

CONTROL CONCEPTS INC.

INSTRUCTION MANUAL MODEL 1029A

**SINGLE-PHASE
PHASE-ANGLE
SCR POWER CONTROLLER**

MODEL NUMBER:

1029A-(FB)-(VOLTS)V-(AMPS)A-(CS)

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

1029A specifies a single phase, phase-angle SCR firing circuit which has the features of current limit, over current trip, shorted SCR detection and provides electrical isolation of the command signal.

(FB)

A specifies *average* voltage feedback. With *average* voltage feedback the controller varies the conduction angle or ON time of the SCRs such that the average voltage applied to the load is proportional to the command signal.

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.

E specifies *external* feedback. The *external* feedback being proportional to some parameter such as speed, current, etc that is ultimately being controlled by the action of the controller.

I specifies *current* feedback and therefore 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) Specifies the supply voltage the controller has been calibrated to operate at. Note: the standard controller has voltage taps on the transformer for operation at 240, 480 or 575 volts @ 50/60 hertz.

(AMPS) Specifies the continuous RMS load current rating.

(CS) The type of command signal is specified by this term. If this term is not included in the model number the controller accepts either a potentiometer or 0/5 Vdc signal as the command.

Milliamp command signals are specified by inserting the minimum and maximum currents.

For example, a 4 to 20 mA command signal is specified as 4/20mA.

A 1 to 5 milliamp signal would be specified as 1/5mA.

DESCRIPTION:

The 1029A SCR power controllers control, depending upon the model number, either the voltage, the current or the power applied to a single phase electrical load by phase-angle operation of silicon controlled rectifiers (SCRs). The product provides current limiting, over current trip, shorted SCR detection and electrical isolation of the command signal.

SPECIFICATIONS:

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

TYPE OF CONTROL:

SCR phase angle control of the voltage applied to a single phase load.

TYPES OF LOADS:

Resistive, capacitive, inductive (0.5 power factor min), Transformer coupled variable resistance and infrared lamps.

SURGE CURRENT RATINGS:

(peak one cycle non-repetitive)

Controller Rating	Surge Current rating
50, 100 & 150 AMP:	2000 Amps Peak
200 Amp:	5000 Amps Peak
250 Amp:	5700 Amps Peak
300 Amp:	8000 Amps Peak
380 Amp:	11500 Amps Peak
425 Amp:	15000 Amps Peak

SUPPLY VOLTAGE AND FREQUENCY:

Field adjustable for operation at 240, 480 or 575 volts +10% -15%. Controller operates at 50/60 hertz with no adjustments required. Other operating voltages are available.

LINEARITY:

The output (voltage or power) is proportional to the control or command signal within 2% of span.

RANGE OF CONTROL:

0 to 98% of supply voltage.

ELECTRICAL ISOLATION:

Heat sink to supply and load voltage 2500 volts peak. Control signal or command signal to supply and load voltage 1500 volts peak. Capacitance between the command signal, the supply and load voltage: 10 pfd.

dV/dT RATING:

200 volts/usec.

An MOV is provided for transient voltage protection.

PEAK VOLTAGE RATING:

SCR Peak voltage rating: 1600 Volts

SPECIFICATIONS: (CONT.)

CONTROL SIGNALS:

Potentiometer: Any value from 1K to 20K, 1/4 watt minimum.

Potentiometer is excited at 5 Vdc supplied by the circuit.

Note optimum linearity is obtained with a 1K pot.

Circuit input impedance 100K.

Voltage: 0/5 Vdc with 100K input impedance.

Higher input voltages are possible by the addition of external resistors.

Milliamp:

1/5 mA 1200 ohms input impedance

4/20 mA 300 ohms input impedance

ZERO AND SPAN:

Potentiometers on the circuit board allow zero and span adjustments of $\pm 25\%$ of span.

CURRENT LIMITING:

Current limiting prevents the load current from exceeding the rating of the SCRs and prevents excessive load current from occurring when variable impedance loads are used. A potentiometer on the printed circuit board allows adjustment of the current limiting setting from 50% to 120% of the controller rating. The current limit potentiometer is factory set for 105% of the rated current.

SOFT START AND MISSING CYCLE DETECTION:

On initiation of power or if the supply power is momentarily interrupted the load voltage is set to zero and increased to the desired value at a rate equal to a time constant of approximately 0.2 seconds.

GATE DRIVE:

A photo coupled current source of 250 mA with a maximum compliance of 20 volts provides the gate drives to the SCRs. Duration or "back porch" is approximately 1.4 milliseconds (60 electrical degrees).

SHORTED SCR DETECTION:

In the event a SCR fails in the shorted mode a relay with form C contacts rated for 5 Amps at 120 Vac is energized which can be used to activate an alarm and/or remove power by operating the trip coil of a circuit breaker.

RUN/IDLE POTENTIOMETERS:

The 1029 can be controlled from either a run or an idle potentiometer by opening or closing a remote switch.

OVER CURRENT TRIP:

If the SCR current exceeds a preset value of approximately twice the rated current the SCRs will be prevented from turning on again and a relay with form C contacts rated for 5 Amps at 120 Vac will be energized. This operation of this relay is intended to be used to sound an alarm or remove power in the same manner as the relay operation that operates if an SCR fails in the shorted mode. Momentary closure of a remote reset switch or momentary interruption of the AC supply will reset the relay and allow the controller to reapply power to the load.

RESET SWITCH:

Momentary closure of a remote switch resets the circuit if an over current condition has occurred. Closure of the reset switch during normal operation prevents the SCRs from operating but does not cause the over current relay to energize. The reset switch may be used as an ON-OFF switch.

NOTE: Removal of system power also resets the controller.

STATUS INDICATORS:

Command Indicator - The intensity of the command indicator is proportional to the command signal and the "ON" time of the SCRs.

Load Indicator - The intensity of the load indicator is proportional to the SCR and load current.

Shorted SCR Indicator - When "ON" an SCR has failed in the shorted mode and full power is applied to the load.

Over current Indicator - When "ON" indicates that the SCRs have been locked "OFF" and that the reset switch must be operated or power momentarily removed to enable the controller.

WEIGHT:

50, 100 & 150 amp controllers: 15 Pounds

All others: 25 Pounds

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).

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 in 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.

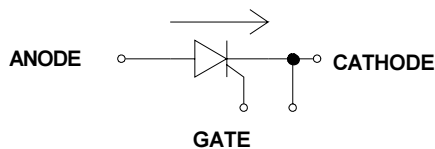


Figure 1. SCR symbol

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 1.1).

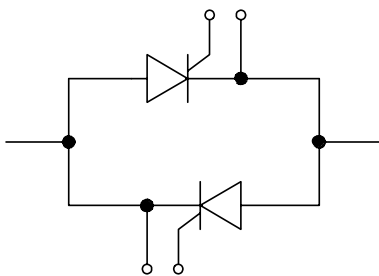
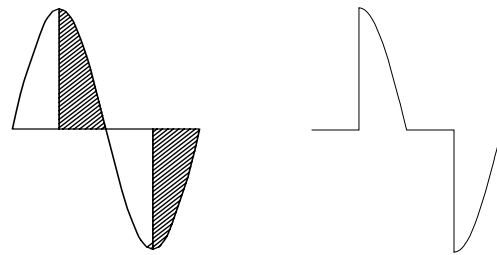


Figure 2. "AC Switch "

Phase-angle: 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 1.2). 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 or inductive.



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

Power is regulated by advancing or delaying the point at which the SCR's are turned on.

Figure 3. Phase-Angle Waveforms

INSTALLATION

TRANSFORMER TAP:

Prior to mounting the controller place the spade terminal on the transformer tap that corresponds with the supply voltage to be used.

MOUNTING AND LOCATION:

The 50 and 100 amp controller must be mounted on a vertical surface that air will flow vertically over the heat dissipating fins. All other controllers are forced air cooled and may be mounted in any direction.

COMMAND:

A potentiometer, a DC voltage or a DC current may be used as a command signal. These connections are made to the black connector as described below. Potentiometer:

NOTE: Terminals 10 & 11 must be connected when controlled by a potentiometer.

A 1000 ohm to 20,000 ohm potentiometer 1/4 watt or higher wattage may be used to adjust the load voltage. A 1000 ohm potentiometer provides the maximum linearity. Connect terminal 12 to the clockwise end of the potentiometer, terminal 13 to the potentiometer wiper, terminal 14 to the counterclockwise end of the potentiometer.

One potentiometer may be used as the command for additional controllers by connecting terminals 13 and 14 to terminals 13 and 14 of the other controllers. Do not connect terminal 12 from one controller to another.

Voltage:

A 0 to 5 Vdc signal may be used as the command signal by connecting the positive signal to terminal 13 and the negative or common signal to terminal 14. Higher DC voltages may be used by placing an external resistor in series with terminal 13 such that the voltage from terminals 13 and 14 is 5 volts.

Current:

The positive current connection is to terminal 13. The negative or return current connection is to terminal 14. The controller may be modified for current commands by the addition, between terminals 13 and 14, of a 1200, 300, or a 120 ohm resistor for a 1/5, 4/20 or 10/50mA input respectively.

If the controller is modified to accept current inputs the zero and span must be adjusted as described in the 'STARTUP' section on page 6.

OVER CURRENT TRIP RELAY:

Connections to the form C contacts of the over current relay are as shown on the cover of the controller and on page 7. The contacts are rated for 5 Amps at 120 Vac and are intended for activating an alarm and/or removing power from the system by operating a contactor or circuit breaker.

OVER CURRENT RESET:

Momentary closure of a switch connected between terminals 9 and 10 will reset the over current relay and will release the SCRs from the locked off state. The reset switch can also be used as an on off control. Closure of the switch causes the SCRs to be immediately turned OFF. When the switch is opened the SCRs begin operation at zero conduction angle and slew at the soft start rate to the desired output.

SHORTED SCR RELAY:

Connections to the 5 Amp 120 Vac form C contacts are shown on the cover of the controller and on page 7. This relay energizes if an SCR fails in the shorted mode and is intended to be used to activate an alarm and/or cause power to be removed from the system by operating a contactor or a circuit breaker.

RUN/IDLE:

A remote switch can be used, as shown on page 8, to cause the controller to be controlled by either a run command or by an idle command.

Connecting terminal 10 to terminal 11 causes the run command to be in control.

Opening the connection between terminal 10 and terminal 11 causes the idle command to be in control. A potentiometer, DC voltage or DC current may be used as a command signal.

POWER CONNECTIONS:

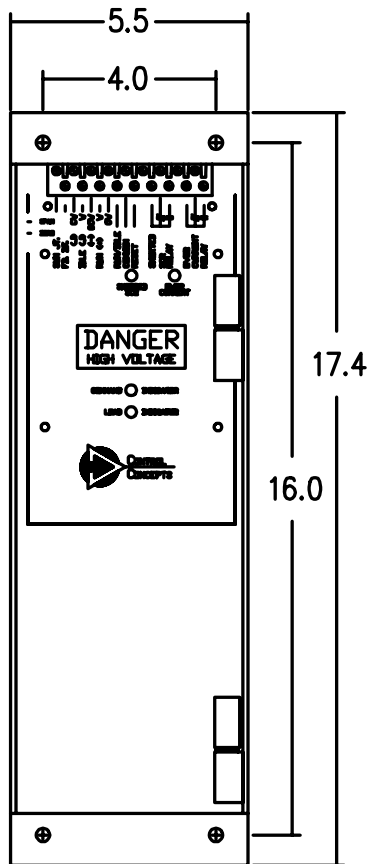
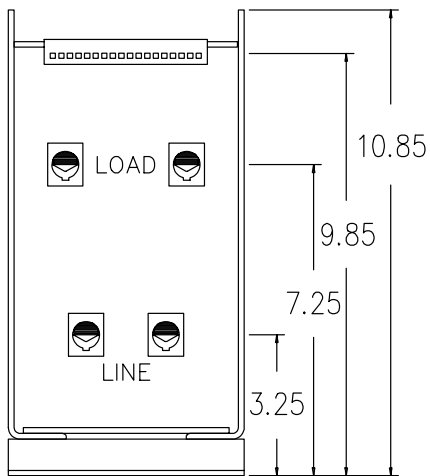
Figure 4 & 5 page 6 show the electrical connections. The line and load connectors are rated for wire sizes from #6 to 250 MCM. The recommended torques as a function of wire size are:

Recommended tightening torque for the line and load connectors:



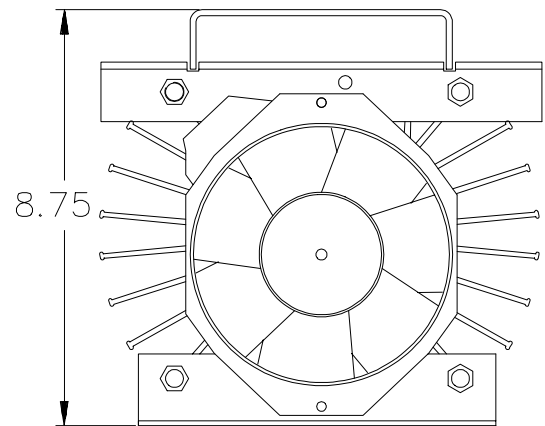
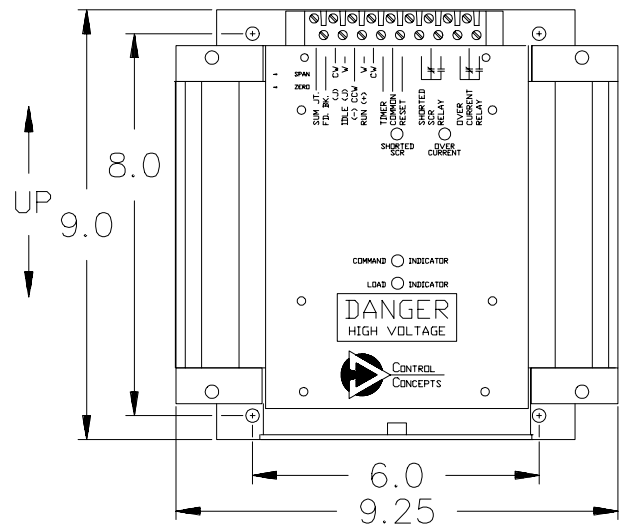
AWG or Circular Mills	Torque
6 to 4 ga	100 in-lbs
2 to 1 ga	125 in-lbs
1/0 to 2/0 ga	150 in-lbs
3/0 to 4/0 ga	200 in-lbs
250mcm	250 in-lbs

INSTALLATION: (CONT.)



INSTALLATION DRAWING 200, 250, 300 & 425 AMP

500 AMP AND LARGER FRAMES
 HEIGHT = 26.00 INCHES
 WIDTH = 7.75 INCHES
 DEPTH = 12.00 INCHES



INSTALLATION DRAWING 50, 100 & 150 AMP

50 & 100 AMP FRAMES DO NOT USE A FAN.
 & MUST BE MOUNTED WITH FINS VERTICAL

START UP:

Set the command to zero and apply system power. The load voltage should be zero and should increase as the command signal is increased. The load voltage and current may be measured with any meter. However, because of the non-sinusoidal wave-form applied by the SCRs, accurate RMS voltage measurements can only be made with true RMS meters and accurate average voltage measurements can only be made with an average responding meter.

ADJUSTMENTS:

Zero: (Factory set to provide zero out with zero command) The zero potentiometer is used to adjust the controller to provide zero load voltage when the command is zero.

Span: (Factory set to provide 100% output with 100% command) The span determines the load voltage for a given command input.

Current Limit: (Factory set at 105% of rated current) Clockwise rotation increases the point at which current limit occurs.

The span and zero have been adjusted at the factory and should require no further adjustments.

If adjustments are required, the following procedures should be used.

1. Set the command signal to minimum and adjust the zero potentiometer until the output is zero.
2. Set the command signal to maximum and adjust the span potentiometer until the output is at the desired maximum value.
3. The span and zero adjustments may interact, therefore it may be necessary to repeat steps 1 and 2.

Note: The rated load current and voltage must be applied when the span and zero are adjusted on controllers controlling load power (Model 1029A-P).

Note: Loads with variable resistance may cause the current limiting feature to limit the output of the controller, which would appear as though the span is not adjusted properly. Rotate the current limit pot 1 turn counterclockwise, if the load current decreases the current limit is controlling the output.

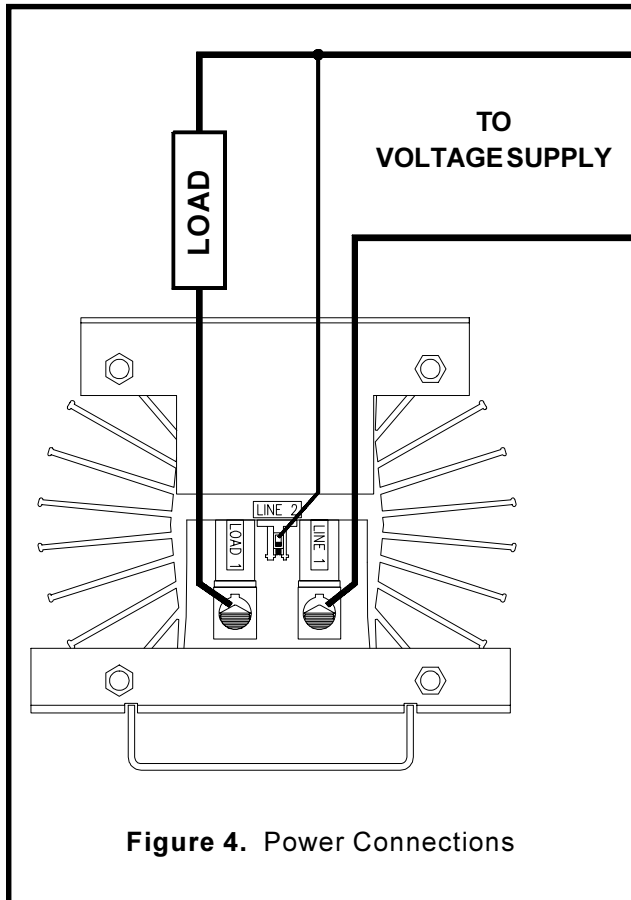


Figure 4. Power Connections

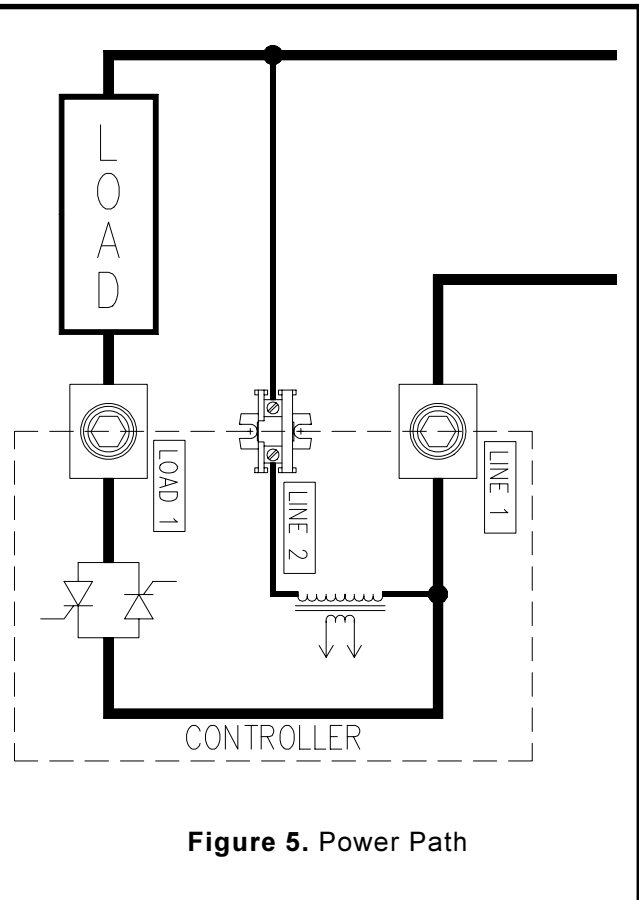


Figure 5. Power Path

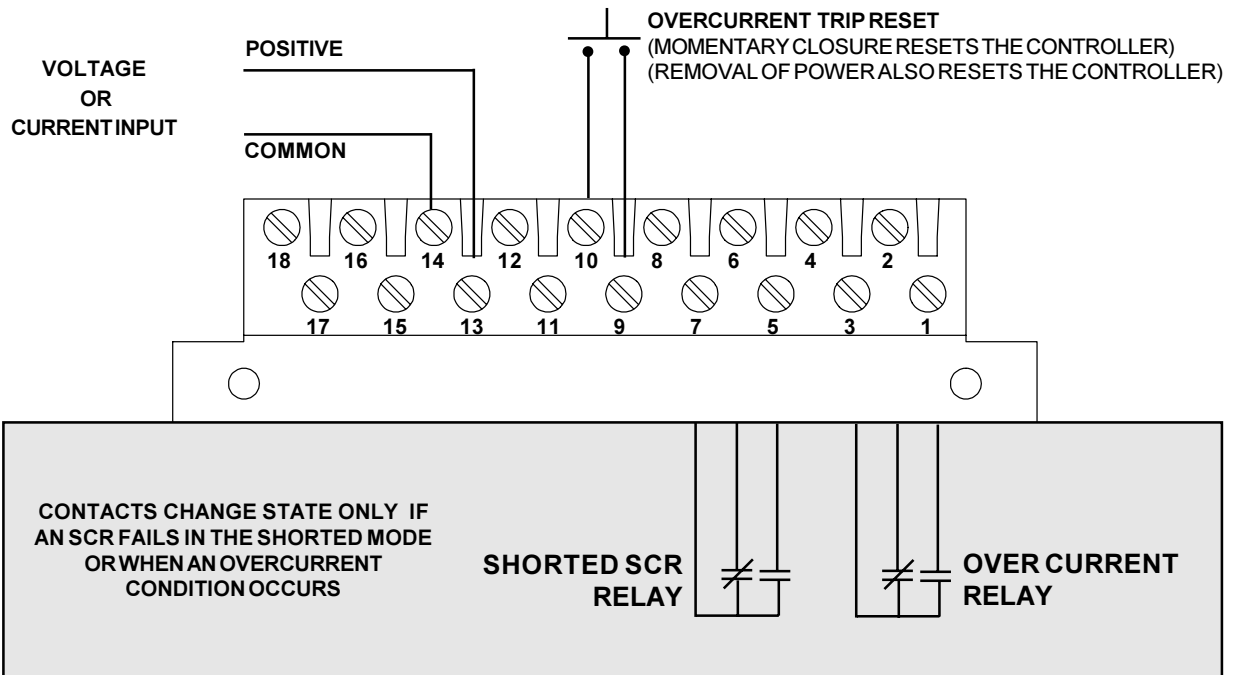


Fig. 6. MODEL 1029 VOLTAGE & CURRENT CONNECTIONS

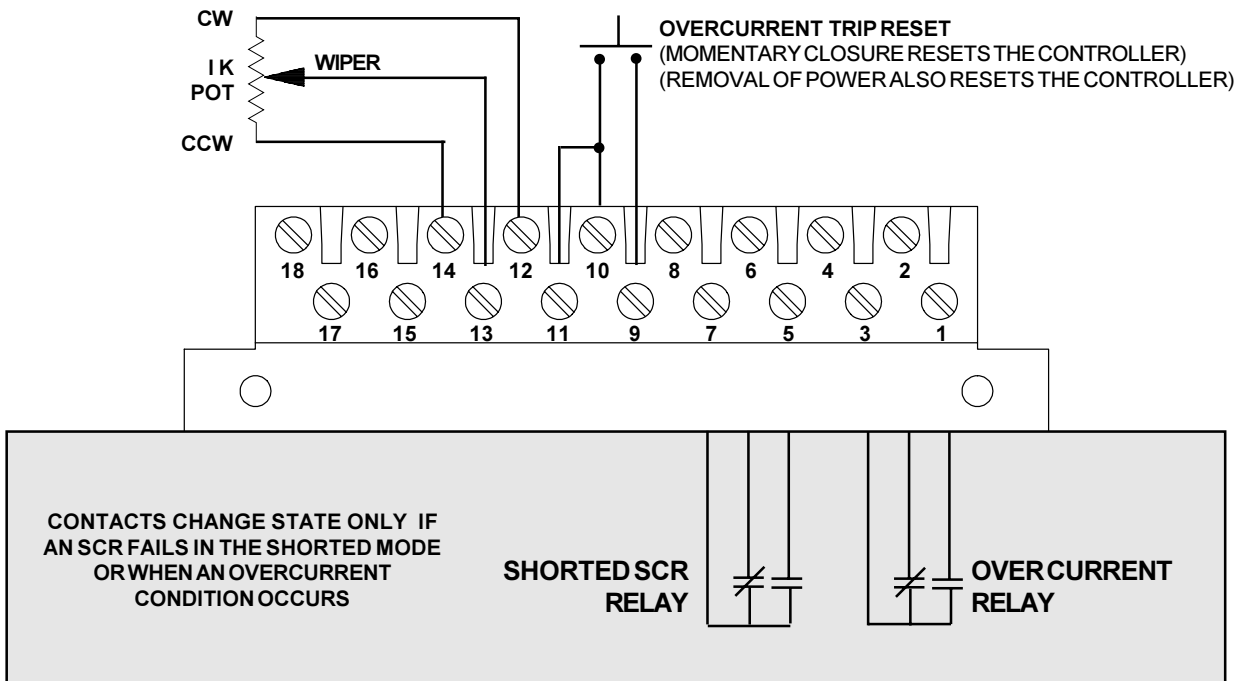


Fig. 7. MODEL 1029 POTENTIOMETER CONNECTIONS

IDLE POTENTIOMETER

RUN POTENTIOMETER

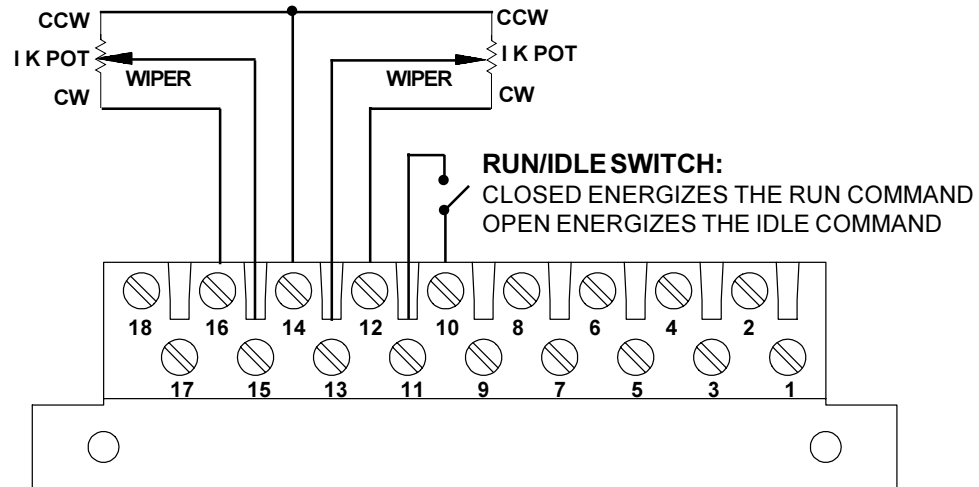


Fig. 8. MODEL 1029 RUN/IDLE CONNECTIONS

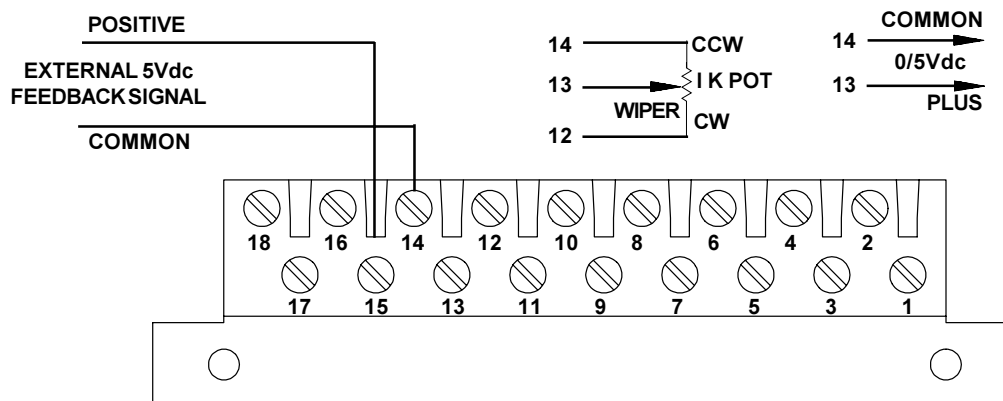


Fig. 9. MODEL 1029A SIGNAL CONNECTIONS
 0 TO 5Vdc EXTERNAL FEEDBACK
 (INPUT IMPEDANCE TERMINAL 15 TO TERMINAL 14 100K OHMS)

(NOTE: RMS CONVERTER U27 MUST BE REMOVED WHEN USING AN EXTERNAL FEEDBACK)

TROUBLE SHOOTING:

CAUTION: PORTIONS OF THE PRINTED CIRCUIT BOARD ARE AT LINE VOLTAGE POTENTIAL AS ARE OTHER PARTS OF THE CONTROLLER. USE EXTREME CARE TO AVOID ELECTRICAL SHOCK.

The command, shorted SCR, over current and line current indicators provide a convenient method of determining the location of problems should they occur. The intensity of the command indicator is proportional to the command signal and therefore should be proportional to the load voltage. Correct operation of the command indicator proves that the command signal is applied and that the majority of the circuit is operating correctly. The intensity of the line current indicator should change as the command signal is changed. The over current indicator will be ON when the load current has exceeded the preset limit. The shorted SCR indicator is ON when an SCR has failed in the shorted mode.

The 1029 circuit is interchangeable with all other 1029 circuits independent of the current rating of the controller. Substituting a circuit known to be good is often a quick method of isolating a problem.

The following are some symptoms and steps to locate problems.

NO LOAD VOLTAGE:

Note: The SCRs must have a load current of at least 1 amp to insure correct operation.

Determine that the over current light is not ON and that the command light changes intensity as the command signal is changed. If the command light is not ON determine that the reset switch, if used, is open and that a command is applied. If the command light is ON but the load current indicator is OFF check the load fuses and system voltage.

If the command light is OFF and the over current light is ON, remove the connection to load 1. If the command light can now be varied and the over current light is OFF, check for load faults. If the command light remains OFF and the over current light remains ON the circuit has probably failed.

LOAD VOLTAGE WILL NOT GO TO ZERO:

If the load voltage is small adjust the zero potentiometer. If the shorted SCR indicator is ON an SCR has failed. It is however possible for a circuit failure to cause the same symptoms. If the load voltage will not go to zero with the circuit card removed from the controller an SCR has failed. If the load voltage does go to zero with the circuit card removed replace the circuit card.

FULL VOLTAGE CANNOT BE OBTAINED:

Determine that the load current is not greater than the current limit setting. Adjust the current limit slightly and determine if the load voltage or current changes. If the maximum obtainable load voltage is approximately 70% of the supply the problem is likely a circuit card failure.

RECOMMENDED SPARE PARTS:

CONTROL CIRCUIT:

1029A-(FB*)-FC

*Specify A, V, I, or P

SCR MODULE:

CONTROLLER CURRENT RATING	CONTROL CONCEPTS PART NUMBER
50 AMPS	28325-0395-516
100 AMPS	28325-0395-516
150 AMPS	28325-0395-516
200 AMPS	28000-0424-516
250 AMPS	28000-0434-516
300 AMPS	28000-0449-516
380 AMPS	28011-0460-516
425 AMPS	28011-0476-516
500 AMPS	28011-0460-516
600 AMPS	28011-0476-516
750 AMPS	28011-0514-516
1000 AMPS	28013-0518-516

REFERENCE DRAWINGS:

1029-V, I, E	Schematic	C1000021H6
	Schematic	C1000397H6

1029-P	Schematic	C1000269H6
--------	-----------	------------

MANUFACTURED BY:



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

8077 Century Blvd
Chanhassen, MN 55317, USA