

**CONTROL
CONCEPTS
INC.**

**INSTRUCTION MANUAL
MODEL 1047**

DESCRIPTION:

The model 1047 linearly controls, with respect to a command or control signal, the electrical power applied to a single-phase resistive load by distributive zero-cross operation of silicon controlled rectifiers (SCRs).

Distributive zero-cross operation implies that the supply voltage is switched on and off only when the instantaneous value of the sinusoidal supply voltage is zero and that the load power is controlled by varying the number of electrical half-cycles that power is applied to, and removed from, the load. (See theory of operation for additional details.)

The controller is capable of accepting: mA current command signals, DC voltage command signals, pulse width modulated command signals of negative or positive polarity, or it may be controlled by a potentiometer.

Electrical isolation is provided to isolate the command signals from the line and load voltages.

Additional features of the 1047 controller include:

1. Line voltage compensation which for a given command signal, maintains the load power constant, independent of line voltage variations.
2. Sync-Guard which provides a means to reduce the synchronous operation of two or more controllers.
3. Isolated mA current command input. Because of the isolation built into the mA current input on this controller, the Sync-Guard feature may be used when multiple controllers are controlled by a single 4/20mA signal connected in series with each controller.
4. Voltage or current feedback, jumper selectable.
5. Fault detection: Form A and form B Relay contacts change state if:
 - An SCR should fail shorted.
 - The power fails.
 - The 24 Vac circuit power is missing.
 - Partial load failure is detected. 10% or more.This relay is energized during normal power-on operation.
6. LED's to monitor operation and indicate faults.
7. Pulse width modulation control with polarity selection.
8. Metering output to monitor percentage of load voltage or percentage of load current.

THEORY OF OPERATION:

THE SCR

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

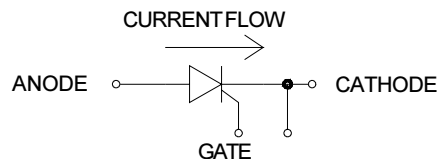


Figure 1. SCR symbol

The SCR has two states, ON and OFF, and allows current to flow in only one direction. SCR's can remain in the off state even though the applied potential may be several thousand volts; in the on state, they can pass several thousand amperes. When a small signal is applied between the gate and cathode terminals (Figure 1.0), 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 called the holding current.

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

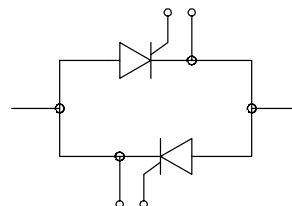
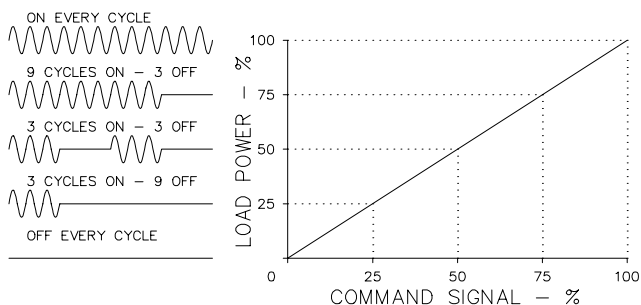


Figure 2.

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 complete electrical half-cycles and then "off" for a number of complete electrical half-cycles.



THEORY OF OPERATION (cont.):

SYNC-GUARD

Two or more zero-cross controllers connected to the same power source, each running at less than 100% command, could all turn on simultaneously causing a power surge.

The sync-guard feature reduces the possibility of synchronous operation of two or more controllers. It reduces the variations in power demand resulting in a more stable supply voltage and improved power factor.

The Sync-Guard feature does not alter the power applied to the load, but adjusts the time when power is applied in such a manner as to reduce the possibility of two or more controllers being ON and OFF at the same time. Up to nine controllers may be connected together in this manner. See fig. 7 on page 5.

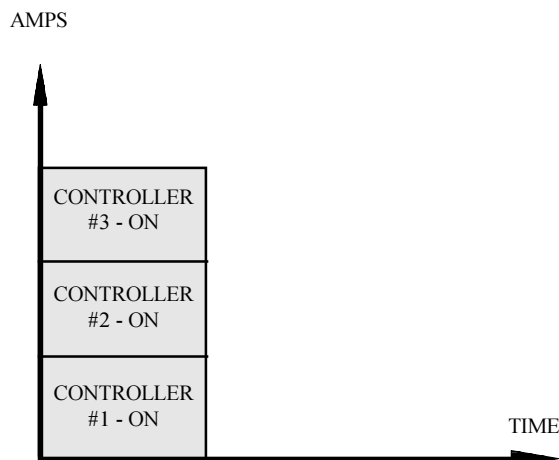


Figure 3. Three controllers, each providing 33.3% power, operating synchronously.

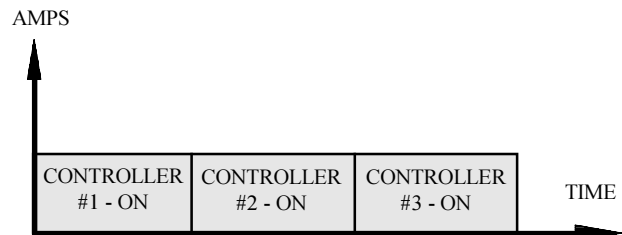


Figure 4. Three controllers, each providing 33.3% power, with sync-guard.

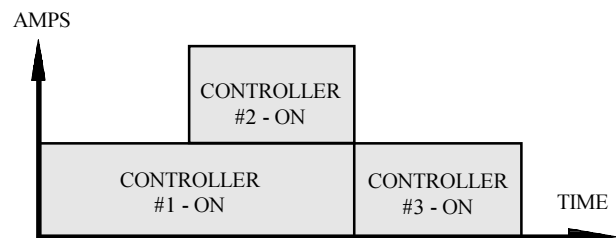


Figure 5. Three controllers, two providing 33.3% power each & one providing 66.6% power, with synch-guard.

As shipped from the factory, each model 1047 controller will have a jumper placed in the Sync-Guard position on the selector connector on the control circuit board. This jumper is placed between P1-5 and P1-6. (See figure 14-F on page 6.) If you connect two or more controllers together for sync-guard, as shown in fig. 7 on page 5, the sync-guard jumper must be removed from all but one of the controllers which are connected together in this manner. The unused jumper may be stored in position P1-7 to P1-8.

INSTALLATION:

The model 1047 must be mounted on a vertical surface with the fins oriented vertically so that air may flow freely between them. Do not apply power until it is determined that all wiring is correct.

When making the input command connections, refer to figures 9 to 11 on page 6 for pin numbers, and figures 14-a to 14-e (page 6) for the selection of that input command.

If sync-guard is used, remember to use the jumper shown in figure 14-f on only one of the controllers. This jumper connects a 1500 ohm resistor required to provide termination/load for the sync-guard line. When shipped, each board will have a jumper installed (5-6) for the sync-guard termination. You may store the unused jumpers on pins 7 & 8 as shown on page 6.

Class "T" Type of fuses are recommended to protect the controller and load. Bussmann type JJN or JJS fuses are recommended. Choose a size which is about 125% of the load current. Control Concepts, Inc. stocks a variety of fuses and fuse holders for your convenience. Call the factory for recommendations.

The relay contacts may be used to sound an alarm or control a contactor which will remove power to the system. The relay is energized when power is on and no fault condition exists. If a fault condition occurs, the relay will be deenergized. The connections to the relay contacts are made through connector P9. See figure 13 on page 6 for details.

A jumper connector to choose between Current or Voltage feedback (P4) is located on the circuit board. Generally this jumper would be in the voltage position (1-2). If a load with a low cold resistance is used, or if current feedback is desired for another reason, the current position (2-3) could be selected.

The V-RANGE jumper is used to select between 240 Vac and 480 Vac to coincide with the line voltage being used.

The I-RANGE jumper chooses the current range: 10 Amps (LO) or 30 Amps (HI) on the smaller frame. 20 Amps (LO) or 60 Amps (HI) on the larger frame.

METERING

A digital or analog meter may be used for the metering output. P2-6(+ output) to P2-7(common). This metering output will indicate a percentage of output voltage or load current. The output of this circuit is 0 to 10 volts DC and will indicate 10 volts when controller output is maximum. A jumper connector (P5) is provided to select either OUTPUT VOLTAGE METERING (P5-1 to P5-2) or LOAD CURRENT METERING (P5-2 to P5-3).

OUTPUT

ADJUSTMENTS:

The controller will be calibrated before leaving the factory and field adjustment is usually not required.

If adjustment becomes necessary, the following procedure should be followed.

(See figure 6 on page 5 for location of potentiometers and push button switch on the circuit board.)

ZERO: Reduce the command signal to minimum and adjust the ZERO pot so that the output of the controller just stays off.

SPAN: Increase the command signal to maximum and adjust the SPAN pot so that the output of the controller is just on continuously.

(The span and zero adjustments may interact, therefore it may be necessary to repeat these two steps.)

4/20: This pot is factory adjusted to compensate for the optical coupler. Consult factory before attempting to adjust this pot.

PLF: *This adjustment must be made with a full operating load on the controller, and the command signal set to cause output to be present .*

While holding the pushbutton switch (**PLF SET**) in, adjust the **PLF** pot so that the red **PLF** LED and the green **OK** LED appear to be the same intensity. If the green **OK** LED is on or blinking by itself, adjust the **PLF** pot clockwise to achieve balance. If the red **PLF** LED is on or blinking by itself, adjust the **PLF** pot counter-clockwise to achieve balance.

In normal operation, with full load, and the button released, the red **PLF** LED will be off and the green **OK** LED will be on.

V-CAL: This pot is factory set for voltage feedback control and adjustments should not be attempted unless you have the proper instruments to do it accurately.

The jumper on the feedback connector and the jumper on the meter connector must be in the voltage (**V**) position.

With the load operating at maximum voltage and the command signal at maximum, adjust this pot to obtain exactly 10 Volts DC on the metering output. (Pins 6 & 7 on P2).

I-CAL: This pot is factory set for current feedback control and adjustments should not be attempted unless you have the proper instruments to do it accurately.

The jumper on the feedback connector and the jumper on the meter connector must be in the current (**I**) position.

With the load operating at maximum current and the command signal at maximum, adjust this pot to obtain exactly 10 Volts DC on the metering output. (Pins 6 & 7 on P2).

SPECIFICATIONS:													
CONTROL MODE:	Single-phase, zero-cross, distributive control.												
CURRENT RATING:	The “A” term within the model number specifies the maximum continuous current rating at the ambient temperature of 55°C.												
COMMAND SIGNAL:	<table> <tr> <td>± PW modulation</td><td>Input Resistance</td></tr> <tr> <td>0-5Vdc</td><td>200K ohms</td></tr> <tr> <td>0-10 Vdc</td><td>100K ohms</td></tr> <tr> <td>4/20mA</td><td>200K ohms</td></tr> <tr> <td>Potentiometer</td><td>60 ohms</td></tr> <tr> <td>(1K POT. recommended; 20K permissible 1/2 watt)</td><td>200K ohms</td></tr> </table>	± PW modulation	Input Resistance	0-5Vdc	200K ohms	0-10 Vdc	100K ohms	4/20mA	200K ohms	Potentiometer	60 ohms	(1K POT. recommended; 20K permissible 1/2 watt)	200K ohms
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4/20mA	200K ohms												
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(1K POT. recommended; 20K permissible 1/2 watt)	200K ohms												
OPERATING VOLTAGE:	240 or 480 Vac 50/60 Hertz +10 -15% Other voltages available, consult factory.												
AMBIENT TEMPERATURE:	<table> <tr> <td>Operating</td><td>0 to 55°C</td></tr> <tr> <td>Storage</td><td>-40 to 80°C</td></tr> <tr> <td>Humidity</td><td>0 to 95%, Non-condensing</td></tr> </table>	Operating	0 to 55°C	Storage	-40 to 80°C	Humidity	0 to 95%, Non-condensing						
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Storage	-40 to 80°C												
Humidity	0 to 95%, Non-condensing												
ISOLATION:	Isolation between power circuit, command signal and ground is greater than 2500 Vrms. The mA current signal is optically isolated to prevent current loop problems when using Sync-Guard.												
LINEARITY:	The load power is linear within 2% of span with respect to the cmd. signal.												
VOLTAGE COMPENSATION:	The load power remains constant within 2% of span for line voltage changes of +10% and -15% variations.												
CONTROL RANGE:	0 to 99% of supply voltage.												
MAX. OFF STATE VOLTAGE:	600 Volts Peak: 240 Volt Unit, 1200 Volts Peak: 480 Volt unit.												
SCR SURGE CURRENT: (1 cycle Surge)	500 Amps: 240 Volt, 30 Amp Unit, 750 Amps: 480 Volt, 30 Amp Unit 1000 Amps: 240 Volt, 60 Amp Unit, 1000 Amps: 480 Volt, 60 Amp Unit.												
SCR I²T RATING: (60 Hz half cycle)	1040 A²Sec: 240 Volt, 30 Amp Unit, 2345 A²Sec: 480 Volt, 30 Amp Unit 4165 A²Sec: 240 Volt, 60 Amp Unit, 4165 A²Sec: 480 Volt, 60 Amp Unit.												
DV/DT AND TRANSIENT VOLTAGE PROTECTION:	DV/DT rating exceeds 200 volts per microsecond. DV/DT snubber circuit and MOV are provided to protect against high frequency transients (dv/dt) and high voltage transients.												
ZERO AND SPAN ADJ:	±20% of span.												
LED INDICATORS:	OK. This is a green LED that will be lighted when line voltage, command signal and normal load current are present. PLF. This red LED lights when the load current drops more than 10% below the calibration point. This would indicate a change in load resistance. PWR. This red LED will be lighted when a load power failure occurs with a command signal present. This would indicate; Line voltage missing, fuse open or the SCR module has failed open. SSCR. This red LED will light if load power is present when there is no command signal. This indicates that an SCR module is probably shorted. With the power removed, disconnect the circuit board from the controller. Reapply power. If the load current is still present, the SCR module is shorted. CMD. This red LED will light when the command signal is present. The rate of blinking will correspond to the percentage of command signal. This LED indicates that the firing circuit is delivering a signal to the SCR module.												
HEAT DISSIPATION:	1.5 watts per amp of SCR current.												
POWER REQUIREMENTS:	Allow 5Volt-Amps @ 24 Vac for each controller.												
METERING OUTPUT:	A 0 to 10 Vdc signal is provided at P2-6 which corresponds to the percentage of output. A jumper on P5 selects output voltage or load current metering.												

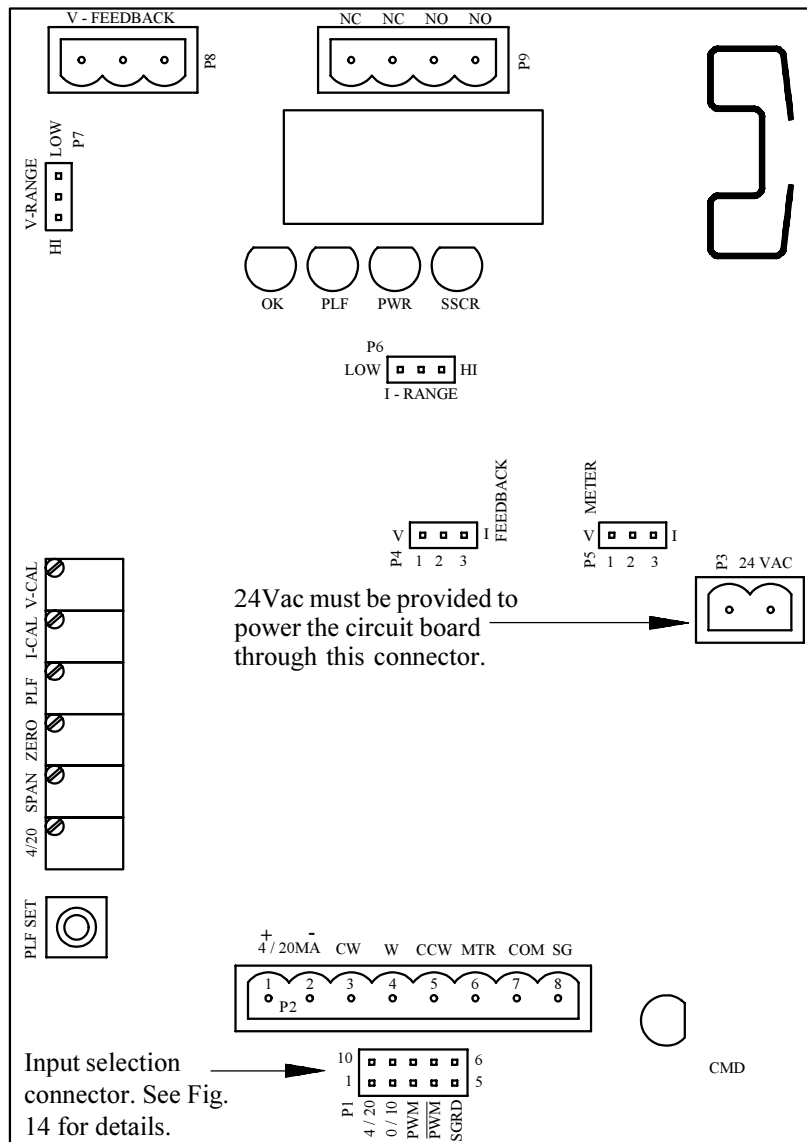


Figure 6. Model 1047 circuit board layout showing major components.

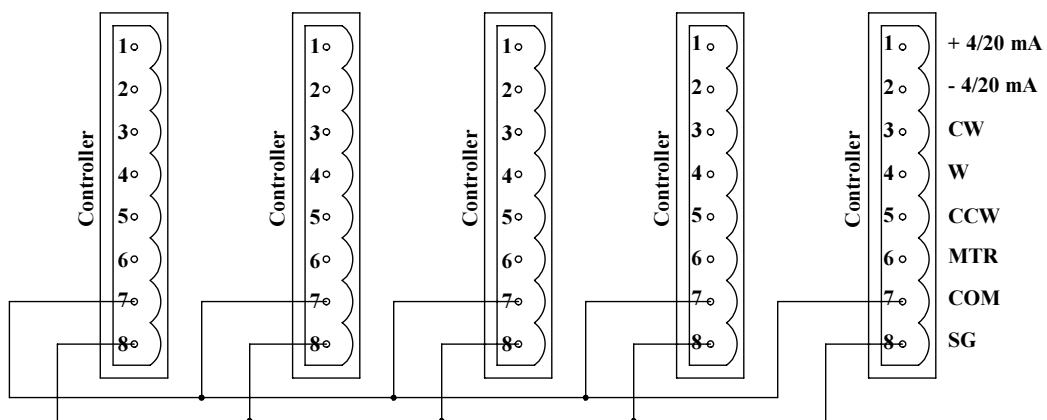
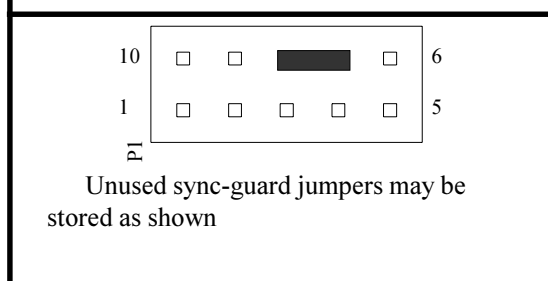
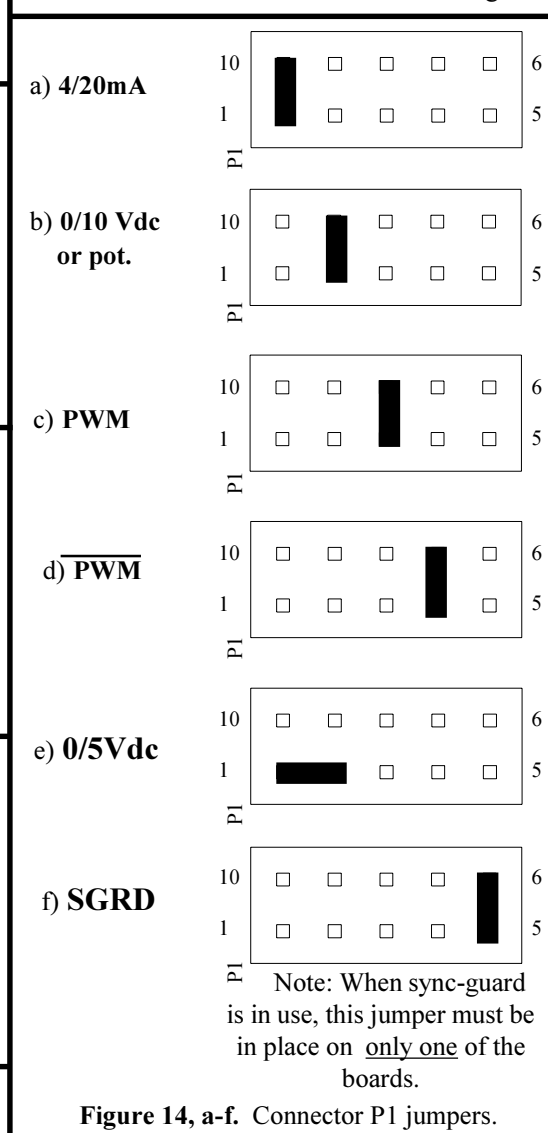
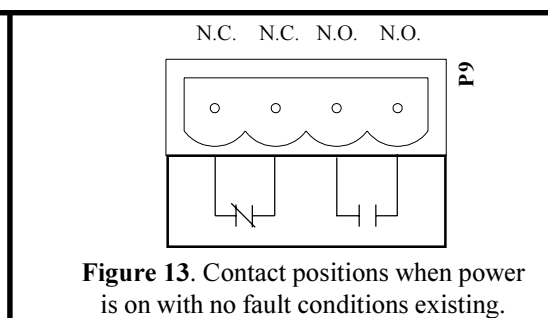
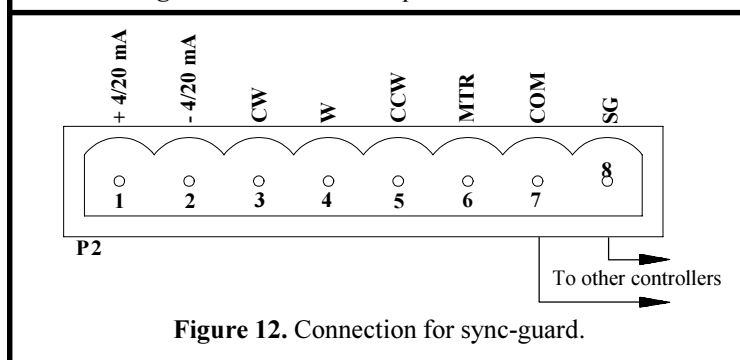
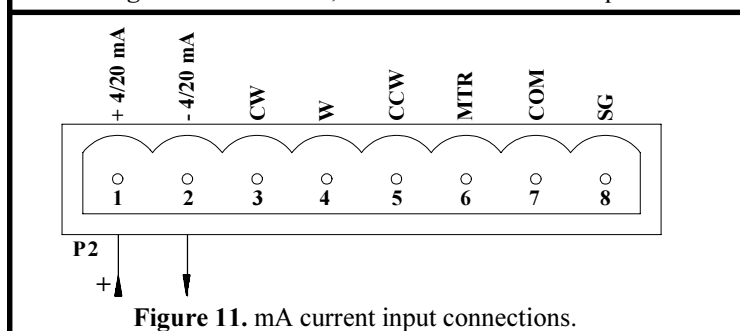
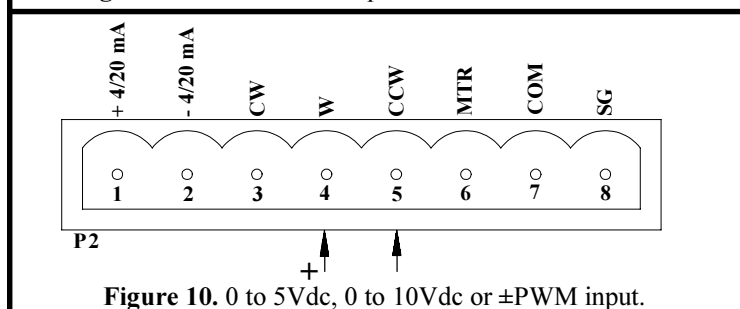
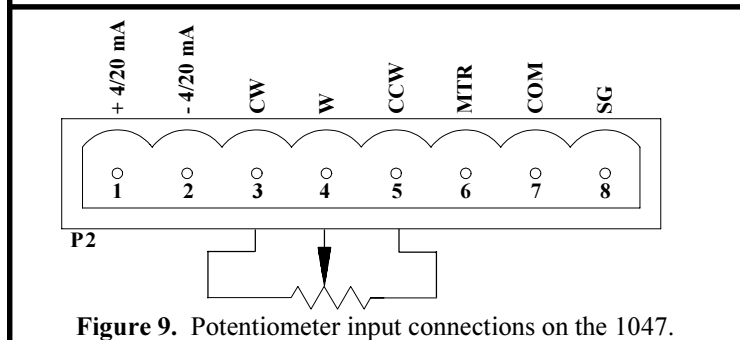
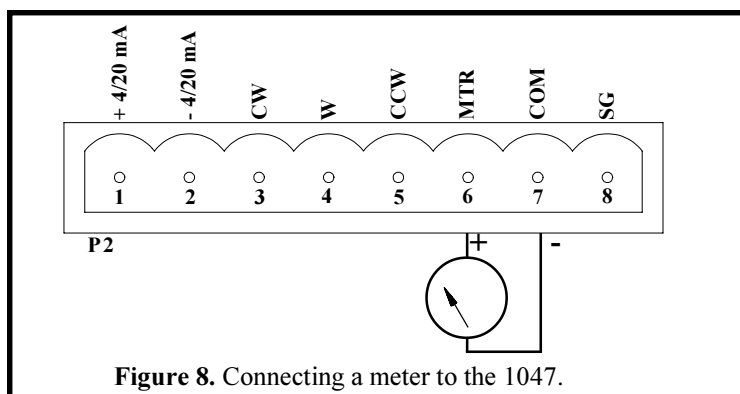


Figure 7. Sync-Guard Connections between multiple controllers.



INSTALLATION DRAWINGS:

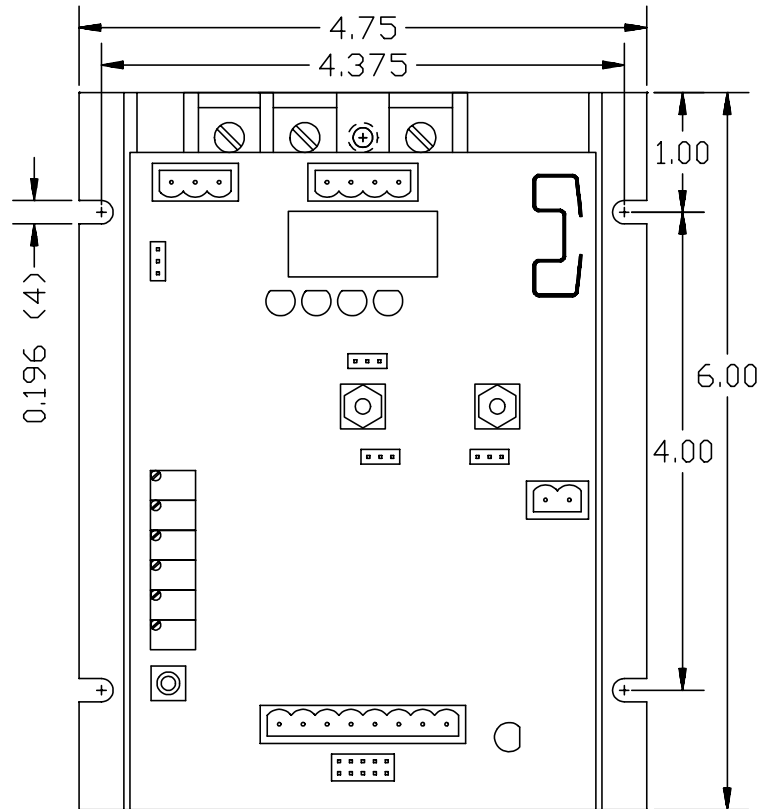


Figure 15. Model 1047, 10 to 30 Amp frame. (Top view)

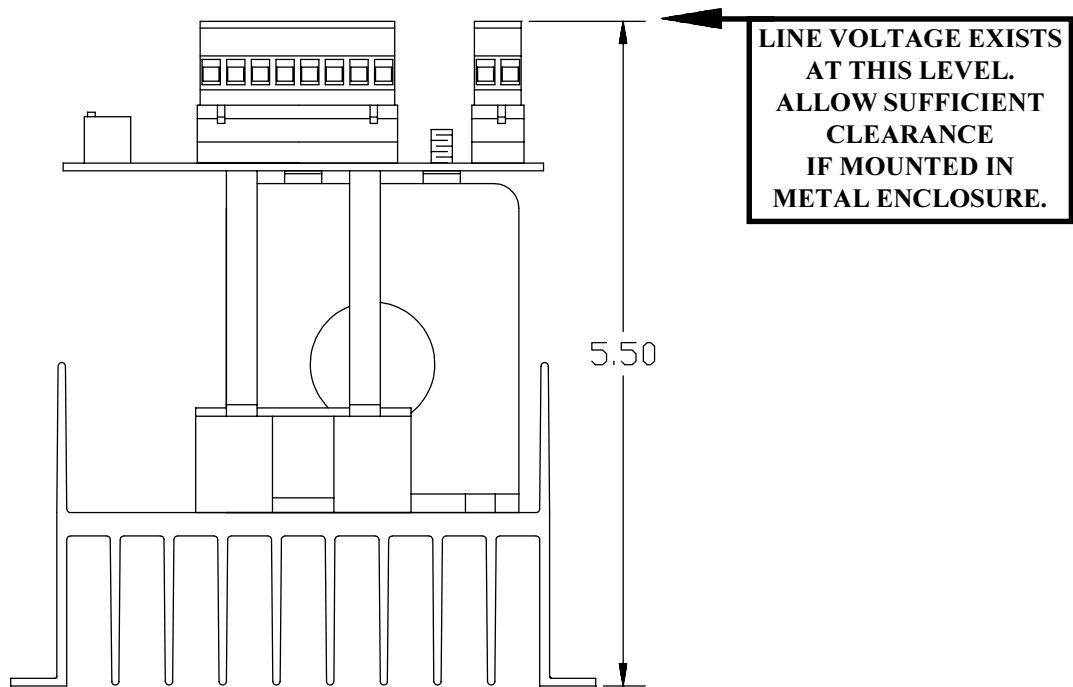
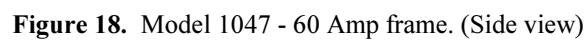
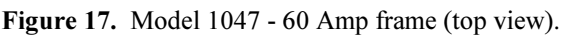
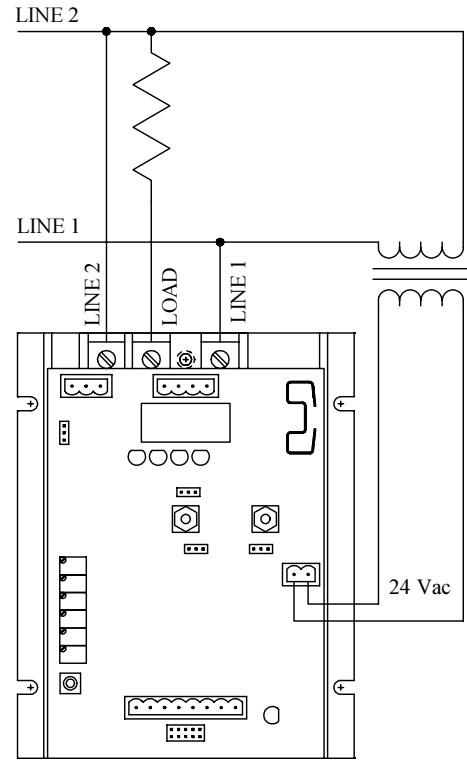


Figure 16. Model 1047, 10 to 30 Amp frame. (End view)

INSTALLATION DRAWINGS. (CONT.)

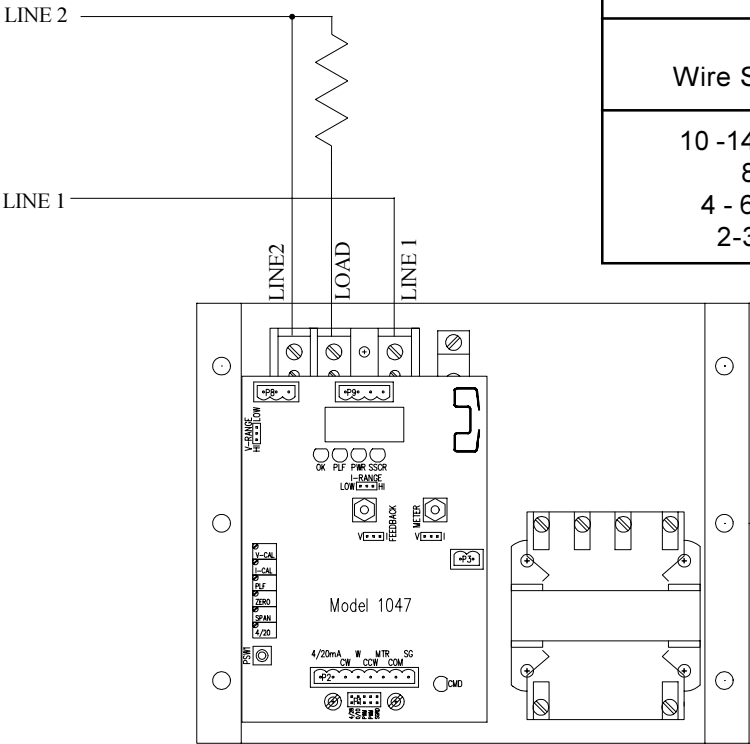


ELECTRICAL CONNECTIONS:



See Figs. 21 to 24 on page 10 for transformer information

Figure 19. Line, load & transformer connections on the 30A model.



TORQUE TABLE FOR LINE & LOAD CONNECTORS	
Wire Size	Recommended Torque
10 -14 ga	35 in-lbs
8 ga	40 in-lbs
4 - 6 ga	45 in-lbs
2-3 ga	50 in-lbs

Figure 20. Line & load connections on the 60A model.

TRANSFORMERS:

It is recommended that transformers be electrically protected.
Control Concepts stocks fuses and fuseblocks suitable for this application.
 Call factory for assistance.

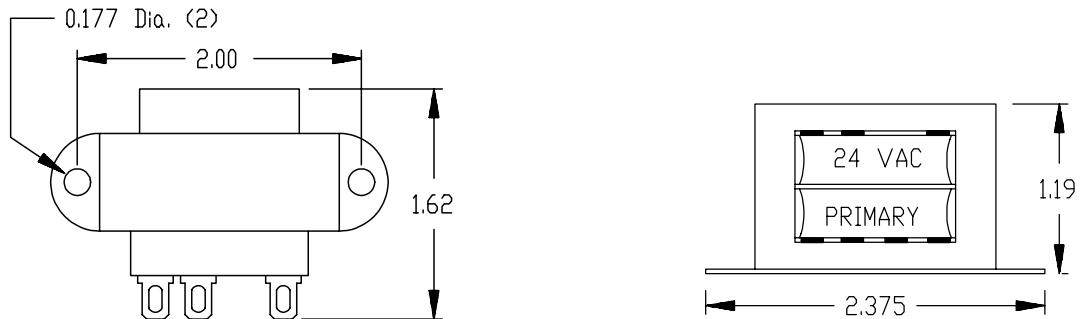


Figure 21. 6 VA transformer. This transformer will provide power for one (1) model 1047 controller.
 Primary voltage 120 Vac = CCI stock # 14020-0006-1024.
 Primary voltage 240 Vac = CCI stock # 14024-0006-3024.

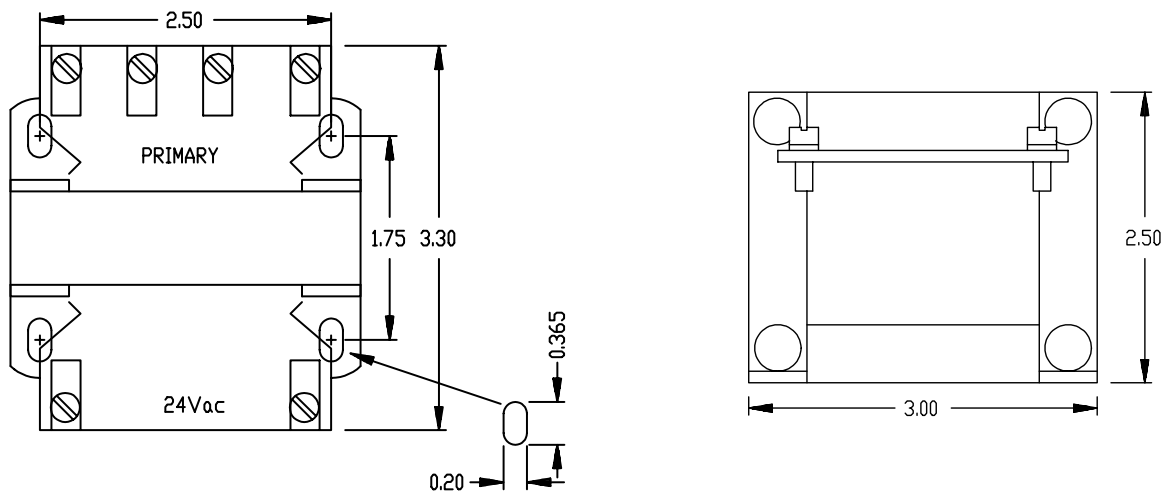


Figure 22. 25VA transformer. This transformer will provide power for up to five (5) model 1047 controllers.
 Primary voltage is either 240 or 480 VAC = CCI stock # 14025-0025-0024.

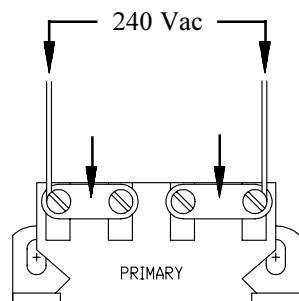


Figure 23. Jumpers in place for 240 Volt operation.

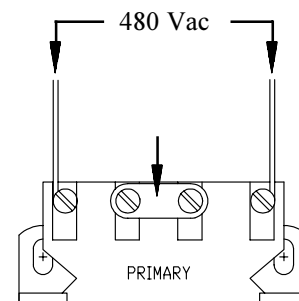


Figure 24. Jumper in place for 480 Volt operation.

TROUBLE SHOOTING:

USE EXTREME CAUTION TO AVOID ELECTRICAL SHOCK

The command indicator can be used to help in determining problems. This LED blinks faster as the circuit directs more power to the load.

THE FOLLOWING ARE SYMPTOMS AND POSSIBLE CAUSES

No load power and command indicator does not function.

1. Check fuses.
2. Determine that the correct transformer tap is selected.
3. Determine that the command signal is present and that electrical connections are made between the lead wires and the green plug-in connector.
4. Determine that 10 Vdc is present between terminal 3(+) and terminal 5(-) on the input connector. If the voltage is greater than 11 Vdc the circuit board has probably failed. If the voltage is less than 9 Vdc the circuit board or transformer has probably failed.

No load power and command indicator does function.

1. The SCR module may have failed.
2. Check load connections and load fuses.

Full or partial load power with command indicator off.

1. The SCR module has probably failed. Disconnect system power and remove circuit board from the controller. Re-apply system power. If no load voltage exists with the circuit card removed, the card has failed.

Load power is maximum, command indicator is on, command signal is at minimum.

1. Check that the command signal is zero. (A convenient method to apply zero command is to remove the input connector from the controller.) If the command indicator remains on with zero command signal, the circuit board has probably failed. If load power goes to zero when the input connector is removed, determine that the command signal is at minimum, check the command wiring and make sure that the polarity of the command signal is correct.

2. Determine if feed-back jumper is in place.

Full load power cannot be obtained and command indicator is on.

1. Visually inspect the circuit board for damage.
2. With the command signal at maximum, the voltage between the line and load terminals should be less than 2 Vdc. A reading greater than 2 volts across the line and load terminals, would indicate that the SCR has probably failed open.
3. Incorrect feedback could prevent full output.
4. The command indicator may blink even though the command signal is at maximum if the line voltage is higher than normal.

MODEL No. IDENTIFICATION:

1047-(FB)-(V)-(A)-(CS)-(FC)-V(x)-I(x)-(XX)

1047 Specifies a single phase zero-cross controller.

FB Indicates which type of feedback is used:

V = Voltage Feedback

I = Current Feedback

V The Line Voltage input value:

12 = 120 VAC

24 = 240 VAC

48 = 480 VAC

A The maximum load current:

10, 20, 30 or 60 Amps

CS The command signal:

4/20mA, 0/5Vdc, 0/10Vdc, Pot., PWM or

PWM.

FC (Optional) Designates a replacement Firing Circuit.

V(x) This number specifies the load voltage when the voltage metering output is 10Vdc.

Dual Range: **V120/240 or V240/480**

Fixed Range **V120 or V240 or V480**

I(x) This number specifies the load current when the current metering output is 10Vdc.

Dual Range: **I10/30 or I20/60**

Fixed Range: **I10 or I20 or I30 or I60**

(XX) (Optional)

SP## is used when a special product is specified.

SC## is used when a special calibration is requested.

RECOMMENDED SPARE PARTS.

Control Concepts Stock #'s for
SCR module replacements

Amps	240 Volts	480 Volts
10	1651-24-10,	1651-48-10
20	1651-24-20,	1651-48-20
30	1651-24-30,	1651-48-30
60	1651-24-60,	1651-48-60

REFERENCE DRAWINGS:

Circuit Schematic

D1000700

MANUFACTURED BY:



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www.ccipower.com

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