## Series Included

### 3-Phase Voltage Monitors
- WVM .................................................. 110
- DLMU ................................................. 111
- HLMU ................................................. 112
- PLMU .................................................. 113
- PLM ..................................................... 114
- TVW ..................................................... 115
- TVM ..................................................... 116

### Low Volts, Phase Reversal
- PLR ...................................................... 117

### Phase Reversal
- PLS ...................................................... 118

### 1-Phase Voltage Monitors
- HLV ..................................................... 119
- KVM ..................................................... 120
The WVM Series provides protection against premature equipment (motor) failure caused by voltage faults on the 3-phase line. The WVM’s microcontroller design provides reliable protection even if regenerated voltages are present. It combines dependable fault sensing with a 10 fault memory and a 6 LED status display. Part instrument, part control, the WVM protects your equipment when you’re not there and displays what happened when you return. The WVM is fully adjustable and includes time delays to prevent nuisance tripping and improve system operation. Time delays include a 0.25 to 30s adjustable trip delay, an adjustable 0.25 to 64m (in 3 ranges) restart delay, plus a unique 3 to 15s true random start delay. The random start delay prevents voltage sags caused by simultaneous restarting of numerous motor loads after a power outage.

**Features:**
- Protects against phase loss & reversal; under & unbalanced voltages; & short cycling
- 10 fault memory & status displayed on 6 LED readout
- Switch selectable automatic restart, delayed automatic restart, & manual reset
- Isolated, 10A, SPDT output contacts
- ASME A17.1 Rule 210.6
- NEMA MG1 14.30, 14.35
- IEEE C62.41-1991 Level B

**Auxiliary Products:**
- 3-phase fuse block/disconnect: P/N: FH3P
- 2 Amp fuse: P/N: P0600-11
- DIN rail: P/N: C103PM (Al)

**Available Models:**
- WVM011AL
- WVM911AL
- WVM611AH
- WVM911AL-60
- WVM811AH
- WVM911RL
- WVM811AH
- WVM911RN-60
- WVM911AH

If desired part number is not listed, please call us to see if it is technically possible to build.

**Order Table:**

<table>
<thead>
<tr>
<th>WVM</th>
<th>3-Phase Line Voltage</th>
<th>1-2.10%</th>
<th>Trip Delay</th>
<th>A</th>
<th>Reset Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6-200/240VAC</td>
<td></td>
<td>- 0.25-30s</td>
<td></td>
<td>- 0.25-64s</td>
</tr>
<tr>
<td></td>
<td>8-355-425VAC</td>
<td></td>
<td></td>
<td></td>
<td>- 6-300s</td>
</tr>
<tr>
<td></td>
<td>0-400-480VAC</td>
<td></td>
<td></td>
<td></td>
<td>- 0.25-64m</td>
</tr>
<tr>
<td></td>
<td>0-500-600VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Specifications**

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Type</th>
<th>Operating Voltage</th>
<th>Overvoltage Trip Point</th>
<th>Undervoltage Trip Point</th>
<th>Voltage Unbalance</th>
<th>Phase Loss</th>
<th>Random Start Delay Range</th>
<th>Reset (Restart) Delay</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-phase delta or wye with no connection to neutral</td>
<td>240</td>
<td>100-113% of adjusted voltage</td>
<td>86-92% of adjusted voltage</td>
<td>Adjustable from ±10%*</td>
<td>±15%</td>
<td>3 - 15s</td>
<td>0.25-64s ±15%</td>
<td>25 oz (709 g)</td>
</tr>
</tbody>
</table>

**Fault Memory**
- Nonvolatile RAM
- Stores last 10 faults

**Status Indicators**
- 6 LEDs provide existing status & memory readout

**Output**
- Electromechanical relay
- ISO/SPDT

**Surge**
- 10A resistive @ 250VAC, 6A inductive (0.4 PF) @ 250VAC

**Isolation Voltage**
- ±2500V RMS input to output

**Mechanical**
- Surface with 2 or 4 #8 (M4 x 0.7) screws
- Screws terminate with captive wire clips for up to 32 AWG (3.2 mm2) wire

**Environmental**
- Operating / Storage Temperature: -40° to 65°C / -40° to 85°C
- Weight: ±25 oz (709 g)

* Unbalance reset is 90% of the unbalance setting (i.e. VUB at 5% reset is 4.5%)
The DLMU Series is a universal voltage, 3-phase voltage monitor. It continuously measures the voltage of each of the three phases with microcontroller accuracy and compares the value to preset trip points. It separately senses phase reversal and loss; over, under and unbalanced voltages; and over or under frequency. Protection is assured during periods of large average voltage fluctuations or when regenerated voltages are present. The unit trips within 200ms when phase loss is detected. Adjustible time delays are included to prevent nuisance tripping and short cycling of sensitive equipment. The isolated, 10A, SPDT and 2A alarm output relays contact trip when a phase voltage exceeds the trip limits for the trip delay. Nominal line voltage, voltage unbalance, and time delays are knob adjustable. The phase loss setpoint and the acceptable frequency range are fixed. Both delta and wye systems can be monitored; no connection to neutral is required.

For more information see:
Appendix B, page 166, Figure 16 for dimensional drawing.
Appendix C, page 168, Figure 11 for connection diagram.

### Operation

Upon application of line voltage, the output is de-energized and the restart delay begins. If all the 3-phase voltages are within the acceptable range, the output energizes at the end of the restart delay. The microcontroller circuitry automatically senses the voltage range, and selects the correct operating frequency (50 or 60Hz). The over and undervoltage trip points are set automatically. When the measured value of any phase voltage exceeds the acceptable range limits (lower or upper) the trip delay begins. At the end of the trip delay the output relay de-energizes. If the phase voltage returns to an acceptable value before the trip delay expires, the trip delay is reset and the output remains energized. Under, over, and unbalanced voltages plus over or under frequency must be sensed for the complete trip delay before the unit trips. The unit trips in 200ms when phase loss or reversal are sensed. The unit will not energize if a fault is sensed as the line voltage is applied. Reset: Reset is automatic upon correction of the voltage or frequency fault or phase sequence.

#### Restart Delay Options:

L= Lockout or minimum OFF time. The restart delay begins when the output trips. The unit cannot be re-energized until the restart delay is complete. This provides a minimum off time or lockout time to allow equipment sensitive to short cycling, time to reset. If the fault is corrected after the restart delay is complete the output energizes immediately. The restart delay also occurs when line voltage is reapplied/reactivated.

R= Restart Delay on fault correction. The restart delay begins when line voltage is reappplied or when a voltage fault is corrected. This option is normally selected when staggered restarting of multiple motors on a power system is required.

N= No Restart Delay. 0.6s initialization delay on application of line voltage applies.

Restart Notes:

- All restart options remain reset when the following conditions are detected:
  1. Phase loss (phase unbalance greater than 25%) 2. Average line voltage less than 120VAC 3. Phase reversal

The restart delay begins when the condition is corrected.

### LED Operation

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/ green if phase reversal is sensed. If a fault is sensed during the restart delay, the LED will glow red during that portion or the full restart delay.

### Order Table:

<table>
<thead>
<tr>
<th>DLM</th>
<th>Line Voltage</th>
<th>X</th>
<th>Output</th>
<th>X</th>
<th>Restart Function</th>
<th>X</th>
<th>Voltage Unbalance</th>
<th>X</th>
<th>Trip Delay</th>
<th>X</th>
<th>Restart Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>200-480VAC</td>
<td></td>
<td>B</td>
<td></td>
<td>L - Lockout, min off time</td>
<td></td>
<td>A - Adjustable 2-10%</td>
<td></td>
<td>A - Adjustable 1-30s</td>
<td></td>
<td>A - Adjustable 0.6-300s</td>
</tr>
<tr>
<td>H</td>
<td>500-600VAC</td>
<td></td>
<td>C</td>
<td></td>
<td>R - Staggered restarting</td>
<td></td>
<td>Fixed - Specify unbalance 2-10% in 1% increments</td>
<td></td>
<td>Fixed - Specify delay 1-30s in 1s, using two digits[4]</td>
<td></td>
<td>N - No Restart Delay</td>
</tr>
</tbody>
</table>

### Specifications

- **Line Voltage**: Universal voltage, 3-phase delta or wye with no connection to neutral
- **Operating Voltage**: 200-480VAC
- **Type**: 3-phase delta or wye
- **Restart Delay**: Adjustable from 0.6 - 300s; if no restart delay is selected a 0.6s initialization delay applies
- **Voltage Unbalance**: Adjustable from 1 - 30s or specify fixed delay 1 - 30s in 1s increments
- **Response Time**: ≤200ms
- **Environmental**: Operating / Storage Temperature: -40°C to 60°C / -40°F to 85°F
- **Rating**: 10A resistive @ 240VAC, 8A resistive @ 277VAC
- **Protection**: IEEE C62.41-1991 Level B
- **Dimensions**: 35mm DIN Rail
- **Weight**: ≤8.6 oz (244 g)

### Features:

- Protects against phase & reversal; over, under & unbalanced voltages; & over & under frequency
- 35mm DIN rail or surface mounting
- Isolated, 10A, relay contacts
- Isolated, 2A, NO or NC, SPST relay contact
- LED indicates relay, faults, & time delays
- Universal line voltage 240 to 480VAC
- 600VAC version available
- 3-wire connection for delta or wye systems
- ASME A17.1 rule 210.6
- NEMA MG1 14:30, 14:35
- IEEE C62.41-1991 Level B

### Auxiliary Products:

- 3-phase fuse block/disconnect: P/N: FH3P
- 2 Amp fuse: P/N: P0600-11
- DIN rail: P/N: C103PM (Al)

### Available Models:

DLMHBRAAA
DLMUBNAN
DLMUBRAAA

If desired part number is not listed, please call us to see if it is technically possible to build.
The HLMU Series is a universal voltage, encapsulated, 3-phase voltage monitor. It continuously measures the voltage of each of the three phases with microcontroller accuracy and compares the value to preset trip points. It separately senses phase reversal and loss; over, under, and unbalanced voltages; and over or under frequency. Protection is assured during periods of large average voltage fluctuations, or when regenerated voltages are present. The unit trips within 200ms when phase loss is detected. Adjustable trip delays are included to prevent nuisance tripping and short cycling of sensitive equipment. The isolated, 10A, DPDT relay contacts trip when a phase voltage exceeds the trip limits for the trip delay. Nominal line voltage, voltage unbalance, and time delays are knob adjustable. The phase loss setpoint and the acceptable frequency range are fixed. Both delta and wye systems can be monitored; no connection to neutral is required.

For more information see:
Appendix B, page 166, Figure 17 for dimensional drawing.
Appendix C, page 168, Figure 12 for connection diagram.

### Operation
Upon application of line voltage, the output is de-energized and the restart delay begins. If all the three-phase voltages are within the acceptable range, the outputs energize at the end of the restart delay. The microcontroller circuitry automatically senses the voltage range, and selects the correct operating frequency (50 or 60Hz). The over and under voltage trip points are set at ±10% of the adjusted line voltage. When the measured value of any phase voltage exceeds the acceptable range limits (lower or upper) the trip delay begins. At the end of the trip delay the output relay de-energizes. If the phase voltage returns to an acceptable value before the trip delay expires, the trip delay is reset and the output remains energized. Under, over, and unbalanced voltages plus over or under frequency must be sensed for the complete trip delay before the unit trips. The unit trips in 200ms when phase loss or reversal are sensed. The unit will not energize if a fault is sensed as the line voltage is applied.

**Reset:** Reset is automatic upon correction of the voltage or frequency fault or phase sequence.

**Restart Delay Options:**
L= Lockout or minimum OFF time. The restart delay begins when the output trips. The unit cannot be re-energized until the equipment sensitive to short cycling is reset, time to reset. If the fault is corrected after the restart delay is complete, the output energizes immediately. The restart delay also occurs when line voltage is reapplied/reapplied. R= Restart Delay on fault correction. The restart delay begins when line voltage is reapplied or when a voltage fault is corrected. This option is normally selected when staggered restarting of multiple motors on a power system is required.

N= No Restart Delay. 0.6 second initialization delay on application of line voltage applies.

**Restart Notes:**
All restart options remain reset when the following conditions are detected:
1.) Phase loss (phase unbalance greater than 25%) 2.) Average line voltage less than 120VAC 3.) Phase reversal

The restart delay begins when the condition is corrected.

### LED Operation
The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows when the output de-energizes. It flashes red/green if phase reversal is sensed. If a fault is sensed during the restart delay, the LED will glow red during that portion or the full restart delay.

### Order Table: HLMU

<table>
<thead>
<tr>
<th>Output</th>
<th>X</th>
<th>Restart Function</th>
<th>X</th>
<th>Voltage Unbalance</th>
<th>X</th>
<th>Trip Delay</th>
<th>X</th>
<th>Restart Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>D - DPDT</td>
<td>L</td>
<td>Lockout, Min Off Time</td>
<td>A</td>
<td>Adjustable 2-10% Fixed</td>
<td>- Specify Unbalance</td>
<td>1-30s in 1s increments, using two digits [04]</td>
<td>A*</td>
<td>Adjustable 0.6-300s</td>
</tr>
<tr>
<td>S - SPDT</td>
<td>R</td>
<td>Staggered Restarting</td>
<td>N</td>
<td>No Restart Delay</td>
<td>- Specify Unbalance</td>
<td>1-30s in 1s increments, using two digits [05]</td>
<td>N</td>
<td>No Restart Delay</td>
</tr>
</tbody>
</table>

### Specifications

#### Line Voltage

<table>
<thead>
<tr>
<th>Type</th>
<th>200 - 480VAC</th>
<th>Range</th>
<th>Voltage Adj. Range</th>
<th>Frequency</th>
<th>50 or 60Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>240</td>
<td>200-240VAC</td>
<td>50 or 60Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>380</td>
<td>340-420VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>480</td>
<td>400-480VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Voltages

<table>
<thead>
<tr>
<th>Over/Under Voltage</th>
<th>109 - 113% of the adjusted line voltage</th>
<th>Reset Voltage</th>
<th>± 3% of the adjusted line voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undervoltage</td>
<td>97 - 103% of the adjusted line voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over/Under Voltage</td>
<td>Adjustable 2 - 10% or specify fixed unbalance of 2 - 10% in 1% increments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undervoltage</td>
<td>Adjustable 3% of the trip voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage Unbalance</td>
<td>Adjusted from 1 - 30s or specify fixed delay 1-30s in 1s increments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>Adjustable from 0.6 - 300s; if no restart delay is selected a 0.6s initialization delay applies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolerance</td>
<td>±15%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Restart Delay

<table>
<thead>
<tr>
<th>Time</th>
<th>Over/Under Frequency</th>
<th>±4%; Reset ±3%; 50/60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time-Phase Reversal &amp; Phase Loss</td>
<td>0.6200ms</td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td>Electrical (at 10A) - DPDT - 1 x 30s</td>
<td></td>
</tr>
</tbody>
</table>

#### Environmental

<table>
<thead>
<tr>
<th>Operating / Storage Temperature</th>
<th>-40°C to 80°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>95% relative, non-condensing</td>
</tr>
<tr>
<td>Weight</td>
<td>± 3.9 oz (111 g)</td>
</tr>
</tbody>
</table>

#### Protection

| Surge | IEEE C62.41-1991 Level B |
| Isolation Voltage | ± 2500V RMS input to output |
| Circuitry | Encapsulated |
| Mechanical | Screw terminal connection up to 12 AWG (3.3 mm²) wire |

#### Auxiliary Products:

- 3-Phase fuse block/disconnect:
  - P/N: FH3P
- 2 Amp fuse:
  - P/N: P0600-11
- DIN rail:
  - P/N: C103PM (A1)
- DIN rail adaptor:
  - P/N: P1023-20

#### Available Models:

- HLMUDRAAA
- HLMUSDRAAA
- HLMUDN040N

If desired part number is not listed, please call us to see if it is technically possible to build.
The PLMU Series continuously measures the voltage of each of the three phases to provide protection for 3-phase motors and sensitive loads. Its microcontroller senses under and overvoltage, voltage unbalance, phase loss, and phase reversal. Protection is provided even when regenerated voltages are present. Universal voltage operation and standard base connection allows the PLMU to replace hundreds of competitive part numbers.

For more information see: Appendix B, page 166, Figure 18 for dimensional drawing. Appendix C, page 168, Figure 13 for connection diagram.

**Operation**

Upon application of power, a 0.6s random start delay begins and the PLMU measures the voltage levels and line frequency and selects the voltage range. The output relay is energized and the LED glows green when all voltages are acceptable and the phase sequence is correct. LED flashes green during trip delay, glows red when output de-energizes. Undervoltage, overvoltage, and voltage unbalance must be sensed for continuous trip delay before the relay de-energizes. Re-energization is automatic upon fault correction. The output relay will not energize if a fault condition is sensed as 3-phase input voltage is applied. The LED alternately flashes red/green when phase reversal is sensed. Line voltage is selected with the knob, setting the over and under voltage trip points. Voltage range is automatically selected by the microcontroller.

**Specifications**

- **Voltage Monitor**
  - **Specifications**
  - Voltage range is automatically selected by the microcontroller.
  - Phase reversal is sensed. Line voltage is selected with the knob, setting the over and under voltage trip points.
  - If a fault condition is sensed as 3-phase input voltage is applied. The LED alternately flashes red/green when voltages are acceptable and the phase sequence is correct. LED flashes green during trip delay, glows red when output de-energizes. Undervoltage, overvoltage, and voltage unbalance must be sensed for continuous trip delay before the relay de-energizes. Re-energization is automatic upon fault correction. The output relay will not energize if a fault condition is sensed as 3-phase input voltage is applied. The LED alternately flashes red/green when phase reversal is sensed. Line voltage is selected with the knob, setting the over and under voltage trip points. Voltage range is automatically selected by the microcontroller.

**Order Table:**

<table>
<thead>
<tr>
<th>Voltage Unbalance</th>
<th>Trip Delay</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustable 2-10%</td>
<td>Adjustable 0.25-30s</td>
<td>PLMU11</td>
</tr>
</tbody>
</table>

**Features:**

- Protects against phase & reversal; & over, under & unbalanced voltages
- Octal plug-in
- Isolated, 10A, SPDT output contacts
- Operates from 200 to 480VAC
- LED indicator glows green when voltages are acceptable, red for faults
- Indicates reverse-phase wiring
- Simple 3-wire connection for delta or wye systems
- ASME A17.1 Rule 210.6
- NEMA MG1 14.30, 14.35
- IEEE C62.41-1991 Level B

**Available Models:**

<table>
<thead>
<tr>
<th>LED Indicator</th>
<th>Energized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady Green</td>
<td>Energized (tripped on fault)</td>
</tr>
<tr>
<td>Steady Red</td>
<td>De-energized</td>
</tr>
<tr>
<td>Flashing Green</td>
<td>Trip Delay</td>
</tr>
<tr>
<td>Alternate Flashing</td>
<td>Red/Green</td>
</tr>
</tbody>
</table>

** Auxiliary Products:**

- Panel mount kit: P/N: BZ1
- 8-pin octal socket: P/N: OT08PC
- 3-phase fuse block/disconnect: P/N: PH18P
- 2 Amp fuse: P/N: P0600-11
- DIN rail: P/N: C103PM (A)
The PLM Series continuously measures the voltage of each of the three phases. The PLM Series uses a microcontroller circuit design that senses undervoltage, voltage unbalance, phase loss, and phase reversal. Protection is assured when regenerated voltages are present. Both delta and wye systems can be monitored; no connection to neutral is required.

For more information see: Appendix B, page 165, Figure 8 for dimensional drawing. Appendix C, page 168, Figure 13 for connection diagram.

**Operation**

The output relay is energized and the LED glows green when all voltages are acceptable and the phase sequence is correct. Under and unbalanced voltages must be sensed for a continuous trip delay period before the relay de-energizes. Reset is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied. The LED flashes red during the trip delay, then glows red when the output de-energizes. The LED flashes green/red if phase reversal is sensed.

**Field Adjustment:**

Set voltage adjustment knob at the desired operating line voltage for the equipment. This adjustment automatically sets the undervoltage trip point. Apply power. If the PLM fails to energize, check wiring of all 3 phases, voltage, and phase sequence. If phase sequence is incorrect, the LED flashes green/red. To correct this, swap any two line voltage connections at the mounting socket. No further adjustment should be required.

**Order Table:**

<table>
<thead>
<tr>
<th>PLM</th>
<th>Line Voltage</th>
<th>Voltage Unbalanced</th>
<th>Trip Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLM</td>
<td>X 6 - 240VAC</td>
<td>Fixed - 4-8%</td>
<td>Fixed - 2-20s</td>
</tr>
<tr>
<td>PLM</td>
<td>X 8 - 380VAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLM</td>
<td>X 9 - 480VAC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Specifications**

- **Phase Loss:** 35% unbalance
- **Reset Type:** Automatic
- **Output Type:** Electromechanical relay
- **Form Rating:** Isolated, SPDT
- **Rating:** 10A resistive @ 240VAC, 277VAC max, 1/2 Hp @ 240VAC, 1/4 Hp @ 120VAC
- **Life:** Mechanical - 1 x 10⁸; Electrical - 1 x 10⁷
- **Protection:** Surge IEEE C62.41-1991 Level B
- **Isolation Voltage:** ≥ 2500V RMS input to output
- **Mechanical Mounting:** 8-pin plug-in socket rated 600VAC
- **Environmental Dimensions:** 3.2 x 2.39 x 1.78 in. (81.3 x 60.7 x 45.2 mm)
- **Weight:** 4.4 oz (125 g)

*CAUTION: Select an octal socket rated for 600VAC operation.

**Features:**

- Protects against phase loss & reversal; & under & unbalanced voltages
- 8-pin plug-in base
- Adjustable low voltage trip point
- Factory fixed unbalance & trip delay
- Line voltages 200 to 480VAC in 3 ranges
- Isolated, 10A, SPDT output contacts
- ASME A17.1 rule 210.6
- NEMA MG1 14:30, 14:35
- IEEE C62.41-1991 Level B

**Auxiliary Products:**

- Panel mount kit: P/N: BZ1
- Octal 8-pin socket: P/N: OT08PC
- 3-phase fuse block/disconnect: P/N: FH3P
- 2 Amp fuse: P/N: P0600-11
- DIN rail: P/N: C10D3M (Al)

**Available Models:**

- PLM6405
- PLM6502
- PLM6805
- PLM8405
- PLM8805
- PLM9405
- PLM9502
- PLM9805
- PLM9820

If desired part number is not listed, please call us to see if it is technically possible to build.
Provides protection for motors and other sensitive loads. Continuously measures the voltage of each of the three phases using a microcontroller circuit design that senses under and overvoltage, voltage unbalance, phase loss, and phase reversal. Protection is provided even when regenerated voltages are present. Includes a trip delay to prevent nuisance tripping and a restart delay to prevent short cycling after a momentary power outage.

For more information see: Appendix B, page 167, Figure 30 for dimensional drawing. Appendix C, page 168, Figure 14 for connection diagram.

Operation
Upon application of line voltage, the restart delay begins. The output is de-energized during restart delay. Under normal conditions, the output energizes after the restart delay. Undervoltage, overvoltage, and voltage unbalance must be sensed for the complete trip delay period before the output de-energizes. The restart delay begins as soon as the output de-energizes. If the restart delay is completed when a fault is corrected, the output energizes immediately. The output will not energize if a fault is sensed as the input voltage is applied. If the voltage selector is set between two voltage marks (i.e. between 220 and 230V), the LED will flash red rapidly. The TVW provides fault protection at the lower of the two line voltages (i.e. 220V).

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed. If the voltage selector knob is between settings, it rapidly flashes red.

Features:
- Protects against phase loss & reversal; over, under & unbalanced voltages; short cycling
- Fixed trip points & delays
- Adjustable voltages from 208 to 480VAC in 4 ranges
- Monitor 600V AC lines by connecting VRM accessory
- Isolated, 10A, SPDT output contacts
- Bi-color LED indicates: output status, faults, time delays, phase reversal & setpoint
- ASME A17.1 rule 210.6
- NEMA MGI 14:30, 14:35
- IEEE C62.41-1991 Level B

Auxiliary Products:
- 3-phase fuse block/disconnect: P/N: FHS3P
- 2 Amp fuse: P/N: P0600-11
- DIN rail: P/N: CI03PM (A1)
- Female quick connect: P/N: PI015-13 (AWG 10/12)
- P/N: PI015-64 (AWG 14/16)
- P/N: PI015-14 (AWG 18/22)
- Voltage reduction module: P/N: VRM6048

Available Models:
TVW3591M
TVW651050.4S
TVW951050.4S

If desired part number is not listed, please call us to see if it is technically possible to build.

Order Table:

<table>
<thead>
<tr>
<th>TVW</th>
<th>X</th>
<th>Line Voltage</th>
<th>X</th>
<th>Voltage Unbalance</th>
<th>X</th>
<th>Trip Delay*</th>
<th>X</th>
<th>Restart Delay*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wide Range</td>
<td></td>
<td>Fixed - Specified</td>
<td></td>
<td>Fixed - Specified</td>
<td></td>
<td>Fixed - Specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 - 208-240VAC</td>
<td></td>
<td>4-10% in 1% increments</td>
<td></td>
<td>0.2-1s in 0.1s increments</td>
<td></td>
<td>1-100s in 1s increments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selectable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>208, 220, 230 &amp; 240VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>460 &amp; 415VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>430, 440, 460 &amp; 480VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Must indicate (S) for secs. or (M) for mins.

Specifications:

- Line Voltage
  - Type: 3-phase delta or wye with no connection to neutral
  - Input Voltage/Tolerance: 208 to 480VAC in 4 ranges / -30% - 20%
  - AC Line Frequency: 50 - 100 Hz
  - Phase Sequence: A BC
  - Power Consumption: Approx. 2W for 240V units
  - Approx. 3W for 480V units

- Overvoltage, Undervoltage, & Voltage Unbalance
  - Voltage detection with delay trip & automatic reset
  - Undervoltage Trip Point: 88 - 92% of the selected line voltage
  - Reset Voltage: ± 3% of trip voltage
  - Overvoltage Trip Point: 109 - 113% of the selected line voltage
  - Reset Voltage: ± 3% of trip voltage
  - Trip Variation vs Temperature: ± 4%
  - Voltage Unbalance: Factory fixed, 4 - 10%
  - Reset On Balance: ± 0.7% unbalance
  - Trip Delay Range: Fixed from 0.2 - 100s ±15% or ±0.1s, whichever is greater
  - Restart Delay Range: Fixed from 0.4s - 999ms ±15% or ±0.2s, whichever is greater

- Phase Reversal & Phase Loss Response: ≤ 200ms automatic reset
- Phase Loss: ≤ 25% unbalance
- Output
  - Type: Isolated, SPDT
  - Rating: 208 to 240VAC (55°C) ≤ 10A resistive @ 125VAC, 5A @ 250VAC
  - 1/4 hp @ 125VAC 380 to 480VAC ≤ 10A resistive @ 240VAC, 1/4 hp @ 125VAC
  - 1/3 hp @ 250VAC, max. voltage 277VAC
- Life: Mechanical - 1 x 10⁶; Electrical - 1 x 10⁹
- Protection
  - Surge: IEEE C62.41-1991 Level B
  - Dielectric Breakdown: 208 to 240VAC: ≥ 1500V RMS input to output terminals
  - 380 to 480VAC: ≥ 2500V RMS input to output terminals
- Mechanical
  - Mounting: Surface mount with one #8 (M5 x 0.8) screw
  - Dimensions: 2 x 2 x 1.25 in. (50.8 x 50.8 x 31.8 mm)
  - Termination: 0.25 in. (6.35 mm) male quick connect terminals
- Environmental
  - Operating / Storage Temperature: -40° to 55°C / -40° to 85°C
  - Humidity: 95% relative, non-condensing
  - Weight: 2.8 oz (79 g)

Weight
- Operating / Storage Temperature
  - -40° to 55°C / -40° to 85°C
  - 95% relative, non-condensing
The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during
operation.

**Operation**
Upon application of line voltage, the restart delay begins. The output relay is de-energized during restart delay.
Under normal conditions, the output energizes after restart delay. Undervoltage, overvoltage, and voltage
unbalance must be sensed for continuous trip delay period before the output is de-energized. The output will not
de-energize if a fault is corrected during the trip delay. The restart delay begins as soon as the output relay de-
energizes. If the restart delay is completed when the fault is corrected, the output relay will energize immediately.
The output relay will not energize if a fault or phase reversal is sensed as 3-phase input voltage is applied.
Reset: Reset is automatic upon correction of a fault.

**LED Operation**
The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during
the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed.

**Order Table:**

<table>
<thead>
<tr>
<th>TVM</th>
<th>X</th>
<th>Voltage Unbalance</th>
<th>X</th>
<th>Trip Delay*</th>
<th>X</th>
<th>Restart Delay*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Voltage</td>
<td>Voltage Unbalance</td>
<td>Fixed - Specify from 0.22s</td>
<td>Fixed - Specify from 1-100s</td>
<td>Fixed - Specify from 1-999min</td>
<td>Fixed - Specify from 1-999min</td>
<td></td>
</tr>
<tr>
<td>-208A - 240VAC</td>
<td>in 1% increments</td>
<td>in 0.1s increments</td>
<td>in 1s increments</td>
<td>in 1min increments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-220A - 230VAC</td>
<td>-40%</td>
<td>-41%</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-240A - 480VAC</td>
<td>-41%</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-380A - 380VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-400A - 400VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-415A - 415VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-440A - 440VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-460A - 460VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-480A - 480VAC</td>
<td>-50%</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Must indicate (S) for secs. or (M) for mins.

**Specifications**
- **Line Voltage**: 3-phase delta or wye with no connection to neutral
- **Input Voltage**: 208 to 480VAC
- **AC Line Frequency**: 50 - 100 Hz
- **Phase Sequence**: ABC
- **Power Consumption**: Approx. 2W for 480VAC units
- **Dimensions**: 2 x 2 x 1.25 in. (50.8 x 50.8 x 31.8 mm)
- **Weight**: ≤ 2.8 oz (79 g)

**Features**
- **Protection**
  - Protects against phase loss & reversal; over, under & unbalanced voltages; short cycling
  - **Fixed trip points & delays**
  - **Fixed voltages from 208 to 480VAC**
  - **Isolated, 10A, SPDT output contacts**
  - **Bi-color LED indicator shows: output status, faults, time delays & phase reversal**
  - **ASME A17.1 rule 210.6**
  - **IEEE C62.41-1991 Level B**

**Available Models**
- TVM208A100-5S5S
- TVM460A510S5S
- TVM200A101S1S
- TVM460A100S5S
- TVM480A101S5S
- TVM480A100.5S5S
- TVM460A410S5S
- TVM480A410S5S

If desired part number is not listed, please call us to see if it is technically possible to build.
Voltage Monitors

The PLR Series provides a cost effective means of preventing 3-phase motor startup during adverse voltage conditions. Proper A-B-C sequence must occur in order for the PLR’s output contacts to energize. In addition, the relay will not energize when an undervoltage or phase loss condition is present. The PLR protects a motor against undervoltage operation. The adjustment knob sets the undervoltage trip point.

For more information see:
Appendix B, page 165, Figure 8 for dimensional drawing.
Appendix C, page 168, Figure 13 for connection diagram.

Operation
The output relay is energized and the LED glows when all voltages are acceptable and the phase sequence is correct. Undervoltage must be sensed for a continuous dropout delay period before the relay de-energizes. Reset is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied.

Field Adjustment: Turn the adjustment knob fully counterclockwise and apply three-phase power. The LED should be ON. Increase adjustment until the LED goes OFF. Decrease adjustment until LED glows again. If nuisance tripping occurs, decrease the adjustment slightly.

NOTE: When properly adjusted and operating in an average system, a voltage unbalance of 10% or more is required for phase loss detection. When a phase is lost while the motor is running, a voltage will be induced into the open phase nearly equal in magnitude to the normal phase-to-phase voltage. This condition is known as regeneration. When regenerated voltages are present, the voltage unbalance during single phasing may not exceed 10% for some motors. The PLR Series may not provide protection under this condition. For systems that require superior phase loss protection, select the PLMU Series.

Order Table:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>95-140VAC</td>
<td>PLR120A</td>
</tr>
<tr>
<td>190-270VAC</td>
<td>PLR240A</td>
</tr>
<tr>
<td>340-450VAC</td>
<td>PLR380A</td>
</tr>
<tr>
<td>380-500VAC</td>
<td>PLR480A</td>
</tr>
</tbody>
</table>

Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>95-140VAC</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>120VAC</td>
</tr>
<tr>
<td>Isolation Voltage</td>
<td>120 &amp; 240VAC</td>
</tr>
<tr>
<td>Surge</td>
<td>P/N: C103PM</td>
</tr>
<tr>
<td>Mechanical Response Times</td>
<td>≤ 400ms</td>
</tr>
<tr>
<td>Pull-in Response Time</td>
<td>≤ 100ms</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>≤ 2%</td>
</tr>
<tr>
<td>Output Type</td>
<td>Electromechanical relay</td>
</tr>
</tbody>
</table>
The PLS Series is a low cost phase sensitive control that provides an isolated contact closure when the proper A-B-C phase sequence is applied. Protects sensitive 3-phase equipment and equipment operators from reverse rotation. Designed to be compatible with motor overloads or other 3-phase equipment protection devices. Protection for equipment control centers where frequent reconnection or electrical code makes reverse rotation protection essential. Examples include: mobile refrigerated containers, construction equipment, hoists, pumps, conveyors, elevators and escalators.

For more information see:
Appendix B, page 166, Figure 19 for dimensional drawing.
Appendix C, page 168, Figure 13 for connection diagram.

Operation
The internal relay and LED are energized when the phase sequence is correct. The output relay will not energize if the phases are reversed. Reset is automatic upon correction of the fault.

Features:
- Protects against phase reversal
- Low cost protection, one unit for all sized motors
- 3-wire connection for delta or wye systems
- Octal base connect - industry standard wiring
- Isolated, SPDT output contacts
- Factory calibrated - no adjustments required

Approvals:

Auxiliary Products:
- Panel mount kit: P/N: BZ1
- Octal 8-pin socket: P/N: OT08PC
- 3-phase fuse block/disconnect:
  - P/N: FH3P
- 2 Amp fuse: P/N: P0600-11
- Din rail: P/N: C103PM (Al)

Available Models:
PLS120A
PLS240A
PLS480A

Order Table:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>120VAC</td>
<td>PLS120A</td>
</tr>
<tr>
<td>208/240VAC</td>
<td>PLS240A</td>
</tr>
<tr>
<td>380/415VAC</td>
<td>PLS380A</td>
</tr>
<tr>
<td>440/480VAC</td>
<td>PLS480A</td>
</tr>
</tbody>
</table>

Specifications

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Type</th>
<th>Nominal Voltage</th>
<th>Minimum Voltage</th>
<th>Maximum Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>120VAC</td>
<td>59VAC</td>
<td>95VAC</td>
<td>135VAC</td>
<td>255VAC</td>
</tr>
<tr>
<td>208/240VAC</td>
<td>175VAC</td>
<td>215VAC</td>
<td>430VAC</td>
<td>500VAC</td>
</tr>
<tr>
<td>380/415VAC</td>
<td>310VAC</td>
<td>380VAC</td>
<td>500VAC</td>
<td></td>
</tr>
<tr>
<td>440/480VAC</td>
<td>380VAC</td>
<td>480VAC</td>
<td>500VAC</td>
<td></td>
</tr>
</tbody>
</table>

Maximum Voltage: 250VAC
Protection Isolation Voltage: 120 & 240VAC: ≥ 1500V RMS input to output 380 & 480VAC: ≥ 2500V RMS input to output

Mechanical
Mounting: Plug-in socket
Dimensions: 3.2 x 2.39 x 1.78 in. (81.3 x 60.7 x 45.2 mm)
Termination: Octal 8-pin plug-in

Environmental
Operating / Storage Temperature: -40° to 55°C / -40° to 85°C
Weight: 6 oz (170 g)

*CAUTION: Select an octal socket rated for 600VAC operation.
The HLV Series is a single-phase undervoltage monitor designed to protect sensitive equipment from brownout or undervoltage conditions. Time delays are included to prevent nuisance tripping and short cycling. The 30A, 1hp rated, SPDT relay contacts allow direct control of motors, solenoids and valves. The output relay can be ordered with isolated SPDT contact to allow monitoring of one voltage and switching a separate voltage. Two undervoltage trip point ranges allow monitoring of 110 to 120VAC or 208 to 240VAC systems.

For more information see:
Appendix B, page 165, Figure 2 for dimensional drawing.
Appendix C, page 169, Figure 15 for connection diagram.

Operation
Upon application of input voltage the output relay remains de-energized. When the input voltage value is above the pull-in voltage, the restart delay begins. At the end of the restart delay, the output relay energizes. When the input voltage falls below the trip point, the trip delay begins. If the input voltage remains below the pull-in voltage for the entire trip delay the relay de-energizes. If the input voltage returns to a value above the pull-in voltage, during the trip delay, the trip delay is reset and the relay remains energized. If the input voltage falls below the trip point voltage during the restart delay, the delay is reset and the relay remains de-energized. Reset is automatic upon correction of an undervoltage fault.

Reset: Removing input voltage resets the output relay and the time delays.

Order Table:

<table>
<thead>
<tr>
<th>Model</th>
<th>Undervoltage Range</th>
<th>Output Connection</th>
<th>Restart Delay</th>
<th>Trip Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLV A</td>
<td>4 - 70 to 120VAC</td>
<td>I - Isolated SPDT</td>
<td>3-300s adjustable</td>
<td>Fixed - Specify from 1-20s in 1s increments</td>
</tr>
<tr>
<td></td>
<td>6 - 170 to 220VAC</td>
<td>N - Non-Isolated SPDT</td>
<td>3-300s</td>
<td></td>
</tr>
</tbody>
</table>

Specifications:

- **Input**
  - Min & Max RMS Voltage: 70 to 264VAC
  - AC Line Frequency: 50/60 Hz
  - Power Consumption: AC 4VA

- **Undervoltage Sensing**
  - Type: Peak voltage sensing
  - Ranges: 70 to 120VAC
  - Pull-In Voltage: 105% or trip point
  - Trip Point Accuracy: ± 3% of trip point
  - Time Delay: 3 - 300s adjustable
  - Repeat Accuracy: ±0.5% or 20ms, whichever is greater
  - Reset Time: ≤ 150ms
  - Time Delay vs. Temp. & Voltage: ≤ ±10%

- **Output**
  - Type: Electromechanical relay
  - Form: SPDT

- **Ratings**
  - SPDT-N.O: 30A
  - SPDT-NC: 15A

- **General Purpose**
  - 125/240VAC: 30A
  - 20A: 10A
  - 125VAC: 2 hp*
  - 240VAC: 2 hp**

- **Life**
  - Mechanical: 1 x 10^6
  - Electrical: 1 x 10^6, 4 x 10^6

- **Protection**
  - Surge: IEEE C62.41-1991 Level A
  - Circuitry: Encapsulated
  - Insulation Voltage: ≥ 1500V RMS input to output; isolated units
  - Insulation Resistance: ≥ 100 MΩ

- **Mechanical**
  - Mounting: Surface mount with one #10 (M5 x 0.8) screw
  - Dimensions: 1.3 x 2 x 1.5 in. (33 x 51.3 x 38.1 mm)
  - Termination: 0.25 in. (6.35 mm) male quick connects

- **Environmental**
  - Operating / Storage Temperature: 40° to 70°C / 40° to 85°C
  - Humidity: 95% relative, non-condensing
  - Weight: 3.9 oz (111 g)

**Features:**
- Protects against undervoltage in single-phase systems
- 30A, SPDT, NO output contacts
- 100 to 240VAC input voltage
- 70 to 220VAC adjustable undervoltage trip point in 2 ranges
- Restart delays from 3 - 300s
- Trip delay 1 - 20s fixed
- Isolated or non-isolated relay contacts

**Available Models:**
HLVA6123

If desired part number is not listed, please call us to see if it is technically possible to build.
The KVM Series is a single-phase undervoltage monitor designed to protect sensitive equipment against brownout undervoltage conditions. The compact design and encapsulated construction make the KVM an excellent choice for OEM equipment.

For more information see:
Appendix B, page 165, Figure 1 for dimensional drawing.
Appendix C, page 169, Figure 16 for connection diagram.

**Operation**
The output relay is energized and the LED glows green when the input voltage is above the reset voltage threshold. If the input voltage drops below the undervoltage setpoint, the output relay and LED will de-energize. The output relay will remain de-energized as long as the input voltage is below the reset voltage. Reset is automatic when the input voltage returns to a normal range.

**Order Table:**

<table>
<thead>
<tr>
<th>Undervoltage Setpoint</th>
<th>Maximum Line Voltage</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>78 to 99VAC</td>
<td>132VAC</td>
<td>KVM4</td>
</tr>
<tr>
<td>156 to 199VAC</td>
<td>264VAC</td>
<td>KVM6</td>
</tr>
</tbody>
</table>

**Specifications**

- **Line Voltage**
  - Type: Single phase
  - Input Voltage: 110 to 120VAC or 220 to 240VAC
  - AC Line Frequency: 50/60 Hz
  - Power Consumption: 2.5W @ 132VAC; 4.5W @ 264VAC
  - Power Off Reset Time: ≤ 150ms
  - Undervoltage Detection
    - Undervoltage Setpoint: KVM4 - 78 to 99VAC, KVM6 - 156 to 199VAC
    - Undervoltage Reset Point: KVM4 - Fixed at 104VAC, KVM6 - Fixed at 209VAC
    - Repeatability: ±0.5% under fixed conditions
    - Voltage Sensing Accuracy: ±2% at 25°C
  - Isolation Voltage: > 1500V RMS input to output
  - Insulation Resistance: > 100 MΩ minimum
  - Mechanical
    - Mounting: Surface mount with one #10 (M5 x 0.8) screw
    - Dimensions: 2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm)
    - Termination: 25 in. (63.5 mm) male quick connect terminals
  - Environmental
    - Operating / Storage Temperature: -25 to 55°C / -40 to 85°C
    - Humidity: 95% relative, non-condensing
  - Weight: 2.6 oz (74 g)

- **Features:**
  - Economical single-phase brownout/undervoltage protection
  - Isolated, 8A, SPDT output contacts
  - Protects sensitive 110 to 120VAC or 220 to 240VAC loads
  - Adjustable low voltage trip point
  - LED Indicator

- **Approvals:**

- **Auxiliary Products:**
  - Quick connect to screw adaptor:
    - P/N: P1015-18
  - Female quick connect:
    - P/N: P1015-64 (AWG 14/16)
  - DIN rail:
    - P/N: C103PM
  - DIN rail adaptor:
    - P/N: P1023-20

- **Available Models:**
  - KVM4
  - KVM6