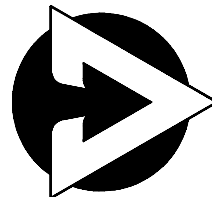


CONTROL CONCEPTS INC.

MODEL 3027M INSTRUCTION MANUAL



CONTROL
CONCEPTS

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DESCRIPTION:

The model 3027M is a three-phase, zero cross power controller that controls two legs of the three phase supply. The average output voltage is proportional to the command signal.

Sync-Guard and Trans-Guard features are built into the model 3027M.

The model 3027M will accept a 4 to 20mA command signal. When this signal is absent, the controller will automatically use the internal manual command pot to control the output.

If an external potentiometer is desired for remote operation, terminals are provided for this purpose.

For full range control by the external pot, the internal pot must be turned to minimum.

The internal pot may be used to set a minimum level of command for the external potentiometer.

MODEL NUMBER:

3027M-[vvv]V-[aaa]A-[4/20mA]-[FC]-[SC]

3027M specifies a three-phase, zero-cross SCR controller.

[vvv] specifies the line voltage.

Standard choices are: 208, 240, 277, 380, 415, 480 or 575 Vac. Consult factory for other voltages.

[aaa] specifies the continuous RMS load current rating.

Choices are: 85, 145, 175, 240, 295, 370 or 425 Amps.

[4/20mA] specifies that the controller will accept a current loop command signal of 4/20mA.

[FC] specifies a replacement firing circuit only.

This term is omitted when ordering a complete controller.

[SC] specifies special calibration. This term is omitted if standard calibration is desired.

For example, **3027M-480V-145A-4/20mA** specifies a three-phase, zero cross 3027M controller built to operate on a 480 volt line, 145 amps continuous load current and operate over a command signal range of 4 to 20mA.

ZERO-CROSS OPERATION:

In zero-cross control, load power is turned on or off only when the instantaneous value of the sinusoidal waveform is zero. Load power is controlled by switching the SCRs "on" for a number of electrical half-cycles and then "off" for a number of electrical half-cycles. The odd "on" and even "off" cycle is a result of the Trans-Guard feature.

The following tabulation shows the number of "on" and "off" electrical half-cycles of power that are applied to the load to achieve the percentage of load power indicated. The percentage of load power is equal to the ratio of the number of electrical half-cycles that power is applied to the total number of electrical half-cycles.

Typical Load Power / ON-OFF time.

10%	25%	50%	75%	85%
5 on	5 on	9 on	17 on	23 on
46 off	14 off	8 off	6 off	4 off
5 on	5 on	7 on	19 on	23 on
44 off	16 off	8 off	6 off	4 off
				23 on
				4 off
				23 on
				4 off
				23 on
				4 off
				21 on
				4 off

From the above tabulation, it can be seen that power is applied for 16 out of 32 electrical half-cycles to achieve 50% load power and that power is applied for 136 out of 160 electrical half-cycles to obtain 85% power. When operated with a 60 hertz supply, the sequence of on and off cycles repeats every 0.266 seconds at 50% and every 1.33 seconds at 85% power. Note that even though it takes 1.33 seconds to obtain precisely 85% power, the load power during the 23 on and 4 off cycles is 23/27 or 85.185% power and that this cycle is repeated every 0.225 seconds.

SPECIFICATIONS:

These specifications apply over an ambient temperature of 0 to 55°C;
Supply voltage of 208, 240, 277, 380, 415, 480 or 575 Vac (+10% - 15%); 50/60 Hertz.

CONSTRUCTION:	The firing circuit, with gate drivers and all associated circuitry is contained on a single printed circuit board.
CONTROL MODE:	The model 3027M SCR power controller linearly controls, with respect to a command signal, the electrical power applied to a three-phase resistive load by zero-cross operation of silicon controlled rectifiers (SCRs). The controller provides line voltage compensation which maintains the load power constant, independent of line voltage variations.
FIRING MODE:	Distributed zero cross. Average load voltage is proportional to the command signal.
CONTROL RANGE:	0 to 98% of supply voltage.
CONTROL POWER:	24 Vac + 20% - 15%. VA = 15
DV/DT AND TRANSIENT VOLTAGE PROTECTION:	DV/DT rating exceeds 200 volts per microsecond. A DV/DT snubber circuit protects against high frequency transients. A Metal Oxide Varistor protects against high voltage transients.
SETPOINTS:	The controller accepts a 4/20mA current loop command signal. The input impedance is 249 ohms.
SETPOINT ISOLATION:	Plus or minus 200 Volt peak isolation is provided between the 4/20 mA input and ground by means of a high common mode voltage instrumentation amplifier. The 3027M provides electrical isolation of the command signals from the line and load voltages.
ENVIRONMENT:	Operating temperature: 0 to 55°C (32 to 132°F) Storage temperature: -20 to 80°C (-4 to 176°F). Humidity: 0 to 95%, Non condensing.
DISSIPATION:	Approximately 1.5 watts per amp of current per phase will be dissipated by the controller.
FRAME SIZES:	85 Amps, convection cooled. 145 Amps, forced air cooled. 175 Amps, forced air cooled. 240 Amps, forced air cooled. 295 Amps, forced air cooled. 370 Amps, forced air cooled. 425 Amps, forced air cooled. See page 4 & 5 for mechanical dimensions.
ISOLATION:	Isolation between power circuit, command signal and ground is greater than 2500 Vrms.

SPECIFICATIONS: (CONTINUED)

GATE DRIVES:	Optically coupled SCR drivers.		
LINEARITY:	The average load voltage is linear within 2% of span with respect to the command signal.		
SCR I²T AND SURGE CURRENT RATING:	Frame rating 85 Amps 145 Amps 175 Amps 240 Amps 295 Amps 370 Amps 425 Amps	SCR I²T rating @25°C 20,000A²s 20,000A²s 110,000A²s 145,000A²s 145,000A²s 361,000A²s 405,000A²s	I_{TSM} Surge Current Rating @25°C 2000A 2000A 4700A 5400A 5400A 8500A 9000A
SCR VOLTAGE RATING:	1600 volts peak		
SCR CONFIGURATION:	Inverse-parallel SCR switches, in-line with two of three load leads.		
VOLTAGE COMPENSATION:	The load power remains constant within 2% of span for line voltage changes of +10% and -15% variations.		
LED INDICATORS:	Green 'Command' LED indicates presence of gate drive signal. Amber 'Manual Mode' LED indicates P2-5 (Auto/Manual) terminal is tied to P2-6 (CCW) which is circuit common. Red 'Auto Command Fault' LED indicates the absence of 'AUTO' command between terminals P2-9 (-mA) and P2-10 (+mA).		
ZERO AND SPAN ADJUSTMENTS:	Multi-turn potentiometers allow zero and span adjustments of ±25% of span.		
SYNC-GUARD™:	"SYNC-GUARD™" reduces the possibility of two or more controllers operating synchronously (cycling on and off at the same time). The "SYNC-GUARD™" feature provides a more uniform or continuous power demand and therefore reduces the variations of the supply voltage that can occur when multiple controllers operate synchronously. Up to ten controllers may be connected together for synch-guard regardless of load current rating. Only one termination resistor should be used in each group of controllers tied together in this way. See Figure 7 on page 9.		
TRANS-GUARD™:	The "TRANS-GUARD™" feature eliminates the DC load voltage and current that can exist with zero-cross operation. The "TRANS-GUARD™" feature therefore prevents saturation and over heating of supply transformers due to DC voltage which can occur on the transformer primary because of secondary DC currents. "TRANS-GUARD™" is accomplished by always causing the controller to be ON for an odd number of electrical half-cycles and OFF for an even number of electrical half cycles.		

INSTALLATION:

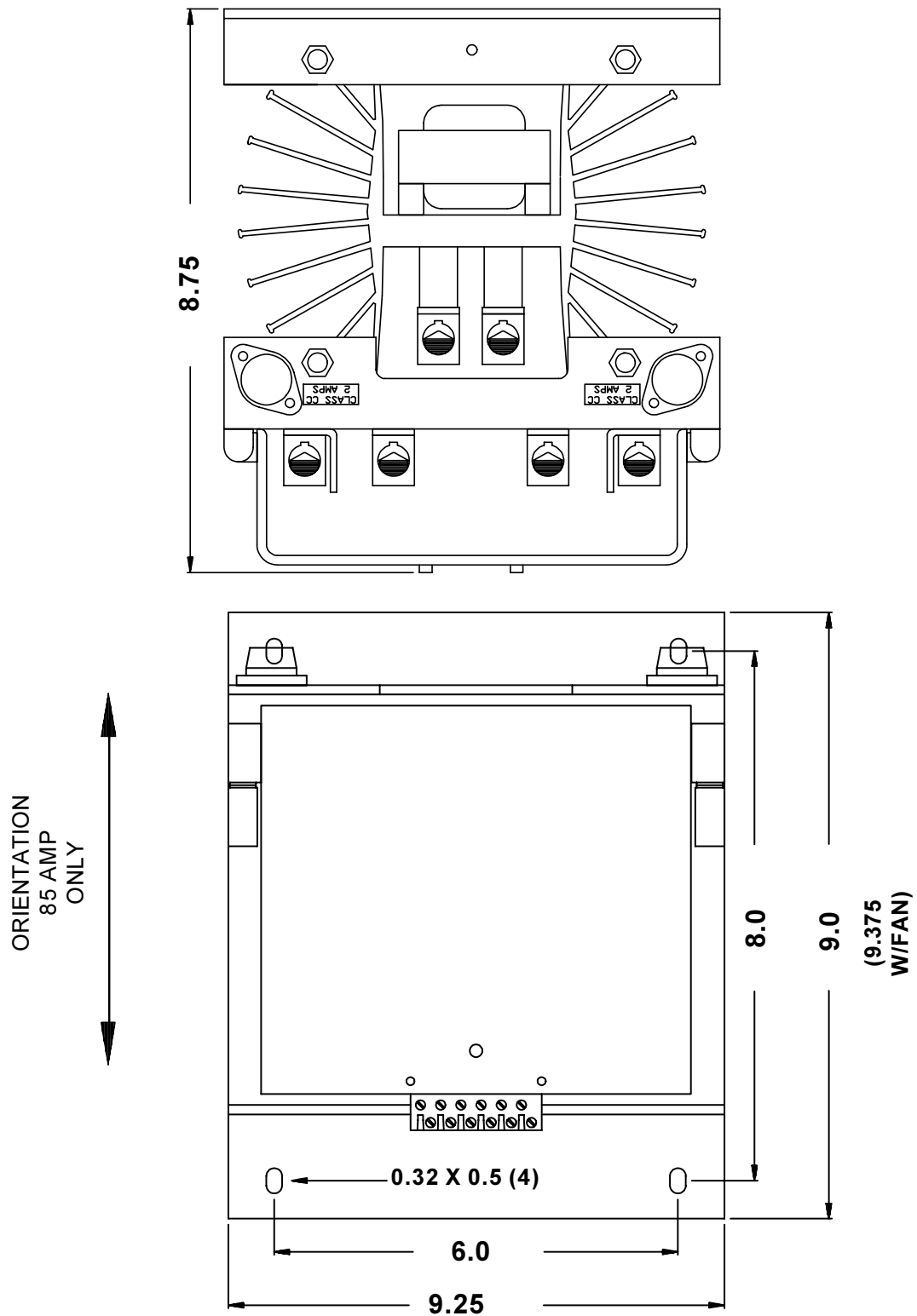


Figure 1. Mounting dimensions, Model 3027M, 85, 145 & 175 Amps
145 & 175 Amp models have fan for forced air cooling.

INSTALLATION: (CONTINUED)

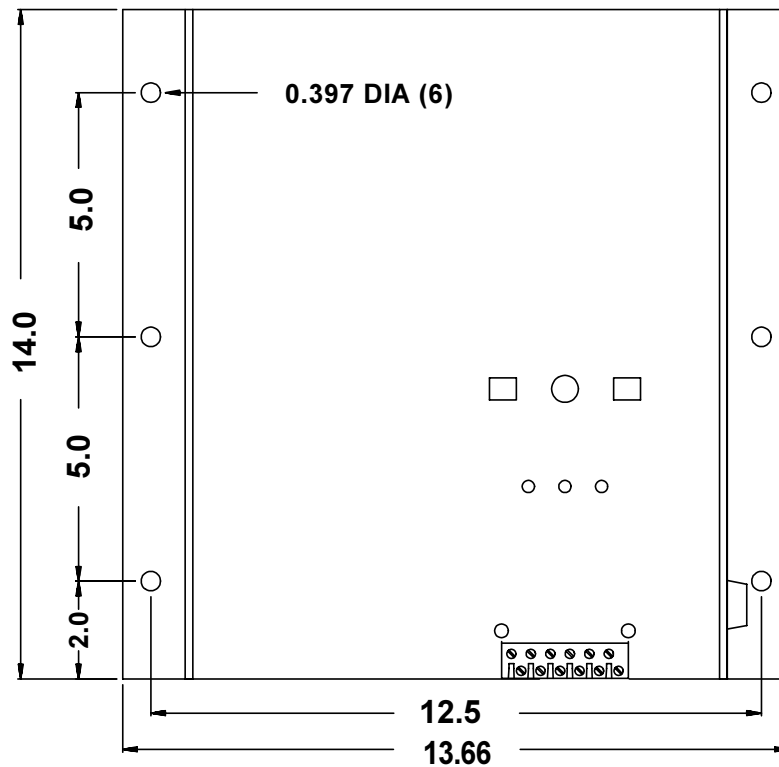
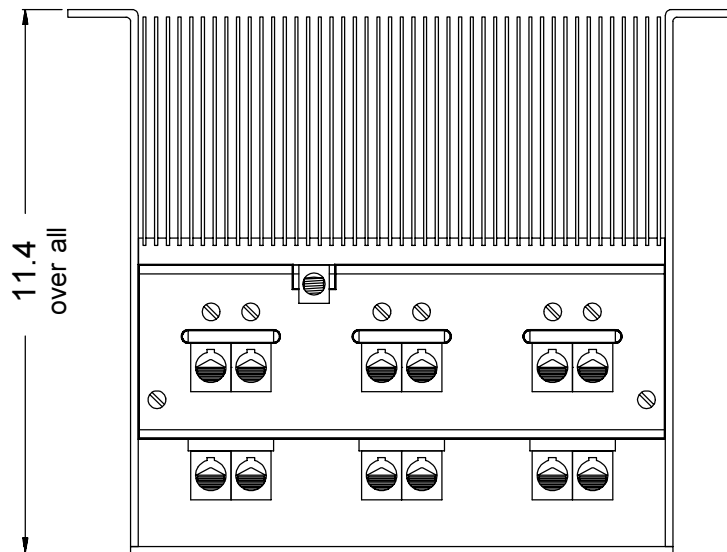


Figure 2. Mounting dimensions, 240 to 425 Amp frame

INSTALLATION: (CONTINUED)

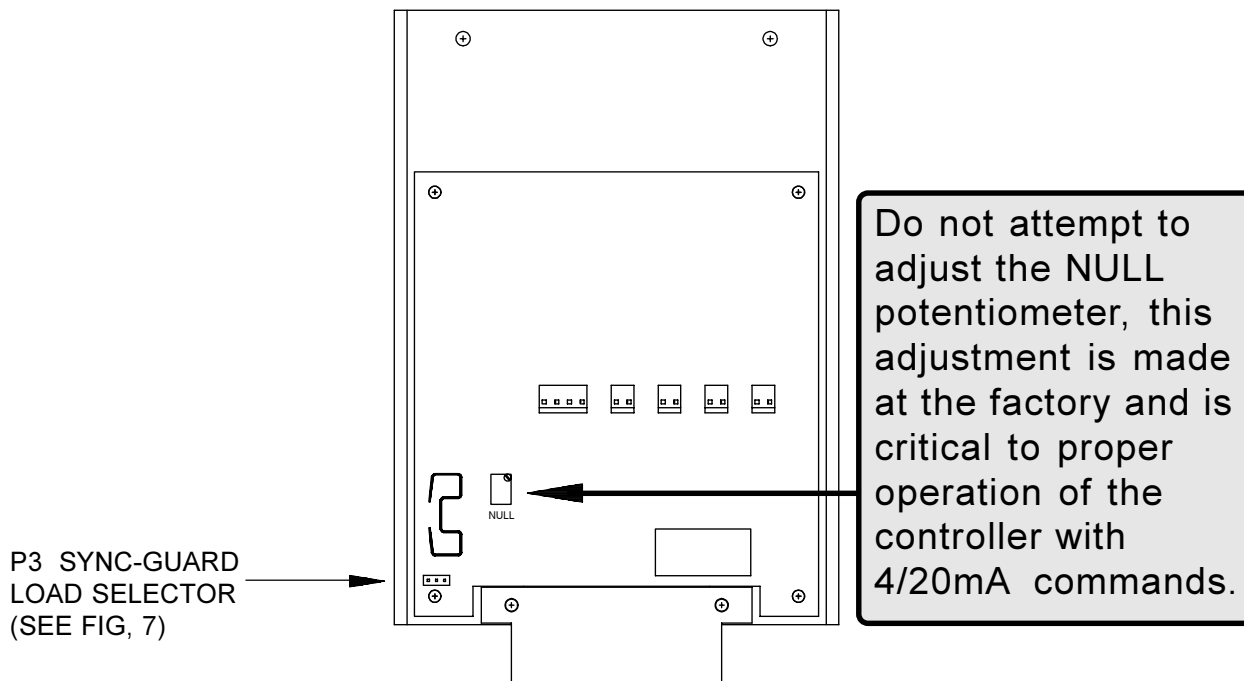


Figure 3. Underside of lid showing component side of circuit board.

USE EXTREME CAUTION TO AVOID ELECTRICAL SHOCK
Portions of the electronic circuit and other parts of the controller are at line voltage.

BEFORE MOUNTING, DETERMINE THAT THE TRANSFORMER TAP IS SET TO A VALUE CORRESPONDING TO THE SUPPLY VOLTAGE.

POWER CONNECTIONS:

Wire the controller in accordance with the electrical codes for the area in which it will be used. Connect the supply power and load as shown in the electrical installation drawing on page 7. The connectors are rated for use with copper or aluminum wire sizes from 250MCM to 6ga. Type THWN or THNN wire is recommended and an oxide inhibitor such as Burndy Penetrox a, Ideal No-Alox or IlSCO De-OX be used to insure good electrical connections. See page 10 for command signal wiring diagrams.

Recommended tightening torque for the line and load Connectors:



AWG or Circular Mills	Torque
4 to 6ga	100 in-lbs
1 to 2ga	125 in-lbs
1/0 to 2/0ga	150 in-lbs
3/0 to 4/0ga	200 in-lbs
250 MCM	250 in-lbs

STARTUP:

Set the command signal to minimum and apply system power. The command indicator light should be off and no power should be applied to the load. Slowly increase the command signal. The command indicator should blink on and off proportional to the magnitude of the command signal and load power should increase.

If the command indicator blinks on and off with no command signal, adjust the "zero" potentiometer until the indicator no longer turns on. If the command indicator blinks when the maximum command signal is applied, adjust the "span" potentiometer until the indicator is steady on.

POWER WIRING:

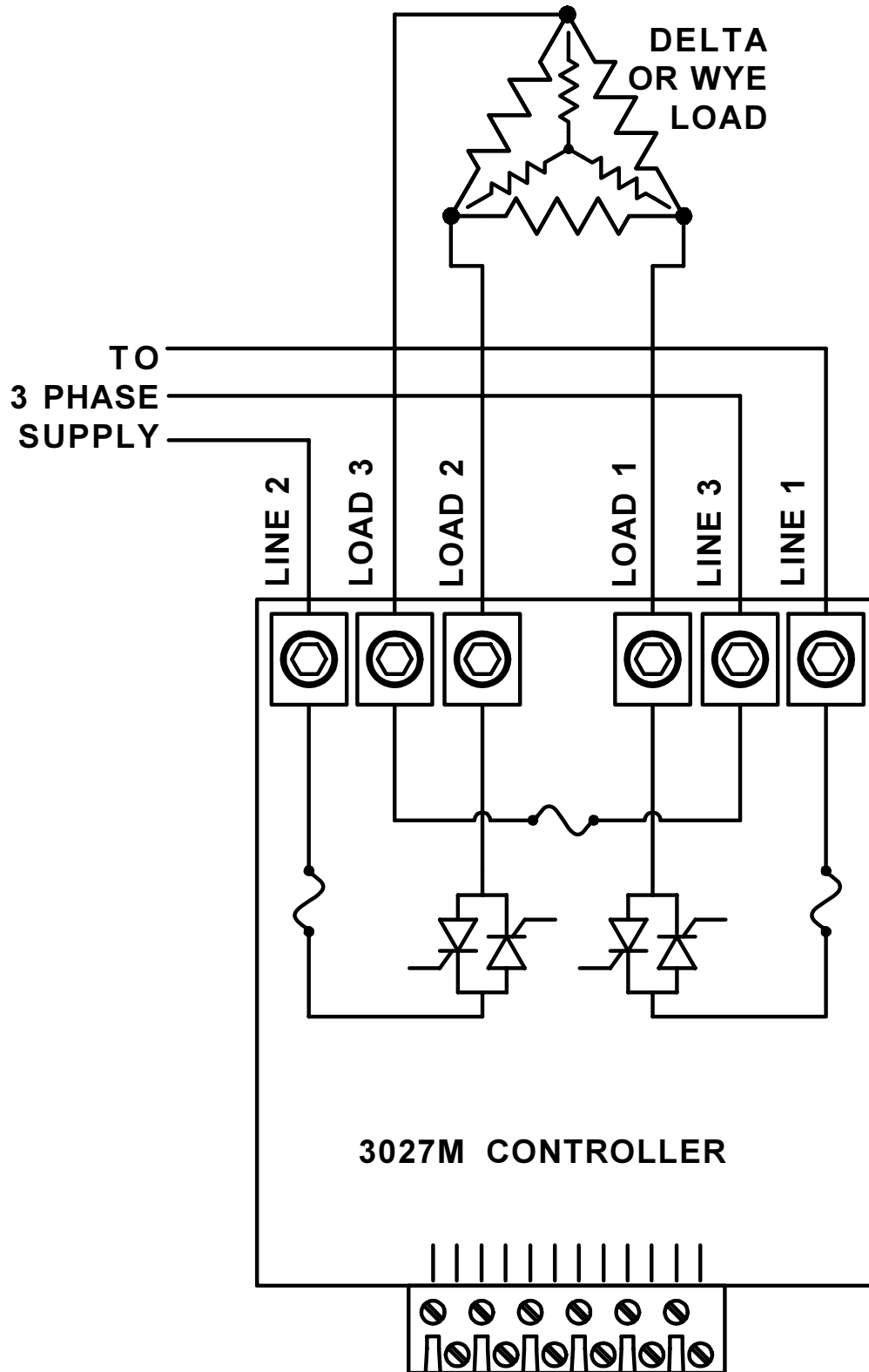


Figure 4. In-line power connections.

ADJUSTMENTS:

ZERO AND SPAN POT ADJUSTMENTS.

If adjustments become necessary, the following procedures should be followed.

AUTO MODE

Determine that Pin P2-5 (Auto/Man) is active high. (No connection.) Amber 'MANUAL MODE' LED must be off.

1. Set the command signal to minimum and adjust the AUTO ZERO potentiometer until the output is just zero.
2. Set the command signal to maximum and adjust the AUTO SPAN potentiometer until the green COMMAND LED lights constantly.
3. The span and zero adjustments may interact, therefore it may be necessary to repeat steps 1 and 2.

If the **zero** pot is set incorrectly, the output of the controller may not be linear with respect to the command signal, or, the controller may be unable to shut off completely.

If the **span** pot is set incorrectly, the output of the controller may not be linear with respect to the command signal, or the controller may be unable to reach full output.

MANUAL MODE

Determine that MANUAL command input is active. (Pin P2-5 is connected to P2-6 (CCW). Amber MANUAL MODE LED must be on.

1. Set the internal MANUAL COMMAND pot (and the external pot connected to pins P2-6 (CCW), P2-7 (W) and P2-8 (CW) if present) to minimum and adjust the **MANUAL ZERO** potentiometer until the output is just zero.
2. Set the MANUAL COMMAND pot (or the external pot) to maximum and adjust the **MANUAL SPAN** potentiometer until the green COMMAND LED lights constantly.
3. The span and zero adjustments may interact, therefore it may be necessary to repeat steps 1 and 2.

Do not attempt to adjust the NULL potentiometer, this adjustment is made at the factory and is critical to proper operation of the controller with 4/20mA commands.

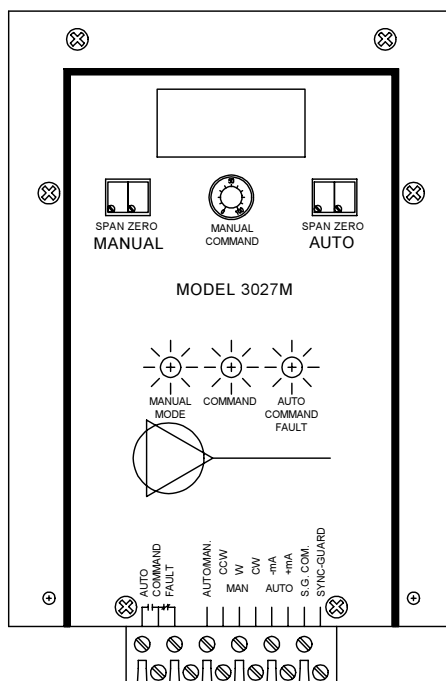


Figure 5. Topside of controller panel showing LED's and exposed adjustment pots.

COMMAND FAULT RELAY:

AUTO COMMAND FAULT relay

A relay with form "C" contacts rated at 120 Vac @ 5A is located on the circuit board. This relay changes state when an Auto Command fault occurs.

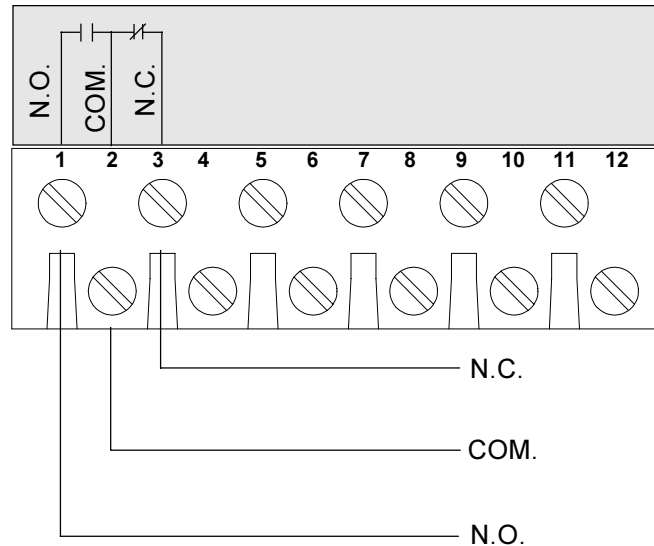


Figure 6. Connections for Auto Command Fault relay.

SYNC-GUARD CONNECTIONS:

The Sync-Guard feature is activated by connecting the sync-guard features on all of the controllers. This is accomplished by joining the #11 terminals on all controllers, and joining the #12 terminals on all controllers,. Although three controllers are shown below, up to 10 controllers, regardless of the current ratings, may be connected in this manner.

A jumper is placed across pins P3-1 and P3-2 on only one of the controllers. This jumper connects a 1K load resistor in the Sync-Guard circuit, and only one resistor is necessary in the Sync-Guard circuit for proper operation.

All other controllers joined in this manner must have the jumper placed across pins P3-2 and P3-3 as shown below to disconnect the internal 1K resistors on those units.

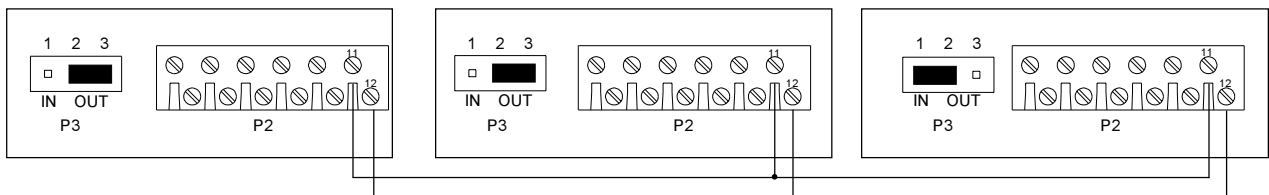
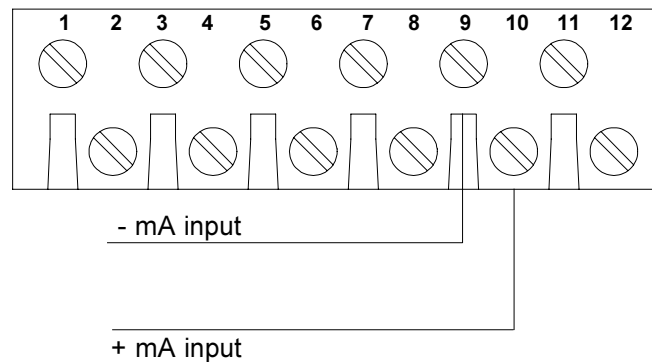


Figure 7. Connecting units together for sync guard.

CONTROL CONNECTIONS:

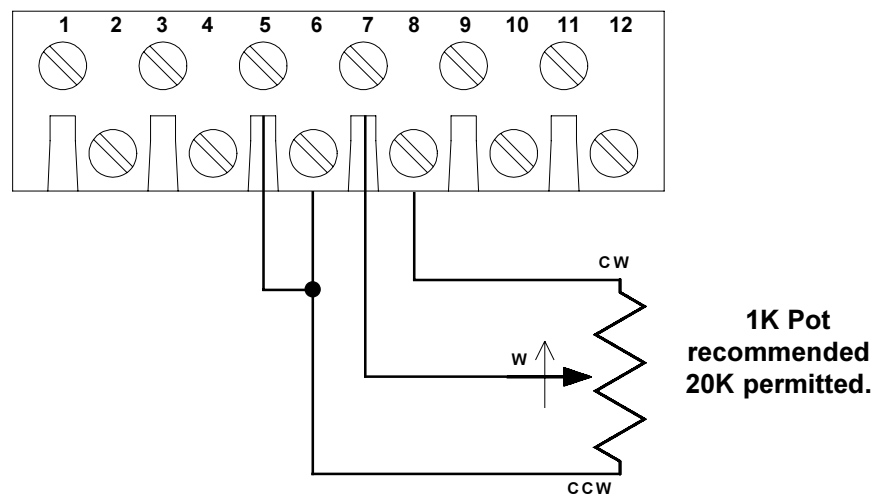


mA INPUT:

NEGATIVE INPUT TO TERMINAL P2-9,
POSITIVE INPUT TO TERMINAL P2-10

(There must be no connection between terminals P2-5 & P2-6.)

Figure 8. Connecting a mA command control.



POTENTIOMETER INPUT:

When manual command is desired, terminal P2-5 must be connected to P2-6. This will enable the Manual Command input and disable the Auto Command input.

The unit has an internal manual potentiometer which can control the set point when manual command input is enabled. (P2-5 tied to P2-6).

An external potentiometer may be wired as shown above. A 1K potentiometer is recommended for linearity, with 20K maximum resistance permissible. Connect the Clockwise potentiometer lug to terminal P2-8. Connect the Wiper lug to terminal P2-7 and the Counterclockwise lug to terminal P2-6. The internal manual command potentiometer must be turned to minimum (0), to allow full range to the external manual command potentiometer.

Note: Shielded control wiring is not required, however, it is recommended that the control wire not be placed adjacent to the power wiring.

Figure 9. Connections for an external potentiometer.

TROUBLE SHOOTING:

CAUTION!

USE EXTREME CAUTION TO AVOID ELECTRICAL SHOCK.
DO NOT ATTEMPT TO OPERATE THE CONTROLLER
WITH THE CATHODE OR GATE LEADS REMOVED.

Below is a list of symptoms followed by suggested steps toward quick solutions.

NO OUTPUT.

1. Check fuses.
2. Check that correct transformer tap has been selected.
3. Determine that line voltage is present on line 1 and line 2 input terminals and that the load is wired correctly. See figure 4.
4. Determine that the command signal is present and wired correctly. Increase command signal.
5. Check external potentiometer wiring or polarity of mA command signal.
6. Determine that 10 Vdc $\pm 0.5V$ is present between terminals P2-6 (CCW) and P2-8 (CW) on the command connector.
 - a. If the voltage is greater than 11 Vdc, the circuit board has probably failed.
 - b. If the voltage is less than 9 Vdc, the circuit board or transformer has probably failed.

NO OUTPUT: COMMAND INDICATOR FUNCTIONS CORRECTLY.

1. Remove system power and visually inspect circuit board for damage.
2. It is unlikely that SCR module has failed.
3. Check load continuity.
4. Check that white gate connector is plugged in and properly seated on firing circuit.

FULL LOAD POWER: COMMAND INDICATOR IS OFF OR BLINKING.

1. Remove system power and remove circuit board from the controller. Reapply system power. If no load voltage exists with the circuit board removed, the circuit board has failed.
2. If voltage still exists across load, SCR module has likely failed.

If unable to resolve your controller problems, call factory for assistance. (612) 474 - 6200

MANUFACTURED BY:

