

## MODEL APMR - 3 PHASE FAULT DETECTION DIN RAIL MODULE



- PROTECTS AGAINST PHASE LOSS, UNBALANCE, UNDER VOLTAGE, AND PHASE REVERSAL
- AVAILABLE IN 230, 380, OR 480 VAC
- LOW COST
- DIN RAIL MOUNTABLE
- INRUSH UNDER VOLTAGE DELAY



UL Recognized Component,  
File # E137808

### DESCRIPTION

The APMR protects three phase equipment, mostly motors, from destructive line conditions. Specifically it detects Phase Reversal, Phase Loss, Phase Unbalance and Low Voltage. All of these conditions, except for Phase Reversal, produce excessive heating of motor windings, causing immediate or cumulative damage to the motor. Phase Reversal will cause a motor to operate in the reverse intended direction, possibly damaging machinery.

There are three models available; 230 VAC, 380 VAC, and 480 VAC. The 230 VAC model is used with 208, 220, 230, and 240 VAC rated equipment. The 380 VAC model is used with 380 and 415 VAC (European) equipment. The 480 VAC model is used with 440, 460, and 480 VAC rated equipment. The electrical connection is three wire Delta or WYE configurations (no neutral connection required).

The output is SPDT relay and LED. The relay is typically connected in series with a motor contactor coil to inhibit motor start or to disconnect the motor in the presence of a fault condition. The relay automatically resets when the fault clears. The relay is typically used in a latching configuration so the motor has to be restarted after the fault is cleared. The LED illuminates green when all conditions are normal - no fault. When the LED is green, the relay is energized. When a fault occurs, the LED turns red and the relay is de-energized. If phase loss occurs on L1 or L3 the LED turns-off and the relay is de-energized.

### SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



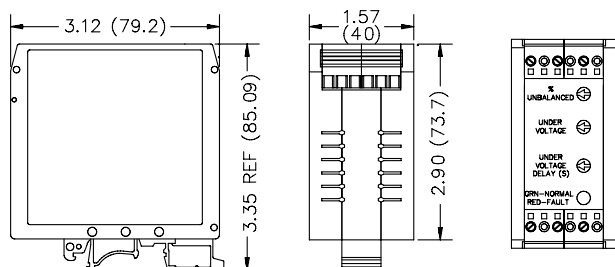
**CAUTION: Risk of Danger.**  
Read complete instructions prior to installation and operation of the unit.



**CAUTION: Risk of electric shock.**

**WARNING:** 3 Phase Fault Detection Modules must never be used as "Primary" protection against hazardous operating conditions. Machinery must first be made safe by inherent design or the installation of guards, shields, or other devices to protect personnel in the event of a hazardous machine condition.

### DIMENSIONS In inches (mm)



### SPECIFICATIONS

#### 1. POWER:

**230 VAC:** 185 min to 264 max, 3 VA (Typ)⇒Nominal is 185 to 240, 48 to 62 Hz.

**380 VAC:** 320 min to 457 max, 3 VA (Typ)⇒Nominal is 320 to 415, 48 to 62 Hz.

**480 VAC:** 380 min to 528 max, 3 VA (Typ)⇒Nominal is 380 to 480, 48 to 62 Hz.

#### 2. OUTPUT: SPDT 10 A @ 240 VAC (resistive load); 1/2 HP @ 240 VAC

##### Response Time:

**Phase Reversal:** Not greater than 120 msec

**Low Voltage:** 0.1 to 20 sec, user adjustable

**Phase Loss and Unbalance:** Not greater than 100 ms

#### 3. TEMPERATURE COEFFICIENTS:

**Unbalance:** ±0.5% Over temperature range

**Undervoltage:** ±200 PPM/°C

#### 4. ENVIRONMENTAL CONDITIONS:

**Operating Temperature:** 0 to 55°C

**Storage Temperature:** -40 to 80°C

**Operating and Storage Humidity:** 85% max. relative humidity (non-condensing) from 0°C to 50°C.

**Altitude:** Up to 2000 meters

#### 5. ISOLATION BREAKDOWN RATING: 3000 V

#### 6. CERTIFICATIONS AND COMPLIANCES:

##### SAFETY

UL Recognized Component, File # E137808, UL 508, CSA C22.2 No. 14

Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.

##### ELECTROMAGNETIC COMPATIBILITY

##### Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz
Simulation of cordless telephone	ENV 50204	Level 3; 10 V/m 900 MHz ± 5 MHz 200 Hz, 50% duty cycle

##### Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A
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Refer to EMC Installation Guidelines for additional information.

#### 7. MOUNTING: Universal mounting foot for attachment to standard DIN style mounting rails, including top hat (T) profile rail according to EN50022 - 35 X 7.5 and 35 X 15, and G profile rail according to EN50035 - G32.

#### 8. CONNECTION: Compression type terminal block

#### 9. CONSTRUCTION: High impact black plastic case. Installation Category II, Pollution Degree 2.

#### 10. WEIGHT: 7.0 oz. (0.20 Kg)

## FUNCTION DESCRIPTIONS

### PHASE UNBALANCE

Unbalance occurs in 3 phase systems when single phase loads are added without regard to voltage effects on the remaining phases. This unbalance in phase voltage causes excessive motor current producing temperatures in excess of specifications. The relationship between voltage unbalance and percentage of temperature rise is approximately the square of the percent voltage unbalance times two. i.e., - % temperature rise = (% unbalance<sup>2</sup> X 2).

Therefore, a 4% voltage unbalance will result in approximately a 32% increase in winding temperature. The effect of temperature rise is immediate failure of winding insulation if unbalance is severe as with single phasing. If unbalance is slight, gradual winding degradation will result in premature insulation failure. The APMR will detect slight unbalances that thermal and magnetic devices usually miss.

### PHASE LOSS

Phase Loss is an extreme case of unbalance known as "single phasing" where a total loss of one of the phases occurs. During this condition the motor will continue to run and the full current is drawn from the remaining phases. Unless the motor is lightly loaded motor failure will occur. The APMR will detect Phase Loss even with regenerated voltages present.

### PHASE REVERSAL

Reversing any two of the three phases will cause a motor to rotate opposite the intended direction causing damage to machinery. Reversal can occur during maintenance of distribution systems. The APMR will detect Phase Reversal regardless of load conditions.

### UNDERVOLTAGE

Undervoltage can occur during Brownouts, excessive system loading and motor startups. An undervoltage **Time Delay** is provided with the undervoltage detection to eliminate false tripping during startups when a motor draws many times its operating current.

## EMC INSTALLATION GUIDELINES

Although this unit is designed with a high degree of immunity to ElectroMagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the unit may be different for various installations. Cable length, routing and shield termination are very important and can mean the difference between a successful or a troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The unit should be mounted in a metal enclosure, that is properly connected to protective earth.
  - a. If the bezel is exposed to high Electro-Static Discharge (ESD) levels, above 4 Kv, it should be connected to protective earth. This can be done by making sure the metal bezel makes proper contact to the panel cut-out or connecting the bezel screw with a spade terminal and wire to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
  - a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
  - b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
  - c. Connect the shield to common of the unit and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.

5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:

Ferrite Suppression Cores for signal and control cables:

Fair-Rite # 0443167251 (RLC #FCOR0000)

TDK # ZCAT3035-1330A

Steward #28B2029-0A0

Line Filters for input power cables:

Schaffner # FN610-1/07 (RLC #LFIL0000)

Schaffner # FN670-1.8/07

Corcom #1VB3

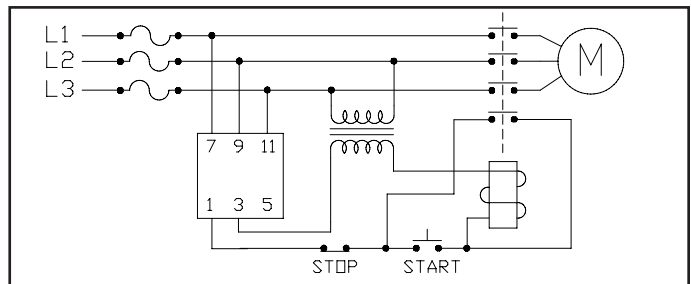
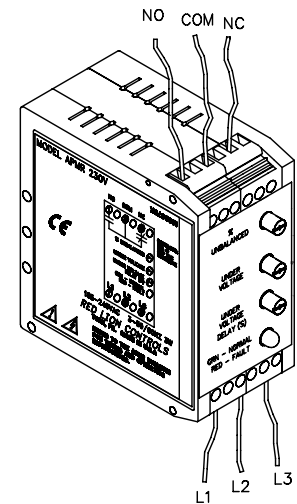
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**Note:** Reference manufacturer's instructions when installing a line filter.

6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

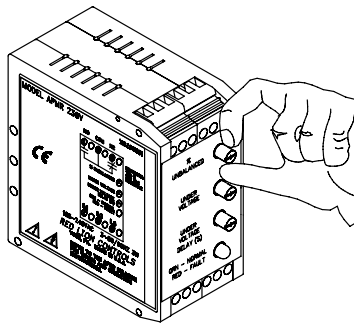
## WIRING CONNECTIONS

All conductors should meet voltage and current ratings for each terminal. Also, cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the unit be protected by a fuse or circuit breaker. When wiring the unit, use the number on the label to identify the position number with the proper function. Strip wire, leaving approximately 1/4" (6mm) of bare wire exposed. Insert the wire into the terminal, and tighten the screw until the wire is clamped tightly.



## SETUP

1. Adjust the dials on the APMR to the following settings:
  - a. Under Voltage to minimum (CCW)
  - b. Under Voltage Delay to minimum (CCW)
  - c. % Unbalanced to maximum (CW)



2. Connect input wire from the fused 3 phase line voltage to Terminals 7 (L1), 9 (L2), and 11 (L3). In Wye systems, connection to neutral wire is not required. Do not wire output contacts until Step 9.

3. TURN POWER ON. When the internal relay energizes, and the Red LED glows green, the phase sequence is correct and the voltages on all three phases are above the minimum under voltage setting.

- a. If the internal output relay does not energize, and the LED stays red, TURN POWER OFF and swap any two (2) of the three (3) input wires. This corrects the phase sequence if the monitor was connected in reverse rotation.

*Note: Insure that the motor is wired for correct rotation.*

4. Select the proper under voltage trip point. (This is the dial marked Under Voltage.) The under voltage setting should be the same as the minimum operating voltage for the equipment to be protected.

*Note: If the recommended setting is not known, turn the Undervoltage adjustment knob CW until the relay de-energizes and the LED glows red. Turn the knob CCW until the relay energizes and the LED glows green. This procedure assumes that the line voltages are at an acceptable level when the adjustments are made.*

5. Set the **Under Voltage Delay** to the desired value. This is the maximum time period that an under voltage condition can exist before de-energizing the internal relay. The exact value of the delay depends on the type of equipment being protected and the quality of the available three phase power. A setting too low, will cause unnecessary interruptions due to momentary dips in the line voltage. On the other hand, if the time delay is too long, damage to the equipment can occur before a legitimate under voltage condition is detected. Three phase motors have a starting current that is many times higher than the normal full load current but lasts for only a few seconds. Setting the delay slightly longer than the duration of this inrush period will prevent the APMR from being tripped due to a low voltage condition caused by the starting current.

*Note: The under voltage delay applies only to under voltage conditions.*

*Exceeding the phase unbalance trip setting or a phase loss will de-energize the relay instantly regardless of the delay setting.*

6. Phase **Unbalance** setting. Maximum permissible unbalance and phase voltages that most three phase powered equipment can tolerate are very seldom specified. In most locations, three phase voltages typically are not perfectly balanced. Use your own discretion when setting this value. Too low of a setting (CCW) can cause unnecessary tripping. Too high of a setting (CW) does not provide adequate protection.

An alternative procedure is to turn the Unbalance adjustment CCW until the relay de-energizes and the LED turns red. Turn the knob CW until the relay energizes and the LED turns green.

*Note: This procedure assumes that the line voltages are sufficiently balanced when the adjustments are made. % Voltage Unbalance is defined by NEMA as: [(Maximum Deviation From Average Voltage/Average Voltage) X 100] where Average Voltage = (L1 + L2 + L3)/3.*

*Note: NEMA recommends not to operate motors with a phase unbalance greater than 5%.*

7. When the phase sequence is correct and the line voltages are within preset limits, the internal relay of the APMR will energize. The LED indicator glows green to show a normal condition.
8. TURN POWER OFF. Refer to the wiring diagram for proper output contact connections.
9. After proper connections are made, TURN POWER ON. The internal relay energizes allowing the monitored load to become active.

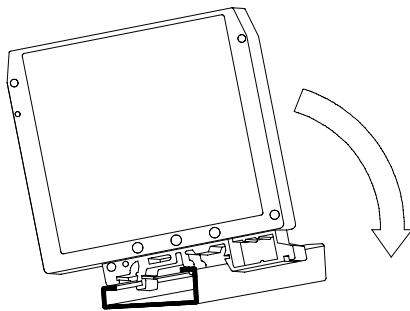
## INSTALLATION

The unit is equipped with a universal mounting foot for attachment to standard DIN style mounting rails, including G profile rail according to EN50035 - G32, and top hat (T) profile rail according to EN50022 - 35 x 7.5 and 35 x 15.

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

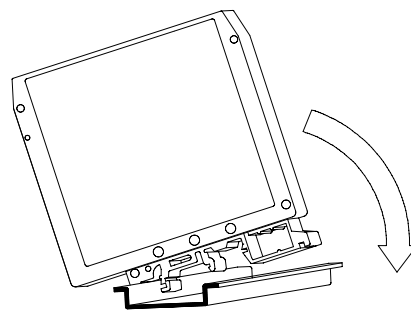
### G Rail Installation

To install the APMR on a "G" style DIN rail, angle the module so that the upper groove of the "foot" catches under the lip of the top rail. Push the module toward the rail until it snaps into place. To remove a module from the rail, push up on the bottom of the module while pulling out away from the rail.



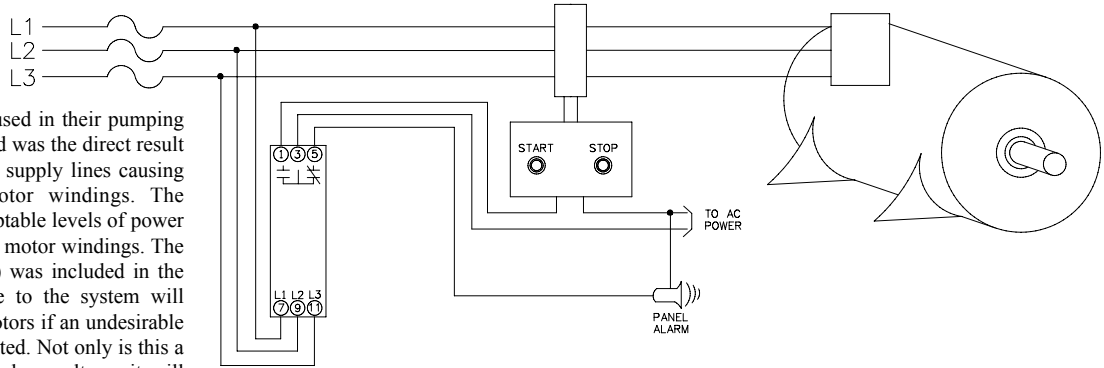
### T Rail Installation

To install the APMR on a "T" style rail, angle the module so that the top groove of the "foot" is located over the lip of the top rail. Push the module toward the rail until it snaps into place. To remove a module from the rail, insert a screwdriver into the slot on the bottom of the "foot", and pry upwards on the module until it releases from the rail.



## APPLICATION

A waste water treatment plant had just completed a costly repair program, reconditioning several motors used in their pumping process. The necessity to rebuild was the direct result of unbalanced and low voltage supply lines causing excessive heating to the motor windings. The continual operation below acceptable levels of power supply lead to the failure of the motor windings. The APMR (3 phase fault detector) was included in the repair program. This upgrade to the system will automatically shut down the motors if an undesirable power supply condition is detected. Not only is this a safeguard against unbalance or low voltage, it will also detect phase loss or reversal. An alarm will also trigger in the control room, alerting the operators of the shut down action.



## TROUBLESHOOTING

For further technical assistance, contact technical support at the appropriate company numbers listed.

## ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBERS FOR AVAILABLE SUPPLY VOLTAGES		
		480 VAC	380 VAC	230 VAC
APMR	3 Phase Fault Detection Module	APMR0096	APMR0086	APMR0016
For more information on Pricing, Enclosures & Panel Mount Kits refer to the RLC Catalog or contact your local RLC distributor.				

## LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

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#### Как с нами связаться

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