CONTROL CONCEPTS INC.

INSTALLATION MANUAL
MODEL 1059-2000

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WARNING: The Control Concepts, Inc. power controllers use 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 Heath 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.

CONTROL CONCEPTS, INC
8077 CENTURY BLVD
CHANHASSEN, MN 55317
PHONE: (952) 474-6200
TOLL FREE: (800) 765-2799
FAX: (952) 474-6070
www.ccipower.com

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INTRODUCTION

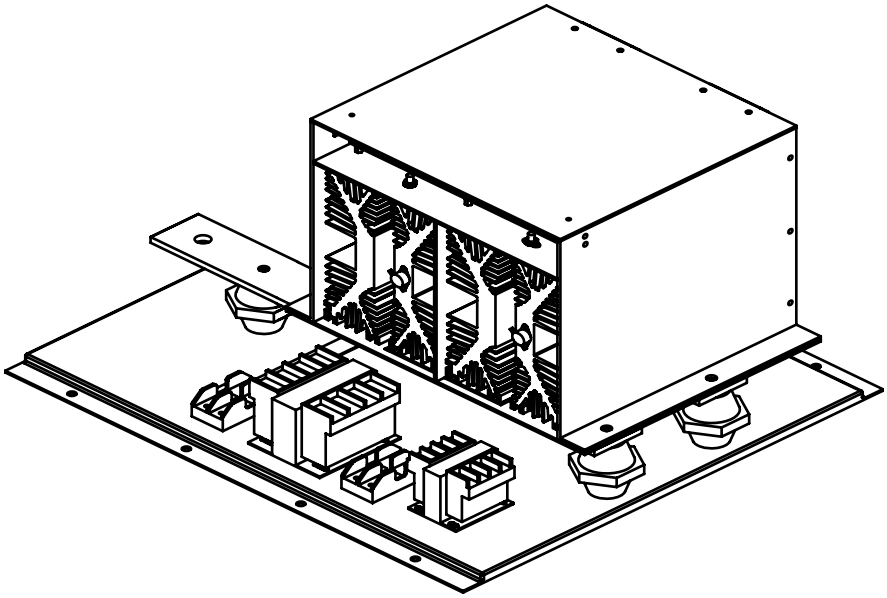
This manual describes the Control Concepts Model 1059-2000 controller with the following ratings:

Load Current:	2000 Amps RMS
Load Voltage:	240, 416, 480 & 600 Volts RMS, 50/60 Hertz

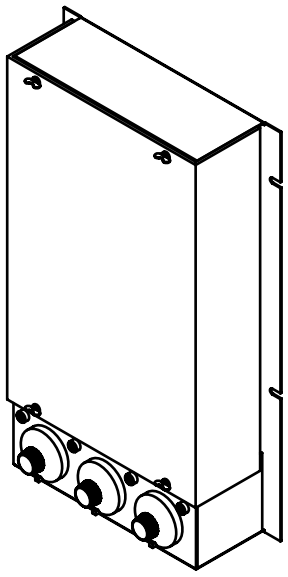
The Model 1059-2000 is a single-phase SCR controller with the following features:

Control Modes:	Phase-angle, Zero-cross or Burst
Phase-angle Feedback:	Power, Proportional or Current
Zero-cross Feedback:	Power, Current or Duty-cycle
Current Limit:	Phase-angle
Over-Current-Trip (OCT):	Phase-angle, Burst and Zero-cross; Latched Relay Output
Command Signals:	4/20 mA , 0/5 Vdc or Potentiometer
Shorted SCR:	Relay Output
Sync Guard:	Zero-cross or Burst Modes
Indicators:	Command Input, Line OK, Load Current, Current Limit / Alarm, Shorted SCR, Shutdown and Thermostat

Refer to the Specifications section for greater details regarding the Model 1059-2000 controller.



Controller



Remote Firing Circuit

CONFIGURATION

It is recommended that the feedback type be configured prior to installing the Model 1059-2000 controller. This is accomplished by setting a shunt jumper located on the control board.

To gain access to the control board, open the top lid and then remove the lid assembly.

CAUTION !
HIGH VOLTAGES PRESENT!

Make sure all power is removed before gaining access to the inside of the Model 1059-2000 controller.

There are two sets of feedback shunt jumpers located on the control board (reference Figure 5), one for Phase-angle Mode and one for Zero-cross/Burst Mode.

PHASE ANGLE FEEDBACK

Proportional (Default)
Place the phase-angle feedback jumper in the Prop position if you desire your feedback to be proportional with the command signal.

RMS Load Current
Place the phase-angle feedback jumper in the I position if you desire your feedback to be the RMS load current.

Load Power (Watts)
Place the phase-angle feedback jumper in the P position if you desire your feedback to be load power (watts).

ZERO-CROSS/BURST FEEDBACK

Duty-Cycle (Default)
Place the zero-cross feedback jumper in the PROP position if you desire the feedback to be the duty-cycle or proportional on-time of the output.

Average Load Current
Place the phase-angle feedback jumper in the I position if you desire your feedback to be the average load current.

Load Power (Watts)
Place the phase-angle feedback jumper in the P position if you desire your feedback to be load power (watts).

SPECIFICATIONS

The following specifications apply over an ambient temperature of 0° to 40°C and a supply voltage of 85% to 110% of the nominal supply voltage rating.	
CONTROL MODE	Single-phase SCR phase-angle, zero-cross or burst mode control.
FRAME SIZE	2000 Amps at 600 Vac. (de-rate 200 Amps per 5,000 ft altitude)
COMMAND SIGNALS	Command signal — Input Impedance 4/20mA — 300 ohms 0-5Vdc — 200K ohms Potentiometer — 200K ohms (1K, 1/4 watt pot recommended for optimum linearity, up to 20K permissible) The control circuit supplies 5 Vdc to the potentiometer.
SCR RATINGS	The peak forward and reverse voltage is 1800 volts. The I^2t rating for fusing is $6x10^6$ A^2SEC.
SCR SURGE RATINGS @ 125C	36,000 Amps Peak/10 mSec
SCR PROTECTION	dv/dt rating=200 volts/microsecond. dv/dt circuit consists of a capacitor in series with a non-inductive resistor. 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.
CURRENT INDICATOR	The intensity of this green LED is proportional to the RMS load current.
CURRENT LIMIT / ALARM INDICATOR	This yellow LED indicates the controller is in current limit.
LINE OK INDICATOR	This green LED indicates proper line voltage is present.
SHUTDOWN INDICATOR	This red LED indicates an over-current-trip, SSCR or over temp. When illuminated (only RED LED ON) indicates a over-current-trip has occurred.
SSCR INDICATOR	When this red SSCR LED illuminates, along with SHUTDOWN LED, it indicates a shorted SCR fault.
T-STAT INDICATOR	When this red T-STAT LED illuminates, along with SHUTDOWN LED, it indicates the heatsink has reached 100° C and the thermostat faulted.
CONTROL RANGE	0 to 98% of supply voltage.
ENVIRONMENT	Operating Temperature: 0° to 40° C Storage Temperature: -40° to 80° C Humidity: 0 to 90% RH, non-condensing Altitude: 0 to 3000 feet Contaminants: Pollution degree 2
WEIGHT	95 pounds
CONTROL POWER REQUIREMENTS	240, 416, 480 or 600 Vac , 150 VA Factory wired for 600 Vac
REPLACEMENT FUSES	Control Power Input — FNQ-R-3/4 Control Transformer — FNQ-R-1/2
ELECTRICAL CONNECTIONS	Buss bar terminations are available to make Line 1 and Load 1 connections. These connections are not fused. It is recommended that line fuses and a disconnect be installed ahead of the controller.
ELECTRICAL ISOLATION	Chassis to supply and load: 2750 volts peak Command to supply and load: 2750 volts peak
OVER-CURRENT-TRIP	Separate OCT adjustments are available for Phase-fired and Zero-cross modes ranging from 50 to 200% and 100% to 350% of current feedback, respectively. Factory calibration is set for 3500 amps.
CURRENT LIMIT	Multi-turn potentiometer allows current limit setting from 20% to 105% of the controller rating in phase-angle mode. Factory setting is 2100 Amps.

SPECIFICATIONS (Continued)

VOLTAGE METER OUTPUT	A filtered metering signal equals 5.0 Vdc when the load voltage feedback is 120 Vac. Valid for Phase-angle only. Metering load = 5mA max.
CURRENT METER OUTPUT	A filtered metering signal equals 5.0 Vdc when the load current feedback is 2000 amps RMS. Valid for Phase-angle only. Metering load = 5mA max.
POWER METER OUTPUT	A filtered metering signal equals 5.0 Vdc when the voltage feedback signal is 120 volts and the load current is 2000 amps. Metering load = 5mA max.
POWER DISSIPATION	1.5 Watts per amp of load current.
FEEDBACK	Phase-angle: True RMS Current, Power, Proportional Zero-cross: Average Current, Power, Duty-cycle
LINEARITY	The controlled variable (feedback) is linear to within ½ % of span with respect to the command signal.
RELAYS	Alarm or Shutdown relay ratings: form “C” contacts rated at 8 Amp, 250 Vac
UPS POWER	In case of a lof of power, a UPS hookup is provided to store latched shutdown conditions for examination. Used in conjunction with CCI transformer 0014028-0025-0024 (120Vac 50/60Hz or 480Vac 50/60Hz to energize transformer primary. Use appropriate fusing to local electrial codes.

INSTALLATION

ENVIRONMENTAL

Installation of the Model 1059-2000 must meet the following environmental conditions:

Temperature	0° to 40° C (32° to 104° F)
Relative Humidity	0 to 90 %, non-condensing
Contaminants	Pollution Degree 2

MOUNTING

Orientation

The Model 1059-2000 was designed for vertical panel mounting with the fans located on the bottom of the controller. In this orientation, the bus bars will be located on the right side of the controller as indicated in Figure 2.

Location

When locating the Model 1059-2000 controller in your control enclosure, allow adequate clearance for air flow to prevent over heating. It is recommended that the controller be free from all interference for at least 6 inches on the bottom and top.

Dimensions

Refer to Figure 2 for the mounting hole and overall dimensions of the Model 1059-2000 controller. Mounting holes are provided for eight 5/16 inch diameter mounting bolts.

INSTALLATION DRAWINGS

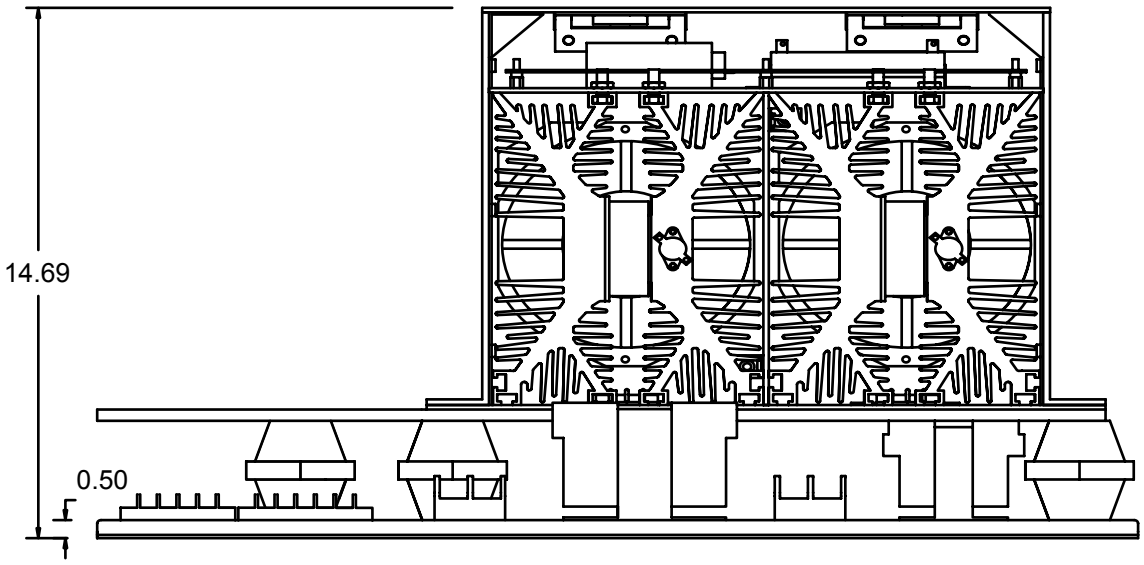


Figure 1. Model 1095-2000 Controller Side View.

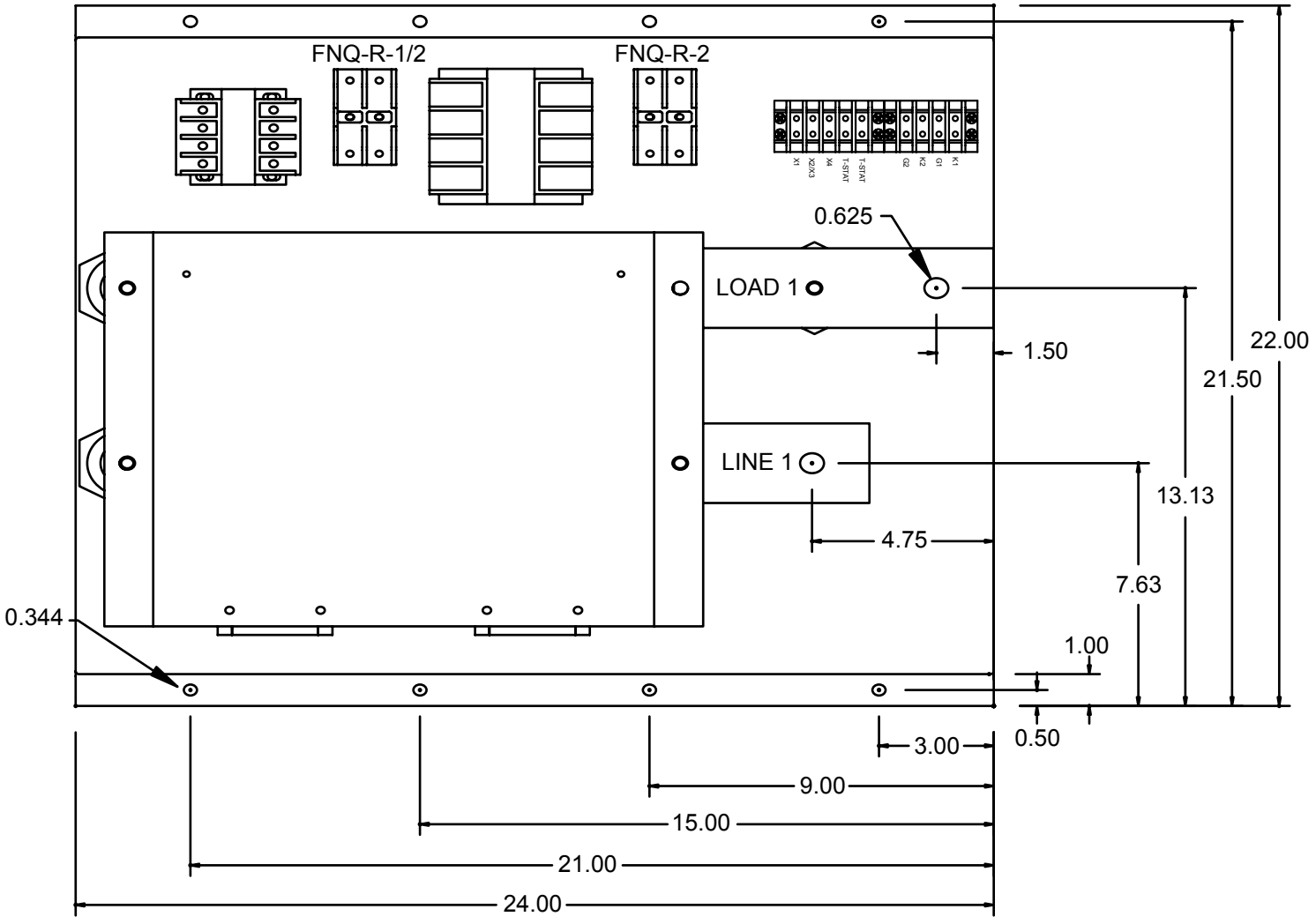


Figure 2. Model 1095-2000 Controller Top View.

INSTALLATION DRAWINGS (Continued)

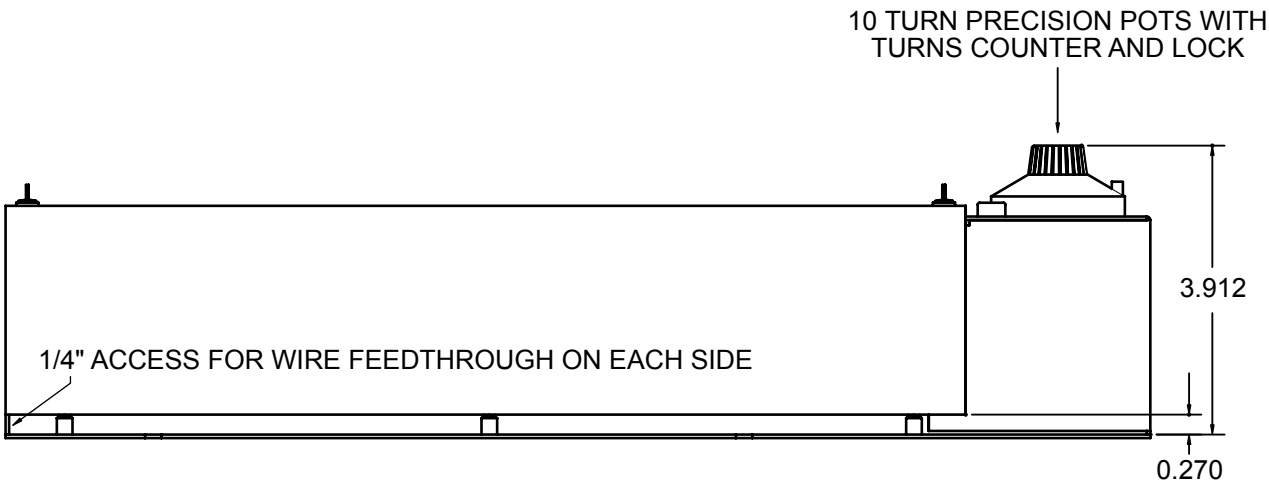


Figure 3. Model 1095-2000 Remote Firing Circuit Side View.

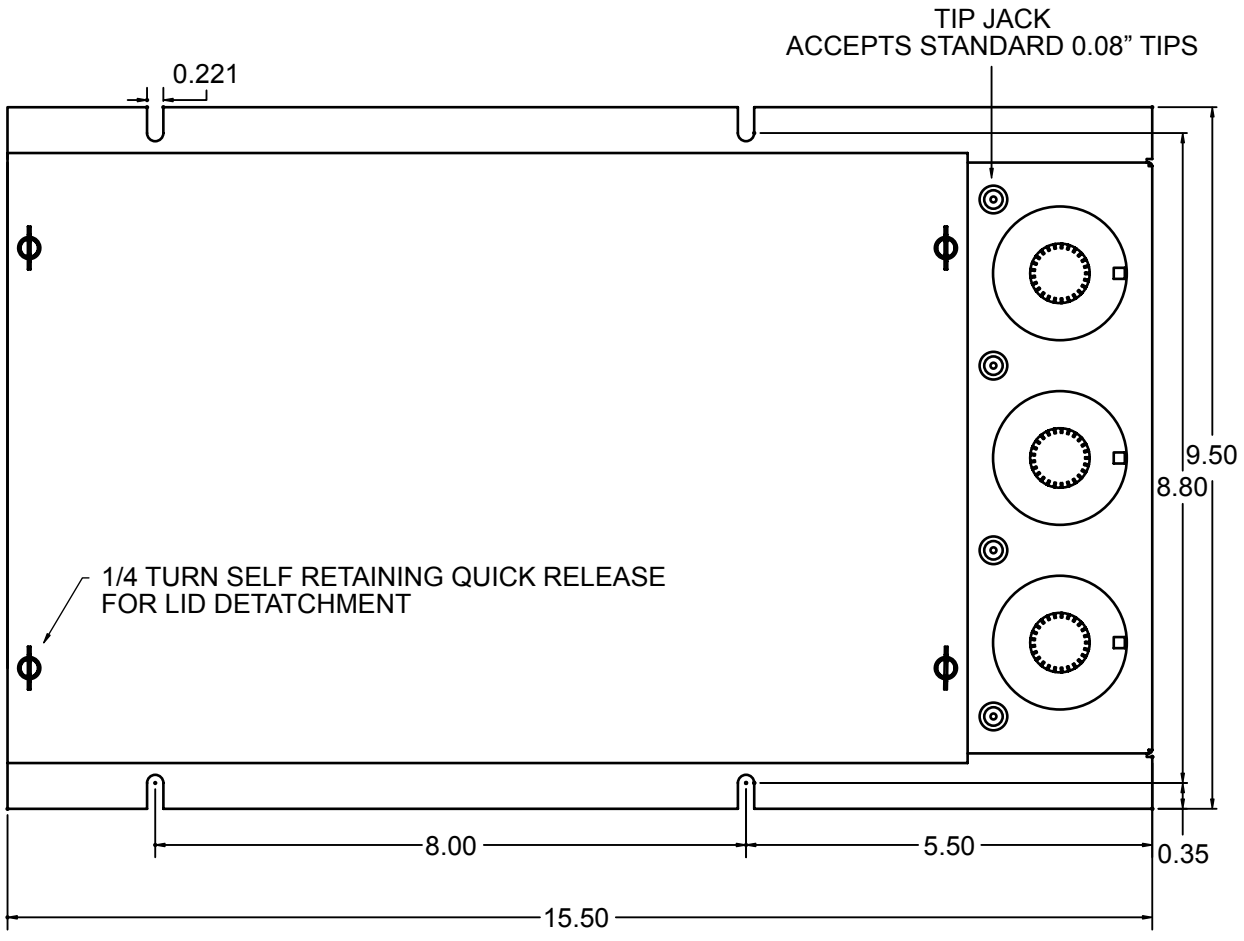


Figure 4. Model 1095-2000 Remote Firing Circuit Top View.

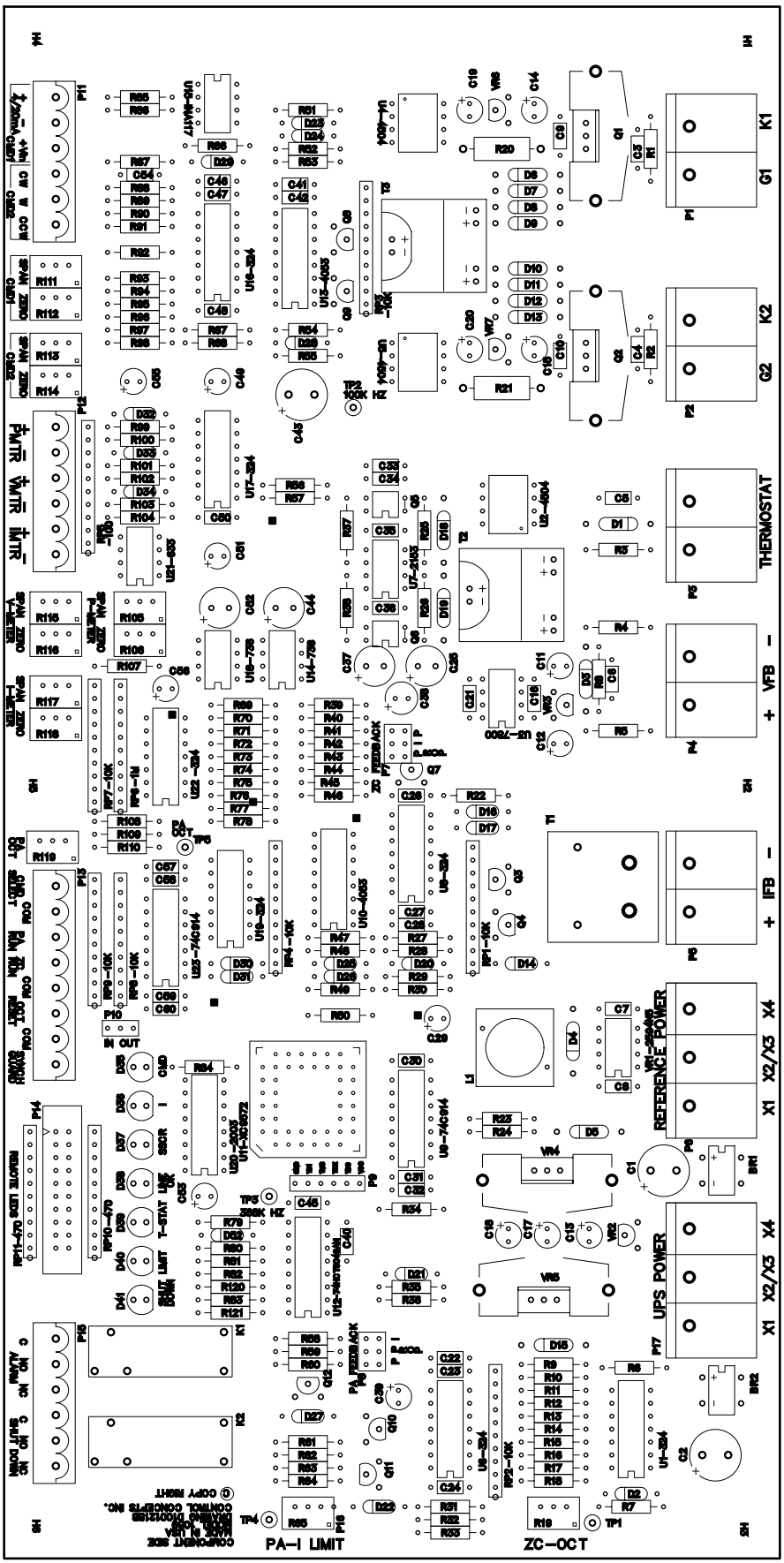


Figure 5. Model 1095-2000 Remote Firing Circuit Board.

CONTROLLER CONNECTIONS

After installation of the Controller and the Remote Firing Circuit a 2000:5 current transformer is required to finish wiring. An optional 120 Vac step down transformer is required for PFB and P & V. There are connections for optional UPS power. Refer to Figures 6 & 7 for wiring diagram for Remote Firing Circuit to Controller.

When wiring the Remote Firing Circuit and the Controller together it is important to use 22 awg, 105° C, 600V minimum TEW or equivalent wire.

Load Connections
The **LINE 1** bus bar connection should be connected to the Line 1 Disconnect of the power source through appropriately rated fusing.

Connect one side of the load to the **LOAD 1** bus bar. The other side of the load should be connected to the Line 2 Disconnect of the power source through appropriately rated fusing.

Load Feedback (Optional)
Connect the primary side of the 120 Vac step-down transformer across the load. Connect the secondary side of the transformer to the VFB terminals on the Remote Firing Circuit. See Figures 6 & 7.

Current Transformer
The current transformer measures the current from the **Load 1** connection. The transformer can be positioned before or after the load. The transformer leads are then wired to the IFB terminals on the Remote Firing Circuit. See Figures 6 & 7.

Control Power
Set the voltage tap to either 240, 416, 480 or 600 Vac from the primary power source to the **CONTROL POWER** fuse block. Connect the output of the fuse block to the appropriate voltage terminals provided on the control transformer.

The control power input must come from the same phase as the load power.
UPS power is NOT phase dependent.

Replacement Fuses
Two sets of internal fuses are provided for the protection of the Model 1059-2000:

Control Power Input	FNQ-R-3/4
Control Transformer	FNQ-R-1/2

Recommended tightening torque for (#6 screw) terminal block : 	
Wire Size (AWG)	Torque
12 to 22GA	**16 in-lbs**

Recommended tightening torque for screw down terminals: 	
Wire Size (AWG)	Torque
12 to 22GA	**7.0 in-lbs**

Recommended tightening torque for green connector: 	
Wire Size (AWG)	Torque
12 to 26GA	**5.0 in-lbs**

CONTROLLER CONNECTIONS (Continued)

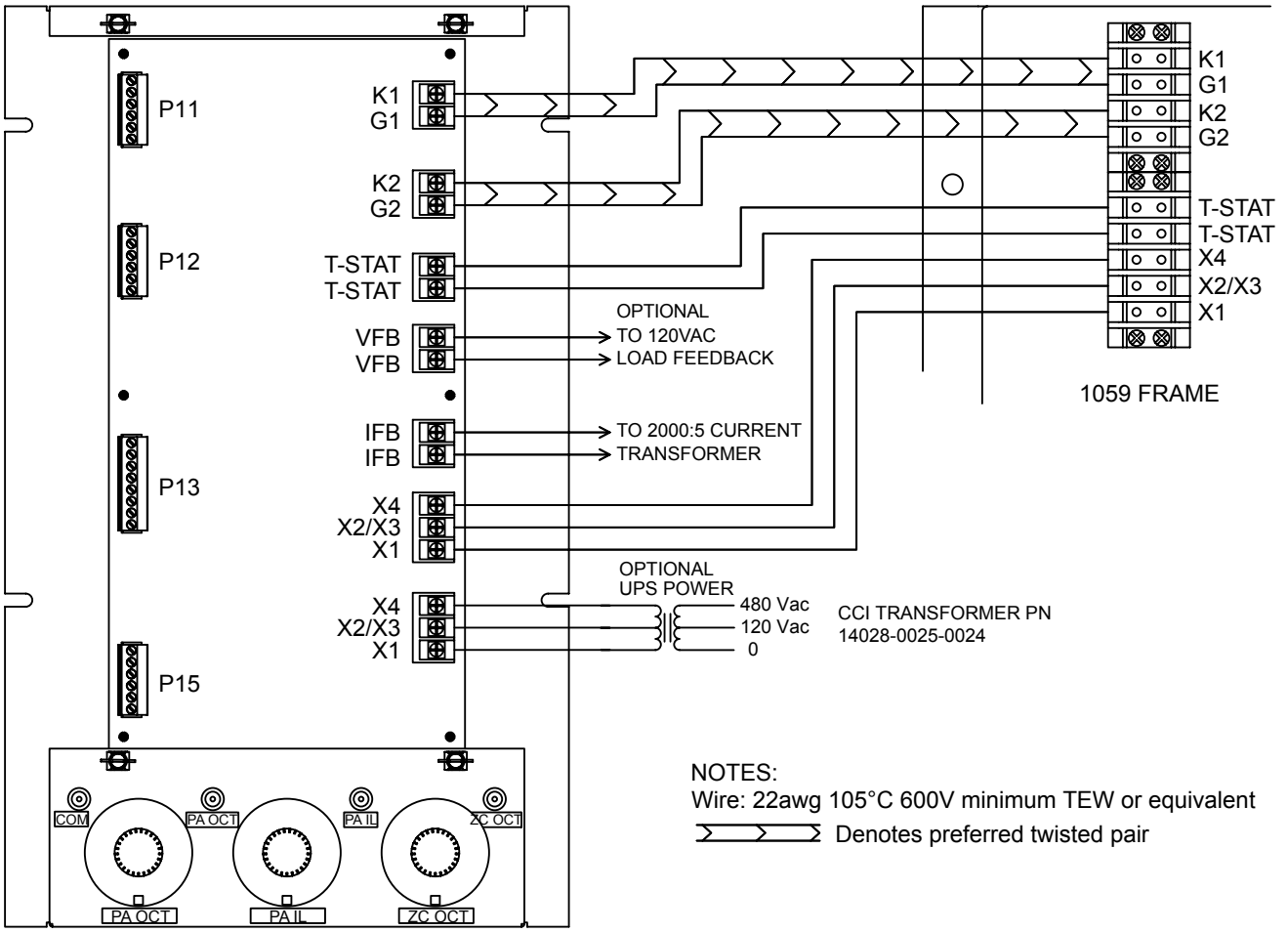


Figure 6. Remote Firing Circuit to Controller.

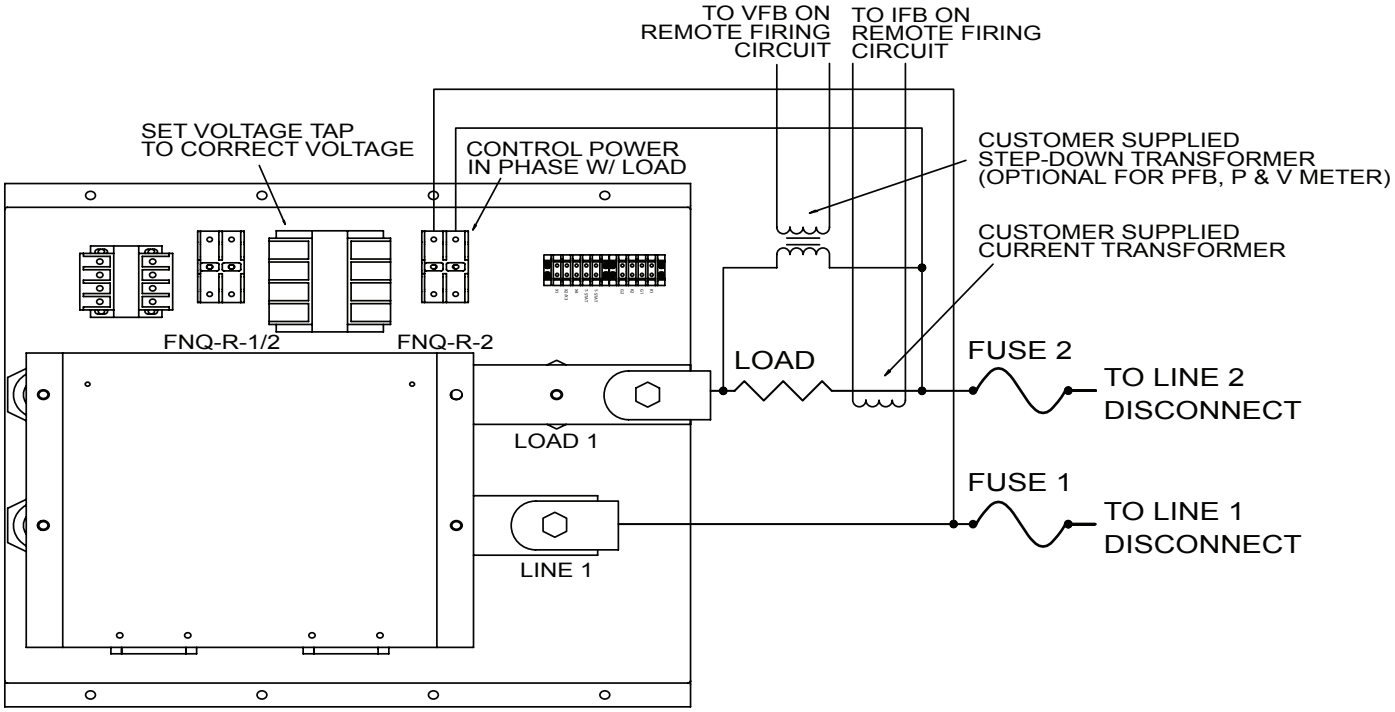


Figure 7. Controller Line/Load Connections.

COMMAND CONNECTIONS

Phase-Angle Mode Select

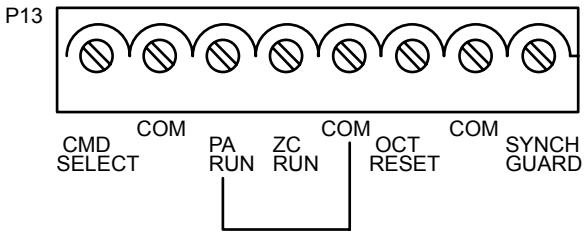


Figure 8. To select the Phase-angle control mode, short the PA RUN and the COM terminals on P13.

Zero-Cross Mode Select

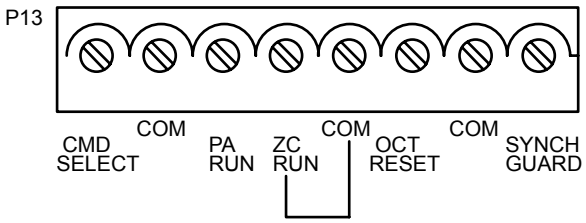


Figure 9. To select the Zero-cross control mode, short the ZC RUN and the COM terminals on P13.

Burst Mode Select

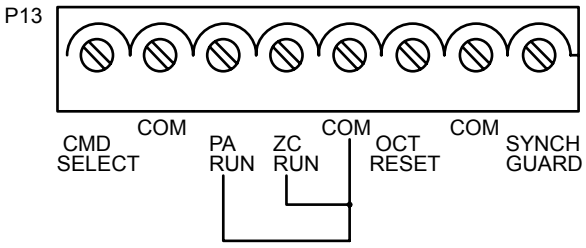


Figure 10. To select the Burst control mode, short both the PA RUN and ZC RUN to the COM terminals on P13.
Note: When both the PA RUN and ZC RUN circuits are open, the control output will immediately go to zero.

Reset

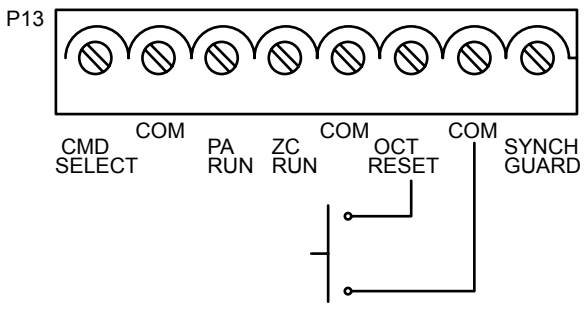


Figure 11. To reset the Shutdown circuit and latching relay output, short the OCT RESET to the COM terminal on P13.

COMMAND CONNECTIONS (Continued)

Command Select

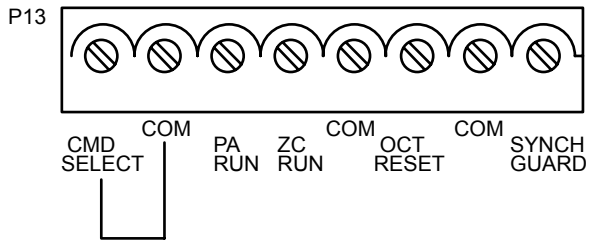


Figure 12. To select the Voltage or Potentiometer command (CMD2), short the CMD SELECT to COM terminals on P13. To select the 4/20 mA command (CMD1), leave the CMD SELECT to COM terminals open on P13.

Voltage Command Signal

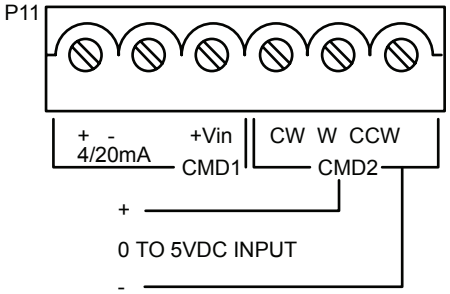


Figure 13. Connect the positive voltage connection to the W CMD2 terminal on P11. Connect the negative voltage connection to the CCW CMD2 terminal on P11.

Potentiometer Command Signal

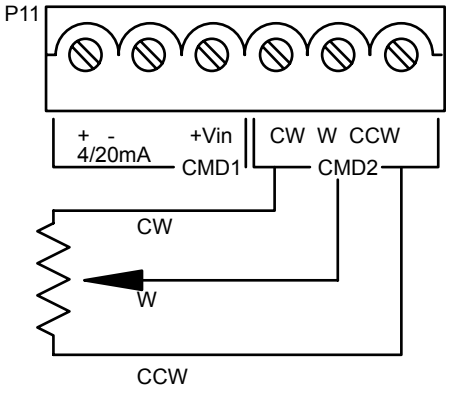


Figure 14. Connect the clockwise potentiometer connection to the **CW CMD2** terminal on **P11**. Connect the wiper potentiometer connection to the **W CMD2** terminal on **P11**. Connect the counterclockwise potentiometer connection to the **CCW CMD2** terminal on **P11**.

Note: A potentiometer may be connected to provide an easy means to operate the controller in a trouble shooting mode. A 1K - 20K potentiometer is recommended.

4/20mA Command Signal

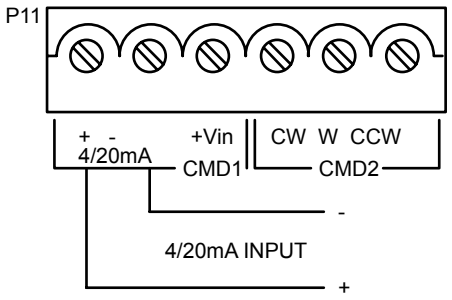


Figure 15. Connect the positive current connection to the (+) CMD1 terminal on P11. Connect the negative current connection to the (-) CMD1 terminal on P11.

Alarm

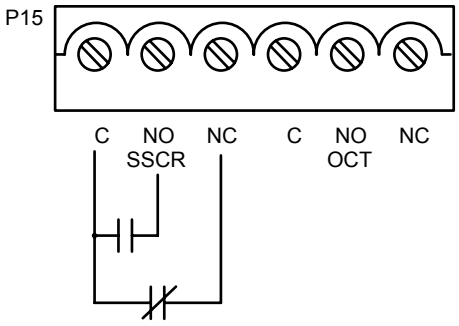


Figure 16. A Form C relay contact output is available to indicate the presence of a IL condition. When a Current Limit condition exists, the NO to C contact will be closed and the NC to C contact will be open on the Alarm relay output of P15.

Shut down

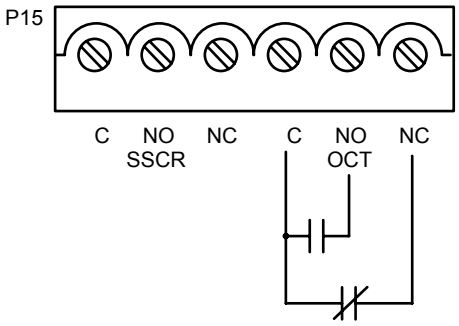


Figure 17. A Form C relay contact output is available to indicate the presence of an OCT, over temp or SSCR condition. When a shut down condition exists, the NO to C contact will be closed and the NC to C contact will be open on the shutdown relay output of P15.

Note: The circuit latches on all shutdown conditions.
To reset the circuit, refer to the OCT Reset section (Figure 11).

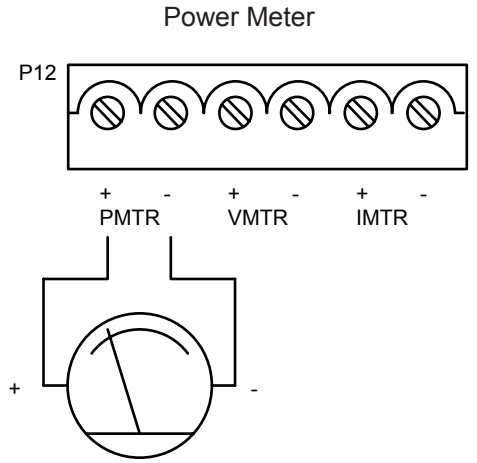


Figure 18. A load Power retransmit signal is available between terminals (+) PMTR and (-) PMTR on connector P12.
Note: This can also be measured from the TIP JACKS on the front of the Remote Firing Circuit

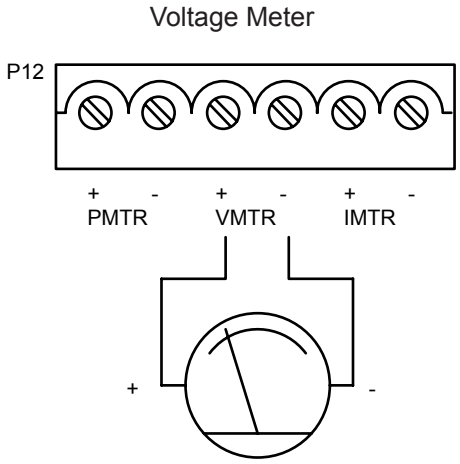


Figure 19. A load Voltage retransmit signal is available between terminals (+) VMTR and (-) VMTR on connector P12.
Note: This can also be measured from the TIP JACKS on the front of the Remote Firing Circuit

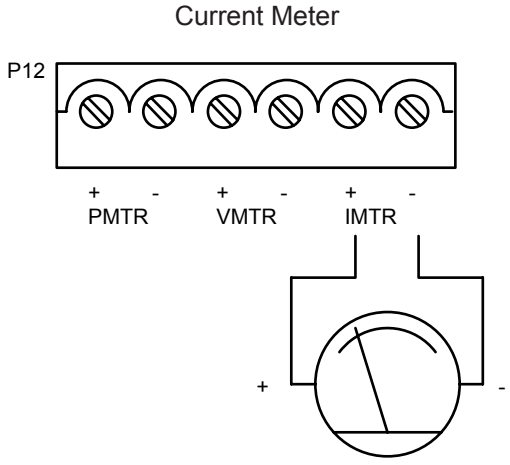


Figure 20. A load Current retransmit signal is available between terminals (+) IMTR and (-) IMTR on connector P12.
This output is only valid when controller is in Phase-Angle mode.
Note: This can also be measured from the TIP JACKS on the front of the Remote Firing Circuit

COMMAND CONNECTIONS (Continued)

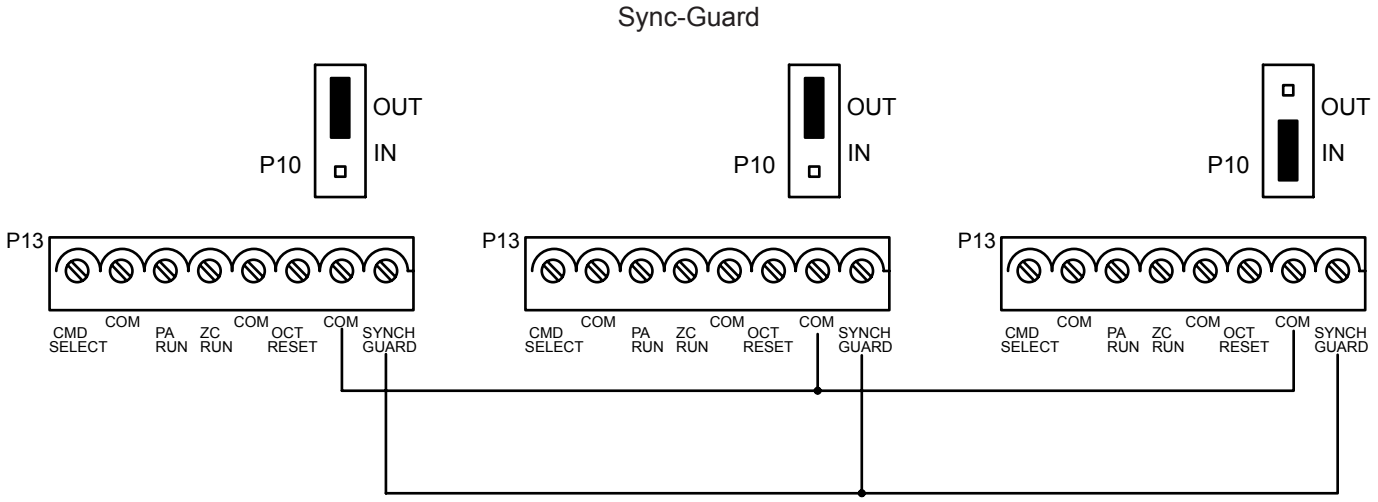


Figure 21. The sync-guard feature is implemented by connecting the SYNCH GUARD terminal of P13 from all the controllers together, and the COM terminal of P13 from all the controllers together.

One and only one of the controllers must have the P10 jumper in the "IN" position when using the Sync-Guard feature. See Figure 5 for jumper location.

Note: A maximum of 8 controllers can be connected together.

ADJUSTMENTS

The Model 1059-2000 is shipped from the factory fully calibrated. In most application very little or no calibration will be required. If field calibration is required, refer to the procedures below.

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

See Figure 5 for location of adjustment potentiometers.

PA I-LIMIT (Phase-angle Current Limit)
Rotating the PA I-LIMIT potentiometer clockwise will increase the point at which the RMS load current will no longer increase when using phase-angle control. Current limit is not active in zero-cross or burst mode.

PA OCT (Phase-angle Over-Current Trip)
Rotating the PA OCT potentiometer clockwise will increase the point at which the RMS load current will cause the controller to trip or shut down when using phase-angle control.

ZC OCT (Zero-Cross/Burst Over-Current Trip)
Rotating the ZC OCT potentiometer clockwise will increase the point at which the peak load current will cause the controller to trip or shut down when using zero-cross or burst control. The peak trip is programmed to approximate the burst RMS limit.

ADJUSTMENTS (Continued)

See Figure 5 for location of adjustment potentiometers.

The zero and span adjustments for a given input or output will interact. If adjustments become necessary, the following procedure should be followed.

1. Set the command signal to minimum and adjust the zero potentiometer until the output is zero. If this 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.
2. Set the command signal to maximum and adjust the span potentiometer until the output is at the desired maximum value. If this 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.
3. Repeat steps 1 and 2 until no further adjustment is necessary.

CMD1
ZERO (Command 1 Zero)
Rotating the CMD1 ZERO potentiometer clockwise will increase the output when the 4/20 mA command input is at its minimum. Rotating counter clockwise will decrease the output at a minimum.

SPAN (Command 1 SPAN)
Rotating the CMD1 SPAN potentiometer clockwise will increase the output when the 4/20 mA command input is at its maximum. Rotating counter clockwise will decrease the output at a maximum.

CMD2
ZERO (Command 2 Zero)
Rotating the CMD2 ZERO potentiometer clockwise will increase the output when the voltage or potentiometer command input is at its minimum. Rotating counter clockwise will decrease the output at a minimum.

SPAN (Command 2 Span)
Rotating the CMD2 SPAN potentiometer clockwise will increase the output when the voltage or potentiometer command input is at its maximum. Rotating counter clockwise will decrease the output at a maximum.

P-METER
ZERO (Power Meter Zero)
Rotating the P-METER ZERO potentiometer clockwise will increase the power meter retransmit output when the current and voltage feedback are at their minimum. Rotating counter clockwise will decrease the output at a minimum.

SPAN (Power Meter Span)
Rotating the P-METER SPAN potentiometer clockwise will increase the power meter retransmit output when the current and voltage feedback are at their maximum. Rotating counter clockwise will decrease the output at a maximum.

I-METER
ZERO (Current Meter Zero)
Rotating the I-METER ZERO potentiometer clockwise will increase the current meter retransmit output when the current feedback is at its minimum. Rotating counter clockwise will decrease the output at a minimum.

SPAN (Power Meter Span)
Rotating the I-METER SPAN potentiometer clockwise will increase the current meter retransmit output when the current feedback is at its maximum. Rotating counter clockwise will decrease the output at a maximum.

V-METER
ZERO (Voltage Meter Zero)
Rotating the V-METER ZERO potentiometer clockwise will increase the voltage meter retransmit output when the voltage feedback is at its minimum. Rotating counter clockwise will decrease the output at a minimum.

SPAN (Power Meter Span)
Rotating the V-METER SPAN potentiometer clockwise will increase the voltage meter retransmit output when the voltage feedback is at its maximum. Rotating counter clockwise will decrease the output at a maximum.

OPERATION

PHASE-ANGLE CONTROL

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.

Power is regulated by advancing or delaying the point at which the SCR is turned on within each half cycle.

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

ZERO-CROSS CONTROL

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 complete half-cycles and then “off” for a number of complete half-cycles.

Because of the Trans-Guard feature, the 1059 always applies an odd number of “on” half-cycles and an even number of “off” half-cycles. The following tabulation shows the number of “on” and “off” half-cycles that are applied to the load to achieve the percentage of load power indicated. The percentage of power is equal to the ratio of the number of half-cycles that are “on” to the total number of half-cycles.

LOAD POWER				
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 off
				4 off
				23 on
				4 off
				23 on
				4 off
				21 on
				4 off

Table 1. Load Power Timing

From the tabulation, it can be seen that power is applied for 16 out of 32 half-cycles to achieve 50% power and that power is applied for 136 out of 160 half-cycles to achieve 85% power. When operated with a 60 hertz supply, the sequence of on and off half-cycles repeats ever 0.266 seconds at 50% power and 1.33 seconds at 85% power.

BURST CONTROL

Burst control operates the same as zero-cross control with the exception that the first half –cycle of every “on” period is fired at 90 electrical degrees instead of at 0 degrees. This hybrid type of control can consequently be used to control the primary of a transformer with transformer coupled loads by avoiding the excessive inrush currents that can occur with magnetizing inductance of the transformer.

TROUBLESHOOTING

INDICATORS
The Model 1059-2000 has the following LED indicators to assist in determining the status of the Model 1059-2000, and also assist with troubleshooting:

CMD (Command)
The intensity of this *Green* LED indicator is proportional to the command signal.

I (Current)
The intensity of this *Green* LED is proportional to the load current.

LIMIT (Current Limit)
This *Yellow* LED will be illuminated when the Model 1059-2000 controller is in phase-angle current limit. This also activates the Alarm relay.

LINE OK
This *Green* LED indicates that proper line voltage is present for control.

T-STAT (Thermostat)
This *Red* LED will be illuminated if the thermostat on the controller heatsink exceeds 100° C. This also activates the Shut down relay and shut down LED.

SSCR
This *Red* LED will be illuminated if the Model 1059-2000 has a shorted SCR. The Shutdown relay will be activated when this LED is illuminated along with the shutdown LED.

SHUT DOWN
This *Red* LED will be illuminated if the Model 1059-2000 had an over-current-trip, SSCR or over temp condition. If the controller OCT it will remain latched until the Shut down condition is removed and the OCT Reset input activated. If in over temp or SSCR it will automatically de-energize when the condition is removed.

MANUFACTURED BY

CONTROL CONCEPTS

TEL: (952) 474-6200 (800) 765-2799
FAX: (952) 474-6070 www.ccipower.com

8077 Century Blvd
Chanhassen, MN 55317, USA