables or disables the undervoltage inhibit feature.

Undervoltage inhibit establishes the voltage level below which the function will be disabled.

The operating time of the function.

#### 2/3 Winding

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>27#1 PICKUP</td>
<td>108 Volts</td>
</tr>
<tr>
<td>27#1 INHIBIT</td>
<td>DISABLE enable</td>
</tr>
<tr>
<td>27#1 INHIBIT</td>
<td>108 Volts</td>
</tr>
<tr>
<td>27#1 DELAY</td>
<td>30 Cycles</td>
</tr>
</tbody>
</table>

**NOTE:** These screens are the same for #2 and #3 elements on 2/3 applications.
**NOTE:** Elements #2 and #3 are not available in Four Winding applications.

*Figure 4-30 IPScom (27) Undervoltage Setpoint Ranges (2/3 Winding)*

*Figure 4-31 IPScom (27) Undervoltage Setpoint Ranges (4 Winding)*

**Path:** Relay/Setup/Relay Setpoints/27 Phase Undervoltage

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
46 Negative Sequence Overcurrent

The 46 Negative Sequence Overcurrent function provides protection against possible damage due to unbalanced faults and open conductors.

The pickup setting of this function can be set below the system load for increased sensitivity for phase-to-phase fault backup of feeder protective relays.

This function has a definite time element and an inverse time element. The definite time pickup value and definite operating time are typically associated with an alarm function. The inverse time element is typically associated with a trip function.

The inverse time function can be selected as one of the eleven curve families: definite, inverse, very inverse, extremely inverse, and four IEC curves and three IEEE curves. The operator selects the pickup and time dial settings.

This protection must not operate for system faults that will be cleared by feeder/line relaying. This requires coordination with feeder line protection, bus differential, and breaker failure backup protections.

■ NOTE: Winding Four is not available in Two or Three Winding applications.

Winding 2 negative sequence overcurrent pickup establishes the negative sequence overcurrent level above which the definite time function timer will start. This element operates on $I_2$.

This setting is the operating time of the definite time function.

Negative sequence overcurrent pickup establishes the negative sequence overcurrent level above which the inverse time function timer will start. This element operates on $I_2$.

This setting selects one of eleven families of curves, as shown in Appendix D, Figures D-5 through D-15.

The appropriate curve in the selected family of curves is chosen here.

■ NOTE: These screens are the same for Winding 4.
**NOTE:** Winding Four is not available in Two or Three Winding applications.

*Figure 4-32  IPScom® (46) Negative Sequence Overcurrent Setpoint Ranges*

**Path:** Relay/Setup/Relay Setpoints/46 Negative Sequence Overcurrent

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
49 Winding Thermal Protection

The thermal overload function provides protection against possible damage during overload conditions. Temperature and overload monitoring of oil-filled transformers are carried out with the use of indicating thermostats (standard). The oil thermometer, which measures the top oil temperature, cannot be relied upon to detect short-time overloads beyond permissible limits.

Transformers without winding thermometers should have a thermal current protection with operating current/time characteristics that correspond to the current overload characteristic of the transformer windings. For transformers with winding thermometers, a thermal current protection will provide a back-up function for this monitoring device.

The 49 function uses the demand current as pre-load current, to protect the transformer following the IEC-255-8 standard:

\[ t = \tau \times \ln \left( \frac{(I_{\text{load}}/I_{\text{max}})^2 - (I_{\text{preload}}/I_{\text{max}})^2}{(I_{\text{load}}/I_{\text{max}})^2 - 1} \right) \]

Where:
- \( t \) = time to trip
- \( \tau \) = time constant
- \( I_{\text{load}} \) = relay current
- \( I_{\text{preload}} \) = pre-load current
- \( I_{\text{max}} \) = maximum allowed continuous overload current

The pre-load current \( "I_{\text{preload}}" \) is the previous average current for the last 15 minutes, 30 minutes, or 60 minutes programmable into the demand metering.

The M-3311A includes four setpoint groups that can accommodate a power transformer’s different MVA requirements. One setpoint group can be used for basic rating setpoints and others can be used to change to a second group of setpoints for use with higher ratings when forced cooling is required.

Example: If we consider that the transformer was working with 80% of its rating power prior to overload, then the current goes up to 2.0 times the maximum current \( (I_{\text{load}}/I_{\text{max}}=2.0) \). Selecting the curve \( P=0.8 \) (see Figure 4-33), we have \( t/\tau=0.1133 \). If \( \tau =30 \) minutes, then the time delay for this condition would be: \( t=0.1133 \times 30=3.3999 \) minutes.

\[ \text{NOTE: Winding Four is not available for selection in Two or Three Winding applications.} \]
49 - Overload Curves

where: \( P = \frac{I_{\text{preload}}}{I_{\text{max}}} \)

Figure 4-33  49 Function Overload Curves
49 TIME CONSTANT
5.0 Min

Selects the time constant, ‘τ’

49 MAX OVERLOAD CURRENT
2.00 Amps

Selects the maximum allowed continuous overload current.

49 CURRENT SELECTION
sum1 sum2 w1 w2 w3 w4

Select the winding current to be used as the input.

**NOTE:** Winding Four is not available for selection in Two or Three Winding applications.

*Figure 4-34*  IPScom® (49) Winding Thermal Protection Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/49 Winding Thermal Protection

**COMMAND BUTTONS**

**Save**  Saves all information to the relay.

**Cancel**  Returns the user to the previous window; any changes to the displayed information are lost.
50BF Breaker Failure
The 50BF function is applicable when a transformer breaker is present. If enabled, the 50BF-Ph phase detector element is used for breaker failure and the 50BF-N provides breaker flashover protection (see Figure 4-35). This provides an additional Breaker Failure Initiate, which is active only when the breaker is open.

50BF-Phase Breaker Failure
When the M-3311A Transformer Protection Relay detects an internal transformer fault or an abnormal operating condition, it closes an output contact to trip the transformer breakers. Protection output contacts must be connected to trip the breakers required to isolate the transformer from the system. The breaker failure condition is detected by the continued presence of current in any one or more phases after a breaker trip command is issued.

Implementation of the transformer breaker failure function is illustrated in Figure 4-35. The breaker failure timer will be started whenever any one of the designated output contacts or the external programmed breaker failure initiate control/status inputs are activated. The breaker failure (TDOE) timer continues to time if any one of the phase currents is above the 50BF-Ph pickup setting.

50BF-Residual Element
This overcurrent relay is energized from the residual current, see Figures 4-19 through 4-22, One-Line Functional Diagrams. This function is internally identical to the 50BF-Ph element and operates using residual (triple zero sequence) current.

Figure 4-35  Breaker Failure Logic Diagram
50BFW1 PICKUP RESIDUAL
1.00 Amps

Sets 50BFW1 residual current pickup. 0.5A is a typical setting. This element operates on 3I₀.

50BFW1 PICKUP PHASE
1.00 Amps

Sets 50BFW1 phase current pickup. 0.3 A is a typical setting.

50BFW1 INPUT INITIATE
i6 i5 i4 i3 i2 i1

Designates the control/status inputs which will initiate the breaker failure timer.

50BFW1 OUTPUT INITIATE
o8 o7 o6 o5 o4 o3 o2 o1

Designates the relay outputs which will initiate the breaker failure timer.

50BFW1 DELAY
30 Cycles

For transformer breaker failure use, the time delay should be set to allow for breaker operating time plus margin.

NOTE: These screens are also applicable for Windings 2, 3 and 4.

NOTE: Winding Four is not available in Two or Three Winding applications.

**Figure 4-36** IPScom® (50BF) Breaker Failure Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/50BF Breaker Failure

**COMMAND BUTTONS**

Save Saves all information to the relay.

Cancel Returns the user to the previous window; any changes to the displayed information are lost.
50/50G Instantaneous Overcurrent, Phase & Ground

The Instantaneous phase 50 and Instantaneous Ground 50G overcurrent functions provide fast tripping for high fault currents. The settings of both functions must be set such that they will not pickup for faults or conditions outside the immediate protective zone. Two overcurrent elements are available on Windings 2, 3 and 4 for 50G. The phase overcurrent elements (50) operate when any individual Phase A, B or C current exceeds the pickup. These elements also allow the user to program several logic schemes described in Section 4.5, System Application and Logic Schemes.

- **50#1 PICKUP**
  - Sets ground pickup for instantaneous phase overcurrent element.
  
  - **1.00 Amps**

- **50#1 CURRENT SELECTION**
  - sets the current input for instantaneous phase overcurrent element.
  
  - **sum1 sum2 w1 w2 w3 w4**

- **50#1 DELAY**
  - Sets delay for instantaneous phase overcurrent element.
  
  - **30 Cycles**

**NOTE:** These screens are the same for 50#2 thru 50#8.

- **50GW2#1 PICKUP**
  - Sets ground pickup for instantaneous phase overcurrent element.
  
  - **1.00 Amps**

- **50GW2#1 DELAY**
  - Sets delay for instantaneous ground overcurrent element.
  
  - **30 Cycles**

- **50GW2#2 PICKUP**
  - Sets ground pickup for instantaneous ground overcurrent element.
  
  - **1.00 Amps**

- **50GW2#2 DELAY**
  - Sets delay for instantaneous ground overcurrent element.
  
  - **30 Cycles**

**NOTE:** These screens are also applicable for Windings 3 and 4 (Function 50G).

- **NOTE:** 50 Phase Instantaneous Overcurrent Elements #7 and #8 are not available in Two or Three Winding applications.

- **NOTE:** Winding Four is not available in Two or Three Winding applications.
**NOTE:** Elements #7 and #8 are not available in Two or Three Winding applications.

*Figure 4-37  IPScom® (50) Instantaneous Phase Overcurrent Setpoint Ranges*

Path: Relay/Setup/Relay Setpoints/50 Instantaneous Phase Overcurrent

**COMMAND BUTTONS**
- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.

**NOTE:** Winding Four is not available in Two or Three Winding applications.

*Figure 4-38  IPScom (50G) Instantaneous Ground Overcurrent Setpoint Ranges*

Path: Relay/Setup/Relay Setpoints/50G Instantaneous Ground Overcurrent

**COMMAND BUTTONS**
- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
50N Instantaneous Residual Overcurrent

The Instantaneous Residual (50N) overcurrent function provides fast tripping for high fault currents. Settings must be made in such a way as to prevent pickup for fault or conditions outside the immediate protective zone.

**NOTE:** Instantaneous Residual Overcurrent Elements #7 and #8 are not available in Two or Three Winding applications.

<table>
<thead>
<tr>
<th>50N#1 PICKUP</th>
<th>1.00 Amps</th>
<th>Sets pickup for instantaneous residual overcurrent. This element operates on $I_0$.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50N#1 CURRENT SELECTION</td>
<td>sum1 sum2 w1 w2 w3 w4</td>
<td>Sets current input for instantaneous overcurrent.</td>
</tr>
<tr>
<td>50N#1 DELAY</td>
<td>30 Cycles</td>
<td>Sets delay for instantaneous residual overcurrent.</td>
</tr>
</tbody>
</table>

**NOTE:** These screens are also applicable for 50N#2 through 50N#8.

**Figure 4-39** IPScom®(50N) Instantaneous Residual Overcurrent Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/50N Instantaneous Residual Overcurrent

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
**51 Inverse Time Phase Overcurrent**

The 51 Inverse Time Phase Overcurrent function, one set per winding are used to trip circuits selectively and to time coordinate with up or down stream relays. For this function, eleven complete series of inverse time tripping characteristics are included. The eight curve families to be chosen are definite, inverse, very inverse, extremely inverse, four IEC curves and three IEEE curves. The time dial within each family setting and tap setting is selected through the relay menu.

The curves available for use are shown in Appendix D, *Inverse Time Curves*, Figures D-5 through D-15. They cover a range from 1.5 to 20 times the tap. For currents beyond 20 times the pickup setting, the relay operating time will remain the same as the time at 20 times pickup setting.

**Sets phase current pickup for 51W1.**

**Selects one of the eleven inverse time curves as shown in Appendix D, Figures D-5 through D-15.**

**The appropriate curve in the selected family of curves is chosen here.**

**Sets current input for inverse time overcurrent.**

**NOTE:** These screens are also applicable for 51#2 through 51#4.

**NOTE:** Inverse Time Phase Overcurrent Element #4 is not available in Two and Three Winding applications.

---

**Figure 4-40 IPScom® (51) Inverse Time Phase Overcurrent Setpoint Ranges**

**Path:** Relay/Setup/Relay Setpoints/51 Inverse Time Phase Overcurrent

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
51N Inverse Time Residual Overcurrent

The 51 Inverse Time Residual Overcurrent provides protection against ground faults. Since normal residual current is usually much lower than the full load phase current, this function can be set more sensitively than the phase overcurrent protection.

Sets phase current pickup for 51N#1. This element operates on $I_o$.

Selects one of the eleven inverse time curves, as shown in Appendix D, Figures D-5 through D-15.

The appropriate curve in the selected family of curves is chosen here.

Sets current input for inverse time residual overcurrent.

**NOTE:** These screens are also applicable for 51N#2, 3 and 4.

**NOTE:** Inverse Time Residual Current Element #4 is not available in Two or Three Winding applications.

Figure 4-41  IPScom® (51N) Inverse Time Residual Overcurrent Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/51N Inverse Time Residual Overcurrent

**COMMAND BUTTONS**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Save</td>
<td>Saves all information to the relay.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Returns the user to the previous window; any changes to the displayed information are lost.</td>
</tr>
</tbody>
</table>
**51G Inverse Time Ground Overcurrent**

The 51G Inverse Time Ground Overcurrent function is used to trip circuits selectively and to time coordinate with up or downstream relays. For this function, eleven complete series of inverse time neutral tripping characteristics are included. The four curve families to be chosen are definite, inverse, very inverse, extremely inverse, four IEC and three IEEE curves. The operator selects the time dial within each family setting and tap setting through the relay menu.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>51GW2 PICKUP</strong></td>
<td>Sets residual pickup for 51G.</td>
</tr>
<tr>
<td>1.00 Amps</td>
<td></td>
</tr>
<tr>
<td><strong>51GW2 CURVE</strong></td>
<td>Selects one of the eleven inverse time curves, as shown in Appendix D, Inverse Time Curves, Figures D-5 through D-15.</td>
</tr>
<tr>
<td>BEDEF beinv bevinv beinv</td>
<td></td>
</tr>
<tr>
<td><strong>51GW2 TIME DIAL</strong></td>
<td>The appropriate curve in the selected family of curves is chosen here.</td>
</tr>
<tr>
<td>5.0</td>
<td></td>
</tr>
</tbody>
</table>

| NOTE: | These screens are also applicable for Windings 3 and 4. |

| NOTE: | Winding Four is not available in Two or Three Winding Applications. |

The curves available for use are shown in Appendix D, Inverse Time Curves, Figures D-5 through D-15. They cover a range from 1.5 to 20 times the tap. For currents beyond 20 times the pickup setting, the relay operating time will remain the same as the time at 20 times pickup setting.

**Figure 4-42**  IPScom®(51G) Inverse Time Ground Overcurrent Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/51G Inverse Time Ground Overcurrent

**COMMAND BUTTONS**

<table>
<thead>
<tr>
<th>Button</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Save</strong></td>
<td>Saves all information to the relay.</td>
</tr>
<tr>
<td><strong>Cancel</strong></td>
<td>Returns the user to the previous window; any changes to the displayed information are lost.</td>
</tr>
</tbody>
</table>
59 Phase Overvoltage (2/3 Winding)
The 59 Phase Overvoltage function may be used to provide overvoltage protection for the transformer. Transformers should not be exposed to long periods of overvoltage. If a transformer is operated about 110 percent rated voltage the exciting current becomes very high and can damage the windings. Overvoltage is most likely to occur for step-up units when the generator is brought online or removed from service.

59#1 INPUT VOLTAGE SEL.
PHASE_VOLT pos_seq_volt

59#1 PICKUP
132 Volts

59#1 DELAY
30 Cycles

NOTE: 59#2 and 59#3 screens are identical to 59#1.

The relay provides overvoltage protection functions with three voltage levels and three definite-time setpoints, any one or more of which can be programmed to trip the unit or send an alarm. This is true 3-phase function in that each phase has an independent timing element. Each 59 element can be programmed to use phase voltage (any one of the three phases), positive-sequence voltage, or negative-sequence voltage as the input.

The magnitude calculation is accurate near 50 or 60 Hz and the timer accuracy is ±1 cycle. When the input voltage select is set to positive-sequence voltage or negative-sequence voltage, the 59 functions use the DFT to measure the sequence voltage. Ranges and increments are presented in Figure 4-43.

Figure 4-43  IPScom®(59) Phase Overvoltage Setpoint Ranges (2/3 Winding)

Path: Relay/Setup/Relay Setpoints/59 Phase Overvoltage

COMMAND BUTTONS
Save  Saves all information to the relay.
Cancel  Returns the user to the previous window; any changes to the displayed information are lost.
59G Ground Overvoltage

**NOTE:** Two or Four voltage inputs are available for the M-3311A. The voltage input can be a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable.

Sets voltage pickup for ground overvoltage.

Sets delay for ground overvoltage.

Sets voltage pickup for ground overvoltage.

Sets delay for ground overvoltage.

Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.

The 59G Ground Overvoltage function provides protection for ground faults on the system.

Pickup setting for 59G should be set in such a way that it is higher than normal neutral voltage during unbalanced conditions. The time delay should be set to coordinate with downstream ground relaying.

**NOTE:** The above screens are for Four Winding applications, for two and three winding applications the screens for element number 3 are the same.

4 Winding

Sets voltage pickup for ground overvoltage.

Sets delay for ground overvoltage.

Sets voltage pickup for ground overvoltage.

Sets delay for ground overvoltage.

The 59G Ground Overvoltage function provides protection for ground faults on the system. Pickup setting for 59G should be set in such a way that it is higher than normal neutral voltage during unbalanced conditions. The time delay should be set to coordinate with downstream ground relaying.

**NOTE:** The above screens are for Four Winding applications, for two and three winding applications the screens for element number 3 are the same.
59G Ground Overvoltage (2/3 Winding)
Zero Sequence Voltage Selection

This setting determines the operating quantity of the 59G Overvoltage elements. This applies to all three 59G elements.

This setting will operate properly only for a 2/3 winding, 4 voltage input configuration. When 3V₀ is selected, the operating quantity is the Zero Sequence Voltage (V₀) also known as the residual voltage. V₀ is the calculated zero sequence voltage from the measured quantities of Vₐ, Vₐ, Vₖ. Basically 59G becomes 59N. When V₉ is selected, the operating quantity is the measured voltage at the V₉ terminals of the M-3311A relay.

**NOTE:** This setting is only functional with firmware version V02.03.01 and later.

![Figure 4-45 IPScom® (59G) Ground Overvoltage Setpoint Ranges (2/3 Winding)](image)

Path: Relay/Setup/Relay Setpoints/59G Ground Overvoltage

**COMMAND BUTTONS**

- **Save**  Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
81O/U Over/Underfrequency

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>81#1 PICKUP</td>
<td>55.00 Hz</td>
</tr>
<tr>
<td>81#1 DELAY</td>
<td>30 Cycles</td>
</tr>
<tr>
<td>81#2 PICKUP</td>
<td>55.00 Hz</td>
</tr>
<tr>
<td>81#2 DELAY</td>
<td>30 Cycles</td>
</tr>
<tr>
<td>81#3 PICKUP</td>
<td>55.00 Hz</td>
</tr>
<tr>
<td>81#3 DELAY</td>
<td>30 Cycles</td>
</tr>
<tr>
<td>81#4 PICKUP</td>
<td>55.00 Hz</td>
</tr>
<tr>
<td>81#4 DELAY</td>
<td>30 Cycles</td>
</tr>
</tbody>
</table>

The pickup and time delay setting for load shedding should be selected based on load frequency characteristics of the system.

A minimum time delay of 6 cycles is recommended to prevent relay operation during switching transients.

The 81O/U Over/Underfrequency function provides protection against abnormal frequency. The Underfrequency function is typically used for load shedding applications. The frequency functions are automatically disabled when the input voltage is less than 5 volts.

When the frequency setpoint is selected as below the nominal frequency, the function operates as an underfrequency, otherwise, it operates as an overfrequency function.

Two or Four voltage inputs are available for the M-3311A. The Voltage Input can be a phase voltage input or voltage generated from a broken delta VT connection. 81O/U, 27, and 24 Functions are only available if the voltage input is connected to the phase voltage. If the voltage input is connected to phase voltage, Function 59G will be unavailable. Function 59G is only available if the voltage input is connected to a broken delta VT. If voltage input is connected to broken delta VT, Functions 81O/U, 27, and 24 will be unavailable.
IPScom® (81O/U) Over/Underfrequency Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/81 Over/Under Frequency

**COMMAND BUTTONS**

**Save** Saves all information to the relay.

**Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
87 Phase Differential

87H Phase Differential Unrestrained High Set Overcurrent

The 87H Phase Differential Unrestrained High Set Overcurrent function is used to detect transformer internal winding faults with high currents. Unlike the 87T function, the 87H function is not blocked by harmonic restraint. The pickup for this function should be set above the worst case first peak of the inrush current. This prevents misoperation of the function due to magnetizing inrush current during switching on of the transformer. Typical pickup setting is between 8 to 12 PU. The per unit is based on the CT tap setting. The 87H is typically set with no intentional time delay (one cycle time delay setting corresponds to no intentional time delay).

87H PICKUP
20.0 PU

High-set pickup setting.

87H DELAY
2 Cycles

Figure 4-47  IPScom®(87T) Phase Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/87 Phase Differential Current

COMMAND BUTTONS

Save  Saves all information to the relay.

Cancel  Returns the user to the previous window; any changes to the displayed information are lost.
**Figure 4-48**  IPScom®(87H) Phase Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/87 Phase Differential Current

**COMMAND BUTTONS**

Save  Saves all information to the relay.

Cancel  Returns the user to the previous window; any changes to the displayed information are lost.

**Figure 4-49**  IPScom (C.T. Tap) Phase Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/87 Phase Differential Current

**COMMAND BUTTONS**

Save  Saves all information to the relay.

Cancel  Returns the user to the previous window; any changes to the displayed information are lost.

**NOTE:**  Winding Four is not available for selection in Two or Three Winding applications.
87 Phase Differential

**NOTE:** See Section 4.6, Transformer Connections for detailed discussion on transformer connection applications for 87 function differential.

87T Phase Differential Restricted Overcurrent

The 87T Phase Differential function is a percentage differential function with dual adjustable slope characteristics (see Figure 4-50). This function provides protection for the transformer from internal winding faults. This function offers sensitive differential protection at low fault currents and tolerates larger mismatch of currents that can occur during high through fault current for greater security.

The 87T minimum pickup setting should be set to prevent operation of the 87T function due to transformer excitation current. Typical setting is 0.2 to 0.4 PU of tap setting.

**Slope 1**

The setting of Slope #1 should be set according to various possible errors:

1. Tapchanger operations in the power transformer (worst case ± 10%).
2. CT mismatch due to ratio errors. Errors can be as high as ± 10%.

A typical Slope #1 setting of 30 to 40% prevents misoperation due to above errors.

**Slope 2**

For heavy faults outside the differential zone, CT saturation can occur. Factors such as residual magnetism in the CT core, CT characteristic mismatch and burden mismatch can contribute large differential currents during this condition. Slope #2 should be set higher than Slope #1. It can provide security against misoperation during high through fault currents. A typical Slope #2 setting is 60 to 100%.

**Even Harmonic Restraint**

Transformer magnetizing inrush currents contain significant amounts of 2nd and some 4th harmonic currents. This inrush can cause undesirable trips and delay putting a transformer into service. The even harmonic restraint keeps it from operating during a magnetizing inrush condition. Magnetizing inrush current is distinguishable from fault current by harmonic components. The M-3311A Transformer Protection Relay can be set to restrain if the level of even harmonic current is above a set percentage of fundamental.

The harmonic currents are calculated from the differential current in the windings. The amount of even harmonic current ($I_{d_{24}}$) in PU can be found by using the formula:

$$I_{d_{24}} = \sqrt{I_{d_2^2} + I_{d_4^2}}$$

Where $I_{d_2}$ and $I_{d_4}$ are second and fourth harmonic currents in PU, respectively.

The percentage of even harmonics is found by the ratio $\frac{l_{d_{24}}}{I_{ph}}$. If this ratio is greater than the even harmonic restraint setpoint then 87T is restrained from operating. The equation below illustrates how the restraint works for A-Phase:

$$I_{d_{24}} > \text{Even Harmonic Restraint Setpoint} \times \left| I_{AW1} + I_{AW2} + I_{AW3} + I_{AW4} \right|$$

The amount of even harmonics present in the transformer inrush currents depends upon the magnetization characteristics of the transformer core and residual magnetism present in the core. A setting in the range of 10 to 15% can provide security against misoperations during magnetizing inrush conditions.

Modern transformers tend to have low core losses and very steep magnetizing characteristics. When the relay is applied to this type of transformers, the even harmonic setting should be set around 10% (in some cases, the setting may be lower than 10%). Older transformer designs tend to have higher amounts of even harmonics, where a setting of 15% or greater can provide security against misoperation during magnetizing inrush conditions.

The setting of the even harmonic restraint should be set to a low enough value to provide security against misoperation during transformer magnetizing inrush current and it should not be lower than the amount of even harmonics generated during internal fault conditions with CT saturation so as not to compromise reliability for heavy internal fault detection.

**Fifth Harmonic Restraint**

Transformer over-excitation produces a high amount of excitation current, which will appear as a differential current to the 87T function. The Fifth Harmonic restraint function can prevent misoperation of the 87T function by shifting the minimum pickup to a higher value (typically set at 150 to 200% of 87T minimum pickup), during transformer over-excitation conditions.

The over-excitation condition is detected by the presence of Fifth Harmonic component as a percentage of fundamental component of differential current above a set value.

The amount of Fifth Harmonic depends on the transformer core magnetizing characteristics. A setting of 30% is adequate to discriminate over-excitation from other conditions.
Figure 4-50  87T Programmable Dual Slope Percentage Restraint Characteristic
Cross Phase Averaging

Cross phase averaging is used to average the harmonics of all three phases to provide restraint of phases which may not have enough harmonics. Cross phase average, when enabled, provides security against misoperation during magnetizing inrush. However, it may slightly delay the relay operation for internal faults. The level of cross phase average current may be found using the following equations.

Even Harmonic Cross Phase Average:
\[ I_{dCPA24} = \sqrt{I_{d24}^2 + I_{b24}^2 + I_{c24}^2} \]

Fifth Harmonic Cross Phase Average:
\[ I_{dCPA5} = \sqrt{I_{d5}^2 + I_{b5}^2 + I_{c5}^2} \]

When enabled, the above averages are used along with fundamental component of differential current in each of the phases to calculate the harmonic percentages.

It is recommended to enable the cross phase average for even harmonic restraint, and disable the cross phase average for 5th harmonic restraint.

87T CT Tap Settings

The 87TW1, W2, W3 and W4 CT tap settings are used to convert the W1, W2, W3 and W4 current in terms of PU. These settings are provided to compensate for CT ratio mismatch for 87T and 87H functions. The example calculation is for a three winding application. These should be calculated as follows:

\[ 87T \text{ CT Tap Settings For } W1, W2, W3 \text{ and } W4 \]

\[ 87 \text{ CT Tap}_{WN} = \frac{\text{MVA} \times 10^{3}}{\sqrt{3} \times \text{kVL-L} \times \text{CTR}_{WN}} \]

where \( WN \) is the winding number.

CT Tap Setting Calculation Example

Based on the transformer example in Figure 4-51, the CT tap calculations are presented below.

Since the \( \sqrt{3} \) magnitude compensation for Delta connected CT’s is already taken into account in the relay calculation, the same equation is used to calculate each CT Tap setting.

\[ 87 \text{ CT Tap}_{W1} = \frac{392.8 \text{ MVA} \times 10^{3}}{\sqrt{3} \times 17.1 \text{ kV} \times 1600} = 8.29 \]

\[ 87 \text{ CT Tap}_{W2} = \frac{392.8 \text{ MVA} \times 10^{3}}{\sqrt{3} \times 17.1 \text{ kV} \times 1600} = 8.29 \]

\[ 87 \text{ CT Tap}_{W3} = \frac{392.8 \text{ MVA} \times 10^{3}}{\sqrt{3} \times 161 \text{ kV} \times 400} = 3.52 \]

**NOTE:** Winding Four is not available for selection in Two or Three Winding applications.

Transformer Rating

392.8 MVA / 196.4 MVA / 196.4 MVA
161 kV / 17.1 kV / 17.1 kV

![Figure 4-51 Transformer CT Tap Setting Example](image-url)
See previous pages for more information on these settings.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>87T PICKUP</td>
<td>0.50 PU</td>
</tr>
<tr>
<td>87T SLOPE #1</td>
<td>25%</td>
</tr>
<tr>
<td>87T SLOPE #2</td>
<td>75%</td>
</tr>
<tr>
<td>87T SLOPE BREAKPOINT</td>
<td>2.0 PU</td>
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<tr>
<td>87T EVEN RESTRAINT</td>
<td>disable enable CROSS_AVG</td>
</tr>
<tr>
<td>87T 5TH RESTRAINT</td>
<td>disable enable CROSS_AVG</td>
</tr>
<tr>
<td>87T PICKUP@5TH RESTRAINT</td>
<td>0.75 PU</td>
</tr>
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<td>87 W1 C.T.TAP</td>
<td>1.00</td>
</tr>
<tr>
<td>87 W2 C.T. TAP</td>
<td>1.00</td>
</tr>
<tr>
<td>87 W3 C.T. TAP</td>
<td>1.00</td>
</tr>
<tr>
<td>87 W4 C.T. TAP</td>
<td>1.00</td>
</tr>
</tbody>
</table>
87GD Ground Differential

**NOTE:** This function is not provided on Winding One.

The 87GD ground differential element may provide sensitive ground fault protection on winding 2, 3 or winding 4.

The relay provides a CT Ratio Correction which removes the need for auxiliary CTs when the phase, winding 2, 3 or winding 4 and their ground CT ratios are different.

The directional element calculates the product \((-3I_0\cos f)\) for directional indication. The relay will operate only if \(I_G\) (zero sequence current derived from the phase CTs) and \(I_G\) (ground current from the Ground CT) have the opposite polarity, which is the case for internal transformer faults.

The advantage of directional element is that it provides security against ratio errors and CT saturation during faults external to the protected transformer.

The directional element is inoperative if the residual current \(3I_0\) is approximately less than 140 mA (approx., based on 5 A CT rating). For this case, the algorithm automatically disables the directional element and the 87GD function becomes non-directional differential. The pickup quantity is calculated as the difference between the corrected triple zero sequence current \((CTRCFX 3I_0)\) and the ground current \(I_G\). The magnitude of the difference \((CTRCF X 3I_0 - I_G)\) is compared to the function pickup setting.

In order to use the 87GD function, Winding 2, 3 and Winding 4 CTs must be connected wye.

The 87GD function is automatically disabled if the ground current is less than 200 mA (based on a 5 A rating).

For security purposes during external phase fault currents causing CT saturation, this function is disabled any time the value of \(I_G\) is less than approximately 0.20 amps.

**NOTE:** Winding Four is not available for Two or Three Winding applications.

**NOTE:** For higher values of CT Ratio correction, noise may create substantial differential current making higher settings desirable.

**CAUTION:** DO NOT set the Delay to less than 2 cycles. In order to prevent mis-operation during external faults with CT saturation conditions, a time delay of 6 cycles or higher is recommended.

CT (CTRCF) Ratio Correction Factor = \(\frac{\text{Phase C.T. Ratio}}{\text{Ground C.T. Ratio}}\)

**NOTE:** These screens are also applicable for Windings 3 and 4.
NOTE: Winding Four is not available for Two or Three Winding applications.

Figure 4-52 IPScom® (87GD) Ground Differential Current Setpoint Ranges

Path: Relay/Setup/Relay Setpoints/87GD Ground Differential current

COMMAND BUTTONS
Save Saves all information to the relay.
Cancel Returns the user to the previous window; any changes to the displayed information are lost.
TCM (Trip Circuit Monitoring) Aux Input

External connections for the Trip Circuit Monitoring function are shown in Figure 4-53. The default Trip Circuit Monitor input voltage is 250 V dc. See Section 5.5, Circuit Board Switches and Jumpers, Table 5-3 for other available trip circuit input voltage selections.

This function should be programmed to block when the breaker is open, as indicated by 52b contact input (IN1). If the TCM is monitoring a lockout relay, a 86 contact input (INx) should be used to block when the lockout relay is tripped.

When the Output Contact is open, and continuity exists in the Trip Circuit, a small current flows that activates the Trip Circuit Monitoring Input. If the Trip Circuit is open, and the output contact is open, no current flows and the Trip Circuit Monitoring Input is deactivated. An Output Contact that is welded closed would also cause the Trip Circuit Monitoring Input to deactivate, indicating failure of the Output Contact.

When the Output Contact is closed, no current flows in the Trip Circuit Monitoring Input. If the M-3311A has issued a trip command to close the Output Contact and Trip Circuit Monitoring Input remains activated, this is an indication that the Output Contact failed to close.

The output of the Trip Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

![Figure 4-53 Trip Circuit Monitoring Input](image)

![Figure 4-54 Trip Circuit Monitor (2/3 Winding Aux Input) Setpoint Ranges](image)
TCM (TRIP CIRCUIT MONITOR) EXPANDED I/O

The TCM inputs are provided for monitoring the continuity of the trip circuits (Figure 4-55). The inputs can be used for nominal trip coil voltages of 24 Vdc to 250 Vdc. Trip circuit monitoring is performed in the active breaker status only. Both the DC supply and continuity for the trip circuit is monitored. If a trip coil is detected as being open for the time delay then the selected Output(s) are set.

External connections for the Trip Circuit Monitoring function are shown in Figures 5-8 through 5-28. The default Trip Circuit Monitor input voltage is 250 Vdc. See Section 5.5, Circuit Board Switches and Jumpers, (Table 5-3 for TCM#1, Table 5-5 for TCM#2) for other available trip circuit input voltage selections.

When the Output Contact is open, and continuity exists in the Trip Circuit, a small current flows that activates the Trip Circuit Monitoring Input. If the Trip Circuit is open, and the output contact is open, no current flows and the Trip Circuit Monitoring Input is deactivated. An Output Contact that is welded closed would cause the Trip Circuit Monitoring Input to deactivate, indicating failure of the Output Contact.

When the Output Contact is closed, no current flows in the Trip Circuit Monitoring Input. If the M-3311A closes the Output Contact and Trip Circuit Monitoring Input remains activated, this is an indication that the Output Contact failed to close. This function is blocked when the breaker is open, as indicated by 52b contact input (IN1). If the TCM is monitoring a lockout relay, a 86 contact input (INx) should be used to block when the lockout relay is tripped. This function is also blocked when any output contact is closed.

The output of the Trip Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

The M-3311A will illuminate the appropriate alarm LED on the unit front panel when all of the following conditions exist:

- The M-3311A TCM is connected to the target trip coil circuit.
- An open condition has been detected in the trip coil circuit for the duration of the Time Delay.

NOTE: The TCM circuit is designed to ensure that continuity exists in the circuit, by monitoring the connection for the presence of a small amount of current. If there is no physical connection to the circuit, the TCM alarm LED will illuminate, regardless of whether the TCM protective function is disabled in the relay.

Figure 4-56 displays the settings for the TCM function for Expanded I/O (TCM-1 and TCM-2) and Figure 4-54 for Non-Expanded I/O units (TCM-1 via Aux Input).

Enable/Disable — The top right corner of the display includes a command button that will disable or enable the function. This selection allows the TCM #1 to be disabled (or enabled) independent from the TCM #2.

TCM DELAY
30 Cycles

![Figure 4-55 Trip Circuit Monitoring Input](image-url)
### Trip/Close Circuit Monitor Setpoint Ranges

**Path:** Relay/Setup/Relay Setpoints/TCM/CCM

**TCM #1**
- **Delay:** 30
- **Drop Delay:** 30
- **Outputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
- **Blocking Inputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16

**TCM #2**
- **Delay:** 30
- **Drop Delay:** 30
- **Outputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
- **Blocking Inputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16

**CCM #1**
- **Delay:** 30
- **Drop Delay:** 30
- **Outputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
- **Blocking Inputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16

**CCM #2**
- **Delay:** 30
- **Drop Delay:** 30
- **Outputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
- **Blocking Inputs:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16

**Save/Cancel** — The Save selection saves the TCM Function Dialog Screen settings either to an open file or to the target M-3311A. Cancel, returns the user to the previous open screen.

**Time Delay** — A Time Delay can be applied to delay the TCM function output.

**Dropout Time Delay** — A Time Delay can be applied to delay the reset of the TCM function output.

**I/O Selection** — The I/O Selection allows any input to be selected to block the TCM. The TCM #1(2) Function can also be used to activate a selected Output when it times out.
CCM (CLOSE CIRCUIT MONITOR)

Figure 4-56 displays the settings for the CCM function. The settings for the CCM #2 Close Circuit Monitor are the same as the CCM #1.

The CCM inputs are provided for monitoring the continuity of the close circuits. The inputs can be used for nominal close coil voltages of 24 V dc to 250 V dc. Close circuit monitoring is performed in the active breaker status only. Both the DC supply and continuity for the close circuit is monitored. If a close coil is detected as being open for the time delay then transfers are blocked.

The M-3311A Close Coil Monitor will illuminate the appropriate alarm LED on the unit front panel when all of the following conditions exist:

- The M-3311A CCM is connected to the target close coil circuit.
- An open condition has been detected in the close coil circuit for the duration of the Time Delay.

**NOTE:** The CCM circuit is designed to ensure that continuity exists in the circuit, by monitoring the connection for the presence of a small amount of current. If there is no physical connection to the circuit, the CCM alarm LED will illuminate, regardless of whether the CCM protective function is disabled in the relay.

The close coil circuit open detection circuit will illuminate the alarm LED even when the M-3311A is not physically connected to the close coil circuit. When the M-3311A is not connected to the close coil circuit, then the appropriate CCM alarm LED on the unit front panel should be labeled as necessary to identify the alarm as not valid.

This function is blocked when the breaker is open, as indicated by 52b Contact Input (IN1). If the CCM is monitoring a lockout relay, a 86 Contact Input (INx) should be used to block when the lockout relay is tripped. This function is also blocked when any output contact is closed.

The output of the Close Circuit Monitoring function can be programmed as an alarm to alert maintenance personnel.

**CCM Connection Considerations** — External connections for the Close Circuit Monitoring function are shown in Figures 4-57, 4-58 and Figures 5-8 through 5-28.

The default Close Circuit Monitor input voltage is 250 V dc. See Section 5.5, **Circuit Board Switches and Jumpers**, (Table 5-4 for CCM#1, Table 5-6 for CCM#2) for other available close circuit input voltage selections.

Beckwith Electric Co., Inc. recommends that the M-3311A CCM circuit be connected directly to the close coil, bypassing the anti-pump “Y” relay portion of the close circuit as illustrated in Figure 4-57.

The type of anti-pump “Y” relay that is often found within the close coil circuit is generally a high impedance type, such as an IDEC RR Series Power Relay. The relay coil resistance is high (approximately 8.5 to 10K Ohms), and it’s rated pickup current is 11 to 13 mA, ± 15% at 20° C. However, the relay’s dropout voltage is approximately 10 to 15% of rated 110 V dc voltage. Therefore, the anti-pump relay may be held up and would not drop out until the leakage current is reduced to approximately 2 mA.

▲ **CAUTION:** Connecting the M-3311A Close Coil Monitor (CCM) in parallel with other relay CCMs in the close coil circuit where the anti-pump “Y” relay is not bypassed may not provide reliable breaker closing operations.

If the close coil circuit configuration does not support connecting the CCM directly to the close coil (Figure 4-58), then Beckwith Electric Co., Inc. does not recommend connecting the M-3311A CCM in parallel with other relay CCMs. If two or more CCMs are connected to the close coil circuit, there is a high probability that the anti-pump “Y” coil will not drop out. Therefore, only one CCM, either a M-3311A or other relay should be used in the close coil circuit to provide reliable breaker closing operation.

**Enable/Disable** — The top right corner of the display includes a command button that will disable or enable the function. This selection allows the CCM #1 (Close Circuit Monitor) to be disabled (or enabled) independent from the CCM #2.

**Time Delay** — A Time Delay can be applied to delay the CCM (Close Circuit Monitor) function output.

**Dropout Time Delay** — A Time Delay can be applied to delay the reset of the CCM (Close Circuit Monitor) function output.

**I/O Selection** — I/O Selection allows any input to be selected to block the CCM. The CCM #1 Function can also be used to activate a selected output when it times out.

**Save/Cancel** — The Save selection saves the CCM Function Dialog Screen settings either to an open file or to the target M-3311A. Cancel, returns the user to the previous open screen.
Anti-pump relay prevents reclosing on a sustained close command.

A spring charge limit switch shown with breaker closing spring discharged.

Latch check switch, closed when latch is reset.

Figure 4-57 Recommended Close Circuit Monitoring Input Configuration
Figure 4-58  Close Circuit Monitoring Input Configuration with Anti-pump Relay Not Bypassed

Legend

- Anti-pump relay prevents reclosing on a sustained close command.
- A spring charge limit switch shown with breaker closing spring discharged.
- Latch check switch, closed when latch is reset.
**Breaker Monitoring**

The Breaker Monitoring feature calculates an estimate of the per-phase wear on the breaker contacts by measuring and integrating the current or current squared passing through the breaker contacts during the interruption period. The per-phase values are added to an accumulated total for each phase, and then compared to a user-programmed threshold value. When the threshold is exceeded in any phase, the relay can set a programmable output contact. The accumulated value for each phase can be displayed as an actual value. The integration starts after a set time delay from the initiate point to account for the time it takes for the breaker to start opening its contacts. The integration continues until the current drops below 0.1 PU or 10 cycles, whichever occurs first.

**NOTE:** Winding Four is not available in Two or Three Winding applications.

**BRKRW1 PICKUP**
1000 kA^2-cycles

**BRKRW1 INPUT INITIATE**
i6 i5 i4 i3 i2 i1

**BRKRW1 OUTPUT INITIATE**
08 07 06 05 04 03 02 01

**BRKRW1 DELAY**
10.0 Cycles

**BRKRW1 TIMING METHOD**
it i2t

Pickup setting for BM W1.

Time delay until breaker contacts start to open.

Selects integration timing method. (IT or I^2T)

**NOTE:** These screens are also applicable for BRKRW2, W3 and W4.

**Figure 4-59  IPScom® Breaker Monitor Setpoint Ranges**

**Path:** Relay/Setup/Relay Setpoints/BM Breaker Monitor

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
Through Fault

The Through Fault Monitor feature of the relay provides the user with the means to capture time-stamped Through Fault current information. A “through fault” is defined as an overcurrent event where the overcurrent passes through a transformer and supplies a connected circuit that is faulted. Power transformers may be subjected to Through Fault currents, which can cause mechanical stresses and thermal stress to winding insulation.

The Through Fault monitor data can be used to predict transformer failures facilitating corrective action. Recording the number and severity of Through Faults experienced by a transformer can aid in determining predictive maintenance practices.

The Through Fault monitor is triggered when current in any one of the phases exceeds the set value of the Through Fault Current Threshold for greater than the Time Delay setting.

**NOTE:** Winding Four is not available in Two or Three Winding applications.

### TF: Through Fault

- **THFLT CURRENT THRESHOLD**: 10 Amps
- **THFLT CUM. I^2T LIMIT**: 100 kA^2-cycles
- **THFLT PU OPERATIONS LIM.**: 5 Records
- **THFLT CURRENT SELECT**: sum1 sum2 w1 w2 w3 w4
- **THFLT DELAY**: 30 Cycles

The Through Fault Threshold value is chosen to be above the maximum expected load current and below the minimum expected Through Fault current.

The Through Fault Current Limit and I^2t Threshold Limits are set based on the capability of the transformer. The transformer manufacturer may be consulted for guidance.

The Through Fault Time Delay is typically set at one Cycle.

**NOTE:** Winding Four is not available in Two or Three Winding applications.

*Figure 4-60  IPScom® Through Fault Function Setpoint Ranges*

**Path:** Path: Relay/Setup/Relay Setpoints/Through Fault
IPSlogic
The relay provides six IPSlogic Functions. IPSlogic Functions can be used to allow external devices to trip through the relay, providing additional target information for the external device. More importantly, these functions can be used in conjunction with IPSlogic to expand the capability of the relay by allowing the user to define customized operating logic.

Settings applicable when this function is enabled using the HMI:

**IPS#1 INPUT INITIATE**

\[i_6 \ i_5 \ i_4 \ i_3 \ i_2 \ i_1\]

**IPS#1 OUTPUT INITIATE**

\[o_8 \ o_7 \ o_6 \ o_5 \ o_4 \ o_3 \ o_2 \ o_1\]

**IPS#1 DELAY**

\[30 \text{ Cycles}\]

The initiating inputs are user designated for each enabled IPSlogic function. The activation of one or more of the external contacts will start operation of the IPSlogic function timer.

The initiating outputs can also be set to start the IPSlogic functions timer. This aids in setting up special logic schemes as the output contact does not have to be routed back to the input. This also saves inputs as well as speeds up the triggering process as the output contact delay and input de-bounce delay no longer enter the equation.

Each enabled IPSlogic function requires a time delay setting. Complete settings for each of the 5 remaining IPSlogic contacts (screens not shown).

**NOTE:** These screens are also applicable for IPSlogic Functions #2, 3, 4, 5, and 6.
The following is an example of how to program an IPSlogic function, when programming using the HMI (see Figure 4-61):

- Initiating inputs are IN2 or IN5
- Initiating output is OUT4
- Blocking input is IN3
- IPSlogic function output is OUT6
- Time Delay of 30 cycles

The only logical limitation is that the same status input cannot be designated as both an initiating input and a blocking input. The connection for the external device to the input contacts is illustrated in Chapter 5, Figure 5-5, M-3311A External Connections, and Chapter 6, Table 6-2, Input Contacts.

![IPSlogic Function Setup](image-url)
Settings and Logic Applicable when IPSlogic Function(s) programmed using IPScom®

There are four initiating input sources: Initiating Outputs, Initiating Function Trips (including the IPSlogic Functions themselves), Initiating Inputs, and initiation using the Communication Port. The only limitation is that an IPSlogic Function may not be used to initiate itself. There are two blocking input sources: Blocking Inputs and blocking using the Communication Port.

The IPScom IPSlogic Function programming screen and Initializing Function Trip Selection screens are shown in Figure 4-62, 4-63 and 4-64, respectively.

The activation state of the input function selected in the Initiating Function Trip dialog (Figure 4-62) is the Tripped state, not Pickup. If the user requires an initiating input that indicates a Pickup status, this can be achieved. Since most functions have multiple setpoints, the second setpoint can be set with no intentional time delay and used as the initiating input. The desired time delay for security considerations can be obtained in the IPSlogic Function time delay setting.

The IPSlogic Function can be programmed to perform any or all of the following tasks:

- Change the Active Setting Profile
- Close an Output Contact
- Be activated for use as an input to another External Function

Since there are six IPSlogic Functions per setting profile, depending on the number of different relay settings defined, the scheme may provide up to 24 different logic schemes. The IPSlogic is illustrated in Figure 4-61, and the IPScom® IPSlogic Function Status programming screens are shown in Figures 4-62 and 4-63.

![Figure 4-62 IPScom® (IPS) IPSlogic Functions Setpoint Ranges](image)

**Path:** Relay/Setup/Relay Setpoints/IPSSlogic

**COMMAND BUTTONS**

- **Save** Saves all information to the relay.
- **Cancel** Returns the user to the previous window; any changes to the displayed information are lost.
### Figure 4-63  Select Initiating Functions Screen (2/3 Winding)

<table>
<thead>
<tr>
<th>Functions</th>
<th>24 DT #1</th>
<th>50 #4</th>
<th>50N #5</th>
<th>59G #2</th>
<th>TCM #2</th>
<th>24 DT #2</th>
<th>50 #5</th>
<th>50N #6</th>
<th>59G #3</th>
<th>81 #1</th>
<th>24 IT</th>
<th>50 #6</th>
<th>50N #1</th>
<th>59G #4</th>
<th>TCM #2</th>
</tr>
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<tbody>
<tr>
<td>27</td>
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</tr>
<tr>
<td>27 #1</td>
<td>50BF W1</td>
<td>51</td>
<td>51G W2</td>
<td>87H</td>
<td>87T</td>
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<td>51 #2</td>
<td>51G W3</td>
<td>87GD W2</td>
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<td>46 DT W2</td>
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<td>51 #4</td>
<td>51N W3</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 DT W2</td>
<td>50G W2 2</td>
<td>51 #5</td>
<td>51N W1</td>
<td>87GD W2</td>
<td>87GD W3</td>
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<td>51 #6</td>
<td>51N #2</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 IT W3</td>
<td>50G W2 #2</td>
<td>51 #7</td>
<td>51N #3</td>
<td>87GD W2</td>
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<td>50N #3</td>
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<td></td>
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<td>50N #5</td>
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<td></td>
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<td>50 #3</td>
<td>50N #6</td>
<td>59G #3</td>
<td></td>
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</tbody>
</table>

### Figure 4-64  Select Initiating Functions Screen (4 Winding)

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<thead>
<tr>
<th>Functions</th>
<th>24 DT #1</th>
<th>50 #4</th>
<th>50N #5</th>
<th>59G #2</th>
<th>TCM #2</th>
<th>24 DT #2</th>
<th>50 #5</th>
<th>50N #6</th>
<th>59G #3</th>
<th>81 #1</th>
<th>24 IT</th>
<th>50 #6</th>
<th>50N #1</th>
<th>59G #4</th>
<th>TCM #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
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</tr>
<tr>
<td>27 #1</td>
<td>50BF W1</td>
<td>51</td>
<td>51G W2</td>
<td>87H</td>
<td>87T</td>
<td>27 #2</td>
<td>50BF W2</td>
<td>51 #2</td>
<td>51G W3</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>27 #3</td>
<td>50BF W3</td>
<td>51 #3</td>
<td>87GD W2</td>
</tr>
<tr>
<td>46 DT W2</td>
<td>50G W2 1</td>
<td>51 #4</td>
<td>51N W3</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 DT W2</td>
<td>50G W2 2</td>
<td>51 #5</td>
<td>51N W1</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 DT W3</td>
<td>50G W2 #1</td>
<td>51N #1</td>
<td>87GD W2</td>
</tr>
<tr>
<td>46 IT W2</td>
<td>50G W2 2</td>
<td>51 #6</td>
<td>51N #2</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 IT W3</td>
<td>50G W2 #2</td>
<td>51 #7</td>
<td>51N #3</td>
<td>87GD W2</td>
<td>87GD W3</td>
<td>46 IT W3</td>
<td>50G W2 #3</td>
<td>51 #8</td>
<td>87GD W2</td>
</tr>
<tr>
<td>49</td>
<td>50N #1</td>
<td>59 #1</td>
<td>87 #1</td>
<td>87 #2</td>
<td>87T</td>
<td>50 #2</td>
<td>50N #2</td>
<td>59 #2</td>
<td>87 #3</td>
<td>87 #4</td>
<td>87 #5</td>
<td>50 #3</td>
<td>50N #3</td>
<td>59 #3</td>
<td>87 #6</td>
</tr>
<tr>
<td>50 #1</td>
<td>50N #4</td>
<td>59G #1</td>
<td></td>
<td></td>
<td></td>
<td>50 #2</td>
<td>50N #5</td>
<td>59G #2</td>
<td></td>
<td></td>
<td>50 #3</td>
<td>50N #6</td>
<td>59G #3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4–94
This section of IPSlogic initiates the EXT Function Output

This section of IPSlogic is used to activate the desired Output

This section of IPSlogic is used to block the IPSlogic Function Output

Programmed Profile Setting Group 1-4

Programmed Outputs 1-8

Log Target

EXT # N Activated

Programmed Time Delay

1 - 65,500 Cycles
1091 Sec.

Figure 4-65

IPStlogic® Function Setup

Initiating Outputs
Programmable Outputs 1-8
Selective AND/OR

Initiating Function Trip
Programmable Function(s) Tripped
Status Only
(Including External)
Selective AND/OR
Selective NOT

Initiating Inputs
Programmable Inputs 1-6
Selective AND/OR
Initiate Via Communication Point

Blocking Inputs
Selective AND/OR
Block Via Communication Point
Selective NOT
4.5 System Applications and Logic Schemes

Bus Fault Protection
Digital feeder and transformer protection logic can be combined together to provide high-speed bus fault protection. The 50W2 function will act as a delayed overcurrent detector (see Figure 4-66). A fault detected from any feeder relay will activate a programmable input on the relay. This input will block the 50W2 function from operating under normal feeder trip conditions. If a fault occurs on the bus connected to winding 2 and none of the feeder relays have tripped, the 50W2 function will then proceed to trip the breaker after the specified time delay.

Example
Function 50W2 #1 is programmed with the following I/O settings: trip Output #2, time delay setting of 7 cycles for proper coordination, and IN4 is set as a Blocking Input. This application requires no special logic. In this configuration all feeder relay output contacts will be in parallel on IN4.

![Bus Fault Protection Scheme](image_url)

Figure 4-66  Bus Fault Protection Scheme
Backup for Digital feeder Relay Failure

The M-3311A Transformer Protection Relay can provide backup for digital feeder relays (see Figures 4-67 and 4-68). The backup feature is initiated by the closure of a feeder relay’s self-test error contact. This scheme assumes that some sort of contact multiplying is done on the self-test outputs. A multiplied, normally open self-test contact can be paralleled with all feeder relays to initiate the backup feature.

Example

In this example, the Negative Sequence Overcurrent (46) Function is used to provide the backup protection. Use of the 46 Function allows for sensitive backup protection independent of the load current. If the 51 Function is used, it must be set to coordinate with the load current and results in less sensitive protection.

This application requires no special logic to implement. The scheme is enabled using the 46 Function basic settings through a user-selected control input, configured such that the 46 Function is blocked by an open contact. The parallel contacts from the feeder self-test are wired to that input (see Figure 4-68). The negative sequence function is set to coordinate with the downstream devices of the feeders on the protected bus.

With no feeder alarms, the paralleled self-test alarm contacts will all be open, and the Negative Sequence Overcurrent function blocked. When a feeder relay fails and its self-test contact closes, the Negative Sequence overcurrent function is enabled (unblocked), and the contact stream establishes a trip path to the failed relay breaker trip circuit. The Negative Sequence relay will then provide backup protection to the failed relay circuit.

![Figure 4-67 Digital Feeder Relay Backup Scheme](image-url)

![Figure 4-68 Feeder Backup Logic](image-url)
Load Shedding

Description

In stations where there are two or more transformers (see Figure 4-69), usually there is a normally open tie breaker on the secondary side. If one of the transformers is removed from the system, the tie breaker closes and the remaining transformers will pick up the entire load. To prevent the remaining transformer(s) from overloading, an overcurrent load shedding is used to remove some of the load if it exceeds a predefined level.

The IPSlogic functions can provide a cascading time delay feature that can be used for this load shedding configuration. The 52b contact is wired to a relay input, which is programmed to block the 50W2 Function. The output of the 50W2 Function is programmed to initiate the IPSlogic functions that are associated with the load shedding configuration. Each IPSlogic function output is used to trip a corresponding feeder load or initiate voltage reduction.

Example

The Function 50W2 #1 basic settings provide the first load shedding step. The tie CB 52b contact wired in parallel with the 52a contacts of the low side transformer breakers are programmed as a control input (IN2). They are configured such that the 50W2 #1 Function is blocked by the closed contacts. Closing of the Bus Tie Breaker (opens 52b contact) in conjunction with the opening of one of the low side breakers (opens a 52a contact) enables (unblocks) the 50W2 #1 function.

The 50W2 #1 is programmed to Output #2, providing the first load shedding step. Output #2 is programmed as an “Initiating Output” in the IPSlogic Function providing additional load shedding steps (See Figure 4-70). Each IPSlogic function is programmed with a different time delay setting.

![Figure 4-69 Two Bank Load Shedding Scheme](image-url)
Proposed Beckwith IPSlogic Load Shedding

This section of IPSlogic initiates the EXT Function Output

This section of IPSlogic is used to activate the desired Output

This section of IPSlogic is used to block the IPSlogic Function Output

Programmable Profile Setting Group 1-4

Programmed Outputs 1-8

Log Target

EXT # N Activated

Programmed Time Delay 1 - 65,500 Cycles 1091 Sec.
LTC Blocking During Faults

**Description**

The relay contains logic to block load Tapchangers from operating during feeder fault conditions (see Figure 4-71). Blocking LTC operation during feeder faults can prevent excessive tap changes, reduce contact wear and provide more predictable trip coordination. The blocking contact can be wired to the Auto Disable input (Beckwith M-2270B/M-2001C Tapchanger control, for example) or wired in series with the motor power for the Tapchanger.

**Example**

Function 50W1 #2 is programmed to trip on OUT7 with a pickup of 2X transformer nameplate rated current. The seal-in delay of OUT7 is programmed to 3000 cycles (50 seconds). The normally closed contact of OUT7 is wired to the Auto Disable input of a Beckwith Electric M-2270B/M-2001C Tapchanger control. This application requires no special logic.

![Figure 4-71  LTC Blocking Scheme During Faults](image-url)
4.6 Transformer Connections

Transformer Winding Selection
The M-3311A can be applied in either a two, three or four winding transformer differential application. For applications where a two or three winding differential is required, the user can set the relay system configuration for Two Winding and designate the winding current that will be disabled in the 87 Phase Differential Current function.

Only the current input to the 87 function of the disabled winding is not functional. All other functions associated with the disabled winding may be enabled if desired. If the application requires a separate overcurrent function, the user may enable the desired overcurrent functions.

Transformer and CT Configuration
The M-3311A includes Standard and Custom methods of defining the transformer winding and CT configurations. The Standard and Custom Configuration options are made available by selecting either Disable or Enable for the Custom Mode for Transformer and CT Connection.

Standard Transformer and CT Configuration
The standard transformer and CT configuration selections consist of six connections for each transformer winding and CT configuration. The selectable configurations are:

- Wye
- Delta-ab
- Delta-ac
- Inverse Wye
- Inverse Delta-ab
- Inverse Delta-ac

When the user selects from these connection combinations, the relay automatically computes the phase and magnitude compensation required for the differential currents. The general expression for the compensation is given below.

\[
\begin{pmatrix}
I_A^{\text{CompW}_n} \\
I_B^{\text{CompW}_n} \\
I_C^{\text{CompW}_n}
\end{pmatrix} = \text{Connect Type (WN)}
\begin{pmatrix}
I_A^{W_n} \\
I_B^{W_n} \\
I_C^{W_n}
\end{pmatrix}
\]

Where:
- \( I_A^{W_n}, I_B^{W_n}, \) and \( I_C^{W_n} \) are the uncompensated currents entering/exiting winding "n" of the transformer.
- \( I_A^{\text{CompW}_n}, \) etc. are the compensated phase currents after being multiplied by the 3x3 matrix ConnectType(N).
- The ConnectType(N) is a discrete number representing the number of 30 degree increments a balanced set of currents with abc phase rotation will be rotated in a counterclockwise rotation.

Types 0–11 correspond to phase shifts of 0°, 30°, 60°, ..., 330° with a magnitude gain of 1.

Types 13–23 correspond to phase shifts of 0°, 30°, 60°, ..., 330° with a magnitude gain of \( 1/\sqrt{3} \).

The compensation calculation uses a counter clockwise rotation from zero. Therefore a Delta-ab transformer (defined as 30 degree leading) has a compensation phase angle shift of 330°, \((11x30°)\). The Delta-ac transformer (defined as 30° lagging) has a compensation phase angle shift of 30°, \((1x30°)\). For a system with abc phase rotation, the compensation calculation uses a counterclockwise rotation. For users more familiar with the IEC transformer configuration nomenclature, a comparison between the IEC definitions and the Beckwith connections is provided in Table 4-4. An example of a ConnectType(1) or 30° compensation matrix is illustrated below.

\[
\begin{pmatrix}
I_A^{\text{CompW}_n} \\
I_B^{\text{CompW}_n} \\
I_C^{\text{CompW}_n}
\end{pmatrix} = 
\begin{pmatrix}
1 & -1 & 0 \\
0 & 1 & -1 \\
-1 & 0 & 1
\end{pmatrix}
\begin{pmatrix}
I_A^{W_n} \\
I_B^{W_n} \\
I_C^{W_n}
\end{pmatrix}
\]

Phase Angle Shift - Standard Connections
All inputs are compensated against a Reference Vector of zero degrees. The six standard connections referenced previously result in 6 compensation types for each transformer winding and 12 compensation types for each CT. The transformer compensation types are; 0, 1, 5, 6, 7, and 11, which correspond to 30 degree phase shift multiples of; 0°, 30°, 150°, 180°, 210°, and 330°, all with a gain of one.

The CT compensation types consist of those compensation types listed above and types 13, 17, 19, and 23. Type 13, 17, 19 and 23 correspond to 30 degree phase shift multiples of; 30°, 150°, 210° and 330°, but with a magnitude gain of \( 1/\sqrt{3} \).
<table>
<thead>
<tr>
<th>IEC Connection Description</th>
<th>Beckwith Standard Connection Description</th>
<th>Beckwith Custom Input Value</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yy0</td>
<td>YY</td>
<td>Y Y 0 0</td>
<td></td>
</tr>
<tr>
<td>Dd0</td>
<td>Dac Dac</td>
<td>Dac Dac 1 1</td>
<td></td>
</tr>
<tr>
<td>Yd1</td>
<td>Y Dac</td>
<td>Y Dac 0 1</td>
<td></td>
</tr>
<tr>
<td>Yd11</td>
<td>Y Dab</td>
<td>Y Dab 0 11</td>
<td></td>
</tr>
<tr>
<td>Dy1</td>
<td>Dab Y</td>
<td>Dab Y 11 0</td>
<td></td>
</tr>
<tr>
<td>Dy11</td>
<td>Dac Y</td>
<td>Dac Y 1 0</td>
<td></td>
</tr>
<tr>
<td>Yd5</td>
<td>Y Inverse Dab</td>
<td>Y Inverse Dab 0 5</td>
<td></td>
</tr>
<tr>
<td>Dy5</td>
<td>Dac Inverse Y</td>
<td>Dac Inverse Y 1 5</td>
<td></td>
</tr>
<tr>
<td>Dd10</td>
<td>Dac Dab</td>
<td>Dac Dab 1 11</td>
<td></td>
</tr>
<tr>
<td>Dz2</td>
<td>Dab Custom</td>
<td>Dab Wye 11 1</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-5  Transformer Connections
When the standard connection options are used, the transformer and CT phase angle shifts are combined and the ConnectType returns the correct combined phase angle shift. The MagnitudeCT will compensate for the $\sqrt{3}$ associated with delta connected CT's. The shift and magnitude compensation is defined in Table 4-6. Using a reference angle of zero degrees, the Phase A Winding phase angle shift is obtained as follows:

$$\text{ConnectType (W₁)} = \text{ConnectXfm (Type)} + \text{ConnectCT (Type)}$$

$$\text{MagnitudeCT (W₁)} = \text{ConnectCT (Type)}$$

Where:

ConnectXfm is the connection of any transformer winding

ConnectCT is the connection of any CT

If the transformer connection is a Delta-ac/Delta-ab/Inverse wye with Wye/Delta-ab/Delta-ac CT's, the resulting phase angle compensation shifts and CT magnitude compensation are:

$$\text{ConnectType (W₁)} = \text{ConnectXfm (Delta-ac)} + \text{ConnectCT (Wye)}$$

$$\text{ConnectType (W₁)} = 1 + 0 = 1 \text{ connect type } 1 \text{ or } 30^\circ$$

$$\text{ConnectType (W₂)} = \text{ConnectXfm (Wye)} + \text{ConnectCT (Delta-ab)}$$

$$\text{ConnectType (W₂)} = 0 + 11 = 11 \text{ connect type } 11 \text{ or } 330^\circ$$

$$\text{MagnitudeCT(W₂)} = \text{ConnectCT (Delta-ab)}$$

$$\text{MagnitudeCT(W₂)} = 23 = 1/\sqrt{3}$$

$$\text{ConnectType (W₃)} = \text{ConnectXfm (Inverse Wye)} + \text{ConnectCT (Delta-ac)}$$

$$\text{ConnectType (W₃)} = 6 + 1 = 7 \text{ connect type } 7 \text{ or } 210^\circ$$

$$\text{MagnitudeCT(W₃)} = \text{ConnectCT (Delta-ac)}$$

$$\text{MagnitudeCT(W₃)} = 13 = 1/\sqrt{3}$$

If any transformer winding is a wye with a wye CT, the ConnectType is returned as 0, (or $0^\circ$), the relay automatically eliminates the zero sequence current.

### Phase Angle Shift - Custom Connections

For configurations not available in the standard six selections, a Custom Configuration selection is available. The transformer phase compensation is similar to the Standard Configuration selection. However, the transformer phase shift compensation angle does not include the CT compensation phase shift. In the Custom Mode For Transformer and CT Connection, the user must input the actual compensation number as defined in the Custom Configuration Table. The CT phase and magnitude compensation are entered as one input using the selection from Table 4-7. For reference, examples of the transformer phase shift ConnectType numbers are indicated in Table 4-5, under the Custom column.

<table>
<thead>
<tr>
<th>Transformer Phase Compensation</th>
<th>CT Phase/Magnitude Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCW Increment #</td>
<td>Compensation</td>
</tr>
<tr>
<td>0</td>
<td>$1 \angle 0^\circ$</td>
</tr>
<tr>
<td>1</td>
<td>$1 \angle 30^\circ$</td>
</tr>
<tr>
<td>5</td>
<td>$1 \angle 150^\circ$</td>
</tr>
<tr>
<td>6</td>
<td>$1 \angle 180^\circ$</td>
</tr>
<tr>
<td>7</td>
<td>$1 \angle 210^\circ$</td>
</tr>
<tr>
<td>11</td>
<td>$1 \angle 330^\circ$</td>
</tr>
</tbody>
</table>

*Table 4-6  Standard Transformer and CT Configuration Options*
<table>
<thead>
<tr>
<th>Transformer Phase Compensation</th>
<th>CT Phase/Magnitude Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCW Increment #</td>
<td>Compensation</td>
</tr>
<tr>
<td>0</td>
<td>1 $\angle 0^\circ$</td>
</tr>
<tr>
<td>1</td>
<td>1 $\angle 30^\circ$</td>
</tr>
<tr>
<td>2</td>
<td>1 $\angle 60^\circ$</td>
</tr>
<tr>
<td>3</td>
<td>1 $\angle 90^\circ$</td>
</tr>
<tr>
<td>4</td>
<td>1 $\angle 120^\circ$</td>
</tr>
<tr>
<td>5</td>
<td>1 $\angle 150^\circ$</td>
</tr>
<tr>
<td>6</td>
<td>1 $\angle 180^\circ$</td>
</tr>
<tr>
<td>7</td>
<td>1 $\angle 210^\circ$</td>
</tr>
<tr>
<td>8</td>
<td>1 $\angle 240^\circ$</td>
</tr>
<tr>
<td>9</td>
<td>1 $\angle 270^\circ$</td>
</tr>
<tr>
<td>10</td>
<td>1 $\angle 300^\circ$</td>
</tr>
<tr>
<td>11</td>
<td>1 $\angle 330^\circ$</td>
</tr>
<tr>
<td></td>
<td>$1/\sqrt{3} \angle 0^\circ$</td>
</tr>
<tr>
<td>13</td>
<td>$1/\sqrt{3} \angle 30^\circ$</td>
</tr>
<tr>
<td>14</td>
<td>$1/\sqrt{3} \angle 60^\circ$</td>
</tr>
<tr>
<td>15</td>
<td>$1/\sqrt{3} \angle 90^\circ$</td>
</tr>
<tr>
<td>16</td>
<td>$1/\sqrt{3} \angle 120^\circ$</td>
</tr>
<tr>
<td>17</td>
<td>$1/\sqrt{3} \angle 150^\circ$</td>
</tr>
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<td>18</td>
<td>$1/\sqrt{3} \angle 180^\circ$</td>
</tr>
<tr>
<td>19</td>
<td>$1/\sqrt{3} \angle 210^\circ$</td>
</tr>
<tr>
<td>20</td>
<td>$1/\sqrt{3} \angle 240^\circ$</td>
</tr>
<tr>
<td>21</td>
<td>$1/\sqrt{3} \angle 270^\circ$</td>
</tr>
<tr>
<td>22</td>
<td>$1/\sqrt{3} \angle 300^\circ$</td>
</tr>
<tr>
<td>23</td>
<td>$1/\sqrt{3} \angle 330^\circ$</td>
</tr>
</tbody>
</table>

*Table 4-7  Custom Transformer and CT Configuration*
Calculation of Differential & Restraint Currents

The M-3311A uses the following algorithms for calculating the restraint and differential currents.

\[
I_{\text{restraint}} = \frac{1}{2} \left( |I_{Aw1}| + |I_{Aw2}| + |I_{Aw3}| + |I_{Aw4}| \right)
\]

\[
I_{\text{differential}} = \frac{1}{2} \left( |I_{dW1}| + |I_{dW2}| + |I_{dW3}| + |I_{dW4}| \right)
\]

The differential current \( I_d \) under normal load conditions should equal zero. As indicated by the operate equation, the currents must be correctly defined as entering/exiting the relay terminals. When the transformer CT polarity markings are located away from the transformer input terminals, the correct connection of the CT leads to the relay has the CT leads with the polarity mark connected to the relay input terminals with polarity mark. If a transformer CT polarity marking is toward the transformer input terminals, the Inverse CT connection should be chosen, or the CT leads should be reversed at the relay terminals. Illustrations of the proper CT input connections marking are provided in the following examples.

M-3311A Connection Examples

Figure 4-72 illustrates a typical transformer differential application in a power plant. The connections and input settings required for the GSU, (Generator Step Up) and Auxiliary transformers are reviewed in detail.

Auxiliary Transformer Example (Three Windings)

The Auxiliary Transformer is a Delta/Wye/Wye with resistance grounded wye windings, and Wye/Wye/Wye CT’s. The IEC definition of the windings is Dy11y11. The Beckwith standard connection is a Delta-ac/Wye/Wye. The correct connection of the CT leads is shown in Figure 4-73. If the transformer CT polarity markings are located away from the transformer input terminals, the correct connection of the CT leads to the relay has the CT leads with the polarity mark connected to the relay input terminals with polarity mark.

If the standard transformer configuration option is selected the configuration input selections are:

- Transformer Configuration W1 = Delta-ac
- Transformer Configuration W2 = Wye
- Transformer Configuration W3 = Wye
- CT Configuration W1 = Wye
- CT Configuration W2 = Wye

CT Configuration W3 = Wye

If the custom configuration option is selected, the input settings are illustrated in Figure 4-74. The settings are:

- Transformer W1 Setting = 1
- Transformer W2 Setting = 0
- Transformer W3 Setting = 0
- CT W1 Setting = 0
- CT W2 Setting = 0
- CT W3 Setting = 0

GSU Transformer Example

The GSU transformer illustrated in the example is a Wye/Delta/Delta with a resistance grounded wye winding and Delta-ac/Wye/Wye CT’s. The IEC definition of the transformer is Yd1d1. The Beckwith standard connection is a Wye/Delta-ac/Delta-ac. The application requires an 87GD (Ground Differential) function for the wye winding. Since only Winding 2 and Winding 3 in the M-3311A have an 87GD the wye winding must be assigned to one of these winding inputs.

In the example illustrated in Figure 4-75, the wye winding was assigned to the M-3311A winding number 3. Any transformer winding may be assigned to any relay input winding as long as the polarity marking criteria discussed previously is followed.

If the standard transformer configuration option is selected the configuration input selections are:

- Transformer Configuration W1 = Delta-ac
- Transformer Configuration W2 = Delta-ac
- Transformer Configuration W3 = Wye
- CT Configuration W1 = Wye
- CT Configuration W2 = Wye
- CT Configuration W3 = Delta-ac

If the custom configuration option is selected, the input settings are illustrated in Figure 4-76. The settings are:

- Transformer W1 Setting = 1
- Transformer W2 Setting = 1
- Transformer W3 Setting = 0
- CT W1 Setting = 0
- CT W2 Setting = 0
- CT W3 Setting = 13
CONNECTION EXAMPLES

IEC  Yd1 d1

IEC  Dy11 y11

Figure 4-72  Typical Transformer Differential Application
AUXILIARY TRANSFORMER EXAMPLE

Beckwith Delta-ac/Wye/Wye with Wye/Wye/Wye CTs

IEC $D_y d_{11} d_{11}$

Figure 4-73  Delta-ac/Wye/Wye CT Connection Diagram
### AUXILIARY TRANSFORMER EXAMPLE

<table>
<thead>
<tr>
<th>Winding</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winding Type</td>
<td>Dac</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>CT Type</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Line Current in Degrees °</td>
<td>30°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Phase Compensation</td>
<td>To ref winding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCW Rotation</td>
<td>30°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Relay Phase Setting</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CT Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Degrees</td>
</tr>
<tr>
<td>Magnitude</td>
</tr>
<tr>
<td>Combined Compensation</td>
</tr>
<tr>
<td>Relay CT Setting</td>
</tr>
<tr>
<td>Zero Sequence Filter</td>
</tr>
</tbody>
</table>

Zero Sequence Filtering is applicable for grounded wye winding with wye connected CTs. Otherwise, zero sequence currents could appear in this input to relay but in no other, causing possible false trip during an external fault.

*Figure 4-74  Custom Settings for Delta-ac/Wye/Wye*
GSU TRANSFORMER EXAMPLE

Beckwith Wye/Delta-ac/Delta-ac with Delta-ac/Wye/Wye CTs

IEC Y d1 d1

Figure 4-75  Wye/Delta-ac/Delta-ac CT Connection Diagram
GSU TRANSFORMER EXAMPLE
Breaker and a half application

Beckwith: Y/Delta-ac/Delta-ac
IEC Description: Y d1 d1

REF Winding

<table>
<thead>
<tr>
<th>Winding</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
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</thead>
<tbody>
<tr>
<td>Winding Type</td>
<td>d1</td>
<td>d1</td>
<td>Y0</td>
<td>Y0</td>
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<tr>
<td>CT Type</td>
<td>Y</td>
<td>Y</td>
<td>Dac</td>
<td>Dac</td>
</tr>
<tr>
<td>Line Current in Degrees</td>
<td>30°</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Phase Compensation</td>
<td>To ref winding</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CCW Rotation</td>
<td>30°</td>
<td>30°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Relay Phase Setting</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>CT Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Degrees</td>
</tr>
<tr>
<td>Magnitude</td>
</tr>
<tr>
<td>Combined Compensation</td>
</tr>
<tr>
<td>Relay CT Setting</td>
</tr>
<tr>
<td>Zero Sequence Filter</td>
</tr>
</tbody>
</table>

Zero Sequence Filtering is applicable for grounded wye winding with wye connected CTs. Otherwise, zero sequence currents could appear in this input to relay but in no other, causing possible false trip during an external fault.

Figure 4-76  Custom Settings for Wye/Delta-ac/Delta-ac
5 Installation

5.1 General Information

NOTE: Prior to the installation of the equipment, it is essential to review the contents of this manual to locate data which may be of importance during the installation procedures. The following is a quick review of the contents of this chapter.

The person or group responsible for the installation of the relay will find herein all mechanical information required for the physical installation, equipment ratings, and all external connections in this chapter. For reference, the Three-Line Connection Diagrams are repeated from Chapter 4, System Settings and Setpoints. Further, a pre-commissioning checkout procedure is outlined using the HMI option to check the external CT and VT connections. Additional tests which may be desirable at the time of installation are described in Chapter 6, Testing.

5.2 Mechanical/Physical Dimensions

Figures 5-1 through 5-5 contain physical dimensions of the relay that may be required for mounting the unit to a rack or vertical panel mount.
NOTE: Dimensions in brackets are in centimeters.

Figure 5-1  M-3311A Horizontal Chassis Mounting Dimensions (H1)
**NOTE:** Dimensions in brackets are in centimeters.

*Figure 5-2  M-3311A Mounting Dimensions – Horizontal Chassis With Expanded I/O*
NOTE: Dimensions in brackets are in centimeters.

Figure 5-3  M-3311A Panel Mount Cutout Dimensions
Recommended cutout when relay is not used as standard rack mount and is panel cut out mounted.

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

*Figure 5-4  M-3311A Vertical Chassis Mounting Dimensions Without Expanded I/O (H2)*
Figure 5-5  Mounting Dimensions for GE L-2 Cabinet H3 and H4
5.3 External Connections

▲ CAUTION: The protective grounding terminal must be connected to an earthed ground anytime external connections have been made to the unit.

▲ CAUTION: Only dry contacts must be connected to inputs because these contact inputs are internally wetted. Application of external voltage on these inputs may result in damage to the units.

● WARNING: Do not open live CT circuits. Live CT circuits should be shorted prior to disconnecting CT wiring to the M-3311A. Death or severe electrical shock may result.

▲ CAUTION: Mis-operation or permanent damage may result to the unit if a voltage is applied to Terminals 1 and 2 (aux) that does not match the configured Trip Circuit Monitoring input voltage.

To fulfill requirements for UL and CSA listings, terminal block connections must be made with No. 22–12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector, and wire insulation used must be rated at 75° C minimum.

Replacement Fuses

F1–F4 replacement fuses must be fast-acting 3 Amp, 250 V (3AB) Beckwith Electric Part Number 420-00885. Connector must be tightened to 8-inch pounds torque.

Power Supply

When the M-3311A without expanded I/O is equipped with the optional second power supply (Figure 5-6), the power source may be the same or two different sources.

When the M-3311A with expanded I/O is equipped with two (not redundant) power supplies, the power supplies must be powered from the same source.

Grounding Requirements

The M-3311A is designed to be mounted in an adequately grounded metal panel, using grounding techniques (metal-to-metal mounting) and hardware that assures a low impedance ground.

Unit Isolation

Sensing inputs should be equipped with test switches and shorting devices where necessary to isolate the unit from external potential or current sources.

A switch or circuit breaker for the M-3311A’s power shall be included in the building installation, and shall be in close proximity to the relay and within easy reach of the operator, and shall be plainly marked as being the power disconnect device for the relay.

Insulation Coordination

Sensing Inputs: 60 V to 140 V, Installation Category IV, Transient Voltages not to exceed 5,000 V.

Torque Requirements

Terminal Torque values for Current, Voltage and Aux inputs require a 8.0 in-lbs minimum, and 9.0 in-lbs, maximum. All other terminals require 12 in-lbs.

▲ CAUTION: Over torquing may result in terminal damage.

Relay Outputs

All outputs are shown in the de-energized state for standard reference. Relay standard reference is defined as protective elements in the non-trip, reconnection and sync logic in the non-asserted state, or power to the relay is removed. Output contacts #1 through #4 are high speed operation contacts and close 4ms faster than all other outputs. Outputs 7 and 8 are form “c” contacts (center taped ‘a’ and ‘b’ contacts), all other outputs are form “a” contacts (normally open).

The power supply relay (P/S) is energized when the power supply is OK. The self-test relay is energized when the relay has performed all self-tests successfully.
Figure 5-8  Two Winding – Zero Voltage Inputs External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5-9  Two Winding – Zero Voltage Inputs Extended Output External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
NOTES:

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
NOTES:

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.

---

*Figure 5-11 Two Winding – Two Voltage Inputs Extended Output External Connections*
Figure 5-12 Two Winding – Four Voltage Inputs External Connections

■NOTES:

1. ▲ CAUTION: Before making connections to the Trip Circuit Monitoring input, see 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.

2. ▲ 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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5‑13  Two Winding – Four Voltage Inputs Extended Output External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5-14  Three Winding – Zero Voltage Inputs External Connections

■NOTES: ▲

1. ▲ CAUTION: Before making connections to the Trip Circuit Monitoring input, see 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.

2. ▲ 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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form "a" and "c" contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5-15  Three Winding – Zero Voltage Inputs Extended Output External Connections

NOTES:

1. ▲ CAUTION: Before making connections to the Trip Circuit Monitoring input, see 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.

2. ▲ CAUTION: 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
**Figure 5-16  Three Winding – Two Voltage Inputs External Connections**

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5-17  Three Winding – Two Voltage Inputs Extended Output External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
### Figure 5-19  Three Winding – Four Voltage Inputs Extended Output External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** 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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
Figure 5-20 Four Winding – Two Voltage Inputs External Connections

**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **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.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.
**NOTES:**

1. **CAUTION:** Before making connections to the Trip Circuit Monitoring input, see 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.

2. **CAUTION:** **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 units.

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

4. See Section 5.3, External Connections for details regarding High Speed Output Contact assignment, Form “a” and “c” contact assignments, Power Supply Relay, Self Test Relay and UL/CSA Wire, Connector, Insulation and Terminal Block Torque requirements.

---

**Figure 5-21**  Four Winding – Two Voltage Inputs Extended Output External Connections
Figure 5-22  Two Winding - One Ground Input - Zero Voltage Inputs  
Vertical Chassis External Connections
Figure 5-23  Two Winding - One Ground Input - Two Voltage Inputs
Vertical Chassis External Connections
Figure 5-24  Two Winding - One Ground Input - Four Voltage Inputs
Vertical Chassis External Connections
Figure 5-25  Three Winding - Two Ground Inputs - Zero Voltage Inputs  
Vertical Chassis External Connections
Figure 5-26  Three Winding - Two Ground Inputs - Two Voltage Inputs  
Vertical Chassis External Connections
Figure 5-27  Three Winding - Two Ground Inputs - Four Voltage Inputs
Vertical Chassis External Connections
Figure 5-28  Four Winding - Three Ground Inputs - Zero or Two Voltage Inputs
Vertical Chassis External Connections
Figure 5-29  Typical (Two Winding – Two Voltage Inputs) Three-Line Connection Diagram

NOTES:

1. Delta-Wye power transformer shown with Wye-Wye connected CTs (Connected #4 DABY yy). Other connections are possible.

2. Alternate VT connections (see Instruction Book Chapter 5)

3. Status Inputs and Relay Output are designated.

4. Extra Outputs may be designated for control/supervisory operation.
Figure 5-30  Typical (Two Winding – Four Voltage Inputs) Three-Line Connection Diagram
Figure 5-31  Typical (Three Winding – Two Voltage Inputs) Three-Line Connection Diagram
Figure 5-32  Typical (Three Winding – Four Voltage Inputs) Three-Line Connection Diagram
Figure 5-33 Typical (Four Winding – Two Voltage Inputs) Three-Line Connection Diagram
5.4 Pre-Commissioning Checkout

During M-3311A Transformer Protection Relay field commissioning, check the following procedure to ensure that the CT and VT connections are correct.

1. On the keypad, press ENTER. After a short delay, the unit should display:

```
VOLTAGE RELAY
VOLT curr freq v/hz →
```

2. Press the right arrow button until the unit displays:

```
STATUS
← config sys STAT dmd →
```

3. Press ENTER. The unit should display:

```
VOLTAGE STATUS
VOLT curr freq v/hz →
```

4. Press ENTER to display the phase voltage. Use a voltmeter to compare the actual measurement. If there is a discrepancy, check for loose connections to the rear terminal block of the unit.

```
VOLTAGE
VA= VG=
```

5. Press EXIT, the unit displays:

```
VOLTAGE STATUS
VOLT curr freq v/hz →
```

6. Press the right arrow once, the unit displays:

```
CURRENT STATUS
volt CURR freq v/hz →
```

7. Press ENTER to display line currents for Winding 1 ($I_{AW1}, I_{BW1}, I_{CW1}$). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W1 PHASE CURRENT
A= 5.00 B= 5.00 C= 5.00
```

8. Press ENTER to display line currents for Winding 2 ($I_{AW2}, I_{BW2}, I_{CW2}$). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W2 PHASE CURRENT
A= 5.00 B= 5.00 C= 5.00
```

9. Press ENTER to display line currents for Winding 3 ($I_{AW3}, I_{BW3}, I_{CW3}$). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W3 PHASE CURRENT
A= 5.00 B= 5.00 C= 5.00
```

10. Press ENTER to display line currents for Winding 4 ($I_{AW4}, I_{BW4}, I_{CW4}$). Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit. The unit should display:

```
W4 PHASE CURRENT
A= 5.00 B= 5.00 C= 5.00
```

11. Press ENTER for the unit to display ground current. The Ground current should be $I_{G}W2 \approx 0$ Amps.

```
W2 GROUND CURRENT
0.00 Amps
```

12. Press ENTER for the unit to display ground current. The Ground current should be $I_{G}W3 \approx 0$ Amps.

```
W3 GROUND CURRENT
0.00 Amps
```

13. Press ENTER for the unit to display ground current. The Ground current should be $I_{G}W4 \approx 0$ Amps.

```
W4 GROUND CURRENT
0.00 Amps
```

14. Press ENTER for the unit to display restraint currents. The restraint currents should be $I_{REST} \approx \frac{I_{W1} + I_{W2}}{2}$ for each phase.

```
RERAINT CURRENT (PU)
A=5.000 B=5.000 C=5.000
```
15. Press **ENTER** for the unit to display the fundamental differential currents. The fundamental differential currents should be \( I_{df} \approx W_1 \cdot W_2 \approx 0 \) for each phase. If a significant amount of differential current is present, check the CT polarities.

**DIFF CURRENT FUND. (PU)**
- A=0.000
- B=0.000
- C=0.000

16. Press **ENTER** for the unit to display the second harmonic currents. The second harmonic currents should be \( I_{2nd} \approx 0 \) for each phase.

**DIFF CURRENT 2nd H (PU)**
- A=0.000
- B=0.000
- C=0.000

17. Press **ENTER** for the unit to display the fourth harmonic currents. The fourth harmonic currents should be \( I_{4th} \approx 0 \) for each phase.

**DIFF CURRENT 4th H (PU)**
- A=0.000
- B=0.000
- C=0.000

18. Press **ENTER** for the unit to display the fifth harmonic currents. The fifth harmonic currents should be \( I_{5th} \approx 0 \) for each phase.

**DIFF CURRENT 5th H (PU)**
- A=0.000
- B=0.000
- C=0.000

19. Press **ENTER** for the unit to display the ground differential current. The ground differential current should be \( I_{gdff} \approx 0 \).

**W2 GND DIFF CURRENT**
- 0.00 Amps

Press **ENTER** for W3

**W3 GND DIFF CURRENT**
- 0.00 Amps

Press **ENTER** for W4

**W4 GND DIFF CURRENT**
- 0.00 Amps

20. Press **ENTER** for the unit to display the positive sequence current for winding 1. The positive sequence current should be \( I_{pos} \approx W_0 \approx I_A \approx I_B \approx I_C \).

**W1 POS SEQUENCE CURRENT**
- 5.00 Amps

21. Press **ENTER** for the unit to display the negative sequence current for winding 1. The negative sequence current should be \( I_{neg} \approx 0 \) Amps.

**W1 NEG SEQUENCE CURRENT**
- 0.00 Amps

22. Press **ENTER** for the unit to display the zero sequence current for winding 1. The zero sequence current should be \( I_{zero} \approx 0 \) Amps. If a significant amount of negative or zero sequence current is present (greater than 25% of \( I_A, I_B, I_C \)), then either the phase sequence or the polarities may be incorrect. Modify connections to obtain the correct phase sequence and polarities.

**W1 ZERO SEQUENCE CURRENT**
- 0.00 Amps

23. Repeat steps 18–20 for winding 2, winding 3 and winding 4 currents.

24. Press **ENTER** for the unit to display the Winding Thermal Current value for the selected winding.

**F49 THERMAL CURRENT**
- A=
- B=
- C=

25. Press **EXIT**, the unit displays:

**CURRENT STATUS**
- volt CURR freq v/hz
## 5.5 Circuit Board Switches and Jumpers

<table>
<thead>
<tr>
<th>Dip Jumper</th>
<th>Position</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>J60</td>
<td>AB</td>
<td>Connects CD signal to COM 2 Pin 1*</td>
</tr>
<tr>
<td></td>
<td>AC</td>
<td>Connects +15 V to COM 2 Pin 1</td>
</tr>
<tr>
<td>J61</td>
<td>BC</td>
<td>Connects -15 V to COM 2 Pin 9</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>Disconnects COM 2 Pin 9</td>
</tr>
<tr>
<td>J18</td>
<td>AB</td>
<td>COM 3 Termination Resistor Inserted</td>
</tr>
<tr>
<td></td>
<td>BC</td>
<td>COM 3 Termination Resistor Not Inserted*</td>
</tr>
<tr>
<td>J46</td>
<td>AB</td>
<td>COM 3 Shares Baud Rate with COM 1</td>
</tr>
<tr>
<td></td>
<td>BC</td>
<td>COM 3 Shares Baud Rate with COM 2*</td>
</tr>
<tr>
<td>J5</td>
<td>AB</td>
<td>Demodulated IRIG-B Signal TTL Pin 6</td>
</tr>
<tr>
<td></td>
<td>BC</td>
<td>Modulated IRIG-B Signal BNC*</td>
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* Default Setting

### Table 5-1 Circuit Board Jumpers

<table>
<thead>
<tr>
<th>Switch Positions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
<td>Swtches should not be changed while power is applied to unit</td>
</tr>
<tr>
<td>U X X X</td>
<td>Up for dual Power Supply, Down for Single</td>
</tr>
<tr>
<td>X X U U</td>
<td>Run Mode</td>
</tr>
<tr>
<td>X X D D</td>
<td>Factory Use Only</td>
</tr>
<tr>
<td>X X D U</td>
<td>Initialize access codes and communication parameters to default values*</td>
</tr>
<tr>
<td>X D X X</td>
<td>Flash Update Enabled</td>
</tr>
</tbody>
</table>

* Power down, set switch, then power up. After power up, the RELAY OK LED light remains off and DIAG LED will illuminate when the operation has been satisfactorily completed.

### Table 5-2 Circuit Board Switches

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V dc</td>
<td>A to B</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>48 V dc</td>
<td>B to C</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>125 V dc</td>
<td>B to C</td>
<td>B to C</td>
<td>A to B</td>
</tr>
<tr>
<td>250 V dc*</td>
<td>B to C</td>
<td>B to C</td>
<td>B to C</td>
</tr>
</tbody>
</table>

* Default from Factory

### Table 5-3 Trip Circuit Monitor 1 Input Voltage Select Jumper Configuration
### Close Circuit Monitor 1 Input Voltage Select

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Jumper J4 Position</th>
<th>Jumper J5 Position</th>
<th>Jumper J6 Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V dc</td>
<td>A to B</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>48 V dc</td>
<td>B to C</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>125 V dc</td>
<td>B to C</td>
<td>B to C</td>
<td>A to B</td>
</tr>
<tr>
<td>250 V dc*</td>
<td>B to C</td>
<td>B to C</td>
<td>B to C</td>
</tr>
</tbody>
</table>

* Default from Factory

**Table 5-4** Close Circuit Monitor 1 Input Voltage Select Jumper Configuration

### Trip Circuit Monitor 2 Input Voltage Select

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V dc</td>
<td>A to B</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>48 V dc</td>
<td>B to C</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>125 V dc</td>
<td>B to C</td>
<td>B to C</td>
<td>A to B</td>
</tr>
<tr>
<td>250 V dc*</td>
<td>B to C</td>
<td>B to C</td>
<td>B to C</td>
</tr>
</tbody>
</table>

* Default from Factory

**Table 5-5** Trip Circuit Monitor 2 Input Voltage Select Jumper Configuration

### Close Circuit Monitor 2 Input Voltage Select

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Jumper J16 Position</th>
<th>Jumper J17 Position</th>
<th>Jumper J18 Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V dc</td>
<td>A to B</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>48 V dc</td>
<td>B to C</td>
<td>A to B</td>
<td>A to B</td>
</tr>
<tr>
<td>125 V dc</td>
<td>B to C</td>
<td>B to C</td>
<td>A to B</td>
</tr>
<tr>
<td>250 V dc*</td>
<td>B to C</td>
<td>B to C</td>
<td>B to C</td>
</tr>
</tbody>
</table>

* Default from Factory

**Table 5-6** Close Circuit Monitor 2 Input Voltage Select Jumper Configuration
Figure 5-34  M-3311A Circuit Board Standard I/O
Figure 5-35  M-3311A Circuit Board Expanded I/O
5.6 IPScom Communications and Analysis Software Installation

IPScom Installation and Setup

IPScom is available on CD-ROM, or may be downloaded from our website at www.beckwithelectric.com.

The S-3300 IPScom Communications Software is not copy-protected. For more information on your specific rights and responsibilities, see the licensing agreement enclosed with your software or contact Beckwith Electric.

Hardware Requirements

IPScom will run on any Windows based computer that provides at least the following:

- x86-based personal computer (1GHz or Higher recommended)
- For CD install, a CD or DVD drive
- RS-232 com port or USB to RS-232 dongle
- Mouse or pointing device
- Microsoft Windows™ NT or greater
- Microsoft Internet Explorer 4.0 or greater
- At least 1G free hard disk space available

Installing IPScom

1. Insert software CD-ROM into your drive.
   An Auto-Install program will establish a program folder ( Becoware) and subdirectory (IPScom). After installation, the IPScom program item icon (see Figure 5-36) is located in Becoware. The default location for the application files is on drive C:, in the new subdirectory “IPScom” (C:\Becoware\IPScom).

   ![Figure 5-36 IPScom Program Icon](image)

2. If the Auto-Install program does not launch when the CD-ROM is inserted into the drive then proceed as follows:
   a. Select Run from the Start Menu.
   b. In the Run dialog screen, locate the installation file (setup.exe) contained on the IPScom installation disk.
   c. Select Run to start the installation process.

5.7 Activating Initial Local Communications

The relay and IPScom Communications Software are shipped from the factory with the same default communication parameters. Therefore, it may not be necessary to set up communication parameters.

In order for IPScom to communicate with the relay using direct serial connection, a serial “null modem” cable is required, with a 9-pin connector (DB9P) for the relay, and an applicable connector for the computer (usually DB9S or DB25S). Pin-outs for a null modem adapter are provided in Appendix B, Communications.

Activating initial communications using default communication parameters is accomplished as follows:

1. Verify that a direct serial connection between the PC hosting IPScom and the target relay COM1 (front) is in place.
2. Select the IPScom icon (Figure 5-36) from the Becoware folder or Desktop. The IPScom Main Screen (Figure 3-2) is displayed.
3. Select the Connect menu item. IPScom will display the Serial Port Dialog Screen (Figure 3-5).
4. If the computer is connected through either an RS-232 port or RS-485 port perform the following:
   a. Select the PC Comm Port that is connected to the relay.
   b. Select Connect. This action attempts to establish communication.
5. If IPScom returns a “COM Opened and Level #(1, 2 or 3) access granted” then communications have been established. Enter any valid IPScom command(s) as desired. To close the communication channel when connected locally, select the Communication/Disconnect from the main screen menu bar.
6. If IPScom returns an error message, then determine the relay COM1 communication parameters as follows:
   a. From the relay Front Panel HMI press ENTER. The relay will display:
      
      
      
      
      
      
      
   b. Press the right arrow pushbutton until the relay displays:
      
      
      
      
      
      
   c. Press ENTER. The relay will display:
      
      
      
      
      
      
   d. Press ENTER. The relay will display:
      
      
      
      
      
      
      
      
      
      
      
   e. Press EXIT as necessary to exit the HMI.
   f. Select the Connect menu item. IPScom® will display the Serial Port Dialog Screen (Figure 3-5).
   g. Verify the IPScom COM Port Baud Rate is the same as relay COM1 Baud Rate.
   h. Verify that the PC Comm Port that is connected to the relay is selected.
   i. Select Connect. This action will attempt to establish communication.
   j. If IPScom returns a "COM Opened and Level #(1, 2 or 3) access granted" then communications have been established. Enter any valid ISScom command(s) as desired.

To close the communication channel when connected locally, select Communication/Disconnect from the main screen menu bar.

5.8 Initial Setup Procedure

The relay is shipped with the initial configuration settings as listed in Appendix A, Figure A-1 System Communication Setup, Figure A-2 Setup System (Two or Three Winding), Figure A-3 Setup System (Four Windings), Figure A-4 System Setpoints and Settings. Selected settings that are unique to the application may be recorded on the appropriate record form as calculated from Chapter 4, System Setup and Setpoints.

Setup Procedure

1. Connect power to the relay’s rear power terminals, as marked on the rear panel’s power supply label and as shown in Figures 5-6 and 5-7.

2. When power is initially applied, the M-3311A performs a number of self-tests to ensure its proper operation. During the self-tests, an “X” is displayed for each test successfully executed. If all tests are successful, the unit will briefly display the word PASS. Then, a series of status screens, including the model number, software version number, serial number, date and time as set in the system clock, and the user logo screen will be displayed. (Figure 2-2 illustrates this sequence of screens.)

3. If any test should fail, the DIAG LED will flash the error code, or the error code will be displayed on units equipped with the HMI and the relay will not allow operation to proceed. In such a case, the error code should be noted and the factory contacted. A list of error codes and their descriptions are provided in Appendix C, Error Codes. Assuming that various voltage functions are enabled, and there are no voltage inputs connected, various voltage targets will be identified as having operated.

4. If remote communication is used, the baud rate, address, and other parameters for the communication ports must be set. Refer to the instructions in Section 5.7, Activating Initial Local Communications. Also refer to Chapter 3, IPScom, on S-3300 IPScom Communications Software.
NOTE: UNIT SETUP settings are not considered part of the setpoint profiles. Unit Setup settings are common to all profiles.

5. To setup the unit with general information required, including altering access codes, setting date and time, installing user logos, and other adjustments, refer to Section 4.1, Unit Setup.

NOTE: The relay has been fully calibrated at the factory using very precise and accurate test equipment. There is no need for recalibration before initial installation. Further calibration is only necessary if a component was changed and will be only as accurate as the test equipment used.

6. If desired, calibrate the unit following the calibration procedure described in subsection 6.3, Auto Calibration. For units without HMI, refer to Section 5.5, Circuit Board Switches & Jumpers.

NOTE: System Setup settings are not considered part of the setpoint profiles. System Setup settings are common to all profiles.

7. Setup the relay system parameters for the relay application. Section 4.2, System Setup includes the general system and equipment information required for the operation of the relay. This includes such items as CT and VT ratios, VT configurations, transformer connections and Nominal values.

NOTE: Disabling unused functions improves the response time of the indicators and controls.

8. Enable the desired protective functions for the relay application.

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

- Enable/disable function
- Output choices (OUT1–8)
- Input blocking choices (IN1–6)

The relay is shipped with a certain group of standard functions, including other optional functions, as purchased. Both of these groups define a configurable set of functions. Only members of this set may be enabled/disabled by the end user. (Optional functions not purchased cannot be enabled.)

9. Enter the desired setpoints for the enabled functions. See Section 4.4, System Setpoints.

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

- Pickup settings (converted to relay quantities)
- Time delay settings
- Time dials

Input descriptions are detailed in Section 4.4, System Setpoints. Complete the System Setpoints and Settings Record Form in Appendix A before entering the setpoint and time setting data into the relay.

10. Install the M-3311A and connect external input and output contacts according to the rear panel terminal block markings as shown in Figures 5-8 through 5-28, External Connections as applicable.
# 6 Testing

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  46IT Negative Sequence Overcurrent Inverse Time .......... 6–27
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  51 Inverse Time Phase Overcurrent ........................................... 6–36
  51G Inverse Time Ground Overcurrent ............................... 6–38
  51N Inverse Time Residual Overcurrent .......................... 6–39
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6.1 Equipment and Test Setup

No calibration is necessary, as the M-3311A Transformer Protection Relay is calibrated and fully tested at the factory. If calibration is necessary because of a component replacement, follow the Auto Calibration procedure detailed in Section 6.3.

Required Equipment

The following equipment is required to perform the test procedures outlined in this chapter:

- Two Digital Multimeters (DMM) with a 10 Amp current range. These are not required if using a Pulsar Universal Test System.
- Appropriate power supply for system power.
- Three-phase source capable of 0 to 250 V ac. (Pulsar Universal Test System or equivalent.)
- Three-phase current source capable of 0 to 25 Amps. (Pulsar Universal Test System or equivalent.)
- Electronic timer with a minimum accuracy of 8 msec. (Pulsar Universal Test System or equivalent.)

Equipment Setup

▲ CAUTION: The proper voltage range for the relay is clearly marked on the power supply label affixed to the rear cover.

1. Connect system power to the Relay Power Supply:
   a. PS1 Terminals 62 (hot) and 63 (neutral)
   b. PS2 Terminals 60 (hot) and 61 (neutral)

2. Connect the voltage and current sources as indicated in the configuration listed in the individual function test procedure.

6.2 Diagnostic Test Procedures

The diagnostic procedures perform basic functional tests to verify the operation of the front panel indicators, inputs, and outputs, and the communication ports. These tests are performed in relay test mode, which is entered in the following manner:

▲ CAUTION: The Diagnostic Mode is intended for bench testing the relay only. Do not use the diagnostic mode in relays that are installed in an active protection scheme.

For units with the optional HMI panel:

1. Press the ENTER pushbutton.

2. If Level Access is active, the following is displayed:

<table>
<thead>
<tr>
<th>ENTER ACCESS CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

   a. Input the required Access Code, then press ENTER.

   b. If the proper Access Code has been entered, the HMI will return:

<table>
<thead>
<tr>
<th>LEVEL #(1,2 or 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Granted!</td>
</tr>
</tbody>
</table>

   c. Go to step 4.

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

<table>
<thead>
<tr>
<th>VOLTAGE RELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLT curr freq v/hz</td>
</tr>
</tbody>
</table>

   c. Go to step 4.
Output Test (Relay)

The first step in testing the operation of the function outputs is to confirm the positions of the outputs in the unoperated or \textbf{OFF} position. This is accomplished by connecting a Digital Multimeter (DMM) across the appropriate contacts and confirming open or closed contact status. The de-energized or \textbf{OFF} position for each output is listed in Table 6-1, Output Contacts.

<table>
<thead>
<tr>
<th>Relay/Output Number</th>
<th>Normally Open Contact*</th>
<th>Normally Closed Contacts*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>20 \hspace{1em} 21 \hspace{1em} 22</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>17 \hspace{1em} 18 \hspace{1em} 19</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>14 \hspace{1em} 15 \hspace{1em} 16</td>
</tr>
<tr>
<td>10</td>
<td>13</td>
<td>12 \hspace{1em} N/A \hspace{1em} N/A</td>
</tr>
</tbody>
</table>

* “Normal” position of the contact corresponds to the \textbf{OFF} or de-energized state of the relay.

\textbf{CAUTION:} Do not enter DIAGNOSTIC MODE when protected equipment is in service. Entering \textbf{DIAGNOSTIC MODE} when protected equipment is in service removes all protective functions of the relay.

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

\textbf{SETUP UNIT} \hspace{1em} \leftarrow \textbf{SETUP} \rightarrow

5. Press \textbf{ENTER}, the following is displayed:

\textbf{SOFTWARE VERSION} \hspace{1em} \textbf{VERS eth sn access number} \rightarrow

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

\textbf{DIAGNOSTIC MODE} \hspace{1em} \leftarrow \textbf{alarm time error} \textbf{DIAG}

7. Press \textbf{ENTER}, the following warning will be displayed:

\textbf{PROCESSOR WILL RESET!} \hspace{1em} \textbf{ENTER KEY TO CONTINUE}

8. Press \textbf{ENTER}, the relay will reset and \textbf{DIAGNOSTIC MODE} will be temporarily displayed followed by:

\textbf{OUTPUT TEST (RELAY)} \hspace{1em} \textbf{OUTPUT input led target} \rightarrow

9. When testing in \textbf{DIAGNOSTIC MODE} is complete, press \textbf{EXIT} until the following message is displayed:

\textbf{PRESS EXIT TO} \hspace{1em} \textbf{EXIT DIAGNOSTIC MODE}

10. Press \textbf{EXIT} again to exit \textbf{DIAGNOSTIC MODE}. The relay will reset and then return to normal running mode.

\textbf{CAUTION:} Do not enter DIAGNOSTIC MODE when protected equipment is in service. Entering \textbf{DIAGNOSTIC MODE} when protected equipment is in service removes all protective functions of the relay.

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

\textbf{CAUTION:} Do not enter DIAGNOSTIC MODE when protected equipment is in service. Entering \textbf{DIAGNOSTIC MODE} when protected equipment is in service removes all protective functions of the relay.
For units equipped with an optional HMI panel:

Following completion of testing, the output contacts, can be turned **ON** in the following manner:

1. Press **ENTER**. The following is displayed:
   
   ![RELAY NUMBER 1 OFF on]

2. Press **ENTER**. The following is displayed:
   
   ![RELAY NUMBER 1 off ON]

3. Use the right arrow button to change “on” to uppercase letters, which signifies selection. The following is displayed:

   ![RELAY NUMBER 1 off ON]

4. Press **ENTER**. Output Relay #1 will energize. The following is displayed:

   ![RELAY NUMBER 1]

5. Choose output numbers 2-9 (self-test) (2-17 for extended version) by using the up and down arrow buttons to turn all relays or outputs to the energized or **ON** position. When each output is turned on, the appropriate red **OUTPUT LED** illuminates.

6. Use the DMM to verify the position of the output contacts in the energized or **ON** position. The readings should be the opposite of the initial reading above. All outputs should be returned to their initial de-energized or **OFF** positions. The **OUTPUT LEDs** will extinguish when each output is turned off.

7. If Output Relay testing is complete, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

**Input Test (Status)**

The **INPUT TEST** menu enables the user to determine the status of the individual status inputs.

For units equipped with an optional HMI panel:

Each input can be selected by number using the up and down arrow buttons. The status of the input will then be displayed.

---

<table>
<thead>
<tr>
<th>Input Number</th>
<th>Return Terminal</th>
<th>Input Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (52b)</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 6-2 Input Contacts**

1. When **OUTPUT TEST (RELAY)** is displayed press the right arrow to display the following:

   ![INPUT TEST (STATUS) output INPUT led target→]

2. Press **ENTER**. The following is displayed:

   ![INPUT NUMBER 1]

3. Press **ENTER**. The following is displayed:

   ![INPUT NUMBER 1 CIRCUIT OPEN]

4. Connect **IN RTN** (terminal #11) to **IN1**, (terminal #10). See Table 6-2, Input Contacts.

5. Alternatively, if this specific input is being used in the application, and the external wiring is complete, the actual external status input contact can be manually closed. This will test the input contact operation and the external wiring to the input contacts. The following is immediately displayed:

   ![INPUT NUMBER 1 CIRCUIT CLOSED]

6. Disconnect **IN RTN** (terminal #11) from **IN1** (terminal #10). The following is immediately displayed:

   ![INPUT NUMBER 1 CIRCUIT OPEN]

7. Press **ENTER**. The following is displayed:

   ![INPUT NUMBER 1]
8. Use the up arrow button to advance to the next input. Repeat the procedure using the contacts as shown in Table 6-2, Input Contacts.

9. When testing is complete, press EXIT to return to the DIAGNOSTIC MODE menu.

Status LED Test
The STATUS LED TEST menu enables the user to check the front panel LED's individually.

Target LED Test
NOTE: This test is not applicable to units that are not equipped with the M-3911A Target Module.

The TARGET LED TEST menu allows the user to check the M-3911A Target Module LED's individually.

For units equipped with an optional HMI panel:

1. When INPUT TESTS (STATUS) is displayed, press the right arrow button until the following is displayed: STATUS LED TEST output input LED target

2. Press ENTER. LED #1, RELAY OK, illuminates and the following is displayed: STATUS LED TEST LED NUMBER 1 = ON

3. Repeat Step 2 for each of the 5 remaining LED's shown in Figure 6-1. The PS1 and PS2 LED's are not subject to this test.

4. When STATUS LED testing is complete, press EXIT to return to DIAGNOSTIC MODE.

TARGETS

OUT 1 O OUT 3 O OUT 5 O OUT 7 O
OUT 2 O OUT 4 O OUT 6 O OUT 8 O
Target LED Test (Cont.’d)

2. Press **ENTER**. Target LED #1, **24DT/IT OVEREXCITATION**, illuminates and the following is displayed:

```
TARGET LED TEST
LED NUMBER 1 = ON
```

3. Repeat Step 2 for each of the remaining target and output LED's shown in Figures 6-2 and 6-3.

4. When **TARGET LED** testing is complete, press **EXIT** to return to **DIAGNOSTIC MODE**.

Pressing the **TARGET RESET** button on the front panel also provides a simultaneous test for all **TARGET** LEDs (not applicable in Diagnostic mode).

**Button Test**

**NOTE:** This test is only applicable to units that are equipped with the M-3931 HMI Module.

The **BUTTON TEST** menu selection allows the user to check the M-3931 HMI Module Keypad. As each button is pressed, its name is displayed.

```
Figure 6-4  M-3931 Human-Machine Interface Module
```

1. When the **TARGET LED TEST** is displayed, press the right button until the following is displayed:

```
BUTTON TEST
←BUTTON disp com1 com2→
```

2. Press and hold **ENTER**. The following is displayed:

```
BUTTON TEST
ENTER
```

3. Release **ENTER**. The following is displayed:

```
BUTTON TEST
0
```

**NOTE:** Pressing the **EXIT** button will terminate this test, so it should be tested last. If it is pressed before the test sequence is complete, the test may be restarted by pressing **ENTER**. Notice the word **EXIT** is displayed temporarily before the test sequence is terminated.

4. Repeat this test for each of the buttons on the keypad and the **TARGET RESET** button. As each button is pressed, the display will briefly show the name for each key (“Right Arrow”, “Up Arrow”, etc).

**Display Test**

**NOTE:** This test is only applicable to units that are equipped with the M-3931 HMI Module.

The **DISPLAY TEST** menu selection enables the user to check the alphanumeric display. This test cycles through varying test patterns until the **EXIT** button is pressed.

1. When **BUTTON TEST** is displayed, press the right arrow button until the following is displayed:

```
SCREEN TEST
←button DISP com1 com2→
```

2. Press **ENTER**. The unit will display a sequence of test characters until the **EXIT** button is pressed.

3. After the test has cycled completely through the characters, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.
Communication Tests

**NOTE:** These tests are only applicable to units that are equipped with the M-3931 HMI Module.

**COM1 and COM2 Test**

The **COM1 and COM2 LOOPBACK TESTS** allow the user to test the front and rear RS-232 ports for proper operation. These tests require the use of a loop-back plug (see Figure 6-5).

The loopback plug consists of a DB9P connector (male) with pin 2 (RX) connected to pin 3 (TX) and pin 7 (RTS) connected to pin 8 (CTS). No other connections are necessary.

![Figure 6-5 COM1/COM2 Loopback Plug](image-url)

1. When **DISPLAY TEST** is displayed, press the right arrow button until the following is displayed:
   
   **COM1 LOOPBACK TEST**

   ![button disp COM1 com2](image-url)

2. Press **ENTER**. The following is displayed:
   
   **COM1 LOOPBACK TEST**

   ![CONNECT LOOPBACK PLUG](image-url)

3. Connect the loopback plug to **COM1**, the front-panel RS-232 Connector.
4. Press **ENTER**. After the test, the following is displayed:
   
   **COM1 LOOPBACK TEST**

   ![19200 PASS...](image-url)

5. Press **ENTER** to test each of the baud rates. When all baud rates have been tested, press **ENTER**. The following is displayed:
   
   **COM1 LOOPBACK TEST**

   ![DONE-](image-url)

6. Press the right arrow until the following is displayed:
   
   **COM2 LOOPBACK TEST**

   ![button disp com1 COM2](image-url)

7. Repeat Steps 2-5 to test **COM2**.

**COM3 Test (2-Wire)**

**NOTE:** This test requires a PC with an RS-485 converter and terminal emulator software installed.

The COM3 ECHO TEST 2 WIRE allows the user to test the RS-485 rear terminal connections for proper operation.

1. When **COM2 LOOPBACK TEST** is displayed, press the right arrow button until the following is displayed:
   
   **COM3 ECHO TEST 2WIRE**

   ![COM3 clock led coil →](image-url)

2. Press **ENTER**. The following is displayed:
   
   **COM3 ECHO TEST 2WIRE**

   IDLING....9600, N, 8, 1

3. On the rear of the unit, connect a PC to the relay at terminals 3 (-) and 4 (+) using an RS-485 converter set for 2 wire operation. See Figure 6-6 for diagram.

![Figure 6-6 RS-485 2-Wire Testing](image-url)
4. Set the following PC communications parameters:
   - Baud Rate: 9600
   - Parity: None
   - Data Bits: 8
   - Stop Bits: 1
   - Duplex: Half

5. Open the terminal emulator program on the PC and open the COM port for the RS-485 converter.

6. Press a key on the PC keyboard. Verify that the character pressed shows temporarily on the display of the relay and appears on the PC monitor.

7. When communications has been verified, press **EXIT**. The following is displayed:

   ```plaintext
   COM3 ECHO TEST 2WIRE
   -DONE-
   ``

8. Close the COM port on the PC and exit the terminal emulator program.

**Clock Test**

1. When **COM3 ECHO TEST 2WIRE** is displayed, press the right arrow button until the following is displayed:

   ```plaintext
   CLOCK TEST
   ← com3 CLOCK led cal →
   ``

2. Press **ENTER**. A display similar to the following is shown:

   ```plaintext
   CLOCK TEST
   03-JAN-1998 09:00:00.000
   ``

3. Press **ENTER** again to toggle the clock. If the clock is running, it will stop. If clock has stopped, it will start. The clock stop case is shown below.

   ```plaintext
   CLOCK TEST
   -CLOCK START-
   ``

4. Press **ENTER** and verify the relay clock is running. A display similar to the following is shown with the seconds counting:

   ```plaintext
   CLOCK TEST
   03-JAN-1998 09:0035.000
   ```

   **NOTE:** If the unit is removed from service or is to be without power for long periods of time, the clock should be stopped to preserve battery life.

5. Press **ENTER** again to stop the clock. The following is displayed:

   ```plaintext
   CLOCK TEST
   -CLOCK STOP-
   ``

6. A display similar to the following is shown with the seconds stopped:

   **NOTE:** When the relay clock is stopped, the seconds will be displayed as 80.

   ```plaintext
   CLOCK TEST
   03-JAN-09:01:80.000
   ``

7. Repeat steps 2 and 3 to restart the clock.

**Flash Relay OK LED**

The Flash Relay OK LED function is provided to enable or disable the flashing of the Relay OK LED. This function only has effect while the relay is in normal operating mode and will not be noticed while in Diagnostic Mode.

The operation of this function may be tested by completing the following steps:

1. When **CLOCK TEST** is displayed, press the right arrow button until the following is displayed:

   ```plaintext
   FLASH RELAY OK LED
   ← com3 clock LED cal →
   ``

2. Press **ENTER**. The following is displayed:

   ```plaintext
   FLASH RELAY OK LED
   off ON
   ```

   **CAUTION:** Programming the OK LED to remain illuminated indefinitely is not recommended. It is possible that the LED OK would remain illuminated even if the relay failed.
3. Use the right arrow key to select “ON”, and press ENTER. The unit will display

FLASH RELAY OK LED
DONE

4. Press EXIT to return to the former menu.

5. Repeat step 2 and use the left arrow key to select “OFF”, and press ENTER.

6. Press EXIT to return to the former menu.

Factory Use Only
This function is provided to allow access by factory personnel.

**NOTE:** Must scroll through:

AUTO CALIBRATION
← com3 clock led CAL →

to reach FACTORY USE ONLY menu.

FACTORY USE ONLY
FACTORY
6.3 Automatic Calibration

The M-3311A Transformer Protection Relay has been fully calibrated at the factory. There is no need to recalibrate the unit prior to installation. Further calibration is only necessary if a component was changed.

For units equipped with an optional M-3931 HMI:

**WARNING:** All relay functions and protection will be inoperative while the relay is in Diagnostic Mode.

1. Navigate to the Auto Calibration function in the Diagnostic Mode menu. The following is displayed:

   AUTO CALIBRATION
   ← com3 clock led CAL →

2. Press ENTER. The following is displayed:

   CONNECT REFERENCE INPUTS
   PRESS ENTER TO CALIBRATE

3. Connect voltage inputs in parallel to terminal 36,64 (neutral) and terminal 37,65 (hot) and apply 120.00 (±0.01) VAC θ.

4. Connect all current inputs in series (I_a W_1 = I_b W_2 = I_c W_3 = I_a W_4 = I_b W_5).

5. Apply 5.00 (±0.01) Amps θ. For 1 Amp CT models, use 1.0 (±0.01) Amps θ.

6. Press ENTER to start calibration. While the unit is calibrating, the display will show:

   AUTO CALIBRATION
   -WAIT-

7. When the calibration is complete, unit will display:

   AUTO CALIBRATION
   -DONE-

8. The calibration can be verified by reading the Status (see the Monitor Status menu, and Monitor Status/Metering in Chapter 3).

For units without the optional M-3931 HMI:

It is possible to autocalibrate M-3311A units that are not equipped with the optional M-3931 HMI. The procedure is similar to HMI equipped units:

1. Remove power from the unit.
2. Place unit in calibrate mode by configuring the proper dip switches (see Table 5-2).
3. Connect voltage inputs.
4. Connect all current inputs in series.
5. Apply power to the unit. The DIAG LED will illuminate when operation is complete.
6. Remove power from the unit, then return dip switches to RUN position.
6.4 Input Configurations

Phase angles shown here represent leading angles as positive and lagging angles as negative. Some test equipment manufacturers use lagging angles as positive, in which case $I_{BW1} = \pm 120^\circ$ and $I_{CW1} = \pm 240^\circ$. Other current phase angles should be adjusted in the same manner.

Figure 6-9 Voltage Input, Configuration V1 (2 Winding)

Figure 6-10 Voltage Input, Configuration V2 (2 Voltage Option)

Figure 6-11 Voltage Input, Configuration V3 (4 Voltage Option)

Figure 6-12 Voltage Input, Configuration V4 (2 Voltage Option $V_G$ or Phase)

Figure 6-13 Current Inputs, Configuration C1 (4 Winding)

Figure 6-14 Current Inputs, Configuration C2 (4 Winding)

Figure 6-15 Current Inputs, Configuration C3 (4 Winding)
Current Input 1

Current Input 2

Current Input 3

Current Input 4

Figure 6-16  Current Inputs, Configuration C4 (4 Winding)

Figure 6-17  Current Inputs, Configuration C5 (4 Winding)

Figure 6-18  Current Configuration C6 (4 Winding)
Figure 6-19  Current Inputs, Configuration C7 (2 Winding)
Figure 6-20  Current Inputs, Configuration C8 (3 Winding)
Figure 6-21  Two Voltage Inputs, Configuration V5 (2 Winding)

Figure 6-22  Two Voltage Inputs, Configuration V6 (3 Winding)

Figure 6-23  Four Voltage Inputs, Configuration V7 (2 Winding)

Figure 6-24  Four Voltage Inputs, Configuration V8 (3 Winding)
# 6.5 Protection Elements

<table>
<thead>
<tr>
<th>PROTECTION FUNCTION</th>
<th>NUMBER OF ELEMENTS</th>
<th>WINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Based</td>
<td>24DT #1, #2</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>24IT #1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>27 #1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>59 #1, #2, #3</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>59G #1, #2, #3, #4</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>81 #1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Current Based</td>
<td>#1</td>
</tr>
<tr>
<td></td>
<td>46DT #1</td>
<td>#1</td>
</tr>
<tr>
<td></td>
<td>46IT #1</td>
<td>#1</td>
</tr>
<tr>
<td></td>
<td>49 #1, #2, #3, #4</td>
<td>#1, #2, #3, #4</td>
</tr>
<tr>
<td></td>
<td>50 #1</td>
<td>Sum1, Sum2, W1, W2</td>
</tr>
<tr>
<td></td>
<td>50N</td>
<td>W1/W2</td>
</tr>
<tr>
<td></td>
<td>50G</td>
<td>W1/W2</td>
</tr>
<tr>
<td></td>
<td>51 #1</td>
<td>Sum1, Sum2, W1, W2</td>
</tr>
<tr>
<td></td>
<td>51N</td>
<td>Sum1, Sum2, W1, W2</td>
</tr>
<tr>
<td></td>
<td>51G</td>
<td>W2</td>
</tr>
<tr>
<td></td>
<td>50BF</td>
<td>W2</td>
</tr>
<tr>
<td></td>
<td>87T</td>
<td>W2</td>
</tr>
<tr>
<td></td>
<td>87H</td>
<td>W2</td>
</tr>
<tr>
<td></td>
<td>87GD</td>
<td>#1, #2</td>
</tr>
</tbody>
</table>

*Table 6-3: List of Protection Elements for 2 Winding Version (Four Voltages)*
<table>
<thead>
<tr>
<th>PROTECTION FUNCTION</th>
<th>NUMBER OF ELEMENTS</th>
<th>WINDINGS</th>
<th>SELECTABLE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Based</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24DT</td>
<td>#1, #2</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>24IT</td>
<td>#1</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>#1, #2, #3</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>#1, #2, #3</td>
<td></td>
<td>N/A</td>
<td>Only for 4 Voltage Inputs selectable as: V_{ph}, V_1, or V_2</td>
</tr>
<tr>
<td>59G</td>
<td>#1, #2, #3</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>#1, #2, #3, #4</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Current Based</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46DT</td>
<td>#1</td>
<td></td>
<td>W2/W3</td>
<td></td>
</tr>
<tr>
<td>46IT</td>
<td>#1</td>
<td></td>
<td>W2/W3</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>#1</td>
<td></td>
<td>Sum1, Sum2, W1, W2, W3</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>#1, #2, #3, #4, #5, #6</td>
<td></td>
<td>Sum1, Sum2, W1, W2, W3</td>
<td></td>
</tr>
<tr>
<td>50N</td>
<td>#1, #2, #3, #4, #5, #6</td>
<td></td>
<td>Sum1, Sum2, W1, W2, W3</td>
<td></td>
</tr>
<tr>
<td>50G</td>
<td>#1, #2</td>
<td></td>
<td>W2/W3</td>
<td></td>
</tr>
<tr>
<td>50BF</td>
<td></td>
<td></td>
<td>W1/W2/W3</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>#1, #2, #3</td>
<td></td>
<td>Sum1, Sum2, W1, W2, W3</td>
<td></td>
</tr>
<tr>
<td>51N</td>
<td>#1, #2, #3</td>
<td></td>
<td>Sum1, Sum2, W1, W2, W3</td>
<td></td>
</tr>
<tr>
<td>51G</td>
<td></td>
<td></td>
<td>W2/W3</td>
<td></td>
</tr>
<tr>
<td>87T</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87GD</td>
<td>#1, #2</td>
<td></td>
<td>W2/W3</td>
<td></td>
</tr>
</tbody>
</table>

Table 6-4: List of Protection Elements for 3 Winding Version (Four Voltages)
### 6.6 Terminal Connections

#### Table 6-5 Terminal Connections for 2 Winding Current Inputs

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAW1 (+)</td>
<td>47</td>
</tr>
<tr>
<td>IAW1 (-)</td>
<td>46</td>
</tr>
<tr>
<td>IBW1 (+)</td>
<td>49</td>
</tr>
<tr>
<td>IBW1 (-)</td>
<td>48</td>
</tr>
<tr>
<td>ICW1 (+)</td>
<td>51</td>
</tr>
<tr>
<td>ICW1 (-)</td>
<td>50</td>
</tr>
<tr>
<td>IAW2 (+)</td>
<td>55</td>
</tr>
<tr>
<td>IAW2 (-)</td>
<td>54</td>
</tr>
<tr>
<td>IBW2 (+)</td>
<td>57</td>
</tr>
<tr>
<td>IBW2 (-)</td>
<td>56</td>
</tr>
<tr>
<td>ICW2 (+)</td>
<td>59</td>
</tr>
<tr>
<td>ICW2 (-)</td>
<td>58</td>
</tr>
<tr>
<td>IGW2 (+)</td>
<td>53</td>
</tr>
<tr>
<td>IGW2 (-)</td>
<td>52</td>
</tr>
</tbody>
</table>

#### Table 6-6 Terminal Connections for 3 Winding Current Inputs

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAW1 (+)</td>
<td>39</td>
</tr>
<tr>
<td>IAW1 (-)</td>
<td>38</td>
</tr>
<tr>
<td>IBW1 (+)</td>
<td>41</td>
</tr>
<tr>
<td>IBW1 (-)</td>
<td>40</td>
</tr>
<tr>
<td>ICW1 (+)</td>
<td>43</td>
</tr>
<tr>
<td>ICW1 (-)</td>
<td>42</td>
</tr>
<tr>
<td>IAW2 (+)</td>
<td>45</td>
</tr>
<tr>
<td>IAW2 (-)</td>
<td>44</td>
</tr>
<tr>
<td>IBW2 (+)</td>
<td>47</td>
</tr>
<tr>
<td>IBW2 (-)</td>
<td>46</td>
</tr>
<tr>
<td>ICW2 (+)</td>
<td>49</td>
</tr>
<tr>
<td>ICW2 (-)</td>
<td>48</td>
</tr>
<tr>
<td>IGW2 (+)</td>
<td>51</td>
</tr>
<tr>
<td>IGW2 (-)</td>
<td>50</td>
</tr>
<tr>
<td>IAW3 (+)</td>
<td>53</td>
</tr>
<tr>
<td>IAW3 (-)</td>
<td>52</td>
</tr>
<tr>
<td>IBW3 (+)</td>
<td>55</td>
</tr>
<tr>
<td>IBW3 (-)</td>
<td>54</td>
</tr>
<tr>
<td>ICW3 (+)</td>
<td>57</td>
</tr>
<tr>
<td>ICW3 (-)</td>
<td>56</td>
</tr>
<tr>
<td>IGW3 (+)</td>
<td>59</td>
</tr>
<tr>
<td>IGW3 (-)</td>
<td>58</td>
</tr>
</tbody>
</table>
### Table 6-7 Terminal Connections for Two Voltage Inputs (2 Winding)

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VØ (+)</td>
<td>39</td>
</tr>
<tr>
<td>VØ (-)</td>
<td>38</td>
</tr>
<tr>
<td>VG (+)</td>
<td>45</td>
</tr>
<tr>
<td>VG (-)</td>
<td>44</td>
</tr>
</tbody>
</table>

### Table 6-8 Terminal Connections for Two Voltage Inputs (3 Winding)

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VØ (+)</td>
<td>65</td>
</tr>
<tr>
<td>VØ (-)</td>
<td>64</td>
</tr>
<tr>
<td>VG (+)</td>
<td>71</td>
</tr>
<tr>
<td>VG (-)</td>
<td>70</td>
</tr>
</tbody>
</table>

### Table 6-9 Terminal Connections for Four Voltage Inputs (2 Winding)

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA (+)</td>
<td>39</td>
</tr>
<tr>
<td>VA (-)</td>
<td>38</td>
</tr>
<tr>
<td>VB (+)</td>
<td>41</td>
</tr>
<tr>
<td>VB (-)</td>
<td>40</td>
</tr>
<tr>
<td>VC (+)</td>
<td>43</td>
</tr>
<tr>
<td>VC (-)</td>
<td>42</td>
</tr>
<tr>
<td>VG (+)</td>
<td>45</td>
</tr>
<tr>
<td>VG (-)</td>
<td>44</td>
</tr>
</tbody>
</table>

### Table 6-10 Terminal Connections for Four Voltage Inputs (3 Winding)

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TERMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA (+)</td>
<td>65</td>
</tr>
<tr>
<td>VA (-)</td>
<td>64</td>
</tr>
<tr>
<td>VB (+)</td>
<td>67</td>
</tr>
<tr>
<td>VB (-)</td>
<td>66</td>
</tr>
<tr>
<td>VC (+)</td>
<td>69</td>
</tr>
<tr>
<td>VC (-)</td>
<td>68</td>
</tr>
<tr>
<td>VG (+)</td>
<td>71</td>
</tr>
<tr>
<td>VG (-)</td>
<td>70</td>
</tr>
</tbody>
</table>
### 6.7 Accuracy For Voltage Protection Functions

<table>
<thead>
<tr>
<th>Voltage Function</th>
<th>2/3 Winding Version Two Voltage Inputs (Vₒ, Vₐ)</th>
<th>2/3 Winding Version Four Voltage Inputs (Vₒ, Vₐ, Vₕ, Vₗ)</th>
<th>4 Winding Version Two Voltage Inputs (Vₒ, Vₐ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24DT</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td></td>
<td>• Pickup = ±1%</td>
<td>• Pickup = ±1%</td>
<td>• Pickup = ±1%</td>
</tr>
<tr>
<td></td>
<td>• Time Delay = +25 cycles</td>
<td>• Time Delay = +25 cycles</td>
<td>• Time Delay = +25 cycles</td>
</tr>
<tr>
<td>24T</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td></td>
<td>• Pickup = ±1%</td>
<td>• Pickup = ±1%</td>
<td>• Pickup = ±1%</td>
</tr>
<tr>
<td></td>
<td>• Reset Rate = ±0.06 s or ±1%</td>
<td>• Reset Rate = ±0.06 s or ±1%</td>
<td>• Reset Rate = ±0.06 s or ±1%</td>
</tr>
<tr>
<td>27</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td></td>
<td>• Pickup = ±0.5 Volts</td>
<td>• Pickup = ±0.5 Volts</td>
<td>• Pickup = ±0.5 Volts</td>
</tr>
<tr>
<td></td>
<td>• Inhibit = ±0.5 Volts</td>
<td>• Inhibit = ±0.5 Volts</td>
<td>• Inhibit = ±0.5 Volts</td>
</tr>
<tr>
<td></td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
</tr>
<tr>
<td>59</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ, Vₕ, or Vₗ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td>59G</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td></td>
<td>• Pickup = ±0.5 Volts or ±0.05%</td>
<td>• Pickup = ±0.5 Volts or ±0.05%</td>
<td>• Pickup = ±0.5 Volts or ±0.05%</td>
</tr>
<tr>
<td></td>
<td>• Time Delay = ±1 cycle or ±1%</td>
<td>• Time Delay = ±1 cycle or ±1%</td>
<td>• Time Delay = ±1 cycle or ±1%</td>
</tr>
<tr>
<td>59X</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vₐ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td>81</td>
<td>Voltage source = Vₒ</td>
<td>Voltage source = Vᵣ</td>
<td>Voltage source = Vₒ</td>
</tr>
<tr>
<td></td>
<td>• Pickup = ±0.1 Hz</td>
<td>• Pickup = ±0.1 Hz</td>
<td>• Pickup = ±0.1 Hz</td>
</tr>
<tr>
<td></td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
<td>• Time Delay = -1 to +3 cycles, or ±1%</td>
</tr>
</tbody>
</table>

*Table 6-11 Accuracy for Voltage Protection Functions*
6.8 Functional Test Procedures

The functional tests procedures presented here are for the four winding version of the relay. Use the tables and figures provided in Section 6 to test the two and three winding versions. Tables 6-3 and 6-4 provide a list of the protection elements for the two and three winding versions. Tables 6-5 and 6-6 provide the terminal connections for the two and three winding versions current inputs. Tables 6-7 through 6-10 provide the terminal connections for the two and three winding versions voltage inputs. Table 6-11 provides the accuracy to test voltage protection for relays with two or four voltage inputs. Section 6.4 provides all of the various voltage and current configurations for two, three and four winding relays as well as two or four voltage inputs.

This section details the test quantities, inputs and procedures for testing each function of the relay. The purpose is to confirm the function’s designated output operation, the accuracy of the magnitude pickup settings, and the accuracy of time delay settings. Whereas the first test described, “Power On Self Test,” does not require electrical quantity inputs, all other functional tests require inputs, and the necessary connection configurations are shown. IEEE Time Current equations are illustrated in the individual function tests where applicable.

▲ CAUTION: Care must be taken to reset or re-enable any functions that have been changed from the intended application settings when the test procedures are complete. When a function is re-enabled, both output arrangements and blocking input designations must be reestablished.

In many test cases, it will be necessary to disable other functions not being tested at the time. This action is to prevent the operation of multiple functions with one set of input quantities which could cause confusion of operation of outputs or timers.

The complete description of the method to disable/enable functions and the method to enter setting quantities is found in detail in Section 4.4, System Setpoints.

It is desirable to record and confirm the actual settings of the individual functions before beginning test procedures. Use the SETPOINTS AND SETTINGS RECORD FORM found in Appendix A to record settings.

The tests are described in this section in ascending function number order as in Chapter 4, System Setup and Setpoints.

During the lifetime of the relay, testing of individual functions due to changes in application settings will be more likely than an overall testing routine. An index of the individual test procedures is illustrated at the beginning of this chapter.

It may be desirable to program all test settings in an alternate profile, or to save the relay settings in IPScom® to preserve a desired setup.

Many options for test sequences and methods are possible. As an example, the operation of the output contacts can be tested along with the operation of the LED’s in the Diagnostic Test Procedures. The operation of the output contacts may also be confirmed with the LED and function operation during Functional Test Procedures, Section 6.8, if desired.

If timer quantities are to be checked, the timer must be activated by the appropriate output contacts. The contact pin numbers are enumerated in Table 6-1, Output Contacts.

It is suggested that copies of the following be made for easy referral during test procedures:
- Input Configurations - pages 6–10 through 6–14
- Output Test (Relay)- page 6–3
- Relay Configuration Table - page A–2 and A–3
- Setpoint & Timing Record Form - pages A–4 to A–47

Summing

The 49, 50, 50N, 51 and 51N protection functions can be set so that they operate on the summed current of selected windings. The 87GD can also be set so the function uses summed current for the source of 3I₀. If summing is used for any of these functions either inject current individually into each winding and repeat the pickup tests for each of the selected windings or inject current into the selected windings such that the sum total is above the pickup.
Power On Self Tests

VOLTAGE INPUTS: None
CURRENT INPUTS: None

1. Apply proper power to the power input terminals: 60 (hot) and 61 (neutral)
2. The unit will display:

```
POWER ON SELFTESTS
XXXXXXXXxxxxxxxxxxxxxxxxx
```

3. All LEDs will illuminate simultaneously for approximately 1 second. The POWER and RELAY OK LEDs will remain illuminated; the rest of the LEDs will extinguish.
4. The unit will display:

```
POWER ON SELFTESTS
PASS
```

The model number:

```
BECKWITH ELECTRIC CO.
M-3311A
```

where “xx.xx.xx” signifies the software revision;

```
BECKWITH ELECTRIC CO.
D-0179Vxx.xx.xx
```

where “xxx” signifies the unit serial number:

```
BECKWITH ELECTRIC CO.
SERIAL NUMBER XXX
```

The POWER LED will illuminate. The RELAY OK LED will flash (or remain illuminated as programmed in the Setup menu) and the BREAKER CLOSED LED will remain illuminated. The Power On Self-Test ends with the system date and time and the default logo. Any recorded targets are then displayed.
24DT Volts/Hz Overexcitation Definite Time (#1 or #2)

Relays with four voltage inputs use two positive-sequence voltages for 24DT#1 and #2. Refer to Table 6-11 for the accuracy when testing relays with four voltage inputs.

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** None

**TEST SETTINGS:**
- **Definite Time Pickup**: \( P \) % (100 to 200)
- **Time Delay**: \( D \) Cycles (30 to 8160)
- **Programmed Outputs**: \( Z \) OUT (1 to 8)
- **Expanded I/O**: (9 to 16)

  - Function 24DT #1 or 2: Disable
  - Function 24IT, 27: Disable
  - Function 81O/U: Disable
  - Function 59G: Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the function being tested should be enabled; the other should be disabled.
3. Connect voltage input in Configuration V1 designated previously. Set the V.T. Configuration (Section 4.2) as \( V_a \). Refer to Section 6.4, Input Configurations, for configurations.
4. The Volts/Hz pickup level at a percentage setting of nominal frequency (50 or 60Hz) is Definite Time Pickup = \( \left( \frac{P}{100} \right) \times \text{Nominal Voltage} \), see example below. The Nominal Values have been programmed in the Setup System data described in Section 4.2, Setup System, and are recorded on the SYSTEM COMMUNICATION SETUP & SETUP SYSTEM RECORD FORM. Test voltage levels may be at any percentage of Nominal Voltage. Choose 4 or 5 test levels and calculate for each.

<table>
<thead>
<tr>
<th>150% V/Hz ( \div 100 \times 120 )</th>
<th>=180 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup (( P )) setting divided by 100 times equals voltage level Nominal Voltage</td>
<td></td>
</tr>
</tbody>
</table>

5. **Voltage Pickup Test:**
   a. Apply voltage to input contacts at a level 10% lower than the pickup level calculated in Step 4.
   b. Press and hold the TARGET RESET button in, then slowly increase the voltage until the 24DT/IT OVEREXCITATION LED illuminates or the pickup indicator operates on the computer target screen. The voltage level of operation will be \( P \% \pm 1\% \).
   c. Release the TARGET RESET button, then decrease the voltage. The OUTPUT LED will extinguish.
   d. Press the TARGET RESET button to remove targets.

6. **Frequency Pickup Test:**
   a. Apply voltage to input contacts at the Nominal Voltage level.
   b. Press and hold the TARGET RESET button in, then slowly decrease the frequency until the 24DT/IT OVEREXCITATION LED illuminates or the pickup indicator operates on the computer target screen. The voltage level of operation will be \( P \% \pm 1\% \).
   c. Release the TARGET RESET button, then increase frequency to 1% above the pickup frequency. The OUTPUT LED will extinguish.
   d. Press the TARGET RESET button to remove targets.

<table>
<thead>
<tr>
<th>60 ( \div 150% \times 100 )</th>
<th>=40Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Frequency Pickup (( P )) setting times 100 equals frequency level</td>
<td></td>
</tr>
</tbody>
</table>

7. **Timer Test:** With output contacts connected to the timer, apply the calculated voltage from Step 4 and start timing. The contacts will close after D cycles within \( \pm 25 \) cycles.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
24IT Volts/Hz Overexcitation Inverse Time

Relays with four voltage inputs use the positive-sequence voltages for 24IT. Refer to Table 6-11 for the accuracy when testing relays with four voltage inputs.

VOLTAGE INPUTS: Configuration V1
CURRENT INPUTS: None

TEST SETTINGS:
- Inverse Time Pickup P % (100 to 150)
- Inverse Time Curve C (1 to 4)
- Time Dial Curve #1 K (1 to 100)
- Curves #2 to #4 (0.0 to 9.0)
- Reset Rate R Sec. (1 to 999)
- Programmed Outputs Z OUT (1 to 8)
- Expanded I/O (9 to 16)
- Functions 24DT, 27 Disable
- Functions 81O/U Disable
- Function 59G Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested.
3. Connect voltage input in Configuration V1 designated previously. Set the V.T. Configuration (Section 4.2) as VA. Refer to Section 6.4, Input Configurations, for configurations.
4. The Volts/Hz pickup level at a percentage setting of nominal frequency (50 or 60 Hz) is Definite Time Pickup = (P % ÷ 100) X (Nominal Voltage), see example below. The Nominal Values have been programmed in the Setup System data described in Section 4.2, Setup System, and are recorded on the SYSTEM COMMUNICATION SETUP & SETUP SYSTEM RECORD FORM. Test voltage levels may be at any percentage of Nominal Voltage. Choose 4 or 5 test levels and calculate for each.

<table>
<thead>
<tr>
<th>150% V/Hz ÷ 100 x 120 =180 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup (P) setting divided by100 times equals voltage level Nominal Voltage</td>
</tr>
</tbody>
</table>

5. Test voltage levels may be at any percentage of Nominal Voltage that are a minimum of 5% higher than the selected pickup percentage, P %. It is suggested that 4 or 5 test levels be chosen and voltage level and operating time be calculated for each from the table below.

6. **Timer Test:** With output contacts connected to the timer, apply the calculated voltage from Step 4 and start timing. The operating time will be read from the appropriate Inverse Curve Family and K (Time Dial) setting (refer to Appendix D, Inverse Time Curves). The measured time should be within the time corresponding to ±1% of pickup value. Repeat this step for all chosen test levels. The curve portion extending lower than P% V/Hz values is inactive and can be ignored.

\[
t = \frac{0.03 \times K}{\left(\frac{V/Hz\%}{100}\right)}
\]

<table>
<thead>
<tr>
<th>Curve 1</th>
<th>Curve 2</th>
<th>Curve 3</th>
<th>Curve 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = time in minutes K = Time Dial setting V/Hz in percent (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. **Reset Rate Test:** To test the reset rate, begin timing immediately when the input voltage is reduced below pickup value. Holding the TARGET RESET button in, stop timing when 24DT/IT OVEREXCITATION LED extinguishes. The time will be the Reset Rate (R) within ±1 second or ±1%.

8. If re-testing is required, the unit should be powered down or wait for the programmed Reset time period before the next test to ensure complete resetting of the timer.

9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
27 Phase Undervoltage

VOLTAGE INPUTS: Configuration V1
CURRENT INPUTS: None
TEST SETTINGS:

- Pickup Volts (5 to 140)
- Inhibit Setting Volts (5 to 140)
- Time Delay Cycles (1 to 8160)
- Programmed Outputs Z OUT (1 to 8)
- Expanded I/O (9 to 16)
- Functions 24DT, 24IT Disable
- Function 81O/U Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested.
3. Connect voltage input in Configuration V1 designated previously. Set the V.T. Configuration (Section 4.2) as Vn. Refer to Section 6.4, Input Configurations, for configurations.
4. Set Phase Voltage Inputs at 1.2 x P volts at the Nominal Frequency.
5. **Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly decrease the input phase voltage until the 27 PHASE UV LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be P volts ±0.5 V.
   b. Release the TARGET RESET button, then increase the input to the Nominal Voltage. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets.
6. **Undervoltage Inhibit Test:** Slowly decrease the input voltage until the 27 PHASE UV LED extinguishes. The level will be U volts ±0.5 volts.
7. **Time Test:** With output contacts connected to the timer and inhibit setting disabled, apply approximately 50% of P volts and start timing. The contacts will close after D cycles within –1 or +3 cycles or ±1%.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
46DT Negative Sequence Overcurrent Definite Time

**VOLTAGE INPUTS:** Configuration V1

**CURRENT INPUTS:** Configuration C2, C3 or C4 (MODIFIED)

**TEST SETTINGS:**
- Definite Time Pickup: P Amps (0.1 to 20) 1 Amp CT Rating (0.02 to 4)
- Time Delay: D Cycles (1 to 8160)
- Programmed Outputs: Z OUT (1 to 8) Expanded I/O (9 to 16)

- Functions 46IT, 49 Disable
- Function 50BF Disable
- Function 50N Disable
- Functions 50W2, 50W3, 50W4 Disable
- Function 51 Disable
- Function 51N Disable
- Function 87H/T Disable
- Function 87GD Disable

**NOTE:** Although a voltage input is not required for the testing of the 46 Function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions operate during these tests they should also be disabled for the test and enabled after the tests are complete.

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 and C2 (MODIFIED) as designated previously. Refer to Section 6.4, Input Configurations for configurations. The modification to C2 is to exchange Current Input 2 and 3 (B current = Input 3 and C current = Input 2). Modification is for ABC phase rotation. Use ABC connection for ACB phase rotation. Set Voltages = Nominal Voltage. Configuration will be Phase B current from Source 3 and Phase C current from Source 2.

**NOTE:** For proper testing use I ≤ 3 X CT rating.

4. **Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly increase the 3-phase currents until the 46DT/IT NEG SEQ O/C (46DT/IT NEG SEQ O/C) LED illuminates or the pickup indicator operates on the computer screen. The level of operation will be equal to Pickup Current P ± 0.1 Amp (± 0.02 Amp 1 A CT) or ±3%, whichever is higher.
   b. Release the TARGET RESET button, then decrease the currents to a level below the Pickup Current. The OUTPUT LED will extinguish.
   c. Press the TARGET RESET button to remove targets.

5. **Time Test:** With output contacts connected to the timer, apply current of at least 1.1 X Pickup (P) and start timing. The contacts will close after (D) cycles within –1 or +3 cycles or ±1%.
6. Reduce input currents to 0 Amps
7. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
8. Repeat steps 3, 4, 5, and 6 for Winding 3 and Winding 4.
9. If testing is complete, enable any functions disabled for this test.
46IT Negative Sequence Overcurrent Inverse Time

**VOLTAGE INPUTS:**  
Configuration V1

**CURRENT INPUTS:**  
Configuration C2, C3 or C4 (MODIFIED)

**TEST SETTINGS:**

- **Inverse Time Pickup:**  
  P Amps  
  1 Amp CT Rating  
  (0.50 to 5.00)  
  (0.10 to 1.00)

- **Standard Inverse Time Curves:**
  - Curve C  
  (1 to 4)

- **Time Dial:**  
  TD  
  (0.5 to 11.0)

- **IEC Inverse Time Curves:**
  - IEC Curve C  
  (5 to 8)

- **IEC Time Dial:**  
  TD  
  (0.05 to 1.10)

- **IEEE Inverse Time Curves:**
  - IEEE Curve C  
  (9 to 11)

- **IEEE Time Dial:**  
  TD  
  (0.5 to 15.0)

- **Programmed Outputs:**  
  Z OUT  
  (1 to 8)

  - Expanded I/O  
  (9 to 16)

- **Function 46DT, 49:** Disable
- **Function 50BF:** Disable
- **Function 50W2/W3/W4:** Disable
- **Function 50N:** Disable
- **Function 51, 51N:** Disable
- **Function 87H/87T:** Disable
- **Function 87GD:** Disable

1. Disable functions as shown. Refer to Section 4.4, **System Setpoints**, for procedures.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C2 (MODIFIED) as designated previously. Refer to Section 6.4, **Input Configurations**, for configurations. The modification to C2 is to exchange Current Input 2 and 3 (BΦ current = input 3 and CΦ current = input 2). This modification is for ABC phase rotation. Use ABC connection for ACB phase rotation. Set Voltages = Nominal Voltage.

**NOTE:** For proper testing use I ≤ 3 X CT rating.

4. **IEC Curve Testing:** Test current level may be chosen as a multiple of any level within the Pickup (P) range. Calculate the operating time for the applied current and appropriate Time Dial (TD) setting from the table below. Choose 4 or 5 test levels and calculate the operating times for each.

<table>
<thead>
<tr>
<th>IEC Standard Inverse</th>
<th>IEC Very Inverse</th>
<th>IEC Extremely Inverse</th>
<th>IEC Long Time Inverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = TD x ( \frac{0.14}{M^{0.52}} )</td>
<td>t = TD x ( \frac{13.5}{M^{0.5}} )</td>
<td>t = TD x ( \frac{80}{M^{0.75}} )</td>
<td>t = TD x ( \frac{120}{M^{0.75}} )</td>
</tr>
</tbody>
</table>

\( t = \) time in seconds \( TD = \) Time Dial setting \( M = \) current in multiples of pickup

\( ^{1}\)Either a Standard Curve, IEC Curve or IEEE Curve must be selected.
Standard Curve Testing: The operating time will be read from Appendix D, Negative Sequence Inverse Time Curves for the applied current and appropriate Time Dial (TD) setting. The curve portions extending to lower than P current values are inactive and can be ignored.

<table>
<thead>
<tr>
<th>IEEE</th>
<th>Moderately Inverse</th>
<th>IEEE</th>
<th>Very Inverse</th>
<th>IEEE</th>
<th>Extremely Inverse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( t = \frac{TD}{5} \times \left[ \frac{0.0515}{M^{0.83} - 1} + 0.114 \right] )</td>
<td></td>
<td>( t = \frac{TD}{5} \times \left[ \frac{19.61}{M^2 - 1} + 0.491 \right] )</td>
<td></td>
<td>( t = \frac{TD}{5} \times \left[ \frac{28.2}{M^2 - 1} + 0.1217 \right] )</td>
</tr>
</tbody>
</table>

\( t = \text{time in seconds} \quad TD = \text{Time Dial setting} \quad M = \text{current in multiples of pickup} \)

5. **Time Test:** With output contacts connected to the timer, apply currents equal to the multiple of the Inverse Time Pickup (P) and start timing. The operating time will be as calculated in Step 4, \( \pm 3 \) cycles or \( \pm 5\% \). Observe 46DT/IT NEG SEQ O/C (46 DT/IT NEG SEQ O/C) LED for pickup.

6. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

7. Repeat steps 3, 4 and 5 for Winding 3 and Winding 4.

8. If testing is complete, enable any functions disabled for this test.
49 Winding Thermal Protection

VOLTAGE INPUTS: None
CURRENT INPUTS: Configuration C1, C2, C3 or C4

TEST SETTINGS:
- Time Constant \( \tau \) Minutes (1.0 to 999.9)
- Max Overload Current \( I_{\text{max}} \) Amps (1.00 to 10.00)
- 1 Amp CT Rating (0.20 to 2.00)
- Current Selection (Sum1, Sum2, W1, W2, W3, W4)
- Programmed Outputs \( Z \) OUT (1 to 8)
- Expanded I/O (9 to 16)
- Function 46DT, 49 Disable
- Function 50BF Disable
- Function 50W2/W3/W4 Disable
- Function 51 Disable
- Function 87H/87T Disable
- Function 87GD Disable

Test Setup:
1. Determine the Function 49 Thermal Overload settings to be tested. This test requires that the values for the following elements (described in detail in Chapter 4, System Setup and Setpoints) be determined:
   - \( t \) = time to trip
   - \( \tau \) = time constant
   - \( I_{\text{load}} \) = relay current
   - \( I_{\text{preload}} \) = pre-load current
   - \( I_{\text{max}} \) = maximum allowed continuous overload current
2. Enter the Function 49 Thermal Overload settings to be tested utilizing either the HMI or IPScom Communications Software.
3. Connect test current inputs as shown in Figure 6-13, Current Inputs: Configuration C1.
4. Calculate \( t \) (time to trip in minutes) for the desired test settings as follows:
   \[
   t = \tau \times \text{Ln} \left( \frac{(I_{\text{load}}/I_{\text{max}})^2 - (I_{\text{preload}}/I_{\text{max}})^2}{(I_{\text{load}}/I_{\text{max}})^2 - 1} \right)
   \]
   Where: \( t \) = time to trip
   \( \tau \) = time constant
   \( I_{\text{load}} \) = relay current
   \( I_{\text{preload}} \) = pre-load current
   \( I_{\text{max}} \) = maximum allowed continuous overload current

Pickup Test:
1. Press and hold the TARGET RESET pushbutton, then slowly increase the current until the 49 WINDING THERMAL LED illuminates or the pickup indicator illuminates on the IPScom Function Status screen.
   The current level of operation will be \( I_{\text{max}} \) Amps ± 0.1 A or ±2% (±0.02 Amp for 1 A CT).
2. Release the TARGET RESET pushbutton, then decrease the current. The OUTPUT LED will extinguish.
3. Press TARGET RESET button to remove targets.
Time Test (Cold Start):

1. Connect a timer to output contacts (Z) so that the timer stops timing when the contacts (Z) close.

**NOTE:** The 49 Thermal Overload 49 current value can be obtained utilizing either the HMI (Status/Current Status) or IPScom Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Thermal Overload 49 current value. If the value is greater than 0.00 A, then remove power from the relay and then reapply power to reset the current value.

3. Apply a three phase current (I) to the relay greater than \(I_{\text{max}}\) Amps and start timing.
   
The time to trip should be \(t\) minutes ± 5 %.

Time Test (Preload):

1. Connect a timer to output contacts (Z) so that the timer stops timing when the contacts (Z) close.

**NOTE:** The 49 Thermal Overload 49 current value can be obtained utilizing either the HMI (Status/Current Status) or IPScom Communications Software (Relay/Monitor/Secondary Status).

2. Determine the 49 Thermal Overload 49 current value. If the value is greater than 0.00 A, then remove power from the relay and then reapply power to reset the current values.

3. Apply a three phase preload current to the relay equal to \(I_{\text{preload}}\) Amps and allow current readings to stabilize.

4. Apply a three phase current (I) to the relay greater than \(I_{\text{max}}\) Amps and start timing.
   
The time to trip should be \(t\) minutes ± 5 %.
50 Instantaneous Phase Overcurrent 1-8

VOLTAGE INPUTS: None
CURRENT INPUTS: Configurations C1, C2, C3, C4
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>50W1 Pickup P Amps</td>
<td>(1.0 to 100)</td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td>(0.2 to 20)</td>
</tr>
<tr>
<td>Current Selection</td>
<td>(Sum1, Sum2, W1, W2, W3, W4)</td>
</tr>
<tr>
<td>Time Delay D Cycles</td>
<td>(1 to 8160)</td>
</tr>
<tr>
<td>Programmed Outputs Z OUT</td>
<td>(1 to 8)</td>
</tr>
<tr>
<td>Expanded I/O</td>
<td>(9 to 16)</td>
</tr>
</tbody>
</table>

Function 27 Disable
Function 46DT Disable
Function 46IT Disable
Function 49 Disable
Function 50W2/W3 or W4 Disable
Function 50N Disable
Function 51 Disable
Function 51N Disable
Function 59G Disable
Function 87H/T Disable
Function 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect inputs in Configuration C1 as designated previously. Refer to Section 6.4, Input Configurations, for configurations.
4. Select W1 in Winding Config Setpoint.

**NOTE:** Special attention must be taken as to which winding is being tested and which winding is disabled when changing setpoints.

5. **Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly increase current input 3 (C phase) until the selected winding target LED illuminates or the pickup indicator operates on the computer target screen. The current level of operation will be (P) Amps ± 0.1 A (± 0.02 Amp 1 A CT) or ±3%.
   b. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets. This test may be repeated for each of the other phases.
6. **Time Test:** With output contacts (Z) connected to the timer, apply current 5% above pickup (P) Amps and start timing. The operating time will be (D) cycles within ±2 cycles or 1%.
8. **Winding Summing Test:** Later
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
50G Instantaneous Ground Overcurrent

**VOLTAGE INPUTS:** None

**CURRENT INPUTS:** Configuration C5

**TEST SETTINGS:**
- 50GW2/W3/W4 Pickup P Amps (1.0 to 100.0)
- 1 Amp CT Rating (0.2 to 20.0)
- Programmed Outputs Z OUT (1 to 8)
- Expanded I/O (9 to 16)
- Function 51G Disable
- Function 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, **System Setpoints**, for procedures.

2. Confirm settings to be tested.

3. Connect the inputs in Configuration C5 as designated previously. Refer to Section 6.4, **Input Configurations**, for configurations. The other current phases remain disconnected.

4. **Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly increase the $I_{GW2}$ current until the 50,50N #3,4/50GW2 INST OC LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be P Amps ± 0.1 A (± 0.02 Amp 1 A CT) or ± 3%.
   b. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets. This test may be repeated for each of the other phases.

5. **Time Test:** With output contacts (Z) connected to the timer, apply approximately 5% above pickup (P) amps and start timing. The operating time will be (D) cycles within ± 2 cycles or 1%.

6. Repeat Steps 4 and 5, using $I_{GW3}(I_{GW4})$. Observe the winding being tested LED for pickup.

7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
### 50N Instantaneous Residual Overcurrent

<table>
<thead>
<tr>
<th>VOLTAGE INPUTS:</th>
<th>Configuration V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRENT INPUTS:</td>
<td>As Described</td>
</tr>
<tr>
<td><strong>TEST SETTINGS:</strong></td>
<td></td>
</tr>
<tr>
<td>Pickup P Amps</td>
<td>(1.0 to 100.0)</td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td>(0.2 to 20.0)</td>
</tr>
<tr>
<td>Current Selection</td>
<td>(Sum1, Sum2, W1, W2, W3, W4)</td>
</tr>
<tr>
<td>Time Delay D Cycles</td>
<td>(1 to 8160)</td>
</tr>
<tr>
<td>Programmed Outputs Z OUT</td>
<td>(1 to 8)</td>
</tr>
<tr>
<td>Expanded I/O</td>
<td>(9 to 16)</td>
</tr>
<tr>
<td>Functions 46DT, 46IT</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 49</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 50 1-8</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 50BF</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 51</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 51N</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 87H/T</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 87GD</td>
<td>Disable</td>
</tr>
</tbody>
</table>

1. Disable functions as shown. Refer to Section 4.4, *System Setpoints*, for procedures.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 and C1 (MODIFIED). Set to Nominal Voltage. See Section 6.4, *Input Configurations*, for configurations. Modification to C1 is to set all three currents to phase angles, and inject equal magnitude.
4. Select W1 in Winding Config Setpoint.
5. **Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly increase the phase current in all three phases until the selected winding target LED illuminates or the pickup indicator operates on the computer target screen. The current level of operation will be (P) Amps ± 0.1 A (± 0.02 Amp 1A CT) or ± 3%.
   b. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets.
6. **Time Test:** With output contact (Z) connected to the timer, apply approximately 5% above pickup (P) amps, and start timing. The operating time will be (D) cycles within ± 2 cycles or 1%.
7. Repeat steps 4 and 5 using current Configuration C2 (modified), C3 (modified) and C4 (modified). Observe the selected winding target LED for pickup.
8. **Winding Summing Test:** Later
9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
50BF Breaker Failure

VOLTAGE INPUTS: Configuration V1
CURRENT INPUTS: As Described
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50BFW1/W2/W3/W4 Phase Pickup</td>
<td>P</td>
<td>Amps (0.10 to 10.00)</td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50BFW1/W2/W3/W4 Residual Pickup</td>
<td>N</td>
<td>Amps (0.10 to 10.0)</td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Delay</td>
<td>D</td>
<td>Cycles (1 to 8160)</td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z</td>
<td>OUT (1 to 8)</td>
</tr>
</tbody>
</table>

- Functions 46DT, 46IT Disable
- Function 49 Disable
- Function 50 1-8 Disable
- Function 50N Disable
- Function 51 Disable
- Function 51N Disable
- Function 87H/T Disable
- Function 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect inputs in Configuration C1 designated previously to test breaker failure for Winding 1. Refer to Section 6.4, Input Configurations, for configurations.

**NOTE:** For proper testing use \( I \leq 3 \times \text{CT rating} \).

4. Select an input for 50BF Input Initiate (IN) and enter the number.
5. Place a jumper from Terminal 11 (RTN) to the selected input terminal (IN) on the rear of the unit.
6. Verify that all Output Initiates (OUT) are disabled.
7. **Phase Pickup Test:**
   a. Press and hold the TARGET RESET button in, then slowly increase 3-phase current until the BREAKER FAILURE 50BF LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be \( P \text{ Amps} \pm 0.1 \text{ Amps (} \pm 0.02 \text{ Amps 1 A CT)} \) or \( \pm 2\% \).
   b. Release the TARGET RESET button, then decrease the 3-phase current. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets.
8. **Residual Pickup Test (Residual Current):**
   a. Set the 50BF phase to a current higher than the residual pickup to prevent the 50BF phase from tripping.
   b. Connect the inputs in Configuration C1 (modified), designated previously. The modification to C1 is to set all three currents to phase angle 0° and inject equal magnitude. In this configuration, the applied value of $I_0$ is equal to the applied 3-phase currents.
   c. Press and hold the **TARGET RESET** button in, then slowly increase Winding 1 currents until the **BREAKER FAILURE 50BF** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be $(P)$ Amps, ±0.1 Amps (±0.02 Amps 1 A CT) or ±2%.
   d. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   e. Press **TARGET RESET** button to remove targets.

   **NOTE:** When calculating values for residual current functions, the relay adds the three-phase currents ($3I_0 = I_A + I_B + I_C$). The relay operates on $I_0$.

9. **Timer Test:** With output contacts (Z) connected to the timer, apply approximately 110% of above Pickup $(P)$ Amps and start timing. The operating time will be $D$ cycles within −1 or +3 cycles or ±2%.

   **NOTE:** Both the 50BF Phase and Residual Functions use the same timer, therefore, it is only necessary to perform this test once.

10. Reduce input currents to 0 Amps.

11. Repeat Steps 4 through 10 using current Configuration C2 (modified), C3 (modified) and C4 (modified). Observe **BREAKER FAILURE 50BF** LED for pickup.

12. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
51 Inverse Time Phase Overcurrent

VOLTAGE INPUTS: None
CURRENT INPUTS: Configuration C1 or C2 or C3 or C4
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>51W1/W2/W3/W4 Pickup</td>
<td>P Amps</td>
<td>(0.50 to 12.00)</td>
</tr>
<tr>
<td>Current Selection</td>
<td>(Sum1, Sum2, W1, W2, W3, W4)</td>
<td></td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td></td>
<td>(0.1 to 2.4)</td>
</tr>
</tbody>
</table>

Standard Inverse Time Curves:

<table>
<thead>
<tr>
<th>Curve</th>
<th>TD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>TD</td>
<td>(1 to 4)</td>
</tr>
<tr>
<td>Time Dial TD</td>
<td>(0.5 to 11.0)</td>
<td></td>
</tr>
</tbody>
</table>

IEC Inverse Time Curves:

<table>
<thead>
<tr>
<th>Curve</th>
<th>TD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>TD</td>
<td>(5 to 8)</td>
</tr>
<tr>
<td>IEC Time Dial TD</td>
<td>(0.05 to 1.10)</td>
<td></td>
</tr>
</tbody>
</table>

IEEE Inverse Time Curves:

<table>
<thead>
<tr>
<th>Curve</th>
<th>TD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>TD</td>
<td>(9 to 11)</td>
</tr>
<tr>
<td>IEEE Time Dial TD</td>
<td>(0.5 to 15.0)</td>
<td></td>
</tr>
</tbody>
</table>

Programmed Outputs

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Expanded I/O</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z OUT</td>
<td></td>
<td>(1 to 8)</td>
</tr>
</tbody>
</table>

Functions

- 46DT, 46IT Disable
- 49 Disable
- 50 Disable
- 50BF Disable
- 50N Disable
- 51N Disable
- 87H/T Disable
- 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C1 as designated previously. See Section 6.4, Input Configurations, for configurations.
4. Select W1 in Winding Config Setpoint.

NOTE: Special Attention must be paid as to which winding is being tested and which windings are disabled.

5. Refer to Appendix D. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.
6. **Time Test:** With output contacts connected to the timer, apply currents used in calculations from step 4 and start timing. The operating time will be (D) cycles within ±3 cycles or 3% of calculated time. Repeat this step for each test level chosen. The tested points verify the operation of this function.
7. Observe selected winding target LED for pickup.

1Either a Standard Curve, IEC Curve or IEEE Curve must be selected.
8. Repeat Steps 4 and 5 using Configurations C2, C3 and C4. Observe the selected winding target LED for pickup.

9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
51G Inverse Time Ground Overcurrent

VOLTAGE INPUTS: None
CURRENT INPUTS: Configuration C5
TEST SETTINGS: 51GW2/W3/W4 Pickup P Amps (0.50 to 12.00)
1 Amp CT Rating (0.1 to 2.4)
Standard Inverse Time Curves:1 Curve C (1 to 4)
Time Dial TD (0.5 to 11.0)
IEC Inverse Time Curves:1 IEC Curve C (5 to 8)
IEC Time Dial TD (0.05 to 1.10)
IEEE Inverse Time Curves:1 IEEE Curve C (9 to 11)
IEEE Time Dial (0.5 to 15.0)
Programmed Outputs Z OUT (1 to 8)
Expanded I/O (9 to 16)
Function 50G Disable
Function 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C5 as designated previously. See Section 6.4, Input Configurations, for configurations.
4. Refer to Appendix D. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.

\[
\begin{align*}
\text{IEC Standard Inverse} & : t = TD \times \left[ \frac{0.14}{M^{0.02} - 1} \right] \\
\text{IEC Very Inverse} & : t = TD \times \left[ \frac{13.5}{M - 1} \right] \\
\text{IEC Extremely Inverse} & : t = TD \times \left[ \frac{80}{M^2 - 1} \right] \\
\text{IEC Long Time Inverse} & : t = TD \times \left[ \frac{120}{M - 1} \right]
\end{align*}
\]

\[
\begin{align*}
\text{IEE Moderately Inverse} & : t = \frac{TD}{5} \times \left[ \frac{0.0515}{M^{0.02} - 1} + 0.114 \right] \\
\text{IEE Very Inverse} & : t = \frac{TD}{5} \times \left[ \frac{19.61}{M^2 - 1} + 0.491 \right] \\
\text{IEE Extremely Inverse} & : t = \frac{TD}{5} \times \left[ \frac{28.2}{M^2 - 1} + 0.1217 \right]
\end{align*}
\]

\[ t = \text{time in seconds TD = Time Dial setting } M = \text{current in multiples of pickup} \]

5. **Time Test:** With output contacts connected to the timer, apply currents used in calculations from Step 4 and start timing while observing selected winding target LED for pickup. The operating time will be (D) cycles within ±3 cycles or ±3% of calculated time.
6. Repeat Step 5 for each test level chosen.
7. Repeat Steps 4, 5 & 6 using Currents I_{GW3}, I_{GW4} while observing the selected winding target LED for pickup.
8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.

1Either a Standard Curve, IEC Curve or IEEE Curve must be selected.
51N Inverse Time Residual Overcurrent

VOLTAGE INPUTS: None

CURRENT INPUTS: As Described

TEST SETTINGS:
51N W1/W2/W3/W4 Pickup
1 Amp CT Rating
P Amps (0.5 to 6)
(0.1 to 1.2)

Current Selection (Sum1, Sum2, W1, W2, W3, W4)

Standard Inverse Time Curves:¹
Curve C (1 to 4)
Time Dial TD (0.5 to 11)

IEC Inverse Time Curves:¹
IEC Curve C (5 to 8)
IEC Time Dial TD (0.05 to 1.1)

IEEE Inverse Time Curves:¹
IEEE Curve C (9 to 11)
IEEE Time Dial TD (0.5 to 15.0)

Programmed Outputs Z OUT (1 to 8)
Expanded I/O (9 to 16)

Functions 46DT, 46IT, 49 Disable
Function 50 Disable
Function 50N Disable
Function 50BF Disable
Functions 51, 87H/T, 87GD Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedures.
2. Confirm settings to be tested. Only the winding being tested should be enabled; the others should be disabled.
3. Connect current inputs in Configuration C1 (modified). See Section 6.4, Input Configurations, for configurations. The modification to C1 is to set all three currents to phase angle 0° and inject equal magnitude. In this configuration, the applied value of I₀ is equal to the applied 3-phase current.

■NOTE: Special Attention must be paid to which winding is being tested and which winding is disabled.

¹Either a Standard Curve, IEC Curve or IEEE Curve must be selected.
4. Refer to Appendix D. Calculate test times for levels represented on the graphs. It is suggested that 4 or 5 test levels be chosen.

\[
\begin{align*}
\text{IEC Standard Inverse} & : t = TD \times \left[\frac{0.14}{M^{0.125} - 1}\right] \\
\text{IEC Very Inverse} & : t = TD \times \left[\frac{3.5}{M - 1}\right] \\
\text{IEC Extremely Inverse} & : t = TD \times \left[\frac{120}{M - 1}\right] \\
\text{IEEE Moderately Inverse} & : t = \frac{TD}{5} \times \left[\frac{0.0515}{M^{0.125} - 1} + 0.114\right] \\
\text{IEEE Very Inverse} & : t = \frac{TD}{5} \times \left[\frac{19.61}{M - 1} + 0.491\right] \\
\text{IEEE Extremely Inverse} & : t = \frac{TD}{5} \times \left[\frac{28.2}{M - 1} + 0.1217\right]
\end{align*}
\]

Where:
- \(t\) = time in seconds
- \(TD\) = Time Dial setting
- \(M\) = current in multiples of pickup

**NOTE**: When calculating values for residual current functions, the relay adds three-phase current \(3I_0 = I_A + I_B + I_C\). The relay operates on \(I_0\).

5. **Time Test**: With output contacts connected to the timer, apply input current used in calculations from Step 4 and start timing while observing the selected winding target LED for pickup. The operating time will be \((D)\) cycles within \(\pm 3\) cycles or \(\pm 5\%\) of calculated time.

6. Repeat Step 5 for each test level chosen. The tested points verify the operation of this function.

7. Repeat Steps 4, 5 & 6 using Configuration C2 (modified), C3 (modified) and C4 (modified). Observe the selected winding target LED for pickup.

8. **Winding Summing Test**: Later

9. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
59 Phase Overvoltage (#1, #2 or #3)

VOLTAGE INPUTS: Configuration V1 or V3
CURRENT INPUTS: None
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>59 Pickup</td>
<td>P Volts (5 to 180)</td>
</tr>
<tr>
<td>Time Delay</td>
<td>D Cycles (1 to 8160)</td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z OUT (1 to 8)</td>
</tr>
<tr>
<td>Expanded I/O</td>
<td>(9 to 16)</td>
</tr>
<tr>
<td>Function 81O/U</td>
<td>Disable</td>
</tr>
</tbody>
</table>

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedure.
2. Confirm settings to be tested.
3. Connect input in Configuration V1 or V3 as designated previously. See Section 6.4, Input Configurations, for configurations.
4. Voltage selection:
   • If you select phase or positive sequence for the input voltage, then apply a balanced three-phase voltage. Only models with three-phase voltage have the option to select positive or negative sequence voltage as the operate quantity. The four winding version with two voltage inputs does not have phase overvoltage protection.
   • If you select negative sequence for the input voltage, then apply a balanced three-phase voltage and roll Phase B and C phase voltages.
5. Pickup Test:
   a. Press and hold the TARGET RESET button, then slowly increase the input voltage until PHASE OVERVOLTAGE 59 LED illuminates or the pickup indicator operates on the computer target screen. The level should be equal to \( P \) volts \( \pm 0.5 \text{ V} \) or \( \pm 0.5\% \).
   b. Release the TARGET RESET button, then decrease the input voltage. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets.
6. Time Test: With output contracts being connected to the timer, apply \( (P+1) \) Volts and start timing. The operating time will be \( D \) cycles within \( \pm 1 \text{ cycle} \) or \( \pm 1\% \).
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
59G Ground Overvoltage (#1 or #2)

VOLTAGE INPUTS:  Configuration V2
CURRENT INPUTS:  None
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>59G Pickup</td>
<td>P</td>
</tr>
<tr>
<td>Time Delay</td>
<td>D</td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z OUT</td>
</tr>
<tr>
<td>Expanded I/O</td>
<td></td>
</tr>
<tr>
<td>Function 81O/U</td>
<td>Disable</td>
</tr>
</tbody>
</table>

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedure.
2. Confirm settings to be tested.
3. Connect input in Configuration V2 as designated previously. See Section 6.4, Input Configurations, for configurations.
4. Pickup Test:
   a. Press and hold the TARGET RESET button, then slowly increase the input voltage until NEUTRAL OVERVOLTAGE 59G LED illuminates or the pickup indicator operates on the computer target screen. The level should be equal to (P) volts ± 0.5 V or ± 0.5%.
   b. Release the TARGET RESET button, then decrease the input voltage. The OUTPUT LED will extinguish.
   c. Press TARGET RESET button to remove targets.
5. Time Test: With output contracts being connected to the timer, apply (P+1) Volts and start timing. The operating time will be (D) cycles within ± 1 cycle or ± 1%.
6. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
81 Overfrequency/Underfrequency

VOLTAGE INPUTS: Configuration V1
CURRENT INPUTS: None
TEST SETTINGS:
- Pickup \( P \) Hz (55 to 65)
- 50 Hz Relay \( D \) Cycles (45 to 55)
- Time Delay \( P \) Hz (2 to 65,500)
- Programmed Outputs \( Z \) OUT (1 to 8)
- Expanded I/O (9 to 16)
- Functions 24DT, 24IT Disable
- Functions 27 Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedure.
2. Confirm settings to be tested.
3. Connect inputs in Configuration V1 designated previously. Set the V.T. Configuration (Section 4.2) as \( V_a \). Refer to Section 6.4, Input Configurations for configuration.
4. **Pickup Test:**
   - **NOTE:** When using single-phase frequency sources, connect the source to one voltage input.
     a. Set the voltages to the Nominal Frequency. Set the pickup less than nominal frequency.
     b. Press and hold the TARGET RESET button in, then slowly decrease the frequency of the input voltage until the FREQUENCY 81 O/U LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to \( P \) Volts \( \pm 0.1 \) Hz.
     c. Release the TARGET BUTTON, then return to nominal input frequency. The OUTPUT LED will extinguish.
     d. Press TARGET RESET button to remove targets.
     e. Set the pickup greater than nominal frequency. Repeat Step b through d, except you will have to slowly increase the frequency of the input voltage.
5. **Time Test:** With output contacts being connected to the timer, input \( P - 0.5 \) Hz and start timing. The operating time will be \( D \) cycles within \(-1 \) to \(+3 \) cycles or \( \pm 1\% \).
6. Complete the testing for the remaining 81 functions by repeating Steps 4 and 5, above.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
87H Phase Differential Overcurrent

**VOLTAGE INPUTS:** None

**CURRENT INPUTS:** Configuration C6

**TEST SETTINGS:**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup</td>
<td>P</td>
<td>PU</td>
<td>(5.0 to 20.0)</td>
</tr>
<tr>
<td>Time Delay</td>
<td>D</td>
<td>Cycles</td>
<td>(1 to 8160)</td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z</td>
<td>OUT</td>
<td>(1 to 8)</td>
</tr>
</tbody>
</table>

**Expanded I/O**

<table>
<thead>
<tr>
<th>Functions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>46DT, 46IT, 49</td>
<td>Disable</td>
</tr>
<tr>
<td>50</td>
<td>Disable</td>
</tr>
<tr>
<td>50N, 50BF</td>
<td>Disable</td>
</tr>
<tr>
<td>51, 51N</td>
<td>Disable</td>
</tr>
<tr>
<td>87T</td>
<td>Disable</td>
</tr>
</tbody>
</table>

1. Disable functions as shown. Refer to Section 4.4, **System Setpoints**, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration C6 as designated previously. Refer to Section 6.4, **Input Configurations** for configuration. For testing purposes it is recommended that the CT Tap Corrections, CT1, CT2, CT3 and CT4 be set to 1.0. If it is desired to test with other CT Tap settings, the current values must be computed by using the following formulas:

\[
I_{aw1} \text{ (Applied)} = I_{aw1} \text{ (Calculated)} \times CT1.
\]

\[
I_{aw2} \text{ (Applied)} = I_{aw2} \text{ (Calculated)} \times CT2.
\]

\[
I_{aw3} \text{ (Applied)} = I_{aw3} \text{ (Calculated)} \times CT3.
\]

\[
I_{aw4} \text{ (Applied)} = I_{aw4} \text{ (Calculated)} \times CT4.
\]

**NOTE:** All values used for this function are measured in PU's, which requires calculating the actual current in Amps to be used for testing: 1 PU = CT Tap, for three-phase balanced current injection.
4. **Minimum Pickup Test:**
   a. Set the $I_{AW1}$ (Input 1) = 0 Amps.
   b. Press and hold the TARGET RESET button in, then slowly increase $I_{AW2}$ (Input 2) until the PHASE DIFFERENTIAL 87T/H LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to $1.732 \cdot P$ per unit ± 3%.

   **Delta (Winding 1) Wye (Winding 2) Transformer**

   Press and hold the TARGET RESET button in, then slowly increase $I_{AW2}$ (Input 2) until the PHASE DIFFERENTIAL 87T/H LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to $1.5 \cdot P$ per unit ± 3%.

   **Wye (Winding 1) Wye (Winding 2) Transformer**

   c. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   d. Press TARGET RESET button to remove targets. This test may be repeated for testing the opposite winding or another phase.

5. **Timer Check:** With output contacts being connected to the timer, apply at least 10% higher $I_{AW2}$ (Input 2) current than the minimum pickup level and start timing. The input current must be multiplied as shown in Step b. The operating time will (D) cycles within –1 to +3 cycles or ± 1%.

6. If desired, repeat Steps 4 & 5 setting $I_{AW2}$ (Input 2) and/or $I_{AW3}$ (Input 3) or ($I_{AW4}$) to 0 Amps and increasing $I_{AW1}$ (Input 1).

7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
87T Phase Differential Overcurrent

**VOLTAGE INPUTS:** None

**CURRENT INPUTS:** Configuration C6

**TEST SETTINGS:**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup</td>
<td>P, PU</td>
</tr>
<tr>
<td>Percent Slope #1</td>
<td>S1, %</td>
</tr>
<tr>
<td>Percent Slope #2</td>
<td>S2, %</td>
</tr>
<tr>
<td>Slope Break Point</td>
<td>BP, PU</td>
</tr>
<tr>
<td>Even Harmonics Restraint (2nd and 4th)</td>
<td>E, E, D, A</td>
</tr>
<tr>
<td>Restraint</td>
<td>%</td>
</tr>
<tr>
<td>5th Harmonic Restraint</td>
<td>F, E, D, A</td>
</tr>
<tr>
<td>Pickup at 5th Harmonic Restraint</td>
<td>FP, PU</td>
</tr>
<tr>
<td>CT Tap W1/W2/W3/W4</td>
<td>CT1/2/3/4</td>
</tr>
<tr>
<td>1 Amp CT Rating</td>
<td></td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z, OUT</td>
</tr>
<tr>
<td>Functions 46DT, 46IT, 49</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 50</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 50N, 50BF</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 51, 51N</td>
<td>Disable</td>
</tr>
<tr>
<td>Function 87H</td>
<td>Disable</td>
</tr>
</tbody>
</table>

1. Disable functions as shown. Refer to Section 4.4, **System Setpoints**, for procedure.
2. Confirm settings to be tested.
3. Connect inputs in Configuration C6 as designated previously. Refer to Section 6.4, **Input Configurations** for configuration. For testing purposes it is recommended that the CT Tap Corrections, CT1, CT2, CT3 and CT4 be set to 1.0. If it is desired to test with other CT Tap settings, the current values must be computed by using the following formulas:

   \[
   I_{AW1}^{(Applied)} = I_{AW1}^{(Calculated)} \times CT1.
   \]

   \[
   I_{AW2}^{(Applied)} = I_{AW2}^{(Calculated)} \times CT2.
   \]

   \[
   I_{AW3}^{(Applied)} = I_{AW3}^{(Calculated)} \times CT3.
   \]

   \[
   I_{AW4}^{(Applied)} = I_{AW4}^{(Calculated)} \times CT4.
   \]

**NOTE:** All values used for this function are measured in PU’s, which requires calculating the actual current in Amps to be used for testing: 1 PU = CT Tap, for three-phase balanced current injection.

4. **Minimum Pickup Test**:
   a. Set \( I_{AW1} \) (Input 1) = 0 Amps.
   b. Press and hold the **TARGET RESET** button in, then slowly increase \( I_{AW2} \) (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to \( 1.732 \times P \) per unit \( \pm 3\% \).
Delta (Winding 1) Wye (Winding 2) Transformer

Press and hold the **TARGET RESET** button in, then slowly increase \( I_{AW2} \) (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be equal to \( 1.5P \) per unit \( \pm 3\% \).

Wye (Winding 1) Wye (Winding 2) Transformer

c. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.

d. Press the **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

5. **Slope 1 Test:**

   a. Define any number of testing points desirable to verify the trip \( I_{AW2} \) (Input 2) curve.
   
   b. Choose any values for \( I_{AW2} \) (Input 2), and calculate the expected \( I_{AW1} \) (Input 1) according to the following:

   \[
   I_{AW1} = I_{AW2} \left[ \frac{(200 + S1)}{(200 - S1)} \right]
   \]

   Or

   \[ S1 = \text{slope in } \% \text{ from above.} \]

   **NOTE:** The differential current \( I_{AW1} - I_{AW2} \) must be greater than the minimum pickup current \( (P) \) and less than the Break Point \( (BP) \) value for proper operation. Monitor the restraint current using either the HMI or IPScom Secondary Metering and Status Screen. Do not increase the magnitude of \( I_{AW2} \) such that the restraint current is less than \( BP \).

   c. Set \( I_{AW1} \) (Input 1) and \( I_{AW2} \) (Input 2) at the chosen value.
   
   d. Refer to the Pickup test for the current multipliers to use when testing a delta-wye or wye-wye bank. Press and hold the **TARGET RESET** button in, then slowly increase \( I_{AW2} \) (Input 2) until the **PHASE DIFFERENTIAL 87T/H** LED illuminates, or the pickup indicator operates on the computer target screen. The level of operation will equal to \( P \pm 0.02 \text{ PU} \) or \( \pm 5\% \).
   
   e. Release the **TARGET RESET** button, then decrease the current. The **OUTPUT** LED will extinguish.
   
   f. Press the **TARGET RESET** button to remove targets. This test may be repeated for testing the opposite winding or another phase.

6. **Slope 2 Test:**

   a. Define any number of testing points desirable to verify the trip \( I_{AW2} \) (Input 2) current curve.
b. Choose any values for $I_{AW2}$ (Input 2) and calculate the expected $I_{AW1}$ (Input 1) according to the following:

$$I_{AW1} = \left[ I_{AW2} \left( \frac{1 + S2}{200} \right) + BP \left( \frac{S1-S2}{100} \right) \right] \left( \frac{1 - S2}{200} \right)$$

$S1$ and $S2 = \text{slope in } \% \text{ from above. The differential current, } I_{AW1} - I_{AW2}, \text{ must be greater than both the minimum pickup current (P) and the BP values. Select } I_{AW2} > (BP - \frac{S2}{2}) \text{. Monitor the restraint current using either the HMI or IPScom® Secondary Metering and Status Screen. The magnitude of } I_{AW2} \text{ should be high enough that the restraint current is greater than BP.}$

c. Set $I_{AW1}$ (Input 1) and $I_{AW2}$ (Input 2) to the chosen value.

d. Press and hold the TARGET RESET button, then slowly increase $I_{AW1}$ (Input 1) current until the PHASE DIFFERENTIAL 87T/H LED illuminates or the pickup indicator operates on the computer target screen. The level of operation should be equal to (P) PU $\pm 0.02$ PU or $\pm 1\%$.

e. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.

f. Press the TARGET RESET button to remove targets. This test may be repeated for testing the opposite winding or another phase.

7. **Second Harmonic Restraint Test**

a. Ensure that Even Harmonic Restraint is enabled with the amplitude of $I_{AW1}$ (Input 1) at 60 Hz (or 50 Hz) set to 10% above (P) PU setting and verify that the PHASE DIFFERENTIAL 87T/H LED illuminates.

b. Apply 0 Amps at 120 Hz (100 Hz for 50 Hz units) to $I_{AW2}$ (Input 2).

c. Press and hold the TARGET RESET button in, then slowly increase the amplitude of $I_{AW2}$ until the PHASE DIFFERENTIAL 87T/H LED extinguishes. This level will be (E) times (P) PU, $\pm 1\%$ or $\pm 0.1\%$.

8. **Fourth Harmonic Restraint Test:**

a. Ensure that Even Harmonic Restraint is enabled with the amplitude of $I_{AW1}$ (Input 1) at 60 Hz (or 50 Hz) set to 10% above P PU setting and verify the PHASE DIFFERENTIAL 87T/H LED is illuminated.

b. Apply 0 Amps at 240 Hz (200 Hz for 50 Hz units) to $I_{AW2}$ (Input 2).

c. Press and hold the TARGET RESET button in, then slowly increase the amplitude of the $4^\text{th}$ Harmonic current $I_{AW2}$ until the PHASE DIFFERENTIAL 87T/H LED extinguishes. This level will be (E) times (P) PU, $\pm 1\%$.

9. **Fifth Harmonic Restraint Test:**

a. Ensure that 5th Harmonic Restraint is enabled with the amplitude of $I_{AW1}$ (Input 1) at 60 Hz (or 50 Hz) set to above (P) PU, and below (FP) PU settings and verify the PHASE DIFFERENTIAL 87T/H LED is illuminated.

b. Apply (P) times (F) $\times 10\%$ Amps at 300 Hz (250 Hz for 50 Hz units) to $I_{AW2}$ (Input 2), and verify that the PHASE DIFFERENTIAL 87T/H LED extinguishes.

c. Press and hold the TARGET RESET button in, then slowly decrease the amplitude of the $5^\text{th}$ Harmonic current $I_{AW2}$ until the PHASE DIFFERENTIAL 87T/H LED illuminates. This level will be (F) times (P) PU, $\pm 1\%$ or $\pm 0.1\%$.

10. **Elevated Pickup at 5th Harmonic Restraint Test**

a. Ensure that 5th Harmonic Restraint is enabled with 60 Hz (or 50 Hz) with the amplitude of $I_{AW1}$ (Input 1) at 60 Hz (or 50 Hz) set to 10% above (P) PU and verify that the PHASE DIFFERENTIAL 87T/H LED illuminates.

b. Apply (P) times (F) $\times 10\%$ Amps at 300 Hz (250 Hz for 50 Hz units) to $I_{AW2}$ (Input 2), then verify that the PHASE DIFFERENTIAL 87T/H LED extinguishes.

c. Use the HMI or IPScom to enable cross phase averaging. Slowly increase the amplitude of $I_{AW1}$ (Input 3) and verify the PHASE DIFFERENTIAL 87T/H LED illuminates. This level will be FP, $\pm 0.1\%$ PU or $\pm 5\%$.

11. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
87GD Ground Differential (#1, #2)

VOLTAGE INPUTS: None

CURRENT INPUTS: As Described Below

TEST SETTINGS:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>87GD Pickup P</td>
<td>Amps</td>
<td>0.20 to 10.00</td>
</tr>
<tr>
<td>1 Amp CT Rating D</td>
<td>cycles</td>
<td>0.04 to 2.00</td>
</tr>
<tr>
<td>Time Delay</td>
<td></td>
<td>1 to 8160</td>
</tr>
<tr>
<td>CT Ratio Correction Z</td>
<td></td>
<td>0.10 to 7.99</td>
</tr>
<tr>
<td>Programmed Outputs Z</td>
<td>OUT</td>
<td>1 to 8</td>
</tr>
<tr>
<td></td>
<td>Expanded I/O</td>
<td>9 to 16</td>
</tr>
</tbody>
</table>

Function 46DT, 46IT, 49 Disable
Function 50, 50G, 50N, 50BF Disable
Function 51, 51N, 51G Disable
Function 87T, 87H Disable

1. Disable functions as shown. Refer to Section 4.4, System Setpoints, for procedure.

2. Confirm settings to be tested. For testing purposes, it is recommended that the CT Ratio Corrections be set to 1.0. Otherwise, current values must be computed by using the following formulas:

$$I_{GW2} = \text{Applied Current to Winding 2}$$

$$I_{GW3} = \text{Applied Current to Winding 3}$$

$$I_{GW4} = \text{Applied Current to Winding 3}$$

3. **Non-Directional Pickup Test:**
   a. Connect current input to $I_{GW2}$, terminal numbers 50 and 51. No current is inserted into $I_{AW2}$, $I_{BW2}$, and $I_{CW2}$.
   b. Press and hold the TARGET RESET button in, then slowly increase $I_g$ until the GROUND DIFFERENTIAL 87GD LED illuminates or the pickup indicator operates on the computer target screen. The level at operation will be equal to ($P$) Amps ± 0.1 Amps or 5% ($\pm 0.02$ Amp 1 A CT).
   c. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   d. Press TARGET RESET button to remove targets.

4. **Directional Pickup Test:**
   a. Connect one current input to $I_{GW2}$, terminal numbers 50 and 51. Connect another current input to $I_{AW2}$ with a magnitude equal to $\frac{1}{2}$ ($P$) Amps.
   b. Insert current into $I_{AW2}$ that is 180° out of phase with $I_{GW2}$, then slowly increase the phase current until the GROUND DIFFERENTIAL 87GD LED illuminates or the pickup indicator operates on the computer screen. Operation will occur when the sum of $I_{GW2}$ and the applied phase current equal ($P$) Amps ± 0.1 Amps or $\pm 5\%$ ($\pm 0.02$ Amp 1 A CT).
   □ NOTE: $I_{GW2}$ must be greater than 140 mA or the directional element is disabled.
   c. Release the TARGET RESET button, then decrease the current. The OUTPUT LED will extinguish.
   d. Reverse either current (currents are now in-phase) and re-test. The relay will not operate.

5. **Time Test:** With output contacts connected to the timer, apply current at least 10% higher than ($P$) Amps and start timing while observing GROUND DIFFERENTIAL 87GD LED for pickup. The operating time will be ($D$) cycles within $-1$ to $+3$ cycles or $\pm 1\%$.

6. Repeat Step 5 for $I_{GW3}$ and $I_{GW4}$ connecting current to terminals 58 and 59 ($I_{GW3}$) or 72 and 73 ($I_{GW4}$).

7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
BM Breaker Monitoring

VOLTAGE INPUTS: None
CURRENT INPUTS: As Described
TEST SETTINGS:
- Pickup P kAmps (kA²)* (0 to 50,000)
- Delay D Cycles (0.1 to 4095.9)
- Timing Method
- Preset Accumulators
  - Phase A, B, or C kAmp (kA²) Cycles* (0 to 50,000)
- Programmed Outputs Z OUT (1 to 8)
  - Expanded I/O (9 to 16)
- Blocking Inputs
  - Expanded I/O (1 to 6)
  - Expanded I/O (7 to 8)
- Output Initiate
  - Expanded I/O (1 to 8)
  - Expanded I/O (9 to 16)
- Input Initiate
  - Expanded I/O (1 to 6)
  - Expanded I/O (7 to 8)

* kA/kA cycles or kA²/kA² cycles is dependent on the Timing Method that is selected.

Test Setup:
1. Determine the Breaker Monitoring Function settings to be tested (Input Initiate or Output Initiate).
2. Enter the Breaker Monitoring Function settings to be tested utilizing either the HMI or IPScom® Communications Software.
3. Connect current inputs to I_A terminals 38 and 39, I_B terminals 40 and 41, and I_C terminals 42 and 43.

Accumulator Test:
1. Apply a current value that considers Timing Method and Pickup Setting to current input I_A.
2. Place a jumper between the designated input or output contact selected as initiate.
3. Utilizing either the HMI (Breaker Monitoring/Breaker Acc. Status) or IPScom Communications Software (Monitor/Metering II), verify that the Accumulator Status value for Phase A increments in D cycles ± 1 cycles or ± 1%.
4. Remove the jumper placed in Step 2.
5. Decrease applied I_A current to 0 amps.
6. If desired, repeat test for I_B and I_C.
Pickup Test:

1. Apply a current value that considers Timing Method and Pickup Setting to current input $I_A$.

**NOTE:** If the target pickup setting is a large value (0 to 50,000) the Preset Accumulator Settings feature can be used to preset the accumulator values to just below the target setting.

2. Utilizing either the HMI (Breaker Monitoring/Breaker Acc. Status) or IPScom Communications Software (Monitor/Metering II) to monitor the accumulator value, place a jumper between the designated input or output contact selected as initiate and then remove the jumper.

   Following the time out of the Delay the accumulator will increment, repeat the placement and removal of the jumper as necessary to increment the accumulator to a point where the pickup setting is exceeded.

3. When the accumulator value exceeds the pickup value the OUTPUT LED(s) will illuminate, or the function status indicator on the Monitor Function Status screen indicates that the function has picked up.

   The output contacts $Z$ will operate in $D$ cycles $\pm 1$ cycle or $\pm 1\%$ from the last initiate.

4. If desired, repeat test for $I_B$ and $I_C$. 
Trip/Close Circuit Monitoring

VOLTAGE INPUTS: As Described
CURRENT INPUTS: None
TEST SETTINGS:
- Delay: D Cycles (1 to 8160)
- Dropout Time Delay: D Cycles (1 to 8160)
- Programmed Outputs: Z OUT (1 to 8)
  Expanded I/O (9 to 16)

Test Setup:
1. Determine the Trip/Close Circuit Monitoring function settings to be tested.
2. Disable all other functions prior to testing. Refer to Section 4.4, System Setpoints for details that describe disabling/enabling functions.
3. Connect a DC voltage supply capable of supplying 24/48/125/250 V dc (marked on the rear of the relay) to the TCM/CCM terminals (Figures 5-8 through 5-28) to be tested on the relay.
4. Connect a timer to output contacts (Z) so that the timer stops timing when the contacts (Z) close.

Pickup Test:
1. Apply the applicable DC voltage (24/48/125/250 V dc marked on the rear of the relay) to terminals (Figures 5-8 through 5-28) to be tested on the relay.
2. Enable the Trip Circuit Monitoring function and then enter the settings to be tested utilizing either the HMI or IPScom Communications Software.
3. Remove the DC voltage applied in Step 1. The OUTPUT LED will illuminate, indicating that the Trip Circuit Monitoring function has actuated.
   The contacts will close after D cycles within ±1 cycle or 1%.
4. Simulate a 52b contact close by connecting a jumper between terminal 11 (INRTN) and terminal 10 (IN1). The BRKR CLOSED and OUTPUT LEDs on the front of the relay should extinguish.
5. Remove the jumper installed in Step 4.
   The contacts will close after D cycles within ±1 cycle or 1%.
Through Fault

**VOLTAGE INPUTS:**  As Described

**CURRENT INPUTS:**  None

**TEST SETTINGS:**  
- Through Fault Current Threshold: 5 Amps (1.0-100.0)
- Through Fault Current Threshold: 1 Amp (0.2-20.0)
- Pickup Operation Limit: 5 (1-65535)
- Cumulative $I^2T$: 100k A$^2$ Cycles (10-1000000)
- Time Delay: 1 Cycles (1-8160)
- Current Selection: (Sum1, Sum2, W1, W2, W3, W4)

**Threshold and Cumulative $I^2T$ Limit Tests:**

1. Utilize the IPSCom Metering II screen to monitor the counters.
2. Use the System/ Through Fault / Clear command to reset any previous Cumulative Through Current readings.
3. Apply a balanced 4 Amp current to the Winding 1, then verify that counters are not incrementing.
4. Remove the applied current.
5. Press the TARGET RESET button to clear any previous target indication.
6. Apply a balanced 6 Amp current to the Winding 1, then verify that counters are now incrementing. Approximately 46 seconds after the current was applied the Target LED will illuminate and the HMI will display the Through Fault information.
7. Remove the applied current.

**Pickup Operation Limit Test**

1. Use the System/ Through Fault / Clear command to reset any previous Cumulative Through Current readings.
2. Press the TARGET RESET pushbutton to clear any previous target indication.
3. Apply for approximately 2 seconds a balanced 6 Amp current, then remove the current. Repeat this step a second time and the Target LED will illuminate and the HMI will display the Through Fault information.
4. If testing is complete clear the through fault counters and disable the function.
IPSlogic (#1-6)

VOLTAGE INPUTS: As required
CURRENT INPUTS: As required
TEST SETTINGS:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Symbol</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Delay</td>
<td>D Cycles</td>
<td>(1 to 65500)</td>
<td></td>
</tr>
<tr>
<td>Reset/Dropout Delay</td>
<td>RD Cycles</td>
<td>(0 to 65500)</td>
<td></td>
</tr>
<tr>
<td>Programmed Outputs</td>
<td>Z OUT</td>
<td>(1 to 8) Expanded I/O (9 to 16)</td>
<td></td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td></td>
<td>(1 to 6) Expanded I/O (7 to 18)</td>
<td></td>
</tr>
<tr>
<td>Output Initiate</td>
<td></td>
<td>(1 to 8) Expanded I/O (9 to 16)</td>
<td></td>
</tr>
<tr>
<td>Function Initiate</td>
<td>(All Available Functions)</td>
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<tr>
<td>Initiate via Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Initiate</td>
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<td>(1 to 6) Expanded I/O (7 to 18)</td>
<td></td>
</tr>
<tr>
<td>Block via Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Refer to Figure 4-58, IPSlogic, for logic gate configurations.
2. Select gate configuration (AND/OR) for Output Initiate, Function Initiate, Blocking Inputs and Inputs Main.
3. Select Initiating Inputs for each gate (if AND gate is selected, ensure at least two outputs are chosen). It will be necessary to enable and operate other functions to provide inputs for the Function Initiate and Output Initiate gates.
4. **Pickup Test:** With output contact(s) Z connected to the timer, apply inputs to gates and start timing. The operating time will be \(D\) cycles within \(\pm 1\) cycle or \(\pm 1\%\), and the selected IPSlogic target LED and the OUTPUT LED will illuminate or the pickup indicator will operate on the computer target screen.
5. **Blocking Input Test:** To test the designated blocking inputs, press and hold the TARGET RESET button, then short input terminals designated as blocking inputs. The IPS LED will extinguish.
6. Repeat for each designated external triggering contact.
7. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this configuration.
This Appendix contains forms for photocopying, and recording the configuration and setting of the M-3311A Transformer Protection Relay, and to file the data for future reference. Examples of the suggested use of these forms are illustrated in Chapter 4, System Setup and Setpoints and Chapter 2, Operation.

Page A-2 contains a copy of the Relay Configuration Table and is herein provided to define and record the blocking inputs and output configuration for the relay. For each function, check if DISABLED or check the output contacts to be operated by the function. Also check the inputs designated to block the function operation.

The Communication Record Form reproduces the Communication and Setup unit menus. This form records definition of the parameters necessary for communication with the relay, as well as access codes, user logo (identifying) lines, date & time setting, and front panel display operation.

The functional Configuration Record Form reproduces the Configure Relay menus including the Setup Relay submenu which is accessible via S-3300 IPScom® Communication Software or the optional M-3931 HMI front panel module.

For each function or setpoint, refer to the configuration you have defined using the Relay Configuration Table, and circle whether it should be enabled or disabled by the output contacts it will activate, and the inputs that will block its operation.

The Setpoint & Timing Record Form allows recording of the specific values entered for each enabled setpoint or function. The form follows the main menu selections of the relay.

The AS SHIPPED settings are included in brackets [ ] to illustrate the factory settings of the relay.
<table>
<thead>
<tr>
<th>Function</th>
<th>OUTPUTS</th>
<th>BLOCKING INPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1</td>
<td>18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1</td>
</tr>
<tr>
<td>24 Def Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Inv Time</td>
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</tr>
<tr>
<td>27</td>
<td>1</td>
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</tr>
<tr>
<td></td>
<td>2*</td>
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</tr>
<tr>
<td></td>
<td>3*</td>
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</tr>
<tr>
<td>46 Def Time W2</td>
<td></td>
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</tr>
<tr>
<td>46 Inv Time W2</td>
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<tr>
<td>46 Def Time W3</td>
<td></td>
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<td>46 Inv Time W3</td>
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<tr>
<td>46 Def Time W4**</td>
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<td>46 Inv Time W4**</td>
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<tr>
<td>49</td>
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<td></td>
<td>4</td>
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</table>

* Not available in Four Winding applications.
** Not available in Two or Three Winding applications.

**NOTE:** The M-3311A is shipped with all functions disabled.

Table A-1  Relay Configuration (page 1 of 2)
<table>
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<th>BLOCKING INPUTS</th>
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<td>18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1</td>
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</table>

* Not available in Four Winding applications.
** Not available in Two or Three Winding applications.
*** Not Available in Non Expanded I/O units

NOTE: The M-3311A is shipped with all functions disabled.

Table A-1  Relay Configuration (page 2 of 2)
System Communication Setup

Communication Setup

COM 1

Baud Rate: □ 300 □ 600 □ 1200 □ 2400 □ 4800 □ [9600]

COM 2

Baud Rate: □ 300 □ 600 □ 1200 □ 2400 □ 4800 □ [9600]

Dead Sync Time: _____ 2 msec–3000 msecs [50]

Protocol: □ [BECO2200] □ MODBUS □ DNP3

COM 3

Dead Sync Time: _____ 2 msec–3000 msecs [50]

Protocol: □ [BECO2200] □ MODBUS □ DNP3

Communication Address: _____ [1]

Response Time Delay: _____ msec [100]

Communication (COMM) Access Code: __________ [9999]

ETHERNET

☑ Enable ☐ [Disable]

TCP/IP Settings: □ [TCP] □ PROT

Protocol: □ [MODBUS] □ SERCONV

DHCP Protocol: □ Enable □ [Disable]

IP Address: __________ [192.168.1.43]

Net Mask: __________ [255.255.255.0]

Gateway: __________ [192.168.1.1]

■ NOTE: As Shipped settings are contained in brackets [ ] where applicable.

Figure A-1 System Communication Setup
Appendix – A

Setup System – Two or Three Windings

Nominal Voltage: 60 V – 140 V [120]
Nominal Current: 0.50 A – 15.00 A [5.00]
Phase Rotation □ ACB □ [ABC]
Demand Timing Method □ [15 Minutes] □ 30 Minutes □ 60 Minutes
Current Summing 1 □ W1 □ W2 □ W3
Current Summing 2 □ W1 □ W2 □ W3
Voltage/Power Selection □ [W1] □ W2 □ W3
Positive Power Flow □ [In] □ Out
Disable Winding for Function 87 □ W1 □ W2 □ W3 □ [None]

VT Phase Configuration:

Two Voltage Inputs:
  VT Phase Config □ VA □ VB □ VC □ VAB □ VBC □ VCA
  VT G Config □ VA □ VB □ VC □ VAB □ VBC □ VCA □ VG

Four Voltage Inputs □ Line-Line □ [Line-Ground]

Transformer/CT Connection □ [Standard] □ Custom

Standard Selections:

<table>
<thead>
<tr>
<th>Transformer W1</th>
<th>Transformer W2</th>
<th>Transformer W3</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ [Y]</td>
<td>□ [Y]</td>
<td>□ [Y]</td>
</tr>
<tr>
<td>□ Dab</td>
<td>□ Dab</td>
<td>□ Dab</td>
</tr>
<tr>
<td>□ Dac</td>
<td>□ Dac</td>
<td>□ Dac</td>
</tr>
<tr>
<td>□ Inverse Y</td>
<td>□ Inverse Y</td>
<td>□ Inverse Y</td>
</tr>
<tr>
<td>□ Inverse Dab</td>
<td>□ Inverse Dab</td>
<td>□ Inverse Dab</td>
</tr>
<tr>
<td>□ Inverse Dac</td>
<td>□ Inverse Dac</td>
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</table>

<table>
<thead>
<tr>
<th>CT W1</th>
<th>CT W2</th>
<th>CT W3</th>
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<tbody>
<tr>
<td>□ [Y]</td>
<td>□ [Y]</td>
<td>□ [Y]</td>
</tr>
<tr>
<td>□ Dab</td>
<td>□ Dab</td>
<td>□ Dab</td>
</tr>
<tr>
<td>□ Dac</td>
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● NOTE: As Shipped settings are contained in brackets [ ] where applicable.

Figure A-2 Setup System (Two or Three Windings) (page 1 of 3)
### Custom Selections:

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<tr>
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<td>⑥ 5 Inverse Dab</td>
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<td>⑱ 6 (Inverse Y)</td>
<td>⑱ 6 (Inverse Y)</td>
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<td>⑳ 23 (Dab)</td>
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</table>

Custom Transformer/CT Selections (Cont.’d):

- W1 Zero Sequence Filter  □ Enable  □ [Disable]
- W2 Zero Sequence Filter  □ Enable  □ [Disable]
- W3 Zero Sequence Filter  □ Enable  □ [Disable]

**NOTE:** As Shipped settings are contained in brackets [ ] where applicable.
Setup System – Two or Three Windings (Cont.'d)

<table>
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<th>Setting</th>
<th>Default Setting</th>
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<td>VT Vx Ratio:</td>
<td>______:1 1.0 – 6550.0 [1.0]</td>
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<td>CT W1 Phase Ratio:</td>
<td>______:1 1 – 65500.0 [1.0]</td>
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</tr>
<tr>
<td>CT W2 Phase Ratio:</td>
<td>______:1 1 – 65500.0 [1.0]</td>
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</tr>
<tr>
<td>CT W3 Phase Ratio:</td>
<td>______:1 1 – 65500.0 [1.0]</td>
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<tr>
<td>CT W2 Ground Ratio:</td>
<td>______:1 1 – 65500.0 [1.0]</td>
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<tr>
<td>CT W3 Ground Ratio:</td>
<td>______:1 1 – 65500.0 [1.0]</td>
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**OUTPUT SETTINGS**

**Latched Outputs:**
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

**Pulsed Outputs:**
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

**Relay Seal-in Time:**
- Output 1: _____ 2 – 8160 (Cycles) [30]
- Output 2: _____ 2 – 8160 (Cycles) [30]
- Output 3: _____ 2 – 8160 (Cycles) [30]
- Output 4: _____ 2 – 8160 (Cycles) [30]
- Output 5: _____ 2 – 8160 (Cycles) [30]
- Output 6: _____ 2 – 8160 (Cycles) [30]
- Output 7: _____ 2 – 8160 (Cycles) [30]
- Output 8: _____ 2 – 8160 (Cycles) [30]
- Output 9: _____ 2 – 8160 (Cycles) [30]
- Output 10: _____ 2 – 8160 (Cycles) [30]
- Output 11: _____ 2 – 8160 (Cycles) [30]
- Output 12: _____ 2 – 8160 (Cycles) [30]
- Output 13: _____ 2 – 8160 (Cycles) [30]
- Output 14: _____ 2 – 8160 (Cycles) [30]
- Output 15: _____ 2 – 8160 (Cycles) [30]
- Output 16: _____ 2 – 8160 (Cycles) [30]

**INPUT SETTINGS**

**Input Active State (Open):**
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

**Input Active State (Close):**
- [1]
- [2]
- [3]
- [4]
- [5]
- [6]
- [7]
- [8]
- [9]
- [10]
- [11]
- [12]
- [13]
- [14]
- [15]
- [16]
- [17]
- [18]

**NOTE:** As Shipped settings are contained in brackets [ ] where applicable.

Figure A-2  Setup System (Two or Three Windings) (page 3 of 3)
Setup System – Four Windings

Nominal Voltage: _____ 60 V – 140 V [120]

Phase Rotation  ❑ [ACB]  ❑ ABC

Demand Timing Method  ❑ [15 Minutes]  ❑ 30 Minutes  ❑ 60 Minutes

VT Config.  ❑ [VAB]  ❑ VBC  ❑ VCA  ❑ VA  ❑ VB  ❑ VC

Current Summing 1  ❑ W1  ❑ W2  ❑ W3  ❑ W4

Current Summing 2  ❑ W1  ❑ W2  ❑ W3  ❑ W4

Enable/Disable Windings for 87 Function

[More Than 2 Windings]  ❑
Winding 1 and Winding 2 Only  ❑
[Enable All Windings]  ❑
Disable Winding 1  ❑
Disable Winding 2  ❑
Disable Winding 3  ❑
Disable Winding 4  ❑

Transformer/CT Connection  ❑ [Standard]  ❑ Custom

Standard Selections:

<table>
<thead>
<tr>
<th>Transformer W1</th>
<th>Transformer W2</th>
<th>Transformer W3</th>
<th>Transformer W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
</tr>
<tr>
<td>❑ Dab</td>
<td>❑ Dab</td>
<td>❑ Dab</td>
<td>❑ Dab</td>
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<tr>
<td>❑ Dac</td>
<td>❑ Dac</td>
<td>❑ Dac</td>
<td>❑ Dac</td>
</tr>
<tr>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
</tr>
<tr>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
</tr>
<tr>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CT W1</th>
<th>CT W2</th>
<th>CT W3</th>
<th>CT W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
<td>❑ [Y]</td>
</tr>
<tr>
<td>❑ Dab</td>
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<td>❑ Dab</td>
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<tr>
<td>❑ Dac</td>
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<tr>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
<td>❑ Inverse Y</td>
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<tr>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
<td>❑ Inverse Dab</td>
</tr>
<tr>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
<td>❑ Inverse Dac</td>
</tr>
</tbody>
</table>

NOTE: As Shipped settings are contained in brackets [ ] where applicable.

Figure A-3  Setup System (Four Windings) (page 1 of 3)
## Setup System – Four Windings (Cont.'d)

### Custom Selections:

<table>
<thead>
<tr>
<th>Transformer W1</th>
<th>Transformer W2</th>
<th>Transformer W3</th>
<th>Transformer W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Y)</td>
<td>0 Y</td>
<td>0 Y</td>
<td>0 Y</td>
</tr>
<tr>
<td>1 Dac</td>
<td>1 Dac</td>
<td>1 Dac</td>
<td>1 Dac</td>
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<tr>
<td>2</td>
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<td>4</td>
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</tr>
<tr>
<td>5 (Inverse Dab)</td>
<td>5 Inverse Dab</td>
<td>5 Inverse Dab</td>
<td>5 Inverse Dab</td>
</tr>
<tr>
<td>6 (Inverse Y)</td>
<td>6 Inverse Y</td>
<td>6 Inverse Y</td>
<td>6 Inverse Y</td>
</tr>
<tr>
<td>7 (Inverse Dac)</td>
<td>7 Inverse Dac</td>
<td>7 Inverse Dac</td>
<td>7 Inverse Dac</td>
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<td>10</td>
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<tr>
<td>11 (Dab)</td>
<td>11 Dab</td>
<td>11 Dab</td>
<td>11 Dab</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CT W1</th>
<th>CT W2</th>
<th>CT W3</th>
<th>CT W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Y)</td>
<td>0 (Y)</td>
<td>0 (Y)</td>
<td>0 (Y)</td>
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<tr>
<td>6 (Inverse Y)</td>
<td>6 (Inverse Y)</td>
<td>6 (Inverse Y)</td>
<td>6 (Inverse Y)</td>
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<td>13 (Dac)</td>
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<td>16</td>
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<td>16</td>
</tr>
<tr>
<td>17 (Inverse Dab)</td>
<td>17 (Inverse Dab)</td>
<td>17 (Inverse Dab)</td>
<td>17 (Inverse Dab)</td>
</tr>
<tr>
<td>18</td>
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</tr>
<tr>
<td>19 (Inverse Dac)</td>
<td>19 (Inverse Dac)</td>
<td>19 (Inverse Dac)</td>
<td>19 (Inverse Dac)</td>
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<tr>
<td>20</td>
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<tr>
<td>23 (Dab)</td>
<td>23 (Dab)</td>
<td>23 (Dab)</td>
<td>23 (Dab)</td>
</tr>
</tbody>
</table>

**Custom Transformer/CT Selections (Cont.'d):**

- **W1 Zero Sequence Filter**  [ ] Enable  [ ] Disable
- **W2 Zero Sequence Filter**  [ ] Enable  [ ] Disable
- **W3 Zero Sequence Filter**  [ ] Enable  [ ] Disable
- **W4 Zero Sequence Filter**  [ ] Enable  [ ] Disable

**NOTE:** As Shipped settings are contained in brackets [ ] where applicable.

*Figure A-3  Setup System (Four Windings) (page 2 of 3)
Setup System – Four Windings (Cont.'d)

VT and CT Ratio

VT Ratio: __________:1  1.0 – 6550.0 [1.0]
VT Ground Ratio: __________:1  1.0 – 6550.0 [1.0]
CT W1 Phase Ratio: __________:1  1 – 65500.0 [1.0]
CT W2 Phase Ratio: __________:1  1 – 65500.0 [1.0]
CT W3 Phase Ratio: __________:1  1 – 65500.0 [1.0]
CT W4 Phase Ratio: __________:1  1 – 65500.0 [1.0]
CT W2 Ground Ratio: __________:1  1 – 65500.0 [1.0]
CT W3 Ground Ratio: __________:1  1 – 65500.0 [1.0]
CT W4 Ground Ratio: __________:1  1 – 65500.0 [1.0]

OUTPUT SETTINGS

Latched Outputs:
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Pulsed Outputs:
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Relay Seal-in Time:
- Output 1: _____ 2 – 8160 (Cycles) [30]
- Output 2: _____ 2 – 8160 (Cycles) [30]
- Output 3: _____ 2 – 8160 (Cycles) [30]
- Output 4: _____ 2 – 8160 (Cycles) [30]
- Output 5: _____ 2 – 8160 (Cycles) [30]
- Output 6: _____ 2 – 8160 (Cycles) [30]
- Output 7: _____ 2 – 8160 (Cycles) [30]
- Output 8: _____ 2 – 8160 (Cycles) [30]
- Output 9: _____ 2 – 8160 (Cycles) [30]
- Output 10: _____ 2 – 8160 (Cycles) [30]
- Output 11: _____ 2 – 8160 (Cycles) [30]
- Output 12: _____ 2 – 8160 (Cycles) [30]
- Output 13: _____ 2 – 8160 (Cycles) [30]
- Output 14: _____ 2 – 8160 (Cycles) [30]
- Output 15: _____ 2 – 8160 (Cycles) [30]
- Output 16: _____ 2 – 8160 (Cycles) [30]

INPUT SETTINGS

Input Active State (Open):
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

Input Active State (Close):
- [1]
- [2]
- [3]
- [4]
- [5]
- [6]
- [7]
- [8]
- [9]
- [10]
- [11]
- [12]
- [13]
- [14]
- [15]
- [16]
- [17]
- [18]

■ NOTE: As Shipped settings are contained in brackets [ ] where applicable.

Figure A-3  Setup System (Four Windings) (page 3 of 3)
Appendix – A

System Setpoints and Settings

24–Volts/Hz Overexcitation

Definite Time #1  
- Enable
- Disable

Pickup: _____ 100–200 (%)
Time Delay: _____ 30 – 8160 (Cycles)

I/O Selection:
- Outputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

- Blocking Inputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

Definite Time #2  
- Enable
- Disable

Pickup: _____ 100–200 (%)
Time Delay: _____ 30 – 8160 (Cycles)

I/O Selection:
- Outputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

- Blocking Inputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

Inverse Time  
- Enable
- Disable

Pickup: _____ 100–150 (%)
Time Dial: _____ 1 – 100
Reset Rate: _____ 1 – 999 (Sec)

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

I/O Selection:
- Outputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

- Blocking Inputs
  #1  #2  #3  #4  #5  #6  #7  #8
  #9  #10 #11 #12 #13 #14 #15 #16

Figure A-4  System Setpoints and Settings (page 1 of 39)

A-11
System Setpoints and Settings (Cont.’d)

27—Phase Undervoltage

27 #1  □ Disable  □ Enable
Pickup: _____  5–140 (V)
Time Delay: _____  1 – 8160 (Cycles)
Inhibit: _____  5–140 (V) □ Disable  □ Enable

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

27 #2  □ Disable  □ Enable (Not available in Four Winding applications)
Pickup: _____  5–140 (V)
Time Delay: _____  1 – 8160 (Cycles)
Inhibit: _____  5–140 (V) □ Disable  □ Enable

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

27 #3  □ Disable  □ Enable (Not available in Four Winding applications)
Pickup: _____  5–140 (V)
Time Delay: _____  1 – 8160 (Cycles)
Inhibit: _____  5–140 (V) □ Disable  □ Enable

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 2 of 39)
System Setpoints and Settings (Cont.'d)

46 — Negative Sequence Overcurrent

46-W2

Definite Time  □ Disable  □ Enable
Pickup: ______ 0.10 – 20.00 (A)
Time Delay: ______ 1 – 8160 (Cycles)
I/O Selection:
Outputs
☐ #1  ☐ #2  ☐ #3  ☐ #4  ☐ #5  ☐ #6  ☐ #7  ☐ #8
☐ #9  ☐ #10  ☐ #11  ☐ #12  ☐ #13  ☐ #14  ☐ #15  ☐ #16
Blocking Inputs
☐ #1  ☐ #2  ☐ #3  ☐ #4  ☐ #5  ☐ #6  ☐ #7  ☐ #8  ☐ #9
☐ #10  ☐ #11  ☐ #12  ☐ #13  ☐ #14  ☐ #15  ☐ #16  ☐ #17  ☐ #18

Inverse Time  □ Disable  □ Enable
Pickup: ______ 0.50 – 5.00 (A)
Time Dial: ______ 0.5 – 11.0
Inverse Time Curves:
☐ BECO Definite Time  ☐ BECO Inverse  ☐ BECO Very Inverse
☐ BECO Extremely Inverse  ☐ IEC Inverse  ☐ IEC Very Inverse
☐ IEC Extremely Inverse  ☐ IEC Long Time Inverse  ☐ IEEE Moderately Inverse
☐ IEEE Very Inverse  ☐ IEEE Extremely Inverse
I/O Selection:
Outputs
☐ #1  ☐ #2  ☐ #3  ☐ #4  ☐ #5  ☐ #6  ☐ #7  ☐ #8
☐ #9  ☐ #10  ☐ #11  ☐ #12  ☐ #13  ☐ #14  ☐ #15  ☐ #16
Blocking Inputs
☐ #1  ☐ #2  ☐ #3  ☐ #4  ☐ #5  ☐ #6  ☐ #7  ☐ #8  ☐ #9
☐ #10  ☐ #11  ☐ #12  ☐ #13  ☐ #14  ☐ #15  ☐ #16  ☐ #17  ☐ #18

46-W3

Definite Time  □ Disable  □ Enable
Pickup: ______ 0.10 – 20.00 (A)
Time Delay: ______ 1 – 8160 (Cycles)
I/O Selection:
Outputs
☐ #1  ☐ #2  ☐ #3  ☐ #4  ☐ #5  ☐ #6  ☐ #7  ☐ #8
☐ #9  ☐ #10  ☐ #11  ☐ #12  ☐ #13  ☐ #14  ☐ #15  ☐ #16

Figure A-4  System Setpoints and Settings (page 3 of 39)
System Setpoints and Settings (Cont.’d)

46–Negative Sequence Overcurrent (Cont.’d)

46-W3 (Cont.’d)

| Blocking Inputs | #1 | #2 | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #12 | #13 | #14 | #15 | #16 | #17 | #18 |
|-----------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                 |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |

**Inverse Time**  
☐ Enable  
☐ Disable

**Pickup:** _____  0.50–5.00 (A)

**Time Dial:** _____  0.5 – 11.0

**Inverse Time Curves:**

- ☐ BECO Definite Time
- ☐ BECO Inverse
- ☐ BECO Very Inverse
- ☐ BECO Extremely Inverse
- ☐ IEC Inverse
- ☐ IEC Very Inverse
- ☐ IEC Extremely Inverse
- ☐ IEEE Long Time Inverse
- ☐ IEEE Moderately Inverse
- ☐ IEEE Very Inverse
- ☐ IEEE Extremely Inverse

**I/O Selection:**

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16
  - #17
  - #18

---

46-W4 (Not available in Two or Three Winding applications)

**Definite Time**  
☐ Enable  
☐ Disable

**Pickup:** _____  0.10–20.00 (A)

**Time Delay:** _____  1 – 8160 (Cycles)

**I/O Selection:**

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16
  - #17
  - #18

**Inverse Time**  
☐ Enable  
☐ Disable

**Pickup:** _____  0.50–5.00 (A)

**Time Dial:** _____  0.5 – 11.0
System Setpoints and Settings (Cont.'d)

46—Negative Sequence Overcurrent (Cont.'d)

46-W4 (Cont.'d) (Not available in Two or Three Winding applications)

Inverse Time Curves:
- BECO Definite Time
- BECO Inverse
- BECO Very Inverse
- BECO Extremely Inverse
- IEC Inverse
- IEC Very Inverse
- IEC Extremely Inverse
- IEC Long Time Inverse
- IEEE Moderately Inverse
- IEEE Very Inverse
- IEEE Extremely Inverse

I/O Selection:

Outputs
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Blocking Inputs
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

49—Winding Thermal Protection

- Disable
- Enable

Time Constant: _____ 1.0–999.9 (min)
Max Overload Current: _____ 1.00–10.00 (A)

Current Selection:
- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3
- Winding 4 (Not available in Two or Three Winding applications)

I/O Selection:

Outputs
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Blocking Inputs
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18
## System Setpoints and Settings (Cont.'d)

### 50—Instantaneous Phase Overcurrent

#### 50—#1  
- **Disable**  
- **Enable**

- **Pickup:** _____  1.0–100.0 (A)
- **Time Delay:** _____  1–8160 (Cycles)
- **Current Selection:**
  - Summing 1
  - Summing 2
  - Winding 1
  - Winding 2
  - Winding 3
- **I/O Selection:**
  - Outputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
  - Blocking Inputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
    - #17
    - #18

#### 50—#2  
- **Disable**  
- **Enable**

- **Pickup:** _____  1.0–100.0 (A)
- **Time Delay:** _____  1–8160 (Cycles)
- **Current Selection:**
  - Summing 1
  - Summing 2
  - Winding 1
  - Winding 2
  - Winding 3
- **I/O Selection:**
  - Outputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
  - Blocking Inputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
    - #17
    - #18

#### 50—#3  
- **Disable**  
- **Enable**

- **Pickup:** _____  1.0–100.0 (A)
- **Time Delay:** _____  1–8160 (Cycles)
- **Current Selection:**
  - Summing 1
  - Summing 2
  - Winding 1
  - Winding 2
  - Winding 3
- **I/O Selection:**
  - Outputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
  - Blocking Inputs
    - #1
    - #2
    - #3
    - #4
    - #5
    - #6
    - #7
    - #8
    - #9
    - #10
    - #11
    - #12
    - #13
    - #14
    - #15
    - #16
    - #17
    - #18

*Figure A-4  System Setpoints and Settings (page 6 of 39)*
System Setpoints and Settings (Cont.'d)

50–Instantaneous Phase Overcurrent (Cont.'d)

50– #4  □ Disable  □ Enable
  Pickup: _____  1.0–100.0 (A)
  Time Delay: _____  1 – 8160 (Cycles)
  Current Selection:
  □ Summing 1  □ Summing 2  □ Winding 1
  □ Winding 2  □ Winding 3

I/O Selection:
  Outputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

  Blocking Inputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

50– #5  □ Disable  □ Enable
  Pickup: _____  1.0–100.0 (A)
  Time Delay: _____  1 – 8160 (Cycles)
  Current Selection:
  □ Summing 1  □ Summing 2  □ Winding 1
  □ Winding 2  □ Winding 3

I/O Selection:
  Outputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

  Blocking Inputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

50– #6  □ Disable  □ Enable
  Pickup: _____  1.0–100.0 (A)
  Time Delay: _____  1 – 8160 (Cycles)
  Current Selection:
  □ Summing 1  □ Summing 2  □ Winding 1
  □ Winding 2  □ Winding 3

I/O Selection:
  Outputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

  Blocking Inputs
  □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 7 of 39)
System Setpoints and Settings (Cont.'d)

50–Instantaneous Phase Overcurrent (Cont.'d)

50– #7  □ Disable  □ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1–8160 (Cycles)

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

50– #8  □ Disable  □ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)

Time Delay: _____ 1–8160 (Cycles)

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18
System Setpoints and Settings (Cont.'d)

50N—Instantaneous Residual Overcurrent

50N—#1  □ Disable  □ Enable

Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1–8160 (Cycles)

Current Selection:

□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3

I/O Selection:

Outputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

50N—#2  □ Disable  □ Enable

Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1–8160 (Cycles)

Current Selection:

□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3

I/O Selection:

Outputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

50N—#3  □ Disable  □ Enable

Pickup: ______ 1.0–100.0 (A)
Time Delay: ______ 1–8160 (Cycles)

Current Selection:

□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3

I/O Selection:

Outputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Figure A-4  System Setpoints and Settings (page 9 of 39)
System Setpoints and Settings (Cont.'d)

50N—Instantaneous Residual Overcurrent (Cont.'d)

50N—#4  □ Disable  □ Enable

Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1–8160 (Cycles)

Current Selection:
- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3

I/O Selection:
- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

50N—#5  □ Disable  □ Enable

Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1–8160 (Cycles)

Current Selection:
- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3

I/O Selection:
- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16
  - #17
  - #18

50N—#6  □ Disable  □ Enable

Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1–8160 (Cycles)

Current Selection:
- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3

I/O Selection:
- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16
  - #17
  - #18

Figure A-4  System Setpoints and Settings (page 10 of 39)
Appendix – A

System Setpoints and Settings (Cont.’d)

50N–Instantaneous Residual Overcurrent (Cont.’d)

50N– #7  □ Disable □ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)
Time Delay: _____ 1 – 8160 (Cycles)

Current Selection:

- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3
- Winding 4

I/O Selection:

Inputs

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

Blocking Inputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

50N– #8  □ Disable □ Enable (Not available in Two or Three Winding applications)

Pickup: _____ 1.0–100.0 (A)
Time Delay: _____ 1 – 8160 (Cycles)

Current Selection:

- Summing 1
- Summing 2
- Winding 1
- Winding 2
- Winding 3
- Winding 4

I/O Selection:

Inputs

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

Blocking Inputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

Figure A-4   System Setpoints and Settings (page 11 of 39)
System Setpoints and Settings (Cont.’d)

50G—Instantaneous Ground Overcurrent

50G-W2-#1  □ Disable  □ Enable
Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

50G-W2-#2  □ Disable  □ Enable
Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

50G-W3-#1  □ Disable  □ Enable
Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

50G-W3-#2  □ Disable  □ Enable
Pickup: _____  1.0–100.0 (A)
Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 12 of 39)
System Setpoints and Settings (Cont.'d)

50G—Instantaneous Ground Overcurrent (Cont.'d)

50G-W4-#1  □ Disable  □ Enable (Not available in Two or Three Winding applications)
            Pickup: _____ 1.0–100.0 (A)
            Time Delay: _____ 1–8160 (Cycles)
            I/O Selection:
            Outputs
                □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
                □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
            Blocking Inputs
                □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
                □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

50G-W4-#2  □ Disable  □ Enable (Not available in Two or Three Winding applications)
            Pickup: _____ 1.0–100.0 (A)
            Time Delay: _____ 1–8160 (Cycles)
            I/O Selection:
            Outputs
                □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
                □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
            Blocking Inputs
                □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
                □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18
50BF – Breaker Failure

50BF-W1  □ Disable  □ Enable

- Phase Pickup: _____  0.10–10.00 (A)
- Residual Pickup: _____  0.10–10.00 (A)
- Time Delay: _____  1 – 8160 (Cycles)

I/O Selection:

- Output Initiate
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Input Initiate
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

50BF – Breaker Failure (Cont.’d)

50BF-W2  □ Disable  □ Enable

- Phase Pickup: _____  0.10–10.00 (A)
- Residual Pickup: _____  0.10–10.00 (A)
- Time Delay: _____  1 – 8160 (Cycles)

I/O Selection:

- Output Initiate
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Outputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Input Initiate
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

- Blocking Inputs
  - #1
  - #2
  - #3
  - #4
  - #5
  - #6
  - #7
  - #8
  - #9
  - #10
  - #11
  - #12
  - #13
  - #14
  - #15
  - #16

Figure A-4  System Setpoints and Settings (page 14 of 39)
50BF-W3  □ Disable  □ Enable
   Phase Pickup: _____  0.10–10.00 (A)
   Residual Pickup: _____  0.10–10.00 (A)
   Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
   Output Initiate
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Outputs
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Input Initiate
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Blocking Inputs
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16

50BF-W4  □ Disable  □ Enable (Not available in Two or Three Winding applications)
   Phase Pickup: _____  0.10–10.00 (A)
   Residual Pickup: _____  0.10–10.00 (A)
   Time Delay: _____  1 – 8160 (Cycles)
I/O Selection:
   Output Initiate
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Outputs
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Input Initiate
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
   Blocking Inputs
       □ #1          □ #2          □ #3          □ #4          □ #5          □ #6          □ #7          □ #8
       □ #9          □ #10         □ #11         □ #12         □ #13         □ #14         □ #15         □ #16
### System Setpoints and Settings (Cont.’d)

#### 51–Inverse Time Phase Overcurrent

**51– #1**  
- **Disable**  
- **Enable**  

- **Pickup:** _____ 0.50–12.00 (A)  
- **Time Dial:** _____ 0.5 – 11.0  
- **Current Selection:**  
  - Summing 1  
  - Summing 2  
  - Winding 1  
  - Winding 2  
  - Winding 3  
  - Winding 4  

- **Inverse Time Curves:**  
  - BECO Definite Time  
  - BECO Inverse  
  - BECO Very Inverse  
  - BECO Extremely Inverse  
  - IEC Inverse  
  - IEC Very Inverse  
  - IEC Extremely Inverse  
  - IEC Long Time Inverse  
  - IEEE Moderately Inverse  
  - IEEE Very Inverse  
  - IEEE Extremely Inverse  

- **I/O Selection:**  
  - **Outputs**  
    - #1  
    - #2  
    - #3  
    - #4  
    - #5  
    - #6  
    - #7  
    - #8  
    - #9  
    - #10  
    - #11  
    - #12  
    - #13  
    - #14  
    - #15  
    - #16  

  - **Blocking Inputs**  
    - #1  
    - #2  
    - #3  
    - #4  
    - #5  
    - #6  
    - #7  
    - #8  
    - #9  
    - #10  
    - #11  
    - #12  
    - #13  
    - #14  
    - #15  
    - #16  
    - #17  
    - #18  

**51– #2**  
- **Disable**  
- **Enable**  

- **Pickup:** _____ 0.50–12.00 (A)  
- **Time Dial:** _____ 0.5 – 11.0  
- **Current Selection:**  
  - Summing 1  
  - Summing 2  
  - Winding 1  
  - Winding 2  
  - Winding 3  
  - Winding 4  

- **Inverse Time Curves:**  
  - BECO Definite Time  
  - BECO Inverse  
  - BECO Very Inverse  
  - BECO Extremely Inverse  
  - IEC Inverse  
  - IEC Very Inverse  
  - IEC Extremely Inverse  
  - IEC Long Time Inverse  
  - IEEE Moderately Inverse  
  - IEEE Very Inverse  
  - IEEE Extremely Inverse  

- **I/O Selection:**  
  - **Outputs**  
    - #1  
    - #2  
    - #3  
    - #4  
    - #5  
    - #6  
    - #7  
    - #8  
    - #9  
    - #10  
    - #11  
    - #12  
    - #13  
    - #14  
    - #15  
    - #16  

  - **Blocking Inputs**  
    - #1  
    - #2  
    - #3  
    - #4  
    - #5  
    - #6  
    - #7  
    - #8  
    - #9  
    - #10  
    - #11  
    - #12  
    - #13  
    - #14  
    - #15  
    - #16  
    - #17  
    - #18

*Figure A-4  System Setpoints and Settings (page 16 of 39)*
Appendix – A

System Setpoints and Settings (Cont.’d)

51–Inverse Time Phase Overcurrent (Cont.’d)

51–#3  □ Disable  □ Enable

- Pickup: _____  0.50–12.00 (A)
- Time Dial: _____  0.5 – 11.0
- Current Selection:
  - □ Summing 1  □ Summing 2  □ Winding 1
  - □ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
- □ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
- □ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
- □ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
- □ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
- Outputs
  - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
  - □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
- Blocking Inputs
  - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
  - □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

51–#4  □ Disable  □ Enable (Not available in Two or Three Winding applications)

- Pickup: _____  0.50–12.00 (A)
- Time Dial: _____  0.5 – 11.0
- Current Selection:
  - □ Summing 1  □ Summing 2  □ Winding 1
  - □ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
- □ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
- □ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
- □ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
- □ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
- Outputs
  - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
  - □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
- Blocking Inputs
  - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
  - □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 17 of 39)

A–27
System Setpoints and Settings (Cont.'d)

51N—Inverse Time Residual Overcurrent

51N—#1  □ Disable  □ Enable

Pickup: _____  0.50–6.00 (A)
Time Dial: _____  0.5 – 11.0

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

51N—#2  □ Disable  □ Enable

Pickup: _____  0.50–6.00 (A)
Time Dial: _____  0.5 – 11.0

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4   System Setpoints and Settings (page 18 of 39)
System Setpoints and Settings (Cont.'d)

51N–Inverse Time Residual Overcurrent (Cont.'d)

51N– #3  □ Disable  □ Enable

Pickup: _____  0.50–6.00 (A)
Time Dial: _____  0.5–11.0

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

51N– #4  □ Disable  □ Enable (Not available in Two or Three Winding applications)

Pickup: _____  0.50–6.00 (A)
Time Dial: _____  0.5–11.0

Current Selection:
□ Summing 1  □ Summing 2  □ Winding 1
□ Winding 2  □ Winding 3  □ Winding 4

Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:
Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 19 of 39)
System Setpoints and Settings (Cont.’d)

51G—Inverse Time Ground Overcurrent

51G—W2  □ Disable  □ Enable

Pickup: _____  0.50–12.00 (A)
Time Dial: _____  0.5 – 11.0
Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:

Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

51G—W3  □ Disable  □ Enable

Pickup: _____  0.50–12.00 (A)
Time Dial: _____  0.5 – 11.0
Inverse Time Curves:
□ BECO Definite Time  □ BECO Inverse  □ BECO Very Inverse
□ BECO Extremely Inverse  □ IEC Inverse  □ IEC Very Inverse
□ IEC Extremely Inverse  □ IEC Long Time Inverse  □ IEEE Moderately Inverse
□ IEEE Very Inverse  □ IEEE Extremely Inverse

I/O Selection:

Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Figure A-4  System Setpoints and Settings (page 20 of 39)
### System Setpoints and Settings (Cont.'d)

#### 51G–Inverse Time Ground Overcurrent (Cont.'d)

**51G–W4**  
- Disable  
- Enable (Not available in Two or Three Winding applications)

- **Pickup:** _____  0.50–12.00 (A)
- **Time Dial:** _____  0.5 – 11.0

**Inverse Time Curves:**
- BECO Definite Time  
- BECO Inverse  
- BECO Very Inverse  
- BECO Extremely Inverse  
- IEC Inverse  
- IEC Very Inverse  
- IEC Extremely Inverse  
- IEC Long Time Inverse  
- IEEE Moderately Inverse  
- IEEE Very Inverse  
- IEEE Extremely Inverse

**I/O Selection:**

**Outputs**
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

**Blocking Inputs**
- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

---

*Figure A-4  System Setpoints and Settings (page 21 of 39)*
### System Setpoints and Settings (Cont.’d)

**59–Phase Overvoltage (Only available in Two or Three Winding applications)**

**59–#1**  
- Disable  
- Enable  

<table>
<thead>
<tr>
<th>Pickup:</th>
<th>5–180 (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Delay:</td>
<td>1–8160 (Cycles)</td>
</tr>
</tbody>
</table>

**Input Voltage Select**  
- Phase  
- Positive Sequence  
- Negative Sequence

**I/O Selection:**  
- Outputs  
- Blocking Inputs

<table>
<thead>
<tr>
<th>Outputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Blocking Inputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>

**59–#2**  
- Disable  
- Enable  

<table>
<thead>
<tr>
<th>Pickup:</th>
<th>5–180 (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Delay:</td>
<td>1–8160 (Cycles)</td>
</tr>
</tbody>
</table>

**Input Voltage Select**  
- Phase  
- Positive Sequence  
- Negative Sequence

**I/O Selection:**  
- Outputs  
- Blocking Inputs

<table>
<thead>
<tr>
<th>Outputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Blocking Inputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>

**59–#3**  
- Disable  
- Enable  

<table>
<thead>
<tr>
<th>Pickup:</th>
<th>5–180 (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Delay:</td>
<td>1–8160 (Cycles)</td>
</tr>
</tbody>
</table>

**Input Voltage Select**  
- Phase  
- Positive Sequence  
- Negative Sequence

**I/O Selection:**  
- Outputs  
- Blocking Inputs

<table>
<thead>
<tr>
<th>Outputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Blocking Inputs #1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#10</th>
<th>#11</th>
<th>#12</th>
<th>#13</th>
<th>#14</th>
<th>#15</th>
<th>#16</th>
<th>#17</th>
<th>#18</th>
</tr>
</thead>
</table>
System Setpoints and Settings (Cont.’d)

59G–Ground Overvoltage (Only available in Four Winding applications)

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>59G–#1</td>
<td>Disable</td>
</tr>
<tr>
<td>Pickup:</td>
<td>5–180 (V)</td>
</tr>
<tr>
<td>Time Delay:</td>
<td>1–8160 (Cycles)</td>
</tr>
<tr>
<td>I/O Selection:</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>#1</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td>#1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>59G–#2</td>
<td>Disable</td>
</tr>
<tr>
<td>Pickup:</td>
<td>5–180 (V)</td>
</tr>
<tr>
<td>Time Delay:</td>
<td>1–8160 (Cycles)</td>
</tr>
<tr>
<td>I/O Selection:</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>#1</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td>#1</td>
</tr>
</tbody>
</table>
System Setpoints and Settings (Cont.'d)

59G—Ground Overvoltage (Only available in Two or Three Winding applications)

59G – #1  □ Disable  □ Enable
   Pickup: _____  5–180 (V)
   Time Delay: _____  1–8160 (Cycles)
   I/O Selection:
   Outputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
   □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
   Blocking Inputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

59G – #2  □ Disable  □ Enable
   Pickup: _____  5–180 (V)
   Time Delay: _____  1–8160 (Cycles)
   I/O Selection:
   Outputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
   □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
   Blocking Inputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

59G – #3  □ Disable  □ Enable
   Pickup: _____  5–180 (V)
   Time Delay: _____  1–8160 (Cycles)
   I/O Selection:
   Outputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
   □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16
   Blocking Inputs
   □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Zero Sequence Voltage  □ V₀  □ 3V₀

■ NOTE: This setting is only functional with firmware version V02.03.01 and later.
System Setpoints and Settings (Cont.’d)

81 – Over/Under Frequency

81 – #1  □ Disable  □ Enable
Pickup: _____  55.00–65.00 (Hz)
Time Delay: _____  2–65500 (Cycles)
I/O Selection:
Outputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
 □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
Blocking Inputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
 □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

81 – #2  □ Disable  □ Enable
Pickup: _____  55.00–65.00 (Hz)
Time Delay: _____  2–65500 (Cycles)
I/O Selection:
Outputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
 □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
Blocking Inputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
 □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

81 – #3  □ Disable  □ Enable
Pickup: _____  55.00–65.00 (Hz)
Time Delay: _____  2–65500 (Cycles)
I/O Selection:
Outputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
 □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
Blocking Inputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
 □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

81 – #4  □ Disable  □ Enable
Pickup: _____  55.00–65.00 (Hz)
Time Delay: _____  2–65500 (Cycles)
I/O Selection:
Outputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
 □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
Blocking Inputs
 □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
 □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Figure A-4  System Setpoints and Settings (page 25 of 39)
System Setpoints and Settings (Cont.’d)

87 – Phase Differential Current

87T  □ Disable  □ Enable

Pickup: _____  0.10 – 1.00 (PU)
Percent Slope #1: _____  5 – 100 (%)
Percent Slope #2: _____  5 – 200 (%)
Slope Break Point: _____  1.0 – 4.0 (PU)
Even Harmonics Restraint  □ Disable  □ Enable  □ Enable w/cross average
Restraint: _____  5 – 50 (%)
5th Harmonic Restraint  □ Disable  □ Enable  □ Enable w/cross average
Restraint: _____  5 – 50 (%)
Pickup: _____  0.10 – 2.00 (PU)

I/O Selection:

Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

87H  □ Disable  □ Enable

Pickup: _____  5.0 – 20.0 (PU)
Time Delay: _____  1 – 8160 (Cycles)

I/O Selection:

Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

87 CT Tap

Winding 1 CT Tap: _____  1.00 – 100.00
Winding 2 CT Tap: _____  1.00 – 100.00
Winding 3 CT Tap: _____  1.00 – 100.00
Winding 4 CT Tap: _____  1.00 – 100.00 (Not available in Two or Three Winding applications)
Appendix – A

System Setpoints and Settings (Cont.'d)

87GD—Ground Differential

87GD-W2-#1

- Disable
- Enable

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1–8160 (Cycles)

I/O Selection:

Outputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Blocking Inputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

87GD-W2-#2

- Disable
- Enable

Pickup: _____ 0.20–10.0 (A)

Time Delay: _____ 1–8160 (Cycles)

I/O Selection:

Outputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Blocking Inputs

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

87GD-W2-Settings

3I₀ Current Selection:

- Summing 1
- Summing 2
- Winding 2

Directional Element:

- Disable
- Enable

CT Ratio Correction: _____ 0.10–7.99
System Setpoints and Settings (Cont.’d)

87GD–Ground Differential (Cont.’d)

87GD-W3-#1

☐ Disable ☐ Enable

Pickup: ______  0.20 – 10.0 (A)

Time Delay: ______  1 – 8160 (Cycles)

I/O Selection:

Outputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8
☐ #9 ☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9
☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16 ☐ #17 ☐ #18

87GD-W3-#2

☐ Disable ☐ Enable

Pickup: ______  0.20 – 10.0 (A)

Time Delay: ______  1 – 8160 (Cycles)

I/O Selection:

Outputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8
☐ #9 ☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16

Blocking Inputs

☐ #1 ☐ #2 ☐ #3 ☐ #4 ☐ #5 ☐ #6 ☐ #7 ☐ #8 ☐ #9
☐ #10 ☐ #11 ☐ #12 ☐ #13 ☐ #14 ☐ #15 ☐ #16 ☐ #17 ☐ #18

87GD-W3-Settings

3I₀ Current Selection: ☐ Summing 1 ☐ Summing 2 ☐ Winding 3

Directional Element: ☐ Disable ☐ Enable

CT Ratio Correction: ______  0.10 – 7.99

Figure A-4  System Setpoints and Settings (page 28 of 39)
System Setpoints and Settings (Cont.'d)

87GD–Ground Differential (Cont.'d)

87GD-W4-#1  □ Disable  □ Enable (Not available in Two or Three Winding applications)
Pickup: _____  0.20–10.0 (A)
Time Delay: _____  1–8160 (Cycles)
I/O Selection:
Outputs
- #1  #2  #3  #4  #5  #6  #7  #8
- #9  #10  #11  #12  #13  #14  #15  #16

Blocking Inputs
- #1  #2  #3  #4  #5  #6  #7  #8  #9
- #10  #11  #12  #13  #14  #15  #16  #17  #18

87GD-W4-#2  □ Disable  □ Enable (Not available in Two or Three Winding applications)
Pickup: _____  0.20–10.0 (A)
Time Delay: _____  1–8160 (Cycles)
I/O Selection:
Outputs
- #1  #2  #3  #4  #5  #6  #7  #8
- #9  #10  #11  #12  #13  #14  #15  #16

Blocking Inputs
- #1  #2  #3  #4  #5  #6  #7  #8  #9
- #10  #11  #12  #13  #14  #15  #16  #17  #18

87GD-W4-Settings (Not available in Two or Three Winding applications)
3$I_o$ Current Selection:  □ Summing 1  □ Summing 2  □ Winding 4
Directional Element:  □ Disable  □ Enable
CT Ratio Correction: _____  0.10–7.99
System Setpoints and Settings (Cont.’d)

IPSlogic

#1  [ ] Disable  [ ] Enable

Initiating Outputs:

[ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8
[ ] #9  [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16

Initiating Outputs Logic Gate: [ ] OR  [ ] AND

Initiating 87H/TPhase:

[ ] A  [ ] B  [ ] C

Initiating Function Trip:

[ ] 24DT#1  [ ] 24DT #2  [ ] 24IT  [ ] 27 #1  [ ] 27 #2  [ ] 27 #3  [ ] 46DT-W2
[ ] 46IT-W2  [ ] 46DT-W3  [ ] 46IT-W3  [ ] 49  [ ] 50 #1  [ ] 50 #2  [ ] 50 #3
[ ] 50 #4  [ ] 50 #5  [ ] 50 #6  [ ] 50BF-W1  [ ] 50BF-W2  [ ] 50BF-W3  [ ] 50G-W2 #1
[ ] 50G-W2 #2  [ ] 50G-W3 #1  [ ] 50G-W3 #2  [ ] 50N#1  [ ] 50N#2  [ ] 50N#3
[ ] 50N#4  [ ] 50N#5  [ ] 50N#6  [ ] 51#1  [ ] 51#2  [ ] 51#3  [ ] 51G-W2
[ ] 51G-W3  [ ] 51N#1  [ ] 51N#2  [ ] 51N#3  [ ] 59#1  [ ] 59#2  [ ] 59#3
[ ] 59G#1  [ ] 59G#2  [ ] 59G#3  [ ] 81#1  [ ] 81#2  [ ] 81#3  [ ] 81#4
[ ] 87H  [ ] 87T  [ ] 87GD-W2 #1  [ ] 87GD-W2 #2  [ ] 87GD-W3 #1
[ ] 87GD-W3 #2  [ ] TF  [ ] TCM  [ ] IPSlogic #2  [ ] IPSlogic #3  [ ] IPSlogic #4
[ ] IPSlogic #5  [ ] IPSlogic #6  [ ] BM-W1  [ ] BM-W2  [ ] BM-W3

Initiating 87H/T Phase Logic Gate: [ ] OR  [ ] AND

Initiating 87H/T Phase Logic Gate: [ ] ---  [ ] NOT

Initiating Inputs:

[ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  [ ] #9
[ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16  [ ] #17  [ ] #18

Initiating Inputs Logic Gate: [ ] OR  [ ] AND

Initiate via Communication Point: [ ]

Blocking Inputs:

[ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  [ ] #9
[ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16  [ ] #17  [ ] #18

Initiating Inputs Logic Gate: [ ] OR  [ ] AND

Initiating Inputs Logic Gate: [ ] None  [ ] NOT

Block via Communication Point: [ ]

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: [ ] OR  [ ] AND

Delay: ______  1 – 65500 (Cycles)

Reset/Dropout Delay: ______  0 – 65500 (Cycles)  [ ] Reset  [ ] Dropout

Outputs:

[ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8
[ ] #9  [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16

Reset Latched Outputs

Profile Switch: [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] Not Activated

Figure A-4  System Setpoints and Settings (page 30 of 39)
System Setpoints and Settings (Cont.'d)

IPSlogic

#2  □ Disable  □ Enable
Initiating Outputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Initiating Outputs Logic Gate: □ OR  □ AND
Initiating 87H/TPhase: □ A  □ B  □ C

Initiating Function Trip:

□ 24DT#1 □ 24DT #2 □ 24IT □ 27 #1 □ 27 #2 □ 27 #3 □ 46DT-W2
□ 46IT-W2 □ 46DT-W3 □ 46IT-W3 □ 49 □ 50 #1 □ 50 #2 □ 50 #3
□ 50 #4 □ 50 #5 □ 50 #6 □ 50BF-W1 □ 50BF-W2 □ 50BF-W3 □ 50G-W2 #1
□ 50G-W2 #2 □ 50G-W3 #1 □ 50G-W3 #2 □ 50N#1 □ 50N#2 □ 50N#3
□ 50N#4 □ 50N#5 □ 50N#6 □ 51#1 □ 51#2 □ 51#3 □ 51G-W2
□ 51G-W3 □ 51N#1 □ 51N#2 □ 51N#3 □ 59#1 □ 59#2 □ 59#3
□ 59G#1 □ 59G#2 □ 59G#3 □ 81#1 □ 81#2 □ 81#3 □ 81#4
□ 87H □ 87T □ 87GD-W2 #1 □ 87GD-W2 #2 □ 87GD-W3 #1
□ 87GD-W3 #2 □ TF □ TCM □ IPSlogic #1 □ IPSlogic #3 □ IPSlogic #4
□ IPSlogic #5 □ IPSlogic #6 □ BM-W1 □ BM-W2 □ BM-W3

Initiating 87H/T Phase Logic Gate: □ OR  □ AND
Initiating 87H/T Phase Logic Gate: □ --- □ NOT

Initiating Inputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Initiating Inputs Logic Gate: □ OR  □ AND
Initiate via Communication Point: □

Blocking Inputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Initiating Inputs Logic Gate: □ OR  □ AND
Initiating Inputs Logic Gate: □ None □ NOT
Block via Communication Point: □

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: □ OR  □ AND
Delay: _____ 1–65500 (Cycles)
Reset/Dropout Delay: _____ 0–65500 (Cycles) □ Reset □ Dropout

Outputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Reset Latched Outputs □

Profile Switch: □ #1  □ #2  □ #3  □ #4  □ Not Activated

Figure A-4  System Setpoints and Settings (page 31 of 39)
IPSlogic

#3  □ Disable  □ Enable

Initiating Outputs:

□ #1   □ #2   □ #3   □ #4   □ #5   □ #6   □ #7   □ #8
□ #9   □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Initiating Outputs Logic Gate: □ OR □ AND

Initiating 87H/T Phase: □ A □ B □ C

Initiating Function Trip:

□ 24DT #1 □ 24DT #2 □ 24IT □ 27 #1 □ 27 #2 □ 27 #3 □ 46DT-W2
□ 46IT-W2 □ 46DT-W3 □ 46IT-W3 □ 49 □ 50 #1 □ 50 #2 □ 50 #3
□ 50 #4 □ 50 #5 □ 50 #6 □ 50BF-W1 □ 50BF-W2 □ 50BF-W3 □ 50G-W2 #1
□ 50G-W2 #2 □ 50G-W3 #1 □ 50G-W3 #2 □ 50N #1 □ 50N #2 □ 50N #3
□ 50N #4 □ 50N #5 □ 50N #6 □ 51 #1 □ 51 #2 □ 51 #3 □ 51G-W2
□ 51G-W3 □ 51N #1 □ 51N #2 □ 51N #3 □ 59 #1 □ 59 #2 □ 59 #3
□ 59G #1 □ 59G #2 □ 59G #3 □ 81 #1 □ 81 #2 □ 81 #3 □ 81 #4
□ 87H □ 87T □ 87GD-W2 #1 □ 87GD-W2 #2 □ 87GD-W3 #1
□ 87GD-W3 #2 □ TF □ TCM □ IPSlogic #1 □ IPSlogic #2 □ IPSlogic #4
□ IPSlogic #5 □ IPSlogic #6 □ BM-W1 □ BM-W2 □ BM-W3

Initiating 87H/T Phase Logic Gate: □ OR □ AND

Initiating Inputs:

□ #1   □ #2   □ #3   □ #4   □ #5   □ #6   □ #7   □ #8   □ #9
□ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

Initiating Inputs Logic Gate: □ OR □ AND

Initiate via Communication Point:

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: □ OR □ AND

Delay: ______ 1–65500 (Cycles)

Reset/Dropout Delay: ______ 0–65500 (Cycles) □ Reset □ Dropout

Outputs:

□ #1   □ #2   □ #3   □ #4   □ #5   □ #6   □ #7   □ #8
□ #9   □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

Reset Latched Outputs □

Profile Switch: □ #1 □ #2 □ #3 □ #4 □ Not Activated

Figure A-4  System Setpoints and Settings (page 32 of 39)
System Setpoints and Settings (Cont.’d)

IPSlogic

#4

- Disable
- Enable

Initiating Outputs:

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16

Initiating Outputs Logic Gate: OR, AND

Initiating 87H/T Phase: A, B, C

Initiating Function Trip:

- 24DT#1
- 24DT #2
- 24IT
- 27 #1
- 27 #2
- 27 #3
- 46DT-W2
- 46IT-W2
- 46DT-W3
- 46IT-W3
- 49
- 50 #1
- 50 #2
- 50 #3
- 50 #4
- 50 #5
- 50 #6
- 50BFW1
- 50BFW2
- 50BFW3
- 50G-W2 #1
- 50G#1
- 50G#2
- 50G#3
- 81 #1
- 81 #2
- 81 #3
- 81 #4
- 87H
- 87T
- 87GD-W2 #1
- 87GD-W2 #2
- 87GD-W3 #1
- 87GD-W3 #2
- TF
- TCM
- IPSlogic #1
- IPSlogic #2
- IPSlogic #3
- IPSlogic #5
- IPSlogic #6

Initiating 87H/T Phase Logic Gate: OR, AND

Initiating 87H/T Phase Logic Gate: ---, NOT

Initiating Inputs:

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

Initiating Inputs Logic Gate: OR, AND

Initiate via Communication Point:

Block via Communication Point:

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: OR, AND

Delay: 1 – 65500 (Cycles)

Reset/Dropout Delay: 0 – 65500 (Cycles)

Outputs:

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10
- #11
- #12
- #13
- #14
- #15
- #16
- #17
- #18

Reset Latched Outputs

Profile Switch: #1, #2, #3, #4, Not Activated

Figure A-4  System Setpoints and Settings (page 33 of 39)
IPSlogic

#5  □ Disable □ Enable

Initiating Outputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Initiating Outputs Logic Gate: □ OR □ AND

Initiating 87H/TPhase: □ A □ B □ C

Initiating Function Trip:

□ 24DT#1 □ 24DT #2 □ 24IT □ 27 #1 □ 27 #2 □ 27 #3 □ 46DT-W2
□ 46IT-W2 □ 46DT-W3 □ 46IT-W3 □ 49 □ 50 #1 □ 50 #2 □ 50 #3
□ 50 #4 □ 50 #5 □ 50 #6 □ 50BF-W1 □ 50BF-W2 □ 50BF-W3 □ 50G-W2 #1
□ 50G-W2 #2 □ 50G-W3 #1 □ 50G-W3 #2 □ 50N#1 □ 50N#2 □ 50N#3
□ 50N#4 □ 50N#5 □ 50N#6 □ 51#1 □ 51#2 □ 51#3 □ 51G-W2
□ 51G-W3 □ 51N#1 □ 51N#2 □ 51N#3 □ 59#1 □ 59#2 □ 59#3
□ 59G#1 □ 59G#2 □ 59G#3 □ 81#1 □ 81#2 □ 81#3 □ 81#4
□ 87H □ 87T □ 87GD-W2 #1 □ 87GD-W2 #2 □ 87GD-W3 #1
□ 87GD-W3 #2 □ TF □ TCM □ IPSlogic #1 □ IPSlogic #2 □ IPSlogic #3
□ IPSlogic #4 □ IPSlogic #6 □ BM-W1 □ BM-W2 □ BM-W3

Initiating 87H/T Phase Logic Gate: □ OR □ AND

Initiating 87H/T Phase Logic Gate: □ --- □ NOT

Initiating Inputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Initiating Inputs Logic Gate: □ OR □ AND

Initiate via Communication Point: □

Blocking Inputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Initiating Inputs Logic Gate: □ OR □ AND

Initiating Inputs Logic Gate: □ None □ NOT

Block via Communication Point: □

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: □ OR □ AND

Delay: ______ 1–65500 (Cycles)

Reset/Dropout Delay: _____ 0–65500 (Cycles) □ Reset □ Dropout

Outputs:

□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Reset Latched Outputs □

Profile Switch: □ #1 □ #2 □ #3 □ #4 □ Not Activated

Figure A-4  System Setpoints and Settings (page 34 of 39)
System Setpoints and Settings (Cont.’d)

**IPSlogic**

#6  [ ] Disable   [ ] Enable

Initiating Outputs:

- [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  
- [ ] #9  [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16  

Initiating Outputs Logic Gate: [ ] OR   [ ] AND

Initiating 87H/TPhase: [ ] A   [ ] B   [ ] C

Initiating Function Trip:

- [ ] 24DT#1  [ ] 24DT #2  [ ] 24IT  [ ] 27 #1  [ ] 27 #2  [ ] 27 #3  [ ] 46DT-W2  
- [ ] 46IT-W2  [ ] 46DT-W3  [ ] 46IT-W3  [ ] 49  [ ] 50 #1  [ ] 50 #2  [ ] 50 #3  
- [ ] 50 #4  [ ] 50 #5  [ ] 50 #6  [ ] 50BF-W1  [ ] 50BF-W2  [ ] 50BF-W3  [ ] 50G-W2 #1  
- [ ] 50G-W2 #2  [ ] 50G-W3 #1  [ ] 50G-W3 #2  [ ] 50N#1  [ ] 50N#2  [ ] 50N#3  
- [ ] 50N#4  [ ] 50N#5  [ ] 50N#6  [ ] 51#1  [ ] 51#2  [ ] 51#3  [ ] 51G-W2  
- [ ] 51G-W3  [ ] 51N#1  [ ] 51N#2  [ ] 51N#3  [ ] 59#1  [ ] 59#2  [ ] 59#3  
- [ ] 59G#1  [ ] 59G#2  [ ] 59G#3  [ ] 81#1  [ ] 81#2  [ ] 81#3  [ ] 81#4  
- [ ] 87H  [ ] 87T  [ ] 87GD-W2 #1  [ ] 87GD-W2 #2  [ ] 87GD-W3 #1  
- [ ] 87GD-W3 #2  [ ] TF  [ ] TCM  [ ] IPSlogic #1  [ ] IPSlogic #2  [ ] IPSlogic #3  
- [ ] IPSlogic #4  [ ] IPSlogic #5  [ ] BM-W1  [ ] BM-W2  [ ] BM-W3

Initiating 87H/T Phase Logic Gate: [ ] OR   [ ] AND

Initiating 87H/T Phase Logic Gate: [ ] ---   [ ] NOT

Initiating Inputs:

- [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  [ ] #9  
- [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16  [ ] #17  [ ] #18

Initiating Inputs Logic Gate: [ ] OR   [ ] AND

Initiate via Communication Point: [ ]

Blocking Inputs:

- [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  [ ] #9  
- [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16  [ ] #17  [ ] #18

Initiating Inputs Logic Gate: [ ] OR   [ ] AND

Initiating Inputs Logic Gate: [ ] None   [ ] NOT

Block via Communication Point: [ ]

Initiating Outputs/Inputs/Function Trip/87H-T Logic Gate: [ ] OR   [ ] AND

Delay: ______  1–65500 (Cycles)

Reset/Dropout Delay: ______  0–65500 (Cycles)  [ ] Reset   [ ] Dropout

Outputs:

- [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] #5  [ ] #6  [ ] #7  [ ] #8  
- [ ] #9  [ ] #10  [ ] #11  [ ] #12  [ ] #13  [ ] #14  [ ] #15  [ ] #16

Reset Latched Outputs [ ]

Profile Switch: [ ] #1  [ ] #2  [ ] #3  [ ] #4  [ ] Not Activated

*Figure A-4  System Setpoints and Settings (page 35 of 39)*
BM—Breaker Monitor

**BM–W1**  □ Disable  □ Enable

- Pickup: _____  1–50000 (kA Cycles)
- Time Delay: _____  0.1–4095.9 (Cycles)
- Timing Method Selection  □ IT  □ I^2T
- Preset Accumulator Phase A: _____  0–50000 (kA Cycles)
- Preset Accumulator Phase B: _____  0–50000 (kA Cycles)
- Preset Accumulator Phase C: _____  0–50000 (kA Cycles)

**I/O Selection:**

**Outputs Initiate**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
- □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

**Outputs**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
- □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

**Input Initiate**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
- □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

**Blocking Inputs**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
- □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

**BM–W2**  □ Disable  □ Enable

- Pickup: _____  1–50000 (kA Cycles)
- Time Delay: _____  0.1–4095.9 (Cycles)
- Timing Method Selection  □ IT  □ I^2T
- Preset Accumulator Phase A: _____  0–50000 (kA Cycles)
- Preset Accumulator Phase B: _____  0–50000 (kA Cycles)
- Preset Accumulator Phase C: _____  0–50000 (kA Cycles)

**I/O Selection:**

**Outputs Initiate**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
- □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

**Outputs**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
- □ #9  □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16

**Input Initiate**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
- □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

**Blocking Inputs**
- □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
- □ #10  □ #11  □ #12  □ #13  □ #14  □ #15  □ #16  □ #17  □ #18

*Figure A-4  System Setpoints and Settings (page 36 of 39)*
Appendix – A

System Setpoints and Settings (Cont.'d)

**BM—Breaker Monitor (Cont.'d)**

**BM—W3**
- □ Disable  □ Enable
  - Pickup: _____ 1–50000 (kA Cycles)
  - Time Delay: _____ 0.1–4095.9 (Cycles)
  - Timing Method Selection □ IT  □ I^2T
  - Preset Accumulator Phase A: _____ 0–50000 (kA Cycles)
  - Preset Accumulator Phase B: _____ 0–50000 (kA Cycles)
  - Preset Accumulator Phase C: _____ 0–50000 (kA Cycles)
  - I/O Selection:
    - Outputs Initiate
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
    - Outputs
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
    - Input Initiate
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18
    - Blocking Inputs
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

**BM—W4**
- □ Disable  □ Enable (Not available in Two or Three Winding applications)
  - Pickup: _____ 1–50000 (kA Cycles)
  - Time Delay: _____ 0.1–4095.9 (Cycles)
  - Timing Method Selection □ IT  □ I^2T
  - Preset Accumulator Phase A: _____ 0–50000 (kA Cycles)
  - Preset Accumulator Phase B: _____ 0–50000 (kA Cycles)
  - Preset Accumulator Phase C: _____ 0–50000 (kA Cycles)
  - I/O Selection:
    - Outputs Initiate
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
    - Outputs
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16
    - Input Initiate
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18
    - Blocking Inputs
      - □ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
      - □ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

*Figure A-4  System Setpoints and Settings (page 37 of 39)*
System Setpoints and Settings (Cont.'d)

<table>
<thead>
<tr>
<th>TCM #1 – Trip Circuit Monitor</th>
<th>Disable</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dropout Time Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O Selection: Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#9</td>
<td>#10</td>
<td>#11</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#10</td>
<td>#11</td>
<td>#12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TCM #2 – Trip Circuit Monitor</th>
<th>Disable</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dropout Time Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O Selection: Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#9</td>
<td>#10</td>
<td>#11</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#10</td>
<td>#11</td>
<td>#12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CCM #1 – Close Circuit Monitor</th>
<th>Disable</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dropout Time Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O Selection: Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#9</td>
<td>#10</td>
<td>#11</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#10</td>
<td>#11</td>
<td>#12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CCM #2 – Close Circuit Monitor</th>
<th>Disable</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dropout Time Delay: _____ 1 – 8160 (Cycles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O Selection: Outputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#9</td>
<td>#10</td>
<td>#11</td>
</tr>
<tr>
<td>Blocking Inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>#10</td>
<td>#11</td>
<td>#12</td>
</tr>
</tbody>
</table>

_Figure A-4  System Setpoints and Settings (page 38 of 39)_
System Setpoints and Settings (Cont.'d)

TF – Through Fault  □ Disable  □ Enable

Through Fault Current Threshold: _____  1.0–100.0 (A)
Through Fault Current Time Delay: _____  1–8160 (Cycles)
Pickup Operation limit: _____  1–65535
Cumulative I^2T Limit: _____  1–1000000 (kA^2 Cycles)
Current Selection: □ Summing 1  □ Summing 2  □ Winding 1
                      □ Winding 2  □ Winding 3
Inrush Block by Even Harmonics: □ Disable □ Enable
Preset Cumulative I^2T: _____  0–1000000 (kA^2 Cycles)
I/O Selection:

Outputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8
□ #9  □ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16

Blocking Inputs
□ #1  □ #2  □ #3  □ #4  □ #5  □ #6  □ #7  □ #8  □ #9
□ #10 □ #11 □ #12 □ #13 □ #14 □ #15 □ #16 □ #17 □ #18

Figure A-4 System Setpoints and Settings (page 39 of 39)
Appendix – Communications

The M-3311A Transformer Protection Relay incorporates three serial ports for intelligent, digital communication with external devices. Equipment such as RTUs, data concentrators, modem, or computers can be interfaced for direct, on-line real time data acquisition and control.

Generally, all data available to the operator through the front panel of the relay, with the optional M-3931 HMI module is accessible remotely through the BECO 2200 data exchange protocol. This protocol document and the BECO 2200 relay database specified protocol document are available from the factory or our website at www.beckwithelectric.com.

The S-3300 IPScom® Communication Software package has been supplied for communication to any IBM compatible computer running under Windows 95™ or higher.

The protocol implements serial, byte oriented, asynchronous communication, and can be used to fulfill the following communications functions:

- Real time monitoring of line status.
- Interrogation and modification of setpoints.
- Downloading of recorded oscillograph data.
- Reconfiguration of functions.

**NOTE:** The following restrictions apply for MODBUS protocol use:

1. MODBUS protocol is not supported on COM1
2. Parity is supported on COM2 and COM3 only, valid selections are 8,N,1; 8,O,1; 8,E,1; 8,N,2; 8,O,2; 8,E,2.
3. ASCII mode is not supported (RTU only)
4. Standard baud rates from 300 to 9600 are supported.
5. Only the following MODBUS commands are supported:
   a. Read holding register (function 03)
   b. Read input register (function 04)
   c. Force single coil (function 05)
   d. Preset single register (function 06)

For detailed information about communications, refer to Chapter 3, IPScom Operation.

**DNP Configuration Parameters**

M-3311A relays support DNP through the rear RS-232 (COM2) & RS-485 (COM3) communication ports. These ports support baud rates 300, 600, 1200, 2400, 4800, 9600 (default baud rate is 9600). See Figure A-3, Communication Data & Unit Setup, for sequence of DNP setup screens.

**M-3311 Slave Address**

DNP3 Slave IED address range is from 0 to 65519. Address 65535 (hex FFFF) is used to broadcast messages to all devices. The communication address can be set through the HMI (front panel; optional).

The DNP3 device profile document, including the point list, is available from the factory or our website, www.beckwithelectric.com.

The following restrictions apply for DNP3 protocol use:

- DNP3 is not supported on COM1.
- Parity is not supported.
- DNP3 does not support oscillograph record downloading.
The communication database profile in M-3311A using DNP3 protocol is grouped into five object types:

1. **Single Bit Binary Inputs (Status):** (object 01, variation 01) These are considered as class 0 data.
2. **16 Bit Analog Output Block /Status (setpoints):** (object 40, variation 01, variation 02/object 41, variation 01, variation 02) Used to write and read all setpoints and system setup.
3. **Control Relay Output Block (direct control):** (object 12, variation 01) Used to write all configuration points.
4. **16 Bit Analog Inputs:** (object 30, variation 02) Used to represent all demand metering, target information, and control information of the relay.
5. **16 Bit Binary Counters:** (object 20, variation 02, variation 06) Used to represent all counters. Can be used to reset the counters using freeze and clear function code.
6. **Static (class 0) Data:** (object 60, variation 01) Used to represent all binary inputs, demand metering, target and control information, and counters. All points in the M-3311A relay are of static type, meaning that an integrity poll will dump all data to the querying RTU.

**Communication Ports**

The relay has both front and rear panel RS-232 ports and a rear RS-485 port. The front and rear panel RS-232 ports are 9-pin (DB9S) connector configured as DTE (Data Terminal Equipment) per the EIA-232D standard. Signals are defined in Table B-1, Communication Port Signals.

The 2-wire RS-485 port is assigned to the rear panel terminal block pins 3 (−) and 4 (+).

Each communication port may be configured to operate at any of the standard baud rates (300, 600, 1200, 2400, 4800, and 9600). The RS-485 port shares the same baud rate with COM 2 (for COM1 see Section 5.4, Circuit Board Switches and Jumpers).

While the digital communication ports do include some ESD (Electrostatic Discharge) protection circuitry, they are excluded from passing ANSI/IEEE C37.90.1-1989. Beckwith Electric recommends the use of RS-232/485 to fiber optic converters to avoid any question of surge-withstand capability or ground potential rise.

A null modem cable is also shown in Figure B-1, Null Modem Cable: M-0423, if direct connection to a PC (personal computer) is desired.
### Table B-1  Communication Port Signals

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Signal</th>
<th>COM 1</th>
<th>COM 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB</td>
<td>RX</td>
<td>Pin 2</td>
<td>Pin 2</td>
</tr>
<tr>
<td>BA</td>
<td>TX</td>
<td>Pin 3</td>
<td>Pin 3</td>
</tr>
<tr>
<td>CA</td>
<td>RTS</td>
<td>Pin 7</td>
<td>Pin 7</td>
</tr>
<tr>
<td>CB</td>
<td>CTS</td>
<td>Pin 8</td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td>DTR</td>
<td>Pin 4</td>
<td>Pin 4</td>
</tr>
<tr>
<td>CF</td>
<td>DCD</td>
<td>Pin 1</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>GND</td>
<td>Pin 5</td>
<td>Pin 5</td>
</tr>
<tr>
<td></td>
<td>+15 V</td>
<td>Pin 1*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-15 V</td>
<td>Pin 9*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRIG-B (+)</td>
<td>Pin 6*</td>
<td></td>
</tr>
</tbody>
</table>

*OPTIONAL - See Section 5.5, Circuit Board Switches and Jumpers. ±15 V (±15%) @ 100 mA Max.

---

**Figure B-1  Null Modem Cable for M-3311A**
Figure B-2  RS-232 Fiber Optic Network
RS-485 2-Wire Network

▲ CAUTION: Due to the possibility of ground potential difference between units, all units should be mounted in the same rack. If this is not possible, fiber optics with the appropriate converters should be used for isolation.

■ NOTE: Each address on the network must be unique. Only the last physical slave on the network should have the termination resistor installed. This may be completed externally or using a dip jumper internal to the unit. See Section 5.5, Circuit Board Switches and Jumpers.

Figure B-3 RS-485 Network
### Appendix – Error Codes

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Battery backed RAM test fail</td>
</tr>
<tr>
<td>3</td>
<td>EEPROM write powerup fail</td>
</tr>
<tr>
<td>4</td>
<td>EEPROM read back powerup fail</td>
</tr>
<tr>
<td>5</td>
<td>Dual port RAM test fail</td>
</tr>
<tr>
<td>6</td>
<td>EEPROM write calibration checksum fail</td>
</tr>
<tr>
<td>7</td>
<td>EEPROM write setpoint checksum fail loss of power</td>
</tr>
<tr>
<td>8</td>
<td>EEPROM write setpoint checksum fail loss of battery backed RAM</td>
</tr>
<tr>
<td>9</td>
<td>DMA checksum/physical block fail</td>
</tr>
<tr>
<td>10</td>
<td>Oscillograph Memory Test Fail</td>
</tr>
<tr>
<td>11</td>
<td>DSP external program RAM fail</td>
</tr>
<tr>
<td>12</td>
<td>DSP A/D convert fail</td>
</tr>
<tr>
<td>13</td>
<td>DSP ground channel fail</td>
</tr>
<tr>
<td>14</td>
<td>DSP reference channel fail</td>
</tr>
<tr>
<td>15</td>
<td>DSP PGA gain fail</td>
</tr>
<tr>
<td>16</td>
<td>DSP DSP &lt;-&gt; Host interrupt 1 fail</td>
</tr>
<tr>
<td>17</td>
<td>DSP DSP -&gt; Host interrupt 2 set fail</td>
</tr>
<tr>
<td>18</td>
<td>DSP DSP -&gt; Host interrupt 2 reset fail</td>
</tr>
<tr>
<td>19</td>
<td>DSP program load fail</td>
</tr>
<tr>
<td>20</td>
<td>DSP no running run mode code</td>
</tr>
<tr>
<td>21</td>
<td>DSP not running primary boot code</td>
</tr>
<tr>
<td>22</td>
<td>DSP DPRAM pattern test fail</td>
</tr>
<tr>
<td>23</td>
<td>EEPROM write verify error</td>
</tr>
</tbody>
</table>

*Table C-1  Self-Test Error Codes (page 1 of 2)*
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>26</td>
<td>WARNING calibration checksum mismatch warning</td>
</tr>
<tr>
<td>27</td>
<td>WARNING setpoint checksum mismatch warning</td>
</tr>
<tr>
<td>28</td>
<td>WARNING low battery (BBRAM) warning</td>
</tr>
<tr>
<td>30</td>
<td>External DSP RAM test fail</td>
</tr>
<tr>
<td>31</td>
<td>Unrecognized INT1 code</td>
</tr>
<tr>
<td>32</td>
<td>Values update watchdog fail</td>
</tr>
<tr>
<td>34</td>
<td>Restart Error</td>
</tr>
<tr>
<td>35</td>
<td>Interrupt Error</td>
</tr>
<tr>
<td>36</td>
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<td>38</td>
<td>Ethernet Board Not Running (WARNING)</td>
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<td>Interrupt noise INT2</td>
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<td>44</td>
<td>Oscillograph buffer overflow</td>
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<tr>
<td>45</td>
<td>Oscillograph buffer underflow</td>
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<td>Failure of DSP to calculate calibration phasors</td>
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<td>50</td>
<td>Stack overflow</td>
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<tr>
<td>51</td>
<td>Setpoint write overflow</td>
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*Table C-1  Self-Test Error Codes (page 2 of 2)*
Appendix – Inverse Time Curves

This Appendix contains three sets of Inverse Time Curve Families. The first set is used for Volts per Hertz functions (Figures D‑1 through D‑4), the second set is for the M‑3311A functions which utilize the IEC time over current curves (Figures D‑5 through D‑12) and the third set is for those functions that utilize the IEEE Inverse Time Overcurrent Curves (Figures D‑13 through D‑15).

■ Note: Figures D‑1 through D‑4 are Volts per Hertz curves. Figures D‑5 through D‑12 are inverse time curves for 51, 51N, 51G and 46 functions.
Figure D-1  Volts/Hz (24IT) Inverse Curve Family #1 (Inverse Square)
Figure D-2  Volts/Hz (24IT) Inverse Family Curve #2
Figure D-3  Volts/Hz (24IT) Inverse Time Curve Family #3
Figure D-4  Volts/Hz (24IT) Inverse Curve Family #4
### Table D-1A  M-3311 Inverse Time Overcurrent Relay Characteristic Curves

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<tr>
<th>Multiple of Tap Setting</th>
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<th>Inverse Time</th>
<th>Very Inverse Time</th>
<th>Extremely Inverse Time</th>
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<td>3.46578</td>
<td>4.83520</td>
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**NOTE:** The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the above by the time dial value.

Table D-1A  M-3311 Inverse Time Overcurrent Relay Characteristic Curves
Table D-1B  M-3311 Inverse Time Overcurrent Relay Characteristic Curves

<table>
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<tr>
<th>Multiple of Tap Setting</th>
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<th>Very Inverse Time</th>
<th>Extremely Inverse Time</th>
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</table>

**NOTE:** The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the above by the time dial value.
Figure D-5  Definite Time Overcurrent Curve
Inverse Time Overcurrent Curve

Figure D-6  Inverse Time Overcurrent Curve
Figure D-7  Very Inverse Time Overcurrent Curve
Figure D-8   Extremely Inverse Time Overcurrent Curve
\[ t = TD \times \left[ \frac{0.14}{M^{0.02} - 1} \right] \]

*Figure D-9  IEC Curve #1  Inverse*
Figure D-10  IEC Curve #2  Very Inverse

\[ t = TD \times \left[ \frac{13.5}{M - 1} \right] \]
Figure D-11  IEC Curve #3  Extremely Inverse

\[ t = TD \cdot \left( \frac{80}{M^2 - 1} \right) \]
Inverse Time Curves – Appendix D

**Figure D-12**  IEC Curve #4  Long-Time Inverse

\[ t = T_D \times \left( \frac{120}{M - 1} \right) \]
Figure D-13  IEEE (Moderately) Inverse Time Overcurrent Curves

\[ t = \frac{TD}{5} \left[ \frac{0.0515}{M^{0.02} - 1} + 0.114 \right] \]
Figure D-14  IEEE Very Inverse Time Overcurrent Curves

IEEE
Very Inverse

\[
t = \frac{TD}{5} \left[ \frac{19.61}{M^2 - 1} + 0.491 \right]
\]
IEEE Extremely Inverse Time Overcurrent Curves

\[ t = \frac{TD}{5} \times \left[ \frac{28.2}{M^2 - 1} + 0.1217 \right] \]

Figure D-13  IEEE Extremely Inverse Time Overcurrent Curves
Appendix E includes the recommended storage parameters, periodic surveillance activities and layup configuration for the M-3311A Transformer Protection Relay.

Storage Requirements (Environment)
The recommended storage environment parameters for the M-3311A are:

- The ambient temperature where the M-3311A is stored is within a range of 5°C to 40°C.
- The maximum relative humidity is less than or equal to 80% for temperatures up to 31°C, decreasing to 31°C linearly to 50% for relative humidity at 40°C.
- The storage area environment is free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

Storage Requirements (Periodic Surveillance During Storage)
The M-3311A power supply contains electrolytic capacitors. It is recommended that power be applied to the relay (PS1 and optional PS2 redundant power supply when installed) every three to five years for a period of not less than one hour to help prevent the electrolytic capacitors from drying out.

Layup Configuration
The M-3311A includes a removable lithium battery backed TIMEKEEPER® module (Beckwith Electric component U25, Figure 5-10). The TIMEKEEPER module is the M-3311A real-time clock and also provides power to the unit’s nonvolatile memory when power is not applied to the unit.

Layup of the M-3311A requires verifying that the system clock is stopped. The steps necessary to verify system clock status are as follows:

▲ CAUTION: Do not use the diagnostic mode in relays that are installed in an active protection scheme.

For units with the optional HMI panel:

1. Verify that the Power Supply (PS) fuses are installed.
2. Determine the unit power supply rating by observing the check box below the PS terminals on the rear of the unit.
3. Apply power to the unit consistent with the rating determined in Step 2 (see Section 5.3, External Connections). The unit will enter the selftest mode.
4. When the selftests are complete, then press ENTER to begin main menu.
5. Press the right arrow pushbutton until SETUP UNIT is displayed.
6. Press ENTER to access the SETUP UNIT menu.
7. Press the right arrow pushbutton until DIAGNOSTIC MODE is displayed.
8. Press ENTER. A reset warning will be displayed:

   ![Processor Will Reset Warning]

   PROCESSOR WILL RESET!
   ENTER KEY TO CONTINUE

● WARNING: All relay functions and protection will be inoperative while the relay is in diagnostic mode.

9. Press ENTER. Unit will now reset and DIAGNOSTIC MODE will be temporarily displayed, followed by OUTPUT TEST (RELAY). This is the beginning of the diagnostic menu.
10. Press the right arrow pushbutton until the following is displayed:

```
CLOCK TEST
← CLOCK led cal factory
```

11. Press ENTER. The following is displayed:

```
CLOCK TEST
03-JAN-1998 09:00:00.000
```

12. If the clock is running, press ENTER to stop the clock. The following is displayed:

```
CLOCK TEST
-CLOCK STOP-
```

**NOTE:** When the relay clock is stopped, the seconds will be displayed as 80.

13. Press ENTER and verify the relay clock is stopped. A display similar to the following is shown with the seconds stopped:

```
CLOCK TEST
03-JAN-09:01:80.000
```

14. When the clock has been verified to be stopped, then press EXIT until the following message appears:

```
PRESS EXIT TO EXIT DIAGNOSTIC MODE
```

15. Press EXIT again to exit DIAGNOSTIC MODE. The relay will reset and normal running mode will resume.

**NOTE:** Pressing any button other than EXIT will return the user to DIAGNOSTIC MODE.

16. Remove power from the unit. The unit can now be placed in storage.

For units *without* the optional HMI panel:

1. Verify that the Power Supply (PS) fuses are installed.

2. Determine the unit power supply rating by observing the check box below the PS terminals on the rear of the unit.

3. Apply power to the unit consistent with the rating determined in Step 2 (see Section 5.3, External Connections). The unit will enter the selftest mode.

4. Install S-3300 IPScom Communications Software (see Section 5.6, IPScom Communications and Analysis Software Installation) on a PC that includes the following:
   - Microsoft Windows™ 98 Operating System or above
   - Equipped with a serial port

5. Connect a null modem cable from COM1 of the relay to the PC serial port.

6. Open communications with the relay utilizing Section 5.7, Activating Initial Local Communications.

7. Select **Relay/Setup/Set Date & Time** from the menu bar. IPScom will display the “Setup Date/Time dialog screen Figure 3-19.

8. Verify that “Start Clock” is displayed, then proceed as follows:
   a. If “Start Clock” is displayed, then select “Save” and go to Step 9.
   b. If “Stop Clock” is displayed, then select “Stop Clock” and then select “Save”.

9. Close communications with the unit by selecting “Comm” from the menu bar and then select “Exit”.

10. Disconnect the null modem cable and then remove power from the unit. The unit can now be placed in storage.

Storage of the M-3311A greater than five years may require replacement of the lithium battery prior to placing the unit in service. Contact Beckwith Electric Customer Service for replacement procedure.
Appendix — HMI Menu Flow

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F.1  HMI Menu Overview

Appendix F illustrates the Human Machine Interface (HMI) menu flow that is presented on the M-3931 Human-Machine interface module.

Key to Input Data

A. All heavily bordered screens are either MENU screens which have horizontal choices (made with right-left arrows) or screens displaying a result of a choice previously made.

B. Gray boxes enclose screens which bound areas that pushbutton ENTER will move in. In order to move out of one of the gray boxes it is necessary to either push EXIT or make a menu choice change using the Right-Left arrow.

C. The Up/Down arrows only adjust value or letter (lower/upper case) inputs; they do not move within the menus or between menu displays.

D. The Right/Left arrows are used only to make horizontally displayed choices. These can be either menu choices or input value digit choices. The previous choice or location in a menu is highlighted immediately.

E. The ENTER pushbutton records the setting change (whatever is in that screen when ENTER is pressed will be installed in memory) and moves down within a menu. The operator will notice that after the last menu item, ENTER moves to the top of the same menu but does not change menu positions.

F. Pressing EXIT at any time will exit the display screen to the last screen containing a horizontal choice. (Return to the preceding menu).

G. The Left or Right arrow symbol in a screen indicates additional horizontal menu choices are available in the indicated direction. As previously described, the Right and Left arrows will move the operator to those additional choices.

Figure F-1  M-3931 Human-Machine Interface Module
Figure F-3  Voltage Relay Menu Flow
Figure F-4  Current Relay Menu Flow (Page 2 of 2)
2/3/4 Winding

**FREQUENCY RELAY**
W volt curr FREQ v/hz V

**VOLTS PER HERTZ RELAY**
W volt curr freq V/HZ V

**IPS LOGIC**
W IPS brkr thflt tcm V

81 OVER/UNDER FREQUENCY FREQ

- 81#1 PICKUP 55.00 Hz
- 81#1 DELAY 30 Cycles

- 81#2 through 81#4 same as above

24 DEF TIME VOLTS/HERTZ DEF_V/HZ inv_v/hz

- 24DT#1 PICKUP 110 %
- 24DT#1 DELAY 360 Cycles

- 24DT#2 PICKUP 110 %
- 24DT#2 DELAY 360 Cycles

24 INV TIME VOLTS/HERTZ def_v/hz INV_V/HZ

- 24IT PICKUP 105 %
- 24IT CURVE CRV#1 crv#2 crv#3 crv#4

- 24IT TIME DIAL 9
- 24IT RESET RATE 200 Seconds

IPS LOGIC IPS

- IPS#1 INPUT INITIATE i6 i5 i4 i3 i2 j1
- IPS#1 OUTPUT INITIATE o8 o7 o6 o5 o4 o3 o2 o1

- IPS#1 DELAY 30 Cycles

IPS#2 through IPS#6 same as above
Accumulators A, B, C for Windings 2, 3, 4 same as above

**BREAKER  ACCUMULATOR**

- **SET BREAKER MONITORING**
  
  - **BRKR. stat prst clr**
  
  - **BREAKER ACC. STATUS**
    
    - **BRKR. ACCUMULATOR**
      
      - **CLEAR ACCUMULATORS**
        
        - **brkr stat prst CLR**
        
        - **ACC. Status**
          
          - **SET BREAKER ACC. STATUS**
            
            - **brkr stat prst clr**
            
            - **ACC. Status**
              
              - **SET BREAKER ACC. STATUS**
                
                - **brkr stat prst clr**
                
                - **ACC. Status**
                  
                  - **SET BREAKER ACC. STATUS**
                    
                    - **brkr stat prst clr**
                    
                    - **ACC. Status**
                      
                      - **SET BREAKER ACC. STATUS**
                        
                        - **brkr stat prst clr**
                        
                        - **ACC. Status**
                          
                          - **SET BREAKER ACC. STATUS**
                            
                            - **brkr stat prst clr**
                            
                            - **ACC. Status**
                              
                              - **SET BREAKER ACC. STATUS**
                                
                                - **brkr stat prst clr**
                                
                                - **ACC. Status**
                                  
                                  - **SET BREAKER ACC. STATUS**
                                    
                                    - **brkr stat prst clr**
                                    
                                    - **ACC. Status**
                                      
                                      - **SET BREAKER ACC. STATUS**
                                        
                                        - **brkr stat prst clr**
                                        
                                        - **ACC. Status**
                                          
                                          - **SET BREAKER ACC. STATUS**
                                            
                                            - **brkr stat prst clr**
                                            
                                            - **ACC. Status**
                                              
                                              - **SET BREAKER ACC. STATUS**
                                                
                                                - **brkr stat prst clr**
                                                
                                                - **ACC. Status**
                                                  
                                                  - **SET BREAKER ACC. STATUS**
                                                    
                                                    - **brkr stat prst clr**
                                                    
                                                    - **ACC. Status**
                                                      
                                                      - **SET BREAKER ACC. STATUS**
                                                        
                                                        - **brkr stat prst clr**
                                                        
                                                        - **ACC. Status**
                                                          
                                                          - **SET BREAKER ACC. STATUS**
                                                            
                                                            - **brkr stat prst clr**
                                                            
                                                            - **ACC. Status**
                                                              
                                                              - **SET BREAKER ACC. STATUS**
                                                                
                                                                - **brkr stat prst clr**
                                                                
                                                                - **ACC. Status**
                                                                  
                                                                  - **SET BREAKER ACC. STATUS**
                                                                    
                                                                    - **brkr stat prst clr**
                                                                    
                                                                    - **ACC. Status**
                                                                      
                                                                      - **SET BREAKER ACC. STATUS**
                                                                        
                                                                        - **brkr stat prst clr**
                                                                        
                                                                        - **ACC. Status**
Figure F-7: Configure Relay/Voltage Relay Menu Flow (Page 1 of 3)
Figure F-7 Configure Relay/Voltage Relay Menu Flow (Page 2 of 3)
INPUT ACTIVATED PROFILES
IN ap cpy volt vt

ACTIVE SETPOINT PROFILE
in AP cpy volt vt

COPY ACTIVE PROFILE
in ap CPY num_of_wind

NUMBER OF F87 WINDINGS
in ap cpy NUM_OF_WIND

ACTIVE SETPOINT PROFILE
1

NUMBER OF F87 WINDINGS
TWO three

W1 INCLUDE IN WIN SUM#1
no YES

W1 INCLUDE IN WIN SUM#2
no YES

W2 and W3 - SUM#1
same as above

W2 and W3 - SUM#2
same as above

COPY ACTIVE PROFILE
TO_PROFILE_1
COPY ACTIVE PROFILE
TO_PROFILE_2
COPY ACTIVE PROFILE
TO_PROFILE_3
COPY ACTIVE PROFILE
TO_PROFILE_4

COPY ACTIVE PROFILE -WAIT-

Figure F-8
2/3 Winding Setup System Menu Flow (Page 1 of 3)
2/3 Winding

(setup system)

FROM WINDING SUMMING

XFM/CT CONNECTION
sum CONN phase seal in

XFM/CT CONNECTION
standard custom

W1 XFM PHASE COMP TYPE
0

W2 through W3
same as previous

W1 CT PH/MAG COMP TYPE
0

W2 through W3
same as previous

W1 ZERO SEQ. COMP.
DISABLE enable

W2 through W3
same as previous

PHASE ROTATION
sum conn PHASE seal in

PHASE ROTATION
a-c-b A-B-C

RELAY SEAL-IN TIME
conn phase SEAL in

RELAY SEAL-IN TIME OUT01
30 Cycles

ACTIVE INPUT STATE
sum conn phase seal in

ACTIVE INPUT OPEN/close
i6 i5 i4 i3 i2 j1

OUT2 through OUT8
same as above

TO V.T. a RATIO

active input state

To V.T. a ratio

2/3 winding setup system menu flow (Page 2 of 3)
Figure F-8  2/3 Winding Setup System Menu Flow (Page 3 of 3)
INPUT ACTIVATED PROFILES
DISABLE enable
SETUP SYSTEM
Wconfig SYS stat dmdV
ACTIVE SETPOINT PROFILE
COPY ACTIVE PROFILE TO_PROFILE_1
COPY ACTIVE PROFILE TO_PROFILE_2
COPY ACTIVE PROFILE TO_PROFILE_3
COPY ACTIVE PROFILE TO_PROFILE_4
V.T. CONFIGURATION
vab vbc vca VA vb vc
NUMBER OF WINDINGS
NUM_OF_WINDINGS sum
NUMBER OF WINDINGS
three FOUR
ACTIVE SETPOINT PROFILE
COPY ACTIVE PROFILE -WAIT-
WINDING SUMMING
same as above
Figure F-9 4 Winding Setup System Menu Flow (Page 1 of 3)
4 Winding

Figure F-9 4 Winding Setup System Menu Flow (Page 2 of 3)
(Cont’d)

Figure F-9  4 Winding Setup System Menu Flow (Page 3 of 3)
Figure F-10  Relay Status Menu Flow (Page 2 of 2)
Figure F-11  Relay Demand Menu Flow
Figure F-12  View Target History and Oscillograph Recorder Menu Flow
2/3/4 Winding

COMMUNICATION
Wtargets osc_rec COMMV

COM1 SETUP
COM1 com2 com3 com-adr

COM1 BAUD RATE
-> baud_4800 BAUD_9600

COM2 SETUP
COM2 com1 COM2 com3 com-adr

COM2 BAUD RATE
-> baud_4800 BAUD_9600

COM2 DEAD SYNC TIME
50 ms

COM2 PROTOCOL
BECO2200 modbus dnp3

COM3 SETUP
COM3 com1 com2 COM3 com-adr

COM3 DEAD SYNC TIME
50 ms

COM3 PROTOCOL
BECO2200 modbus dnp3

COMMUNICATION ADDRESS
com1 com2 com3 COM-ADR

RESPONSE TIME DELAY
DLY accss eth eth_ip

RESPONSE TIME DELAY
100 ms

TO COMM ACCESS CODE
Figure F-13  Relay Communication Menu Flow (Page 2 of 2)
Figure F-14  Relay Setup Menu Flow (Page 1 of 4)
Figure F-14 Relay Setup Menu Flow (Page 2 of 4)
SETUP UNIT

DIAGNOSTIC MODE

PROCESSOR WILL RESET!
ENTER KEY TO CONTINUE

DIAGNOSTIC MODE

OUTPUT TEST (RELAY)
OUTPUT input led target

RELAY NUMBER 1
OFF on

2 through 8 same as above

INPUT TEST (STATUS)
output input led target

RELAY NUMBER 1

INPUT NUMBER 1

CIRCUIT OPEN

2 through 6 same as above

STATUS LED TEST
output input LED target

STATUS LED TEST
LED NUMBER 1 = ON

TARGET LED TEST
output input led TARGET

TARGET LED TEST
LED NUMBER 1 = ON

2 through 32 same as above

BUTTON TEST
diap com1 com2

BUTTON TEST
0

FROM CLEAR ERROR CODES

TO DISPLAY TEST

Figure F-14
Relay Setup Menu Flow (Page 3 of 4)
Figure F-14  Relay Setup Menu Flow (Page 4 of 4)
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Declaration of Conformity

DECLARATION OF CONFORMITY
(In accordance to BS EN ISO/IEC 17050-1:2010)

No. M-3311A
Manufacturer’s Name: Beckwith Electric Co, Inc.
Manufacturer’s Address: 6190 118th Avenue North
Largo, FL 33773-3724

The manufacturer hereby declares under our sole responsibility that the M-3311A relay product conforms to the following EMC product standard as of September 9th, 2014 in accordance to Directive 2014/30/EU for equipment incorporated into stationary fixed installations:

BS EN/ IEC 60255-26:2013
Electromagnetic compatibility ( EMC )
Requirements for measuring relays and protection equipment

Electromagnetic Emissions: IEC 60255-26:2013
EN 55022:2010 CISPR 22 Conducted 150 kHz to 30MHz
EN 55022:2010 CISPR 22 Radiated 30MHz to 1000MHz
Class A Limits

Electromagnetic Immunity: IEC 60255-26:2013
Electrostatic Discharge ±8kV Contact; ±15kV Air
IEC 61000-4-2:2008
Radiated Immunity 80MHz to 1000MHz 35V/m, 80% AM (1kHz)
IEC 61000-4-3:2010
Fast Transients ±4kV 5ns/50ns Bursts @ 5kHz, 15ms/300ms
IEC 61000-4-4:2012
Surge ±2Kv Line to Line coupling, ±4Kv Line to Earth coupling
IEC 61000-4-5:2014
Conducted Immunity 150kHz to 80MHz 10Vrms
IEC 61000-4-6:2013
Power Frequency Magnetic Field Immunity 100A/m continuous
IEC 61000-4-8:2009
Power frequency disturbance test onto DC input status port
100v 50/60 Hz differential mode
150v 50/60 Hz differential mode
300v 50/60 Hz common mode
IEC 61000-4-16:2011

1 MHz Oscillatory Disturbance ±2,500v differential / common modes
IEC 61000-4-18:2011
Short duration AC/DC Voltage interruptions
0% residual (AC) 5 cycles, (DC) 30ms
40% residual (AC) 5 cycles, (DC) 30ms
70% residual (AC) 30 cycles, (DC) 30ms
IEC 61000-4-11:2010

Environmental: IEC 60255-27:2013 Pollution Degree 2
  IEC 60068-2-1:2007 Cold, -20°C
  IEC 60068-2-2:2007 Dry Heat, +70°C
  IEC 60068-2-78:2012 Damp Heat, +40°C @ 95%rh
  IEC 60068-2-30:2005 Damp Heat condensing cycle +25°C, +55°C @ 95%rh

Environmental: IEC 60255-27:2013 Insulation Category III
  IEC 60255-27:2013 Impulse ±5,000Vpk
  IEC 60255-27:2013 Dielectric 2,000Vac
  IEC 60255-27:2013 Insulation Resistance ≥10GΩ

Mechanical Environmental: IEC 60255-27:2013
  IEC 60255-21-1:1988 Vibration response Class 1 0.5g
    Vibration endurance Class 1 1g

  IEC 60255-21-2:1988 Shock response Class 1 5g
    Shock Withstand Class 1 15g
    Bump Endurance Class 1 10g
**Patent**

The units described in this manual are covered by U.S. Patents, with other patents pending.

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**Indemnification**

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In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

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