CONTROL CONCEPTS INC.

INSTRUCTION MANUAL
MODEL 1029M
30 to 200 Amps

DESCRIPTION:

MODEL COVERED:

This manual describes the Control Concepts model 1029M controller with the following ratings:
CURRENT: 30 Amps to 200 Amps.
VOLTAGE: 120 Vac or 480 Vac. @ 50/60 Hz.
The model 1029M is a single-phase, phase-angle controller, with selectable feedback, adjustable current limiting and retransmit output metering.

FEATURES:

CURRENT LIMITING:

A user adjustable setting which prevents the RMS load current from exceeding the set value.
This feature is useful where variable resistance loads have a heavy current draw as they are warming up.

SOFT START AND MISSING CYCLE DETECTION:

The output voltage is ramped from zero to the desired output at a ramp rate equivalent to a time constant of 0.3 seconds on power interruptions of 1/2 cycle or more.
This feature prevents inrush currents when controlling variable resistance loads or inductive coupled loads.

STATUS INDICATORS:

Load I - The intensity of this green LED is proportional to the load current.
Command - The intensity of this green LED is proportional to the command signal and the "ON" time of the SCRs.
Current Limit - This yellow LED lights when the current limit setting has been reached.
Fault - This red LED lights if the temperature of the heatsink reaches 87°C or if the phase lock circuit fails to lock onto the line frequency.

CHOICE OF FEEDBACK:

The RMS value of the load voltage or the RMS value of the load current can be linearly controlled with respect to the command signal.
The power (watts) applied to the load can also be linearly controlled with respect to the command signal.

OUTPUT RETRANSMIT SIGNALS:

A 0/5 Vdc signal representing the 0-5Vac voltage feedback is provided for remote voltage monitoring.
A 0/5 Vdc signal representing the 0-5Vac current feedback is provided for remote current monitoring.
A 0/5Vdc signal representing the product of the RMS voltage feedback times the RMS load current feedback is provided for remote power monitoring.
Power feedback equals the voltage feedback times the current feedback divided by 5.

$$P_{FB} = \frac{V_{FB} \times I_{FB}}{5}$$

COMMAND CONNECTOR:

The following input/output signals may be found on the command connector.

VOLTAGE COMMAND INPUT:

Two terminals labeled **W +V** (P1-15) and **CCW -V** (P1-14), accept a 0 to 10 Volt dc command signal.

CURRENT COMMAND INPUT: (Optional)

Two terminals labeled: **+ 4/20mA** (P1-18) & **- 4/20mA** (P1-17), accept a 4 to 20 mA command signal.

CURRENT FEEDBACK INPUT:

Two terminals labeled **IFB** (P1-12 & P1-13) accept a 0 to 5 Vac current feedback signal.
See fig 7 on page 8.

VOLTAGE FEEDBACK INPUT:

Two terminals labeled **VFB** (P1-10 & P1-11) accept a 0 to 5 Vac voltage feedback signal.
See fig 7. on page 8.

VOLTAGE RETRANSMIT OUTPUT:

A 0 to 5Vdc signal representing load voltage is available between the terminal labeled **VMTR** (P1-7) and the terminal labeled **COM** (P1-6).
See fig. 10 on page 9.

CURRENT RETRANSMIT OUTPUT:

A 0 to 5Vdc signal representing load current is available between the terminal labeled **IMTR** (P1-8) and the terminal labeled **COM** (P1-6).
See fig. 9 on page 9.

POWER RETRANSMIT OUTPUT:

A 0 to 5Vdc signal representing load power is available between the terminal labeled **PMTR** (P1-9) and the terminal labeled **COM** (P1-6).
See fig. 8 on page 9.

RUN ENABLE :

A contact closure between the terminal labeled **RUN** (P1-5) and the terminal labeled **COM** (P1-4) will enable the output of the controller.
See figure 11 on page 10.

FAULT RELAY OUTPUT:

The fault relay circuit consists of an open collector transistor and a clamp diode. A relay may be connected as shown in figure 12 on page 10.
The transistor remains off if the temperature of the heatsink reaches 87°C or if the phase lock circuit fails to lock onto the line frequency.

THEORY OF OPERATION

THE SCR

The heart of the Control Concepts, Inc. power controller is the SCR (silicon controlled rectifier, sometimes referred to as a thyristor).

The SCR has two states, ON and OFF, and allows current to flow in only one direction when turned on. SCRs can remain in the off state even though the applied potential may be up to 1400 volts.

When a small current is applied between the gate and cathode terminals (Figure 1), the SCR will turn on within 10-100 microseconds.

Once turned on, it will remain on until the current through it is reduced below a very low value, referred to as the holding current.

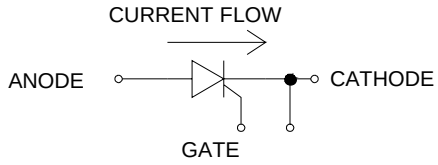


Figure 1. SCR SYMBOL

Because the SCR allows current to flow in only one direction, two SCR's are connected in an "inverse parallel" configuration to control AC current (Figure 2).

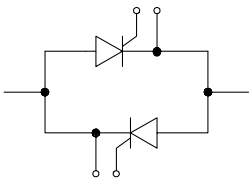


Figure 2. "AC SWITCH "

PHASE-ANGLE OPERATION

In phase-angle control, each SCR of the back-to-back pair is turned on for a variable portion of the half-cycle that it conducts. (Figure 3).

Power is regulated by advancing or delaying the point at which the SCR is turned ON within each half cycle. Light dimmers are an example of phase-angle control.

Phase-angle control provides a very fine resolution of power and is used to control fast responding loads such as tungsten-filament lamps or loads in which the resistance changes as a function of temperature.

Phase-angle control is required if the load is transformer-coupled, capacitive, inductive or a variable resistance load requiring current limiting.

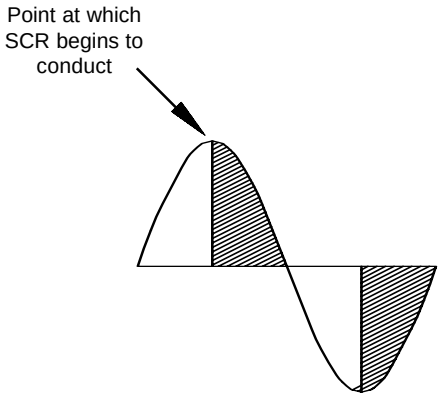


Figure 3. SCR "ON" time, shown by shaded area, is varied to achieve the desired load voltage.

WARNING: the Control Concepts, Inc, model 1029M power controller uses power thyristors to switch voltage to the connected load. Line voltage must be assumed at the output terminals at all times, even when the control signal has been removed and the load voltage appears to be off. It has been mandated by the National Electrical Code and the Occupational Safety and Health Act of 1970 that a physical disconnect be opened ahead of all remotely actuated controls before performing any maintenance work on the controller or its connected load.

SPECIFICATIONS:

The following specifications apply over an ambient temperature of 0 to 55ºC and a supply voltage of 85% to 110% of the nominal supply voltage rating.

CONTROL MODE:	Single phase SCR phase-angle control.
FRAME SIZE:	The "AMPS" term within the model number specifies the maximum continuous RMS current rating at the maximum ambient temperature of 55ºC. The choices are 30, 50, 80, 100 & 200 Amps @ 120 or 480Vac.
COMMAND SIGNAL:	Command signal: 4/20mA, 0-10Vdc Input Impedance: 249 ohms, 200K ohms
SCR RATINGS:	The peak forward and reverse voltage is 1400 volts.
SCR SURGE CURRENT RATINGS:	Controller Rating: 30 to 80 Amp, 100 Amp, 200 Amp Surge Current Rating: 1750 Amps Peak, 1900 Amps Peak, 7500 Amps Peak
SCR PROTECTION:	dV/dT rating = 200 volts/microsecond. dV/dT circuit consists of a capacitor in series with a noninductive resistor. This circuit is in parallel with the SCRs. The SCRs are protected from voltage transients by a Metal Oxide Varistor.
COMMAND INDICATOR:	The intensity of this green LED is proportional to the command signal.
LOAD CURRENT INDICATOR:	The intensity of this green LED is proportional to the load current.
CURRENT LIMIT INDICATOR:	This yellow LED lights when current limit has been reached.
FAULT INDICATOR:	This red LED lights if the temperature of the heatsink reaches 87°C or if the phase lock circuit fails to lock onto the line frequency.
CONTROL RANGE:	0 to 98% of supply voltage.
ENVIRONMENT:	Operating temperature: 0ºC to 55ºC (32ºF to 132ºF) Storage temperature: -40ºC to 80ºC (-40ºF to 176ºF) Humidity: 0 to 95%, non-condensing
WEIGHT:	30 to 100 Amps = 13 pounds. 200 Amps = 23 pounds.
LINE 2 REQUIREMENTS:	The Line 2 connection is the return for the internal control transformer which has a rating of approximately 25 VA. See Fig 13 & 14.

SPECIFICATIONS: (Continued)	
ELECTRICAL CONNECTIONS:	Connectors for line and load are provided for copper wire from 14 ga to 2/0 (30 - 100Amps), 4ga to 500mcm (200Amps). Connectors for line 2 are provided for copper wire from 14ga to 2ga
ELECTRICAL ISOLATION:	Heatsink to supply and load voltage: 2500 Volts Peak. Command signal to supply and load voltage: 2500 Volts Peak.
METERING ZERO AND SPAN:	Multi-turn potentiometers allow zero and span adjustments of ± 25% of span.
FEEDBACK ZERO AND SPAN:	Multi-turn potentiometers allow zero adjustments of ± 25% of span, and span adjustment range of 10 to 125% of feedback.
CURRENT LIMITING:	A potentiometer allows adjustment of the current limit setting from 20% to 125% of the controller rating. (The current limit potentiometer is factory set for 105% of the rated current unless otherwise specified.)
VOLTAGE METER OUTPUT:	A filtered metering signal equals 5.0 Vdc when the load voltage feedback is 5.0 V_{RMS}. Metering load = 5mA max. (See fig. 10.)
CURRENT METER OUTPUT:	A filtered metering signal equals 5.0 Vdc when the load current feedback is 5.0 V_{RMS}. Metering load = 5mA max. (See fig. 9.)
POWER METER OUTPUT:	A filtered metering signal equals 5.0 Vdc when the load voltage feedback is 5.0 V_{RMS} and the load current feedback is 5.0 V_{RMS}. Metering load = 5mA max. (See fig. 8.)
GATE DRIVE:	An optical coupled current source of 250mA with a minimum compliance of 10 volts provides the gate drives to the SCRs. Duration or "back porch" is 60 electrical degrees.
VOLTAGE COMPENSATION:	When using voltage feedback, the load voltage remains constant, independent of supply voltage changes within + 10%, -15%.
POWER DISSIPATION:	1.5 Watts per amp of load current.
FEEDBACK:	True RMS Voltage and True RMS Current. Power feedback is derived from the Voltage and Current feedback. See fig. 7 on Page 8 for connections.
LINEARITY:	The controlled variable is linear within 1/2% of Span with respect to the command signal.

INSTALLATION:

MOUNTING AND LOCATION:
The 30 Amp controller has no fan and therefore must be mounted on a vertical surface with the fins oriented vertically so that air may flow freely between them. The 50, 80, 100 & 200 Amp units are forced air cooled and may be mounted in any direction.

COMMAND SIGNAL OPTIONS:
Voltage:
A 0 to 10 Vdc signal may be used as the command signal by connecting the positive signal to terminal 15. The negative signal is connected to terminal 14 (-) (See fig. 5 on P7).
Current:
Connect the positive current connection to terminal 18. Connect the negative current connection to terminal 17 (-). (See fig. 4 on P7.)
Troubleshooting Potentiometer:
A 1000 to 20,000 ohm potentiometer, 1/4 watt or more, may be used as a substitute command signal for troubleshooting, if desired.
Connect the clockwise end to terminal 16.
Connect the wiper to terminal 15.
Connect the counterclockwise end to terminal 14.
(See fig. 6 on P7.)

POWER & SAFETY CONNECTIONS:
Power Connections:
Figures 13 & 14 show typical electrical connections. The LINE 1 and LOAD 1 connections on the 30 to 100 Amp controllers are approved for:
copper wire sizes from: 14 ga to 2/0 ga.

The LINE 1 and LOAD 1 connections on the 200 Amp controllers are approved for:
copper wire sizes from: 4 ga to 500 mcm.

Line 2 (120 Volt and 480 Volt) connectors on all controllers are approved for:
copper wire sizes from 14 ga to 2 ga.

RETRANSMIT METERING:

Load Voltage:
A Voltage retransmit signal is available between terminal P1-6 (common) and terminal P1-7 (Positive) on the command connector. See Fig 10 on page 9.
Load Current:
A Current retransmit signal is available between terminal P1-6 (common) and terminal P1-8 (Positive) on the command connector. See Fig 9 on page 9.
Load Power:
A Power retransmit signal is available between terminal P1-6 (common) and terminal P1-9 (Positive) on the command connector. See Fig 8 on page 9.

TIGHTENING TORQUE FOR LINE 2 TERMINALS:

WIRE SIZE AWG	RECOMMENDED TORQUE
10 TO 14 GA	35 IN-LBS
8 GA	40 IN-LBS
4 TO 6 GA	45 IN-LBS
2 TO 3 GA	50 IN-LBS

TIGHTENING TORQUE FOR LINE 1 & LOAD 1 TERMINALS:

WIRE SIZE RANGE AWG	RECOMMENDED TORQUE	
	SCREWDRIVER	WRENCH
8 TO 14 GA	20 IN-LBS	75 IN-LBS
4 TO 6 GA	35 IN-LBS	110 IN-LBS
1 TO 2 GA	50 IN-LBS	150 IN-LBS
1/0 TO 2/0 GA	50 IN-LBS	180 IN-LBS
3/0 TO 4/0 GA		250 IN-LBS
250 TO 350MCM		325 IN-LBS
500MCM		375 IN-LBS

FEEDBACK CONNECTION:

(See Fig. 7 on P8.)

External Current feedback: The current transformer must be connected to terminals P1-12 (common) and P1-13 on the command connector.
A jumper on the circuit board must be across P2-2 to P2-5 (I) on the feedback selector.

A burden resistor must be connected across the current transformer to scale the feedback to 5Vac when the current is at the maximum desired level.

External Voltage feedback: The transformer must be connected to terminals P1-10 (common) and P1-11 on the command connector.
A jumper on the circuit board must be across P2-1 to P2-6 on the feedback selector (V).

External Power feedback is derived from the External Current and External Voltage feedback. The feedback jumper must be across P2-3 to P2-4 on the feedback selector (P).

ADJUSTMENTS:

True RMS meters should be used for accurate measurements of True RMS Voltage, Current or Power (RMS Volts times RMS current into a resistive load).

The controller has been calibrated at the factory.
Potentiometers located on the lid fascilitate readjustments as desired.

Because the adjustments may interact, it is recommended that the steps be repeated.

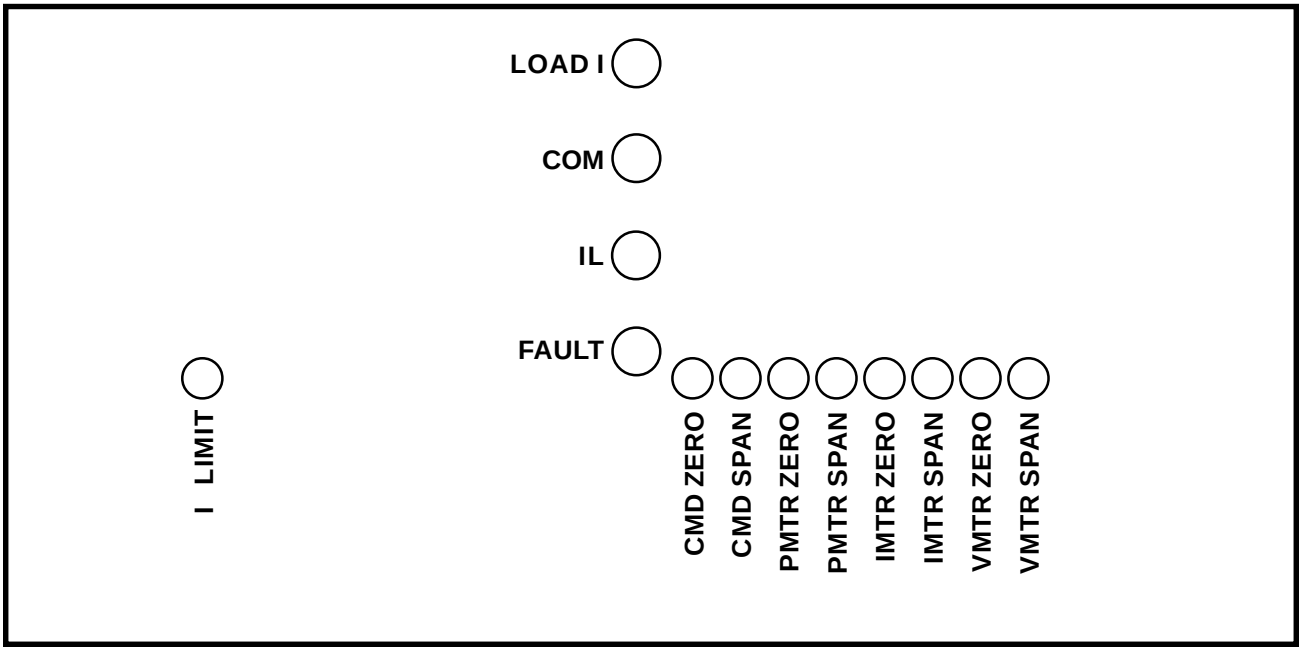
COMMAND:
Rotating the zero potentiometer clockwise will increase the output when the command is at minimum.
Rotating the span potentiometer clockwise will increase the output when the command is at maximum.

LOAD VOLTAGE RETRANSMIT:
Rotating the zero potentiometer clockwise will increase the voltage retransmit signal when the command is at minimum.
Rotating the span potentiometer clockwise will increase the voltage retransmit signal when the command is at maximum.

LOAD CURRENT RETRANSMIT:
Rotating the zero potentiometer clockwise will increase the current retransmit signal when the command is at minimum.
Rotating the span potentiometer clockwise will increase the current retransmit signal when the command is at maximum.

LOAD POWER RETRANSMIT:
Rotating the zero potentiometer clockwise will increase the power retransmit signal when the command is at minimum.
Rotating the span potentiometer clockwise will increase the power retransmit signal when the command is at maximum.

CURRENT LIMIT:
Rotating the current limit potentiometer clockwise will increase the point at which load current will no longer increase.



COMMAND CONNECTOR:

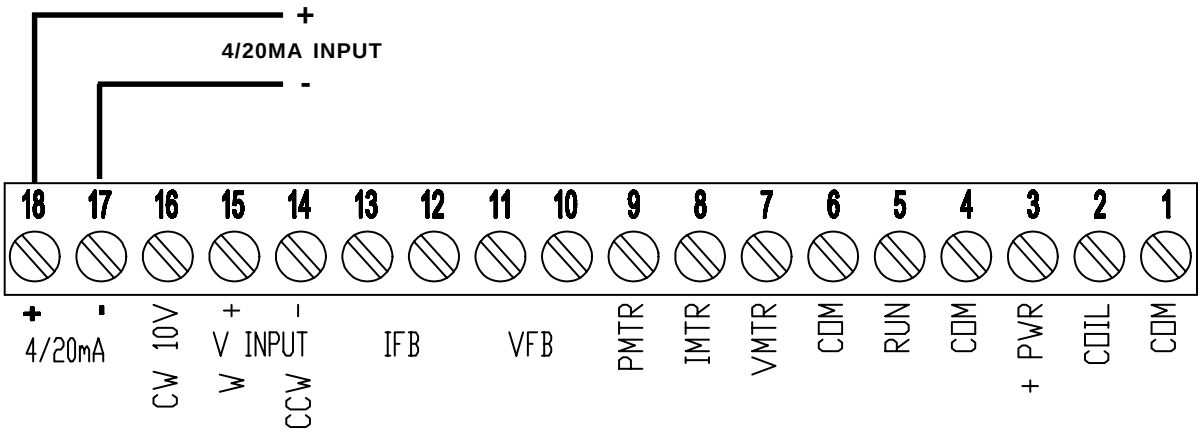


Fig. 4. 4/20mA command connection.

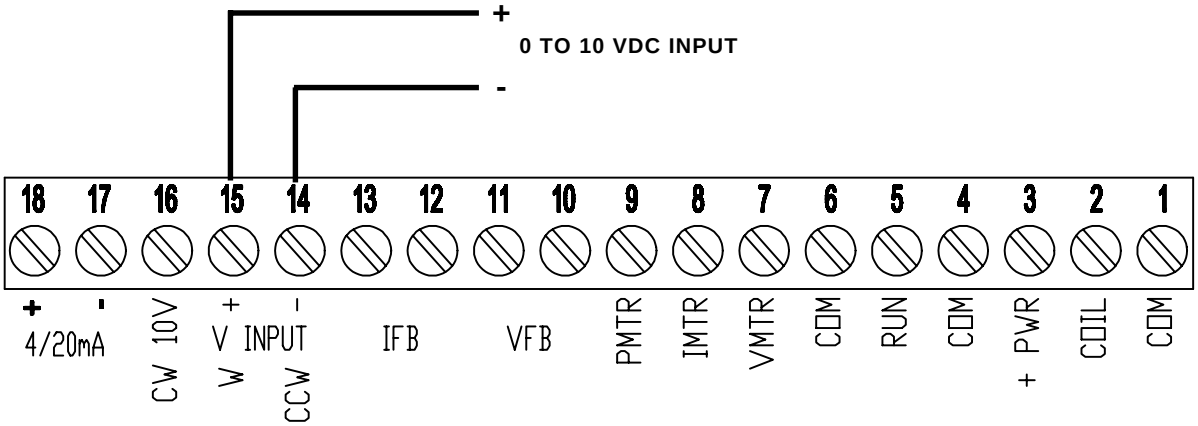


Fig. 5. 0-10Vdc command connection.

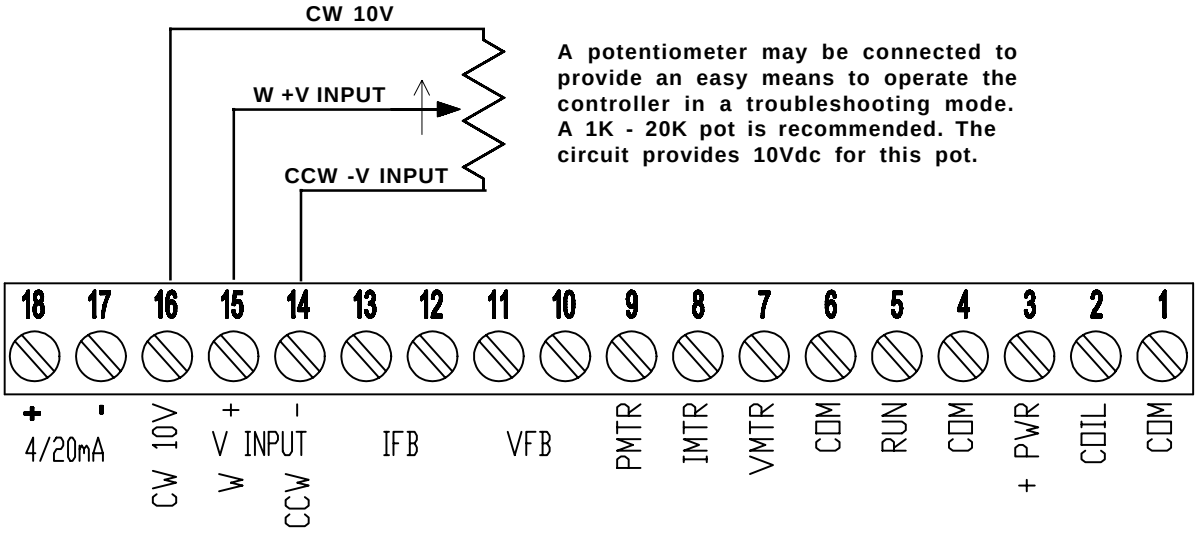


Fig. 6. Troubleshooting potentiometer connection.

FEEDBACK CONNECTIONS:

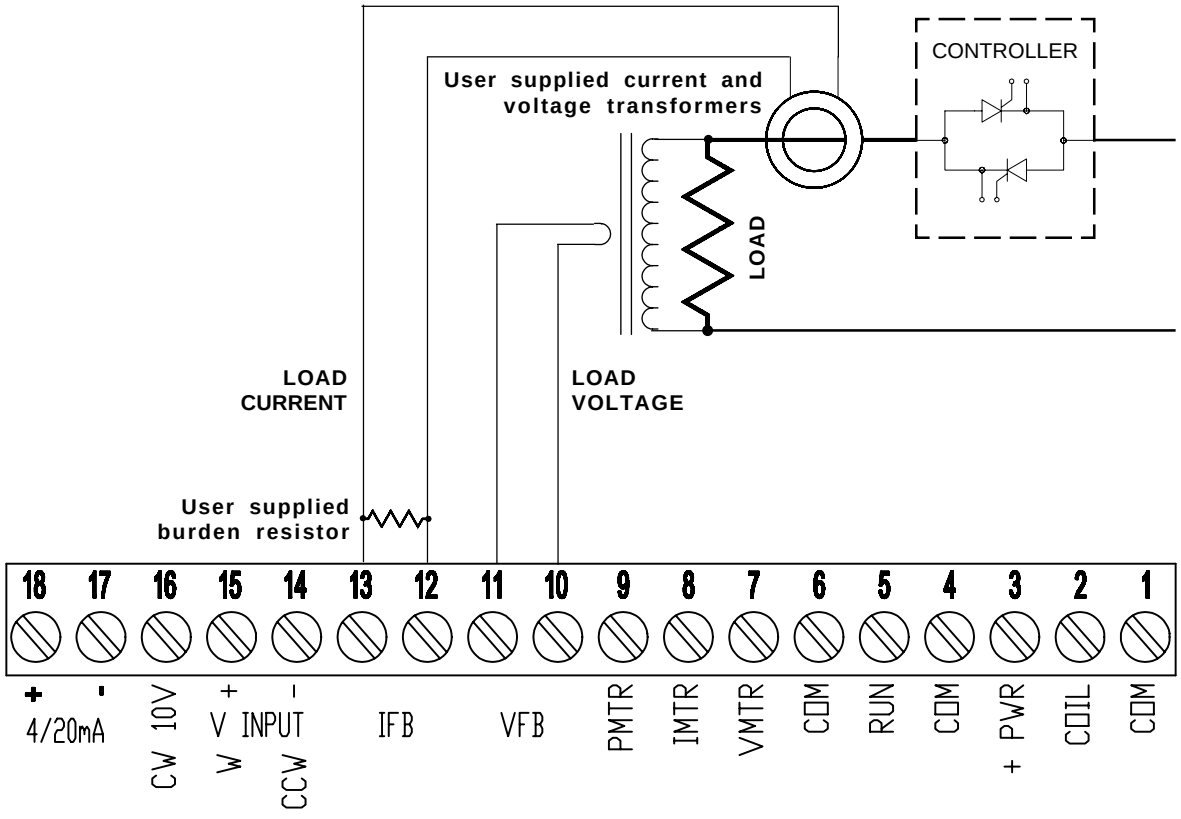


Fig. 7 Current and voltage feedback connection.

COMMAND CONNECTOR:

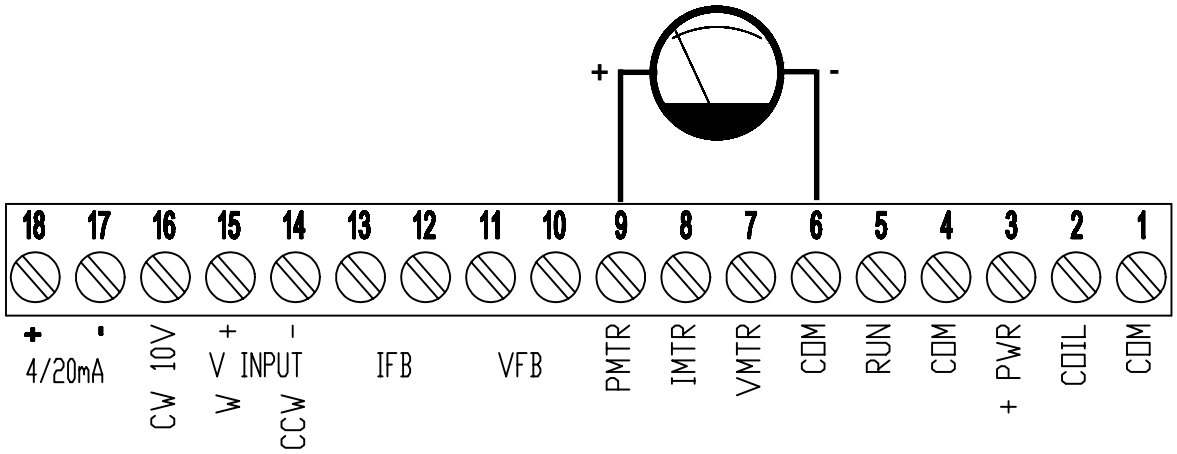


Figure 8. POWER Retransmit Meter.

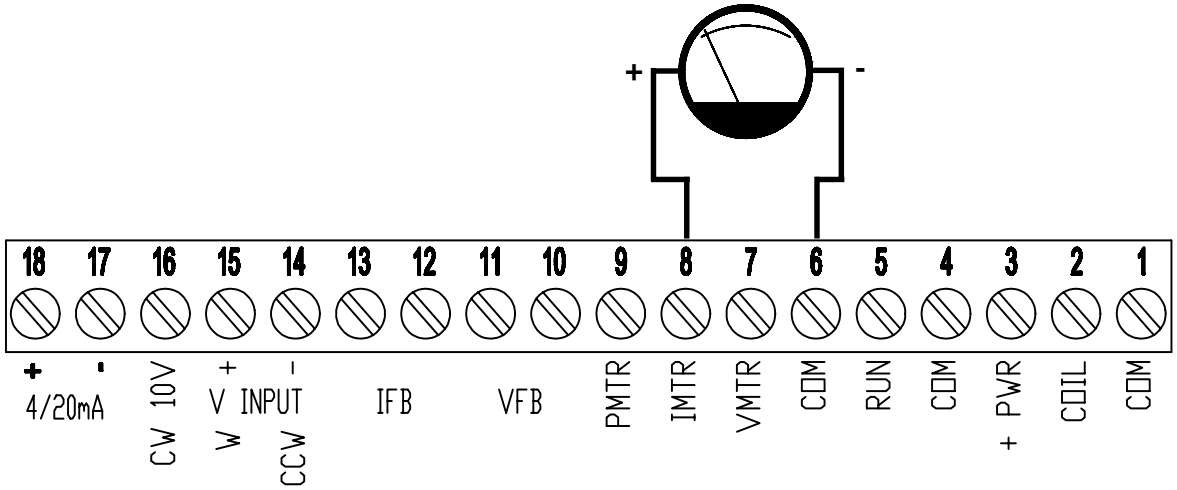


Figure 9. CURRENT Retransmit Meter.

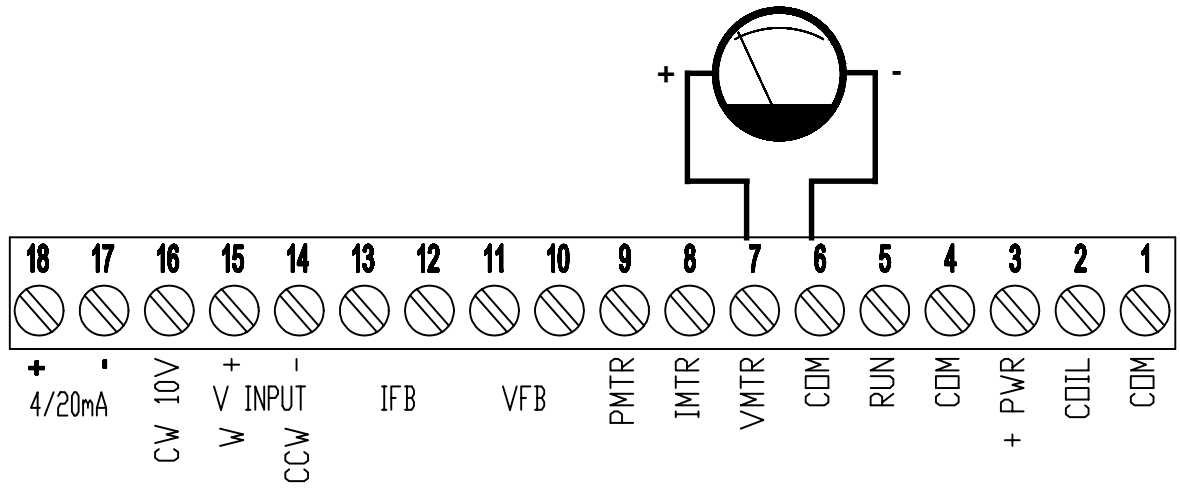


Figure 10. VOLTAGE Retransmit Meter.

COMMAND CONNECTOR:

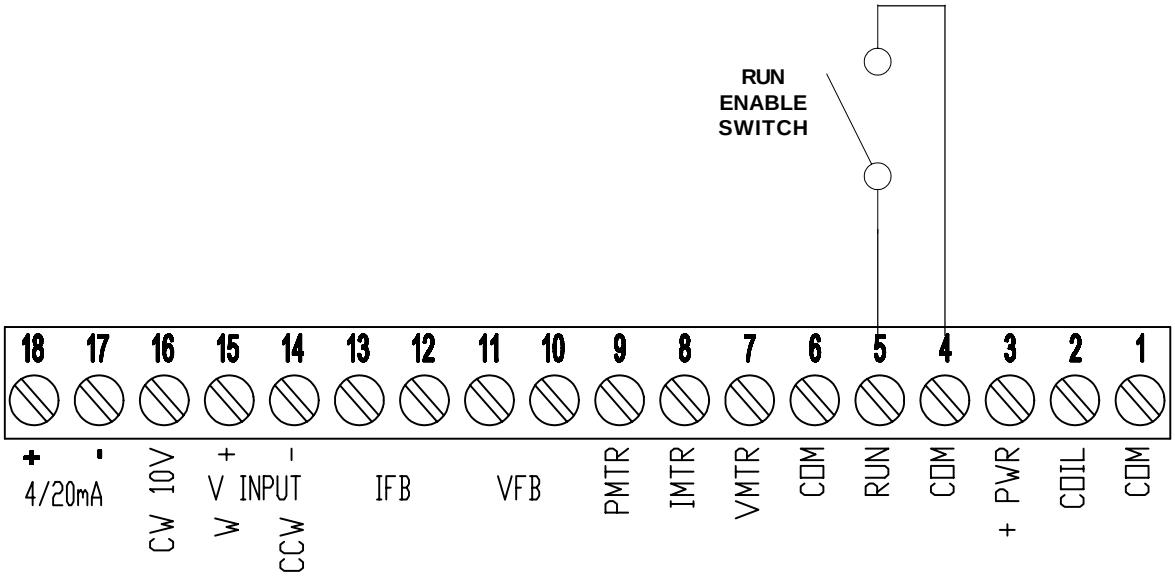


Figure 11. RUN Enable Switch.

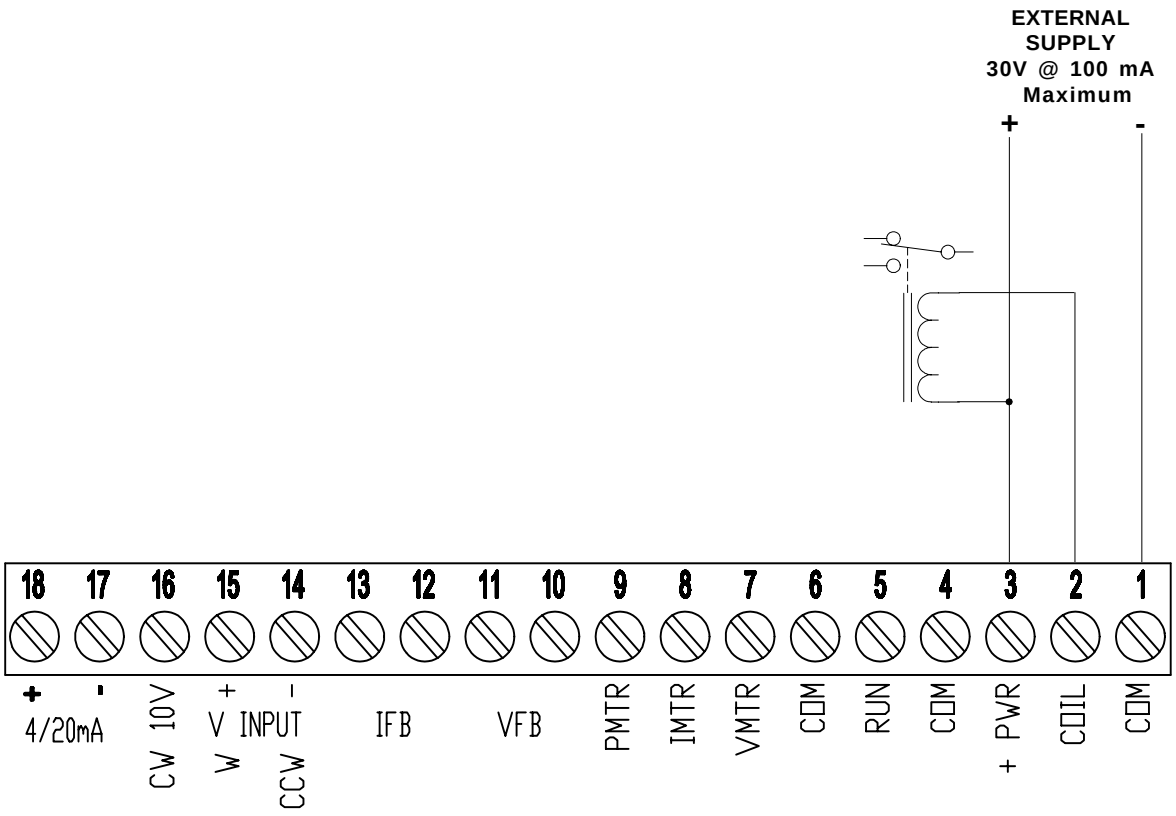


Figure 12. Fault Relay

ELECTRICAL CONNECTIONS: 30 to 100 Amp Units

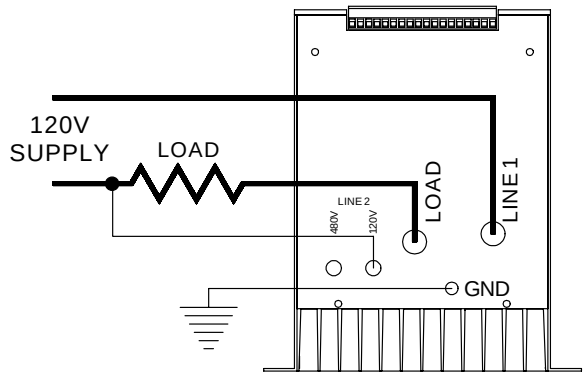


Figure 13. 120 Volt power connections

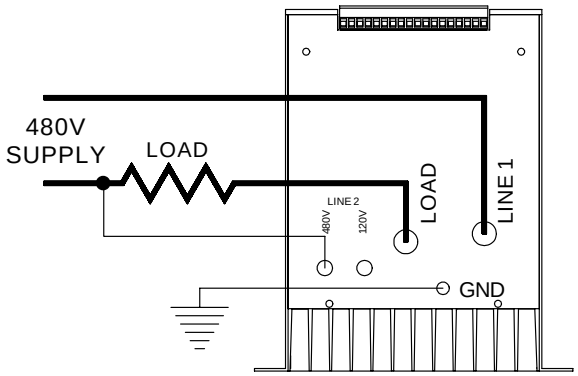


Figure 14. 480 Volt power connections

MODEL No. IDENTIFICATION:

1029M - (**FB**) - (**Volts**)V - (**Amps**)A - **CS - IL**(**Amps**)

The characteristics of the 1029M SCR power controller are defined by the terms in the model number as follows:

1029M Specifies a single phase, phase-angle SCR controller featuring current limit and electrical isolation of the command signal from the line and load voltages.

-(FB) Feedback type (V, I, or P)

V Specifies *RMS voltage* feedback. With *RMS* voltage feedback, the controller varies the conduction angle (or ON time) of the SCRs such that the RMS voltage applied to the load is proportional to the command signal.

I Specifies *RMS current* feedback.
The load *current* is linearly controlled with respect to the command signal.

P Specifies *power* feedback and therefore the load *power* is linearly controlled with respect to the command signal.

-(VOLTS)V Specifies the supply voltage, 120/480Vac

-(AMPS)A Specifies the continuous RMS current rating.
Choices are: 30, 50, 80, 100 or 200 Amps.

-CS Specifies the Command Signal, 0/10V or 4/20mA

-IL(AMPS) Specifies the current limit in amps.

MOUNTING DIMENSIONS: 30 to 100 Amps

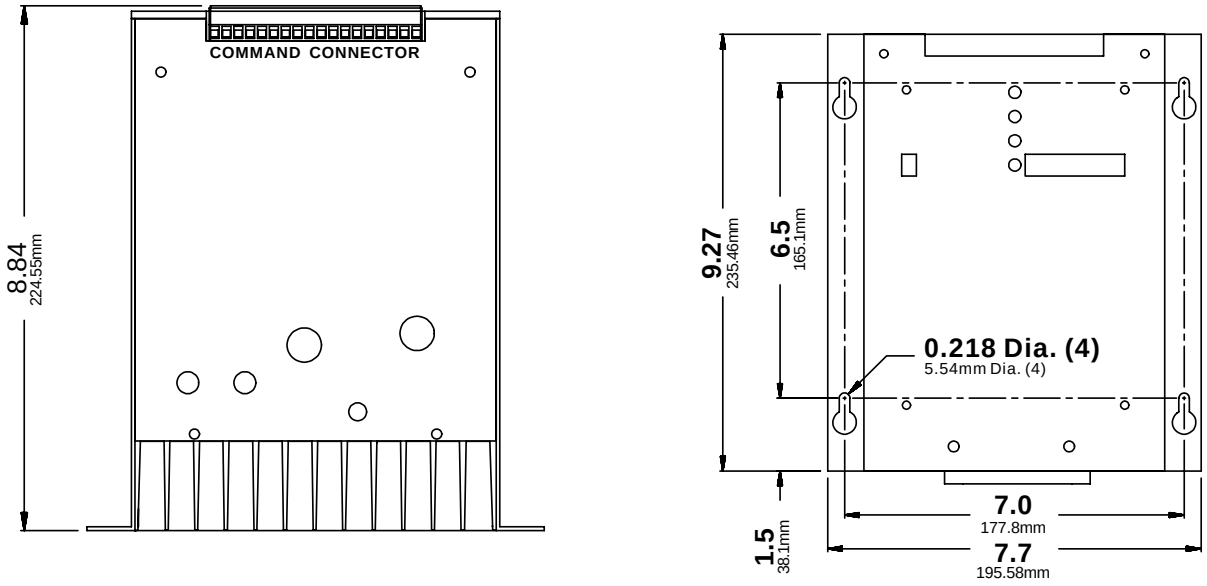


Fig. 15. - Installation drawing
30 to 100 Amp Units.

NOTE: THE 30 AMP UNITS ARE NOT FAN COOLED. THEY MUST BE MOUNTED ON A VERTICAL SURFACE WITH THE FINS ORIENTED VERTICALLY SO THAT AIR MAY FLOW FREELY BETWEEN THE FINS.

50, 80 AND 100 AMP UNITS ARE FORCED AIR COOLED. THEY MAY BE MOUNTED IN ANY DIRECTION.

REPLACEMENT FUSES:

REPLACEMENT LINE FUSE (F1)

Frame size	Fuse type	BUSSMANN	VOLTAGE	CCI Part No.
30 Amps	40 Amp	FWP-40B	700	42220-0470-340
50 Amps	70 Amp	FWP-70B	700	42220-0470-370
80 Amps	100 Amp	FWP-100B	700	42220-0470-410
100 Amps	125 Amp	FWP-125A	700	42220-0470-412

REPLACEMENT CONTROL TRANSFORMER FUSES (F2, 3 & 4)

Frame size	Fuse type	BUSSMANN	VOLTAGE	CCI Part No.
ALL	1/2 Amp Class CC	FNQ-R-1/2	600 Volts	42130-0460-205
(Alternate)	1/2 Amp Time Delay	FNQ-1/2	500 Volts	42130-0450-205

MOUNTING DIMENSIONS: 200 Amp model

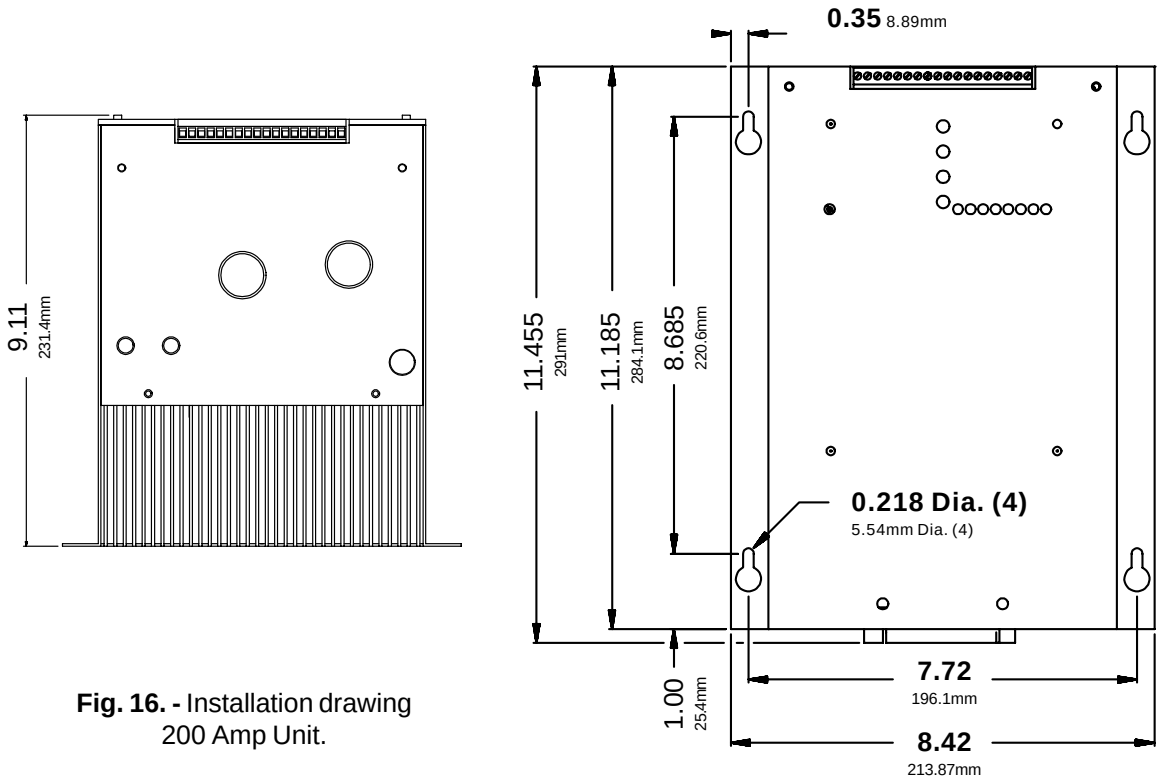


Fig. 16. - Installation drawing 200 Amp Unit.

NOTE: THE 200 AMP UNITS ARE FORCED AIR COOLED. THEY MAY BE MOUNTED IN ANY DIRECTION.

REPLACEMENT FUSES:

REPLACEMENT LINE FUSE (F1)

Frame size	Fuse Size	BUSSMANN	VOLTAGE	CCI Part No.
200 Amps	250 Amp	FWP-250A	700 Volts	42220-0470-425

REPLACEMENT CONTROL TRANSFORMER FUSES (F2, 3 & 4)

Frame size	Fuse Size & type	BUSSMANN	VOLTAGE	CCI Part No.
ALL (Alternate)	1/2 Amp Class CC 1/2 Amp Time Delay	FNQ-R-1/2 FNQ-1/2	600 Volts 500 Volts	42130-0460-205 42130-0450-205

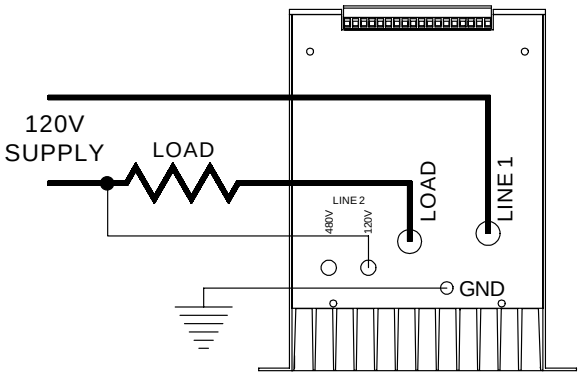


Figure 17. 120 Volt power connections

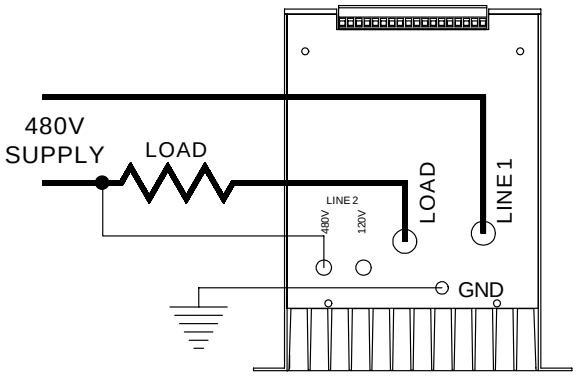


Figure 18. 480 Volt power connections

TROUBLE SHOOTING:

CAUTION: HIGH VOLTAGES ARE PRESENT ON THIS CONTROLLER AND ON PORTIONS OF THE PRINTED CIRCUIT BOARD. USE EXTREME CARE TO AVOID ELECTRICAL SHOCK.

Notes: The LEDs provide a convenient method of determining the general location of controller problems.

The **LOAD** LED indicates that 10% or more of rated load current is present. The intensity of the **LOAD** LED should increase as the command signal is increased.

The **COMMAND** LED indicates the operation of a large part of the circuitry. The intensity of the command indicator should be proportional to the command signal.

NO LOAD VOLTAGE:

Determine that the command light varies with the command signal.

If the Command LED does not vary.

- Determine that the following conditions exist: (Measure voltages at screw terminals to ensure good electrical connections.)
- Voltage between CCW (Pin 14) and CW 10V (Pin 16) is 10 Volts ±0.5.
  If not; Circuit is not receiving power or command connections are shorting out supply.
- Determine that line voltage exists between Line 1 and Line 2.
- Determine that fuses on controller are OK.
- Remove connections to CW (terminal 16).

If Command LED can be varied:

• Determine that the load has continuity. Load continuity can be confirmed by determining that the supply voltage exists between terminals Line 1 and Load 1 when the command signal is zero.

FULL VOLTAGE CANNOT BE OBTAINED:

- Calibration error.
- Determine that the control signal is at maximum.
- Determine that the controller is not in current limit. The yellow LED lights when the current limit setting has been reached.
- If the problem occurs on initial start up, determine that line 2 and the load are connected to the same supply.

LOAD VOLTAGE WILL NOT GO TO ZERO:

If RMS value of the load voltage is greater than 10 percent of the supply voltage.

- With power removed and the load disconnected from Load 1, the resistance between Line 1 and Load 1 should be greater than 1000 ohms.
- If the resistance between Line 1 and Load 1 is less than 1000 ohms the SCR module has failed.

If the RMS value of the load voltage is less than 10 percent of the supply voltage:

- Determine that the command signal is correct. Adjust the zero and span potentiometers to achieve the desired output.

LOAD VOLTAGE REMAINS AT MAXIMUM:

- Deterimine that the feedback signals are present on the command connector.
- Shorted SCR.

CONTROL CONCEPTS

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