

MODEL 1027A

INSTALLATION & MAINTENANCE MANUAL

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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 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.

PROPRIETARY DATA

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DESCRIPTION

This manual describes the model 1027A controller rated 50 to 160 Amps. The model 1027A is a single-phase, distributive-zero-cross SCR controller which linearly controls, with respect to a command signal, the electrical power applied to a single-phase resistive load.

Zero-cross control implies that the load voltage is switched on and off only when the instantaneous value of the sinusoidal supply voltage is zero.

Distributive zero-cross control implies 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 zero-cross control for additional details.)

The controller responds to: a mA command signal, a voltage command signal or a potentiometer. 10Vdc is provided by the controller to excite the potentiometer. Electrical isolation is provided to isolate the command signals from the line and load voltages. The peak load current must be no more than 200 Amps.

SPECIFICATIONS

CONTROL MODE:	Single-phase, distributive zero-cross control.		
CURRENT RATING:	The "[AAA]A" term within the model number specifies the maximum continuous RMS current rating at the maximum operating ambient temperature of 55°C.		
COMMAND SIGNAL:	Input	Resistance	
	1/5 mA	1200 ohms	
	4/20 mA	300 ohms	
	0/10 Vdc	240K ohms	
	0/5 Vdc	120K ohms	
	Potentiometer	240K ohms	
	(1K recommended; 20K permissible 1/2 watt)		
POWER CIRCUIT:	Inverse parallel silicon controlled rectifiers (SCRs)		
OPERATING VOLTAGE:	208 or 240 or 480 Vac 50/60 Hertz +10 -15%. Other voltages are available, consult factory.		
AMBIENT TEMPERATURE:	Operating	0 to 55°C	
	Storage	-40 to 80°C	
HUMIDITY:	0 TO 95% Non Condensing		
ISOLATION:	Isolation between power circuit, command signal and ground is >2500 Vrms.		
LINEARITY:	The load power is linear within 2% of span with respect to the command signal.		
VOLTAGE COMPENSATION:	The load power remains constant within 2% of span for line voltage variations of +10% and -15%.		
CONTROL RANGE:	0 to 99.5% of supply voltage.		
SCR VOLTAGE RATING:	1600 volts peak		
SCR SURGE CURRENT AND I²t RATING	Controller rating	Peak 1 cycle non-repetitive I _{rsm} @ 125°C	I ² t rating @ 125°C
	50 & 80 Amps	1750 Amps Peak	15,000 A²s
	120 Amps	1900 Amps Peak	18,000 A²s
	160 Amps	4000 Amps Peak	80,000 A²s
DV/DT & TRANSIENT VOLTAGE PROTECTION:	DV/DT rating exceeds 200 volts per microsecond. A snubber circuit and MOV are provided to protect against high frequency transients (dv/dt) and high voltage transients.		
ZERO AND SPAN:	Adjustment range is ±20% of span.		
COMMAND INDICATOR:	An LED is lit when the SCRs are turned on.		
HEAT DISSIPATION:	1.5 watts per amp of SCR current.		

SYNC-GUARD™ FEATURE

The sync-guard feature reduces the possibility of synchronous operation of two or more controllers. This 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.

Figures 1 through 3 show the total current as a function of time for three controllers, with, and without SYNC-GUARD™ and various load powers.

Refer to Figure 10 for connections when using SYNC-GUARD™ on multiple model 1027A's. Use only one load resistor for each group of controllers connected in this manner.

When using the SYNC-GUARD™ feature, the mA control signals must be isolated from each other.

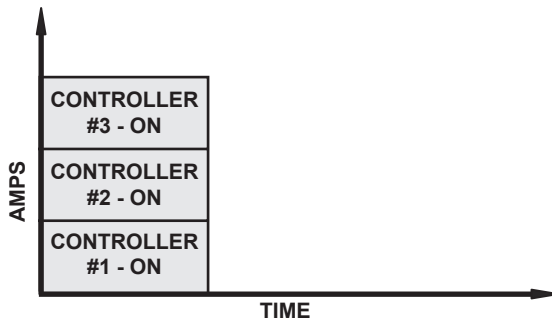


Figure 1. Three controllers providing 33.3% power each, operating synchronously.

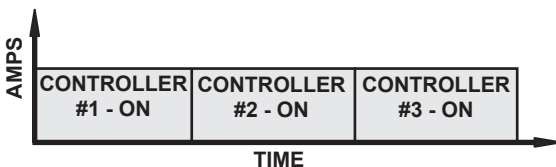


Figure 2. Three controllers providing 33.3% power each, with sync-guard.

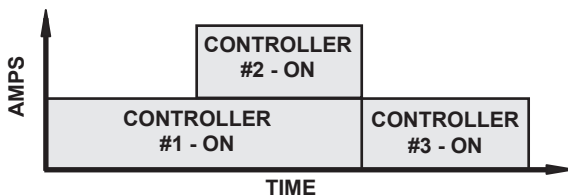


Figure 3. Three controllers with sync-guard, two providing 33.3% power & one providing 66.6% power.

TRANS-GUARD™ FEATURE

The use of zero-cross controllers on the secondary of a transformer can cause saturation of the transformer, resulting in excess transformer temperatures, and early failure.

Transformers can be caused to saturate if a DC voltage is applied to the primary. DC voltage can be induced on the primary by DC components in the secondary. The simple half wave rectifier circuit shown in Figure 4 will induce a DC voltage on the primary due to the fact that the voltage drop across the source resistance during the half-cycle the diode conducts will lower the primary voltage.

The TRANS-GUARD™ feature eliminates the problem by always supplying an odd number of ON half-cycles, and an even number of OFF half-cycles. Refer to table 1.

The saturation problem is not likely to occur when the load is a small percentage of the transformer capacity, or when the source resistance and inductance are small. However, the potential problem is eliminated by the TRANS-GUARD™ feature of the model 1027A.

Note: The AC power source inductance can also cause a DC voltage to occur on the transformer primary.

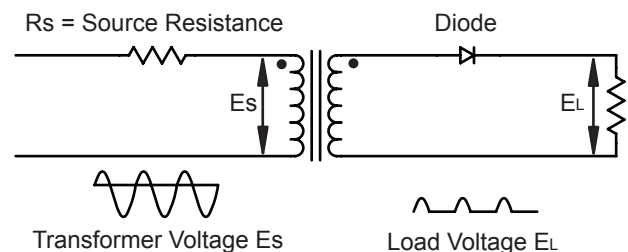


Figure 4. DC components in the secondary induce DC voltage in the primary causing transformer saturation.

INSTALLATION

DETERMINE THAT THE TRANSFORMER TAP IS SET TO A VALUE WHICH CORRESPONDS TO THE SUPPLY VOLTAGE.

MOUNTING AND LOCATION:

The 50 and 80 amp controller must be mounted on a vertical surface with the fins oriented so that air may flow between them. The preferred orientation of forced air cooled controllers is on a vertical surface with the fan blowing the air upward through the heatsink. The controller should be used in an environment that is free from dust and contaminants and which will not exceed 55°C.

POWER CONNECTIONS:

Figure 6 and Figure 7 show the electrical connections. The line and load connectors are rated for wire sizes from #6 to 250 MCM. The table of recommended tightening torques as related to wire size can be found on page 4.

FUSES:

It is recommended that a fast acting fuse such as Bussmann types JJS & JJJ class T or Carbone-Ferraz Class-FA be used to protect both the SCR controller and the load.

Fuses should typically be rated for 120 to 125% of the maximum load current. Control Concepts maintains an inventory of most fuses and fuse holders. Technical personnel are available to answer questions regarding fuse applications.

It has been mandated by the National Electrical Code and the Occupational Safety and Health Act (OSHA) of 1970 that a physical disconnect be installed ahead of all remotely actuated control equipment and that the disconnect must be opened before maintenance work is performed on the controller or it's connected load.

Wire the controller in accordance with the electrical codes for the area in which it will be used. Connect the supply power and load as shown in the electrical installation drawings (Figure 6 & Figure 7). The connectors are rated for use with wire sizes from 6ga to 250MCM.

Type THWN or THNN wire is recommended.

It is also recommended that an oxide inhibitor such as Burndy Petrox A, or IlSCO De-OX be used on power connections to insure good electrical conductivity.

INSTALLATION DRAWINGS

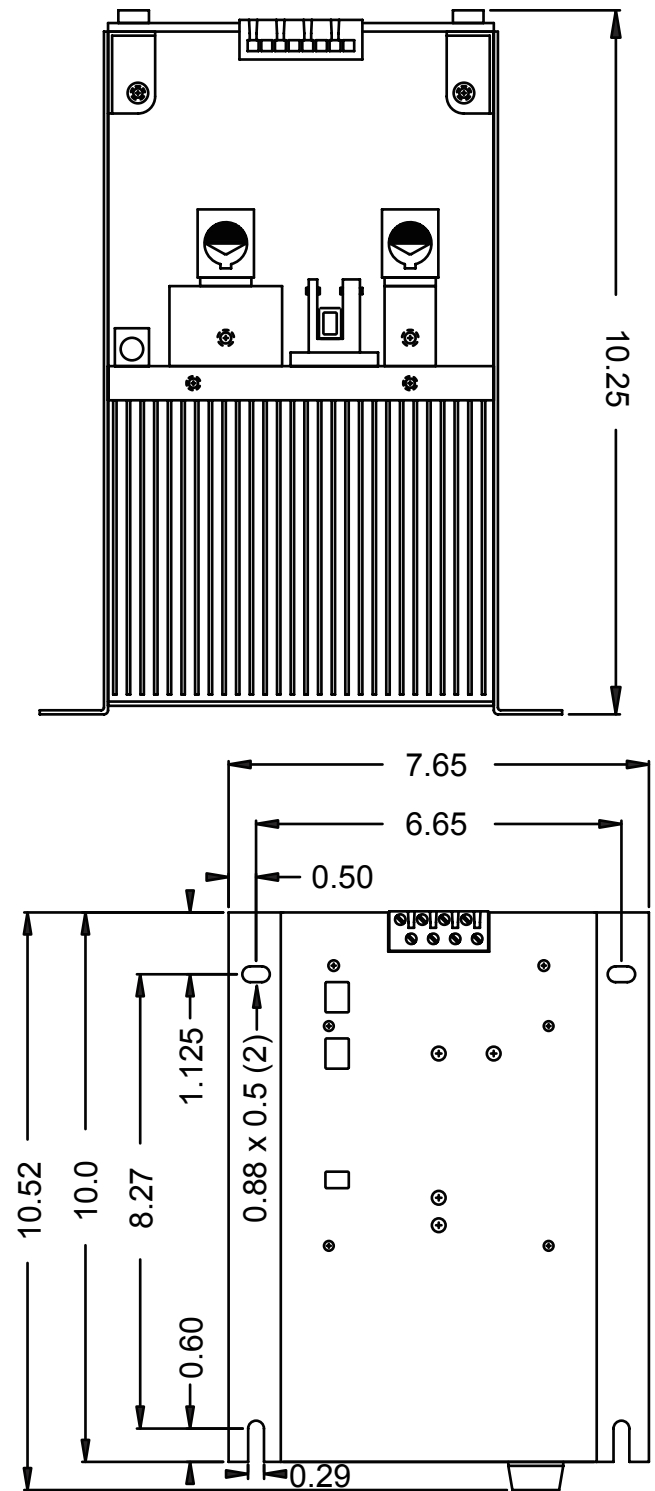


Figure 5. Installation Drawing for 50 to 160 Amp Models.

It is important that the 50 & 80 Amp models, which have no fan, be mounted vertically so that air may flow freely between the heatsink fins.

CONTROL CONNECTIONS

Connect the control wiring as shown in Figure 8.

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

POTENTIOMETER INPUT:

1K to 20K resistance, 1/2 watt.

Clockwise to terminal P2-6 (CW)

Wiper to terminal P2-5 (W)

Counterclockwise to terminal P2-4 (CCW)

Note: If multiple controllers are controlled by one potentiometer, make the connections as described above for one controller and connect terminal P2-4 (CCW) to terminal P2-4 (CCW) on all controllers, and terminal P2-5 (W) to terminal P2-5 (W) on all controllers.

VOLTAGE INPUT:

0 to 10Vdc: Common to terminal P2-4 (CCW),
10Vdc to terminal 5 (W).

0 to 5 Vdc: Common to terminal 4 (CCW),
5Vdc to terminal P2-3 (0/5V).

mA INPUT:

Common (-) to terminal P2-4 (CCW);

"+" input to terminal P2-3 (4/20mA)

AUTO/MANUAL & RUN IDLE CONTROL:

Several circuits by which auto/manual control can be implemented are shown in Figure 9. The SCR controller can be switched from a "RUN" command to an "IDLE" command by either the use of a manual switch or other automatic switching devices.

RECOMMENDED TIGHTENING TORQUE
FOR EDGE CARD CONNECTOR:



WIRE SIZE (AWG)	TORQUE
14 TO 26GA	4.4 - 5.5 IN-LBS

POWER CONNECTIONS

Wire the controller in accordance with the electrical codes for the area in which it will be used. Connect the supply power and load as shown in the electrical installation drawing aside. The connectors are rated for use with wire sizes from 6ga to 250MCM.

Type THWN or THNN wire is recommended.

It is also recommended that an oxide inhibitor such as Burndy Petrox A, or IlSCO De-OX be used on power connections to insure continuous good electrical conductivity.

RECOMMENDED TIGHTENING TORQUE
FOR THE LINE AND LOAD CONNECTORS:



WIRE SIZE (AWG) OR CIRCULAR MILLS	TORQUE
4 TO 6GA	100 IN-LBS
1 TO 2GA	125 IN-LBS
1/0 TO 2/0GA	150 IN-LBS
3/0 TO 4/0GA	200 IN-LBS
250 TO 350MCM	250 IN-LBS
500MCM	300 IN-LBS

Note: Fuses and a disconnect are recommended in the voltage supply lines.

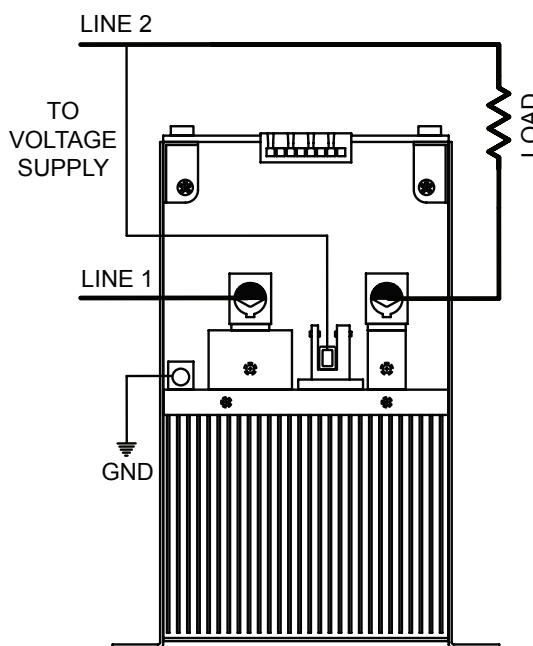


Figure 6. Power Connections.

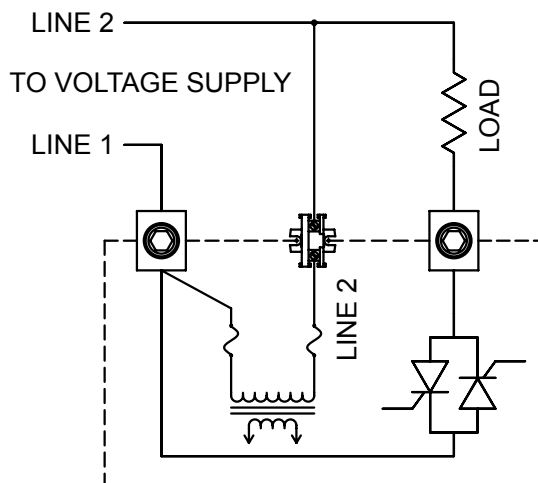


Figure 7. Power Path.

LINE AND LOAD CONNECTIONS

4/20mA: Common (-) to terminal P2-4 (CCW),
"+" input to terminal P2-3 (4/20mA)

0 to 5 Vdc: Common to terminal 4 (CCW),
5Vdc to terminal P2-3 (0/5V).

0 to 10Vdc: Common to terminal P2-4 (CCW),
10Vdc to terminal 5 (W).

Potentiometer (1K to 20K resistance, 1/2 watt):
Clockwise to terminal P2-6 (CW)
Wiper to terminal P2-5 (W)
Counterclockwise to terminal P2-4 (CCW)

Note: If multiple controllers are controlled by one potentiometer, make the connections as described for one controller and connect terminal P2-4 (CCW) to terminal P2-4 (CCW) on all controllers, and terminal P2-5 (W) to terminal P2-5 (W) on all controllers.

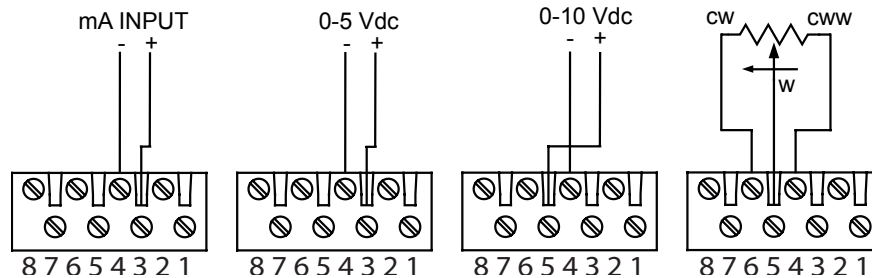
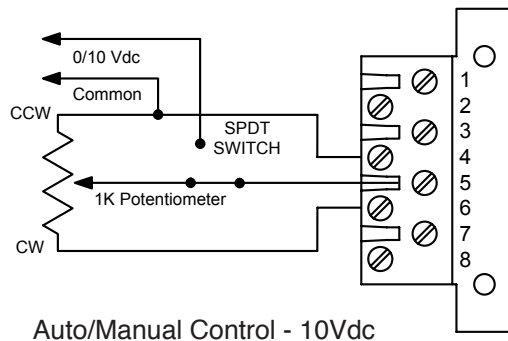


Figure 8. Command Signal Connections.

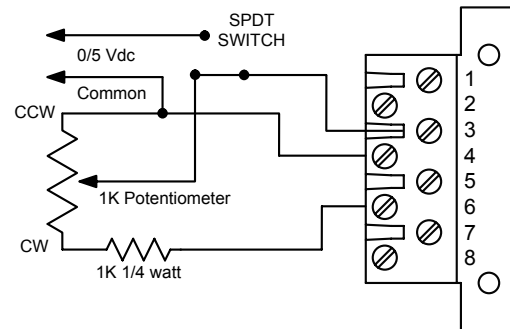
AUTO/MANUAL & RUN IDLE CONTROL:

Several circuits by which auto/manual control can be implemented are shown in Figure 9. The SCR controller can be switched from a "RUN" command to an "IDLE" command by use of a manual switch or other automatic switching devices.

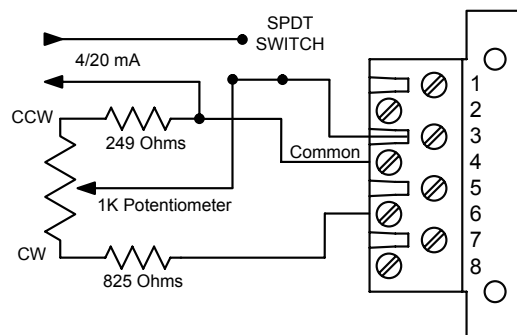
Shielded wiring is not required. It is recommended that the control wire not be placed adjacent to the power wiring.



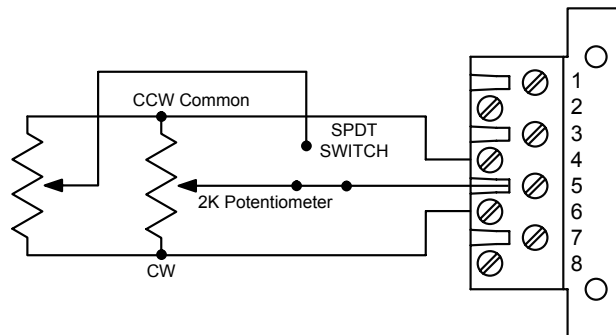
Auto/Manual Control - 10Vdc



Auto/Manual Control - 5Vdc



Auto/Manual Control - 4/20mA
(Specify input range of 1.2 to 6Vdc)



Run/Idle - Potentiometer

Figure 9. Methods of Controlling the Model 1027A with Multiple Command Signals.

SYNC-GUARD CONNECTIONS

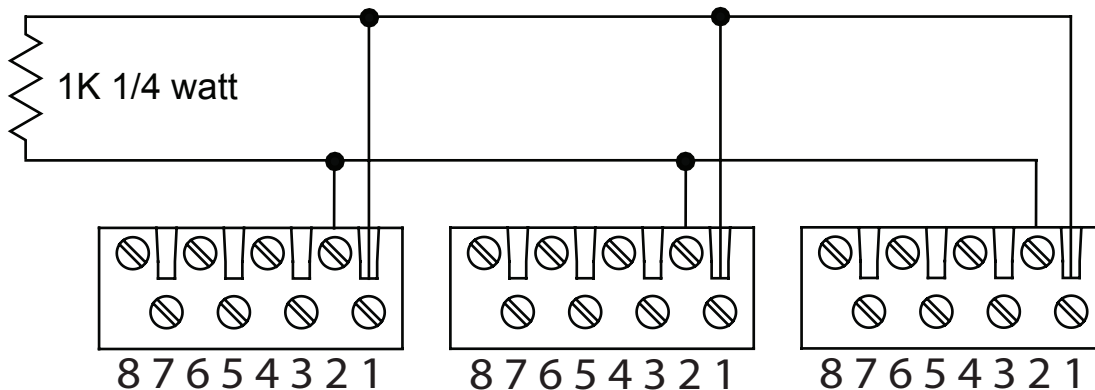


Figure 10. Sync-Guard Connections.

START UP

USE EXTREME CAUTION TO AVOID ELECTRICAL SHOCK

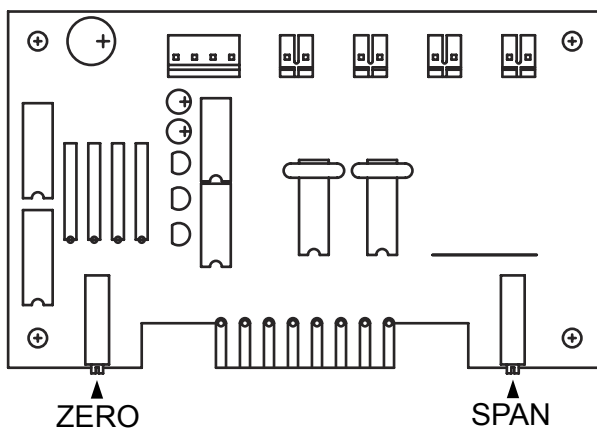
Before applying power, determine that the transformer tap is set at a value corresponding to the supply voltage.

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

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

CAUTION: Portions of the electronic circuit and other parts of the controller are at line voltage.

ADJUSTMENTS



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.

THEORY OF OPERATION

The heart of the 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 up to 1400 volts; in the ON state, they can pass several thousand amperes. When a small signal is applied between the gate and cathode terminals (Figure 11), 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.

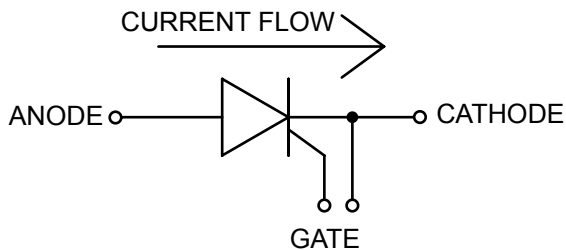


Figure 11. SCR symbol.

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 12).

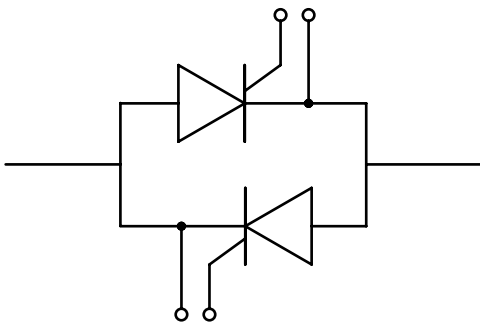


Figure 12. "Inverse Parallel" Configuration.

ZERO-CROSS CONTROL

In zero-cross control, load power is turned ON and OFF only when 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. Because of the TRANS-GUARD feature, the 1027A always applies an odd number of "ON" cycles and an even number of "OFF" half cycles. The following tabulation shows the sequence of "ON" and "OFF" electrical half-cycles that are applied to the load to achieve the percentage of load power indicated. The percentage of load power is equal to; the ratio of the number of electrical half-cycles that power is applied, to the total number of electrical half-cycles.

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 ON
				4 OFF
				23 ON
				4 OFF
				23 ON
				4 OFF
				21 ON
				4 OFF
Table 1. Load Power Timing.				

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

MODEL NUMBER IDENTIFICATION

1027A-[Volts]V-[Amps]A-[CS]

1027A

Specifies a single-phase SCR controller which linearly controls, with respect to a command signal, the power applied to a single-phase resistive load by distributive zero-cross operation of a pair of inverse parallel SCRs.

[Volts]V

Specifies the operating voltage. It refers to the supply voltage the controller has been calibrated to operate at. Note: the standard transformer installed in the model 1027A has primary voltage taps for operation at 208, 240 or 480 volts, 50/60 hertz. Other voltages are available. Contact factory for information.

[Amps]A

Specifies the continuous RMS current rating: 100, 150, or 180 Amps.

[CS]

Specifies the range and type of command signals the controller is factory calibrated to respond to. If the [CS] term is blank, the controller will accept a **potentiometer** input, a **0/5Vdc** command signal or a **0/10Vdc** command signal.

Example:

1027A-480V-80A-4/20mA

Specifies 480 volt operation, 80 amps continuous current rating and a 4/20mA command signal.

If a "SC(**VVV**)" term is included, it implies special calibration, meaning that the controller has been calibrated for a maximum output of (**VVV**) voltage rather than the rated (line) voltage. Contact factory for information.

TROUBLESHOOTING

USE EXTREME CAUTION TO AVOID
ELECTRICAL SHOCK

DO NOT APPLY POWER TO THE SCR WITH THE
CATHODE OR GATE LEADS REMOVED

It has been mandated by the National Electrical Code and the Occupational Safety and Health Act (OSHA) of 1970 that a physical disconnect be installed ahead of all remotely actuated control equipment and that the disconnect must be opened before maintenance work is performed on the controller or its connected load.

THE FOLLOWING ARE SOME SYMPTOMS WITH
SUGGESTIONS TO HELP LOCATE PROBLEMS:

No load power and no command indicator.

1. Check fuses.
2. Determine that power is present between line 1 and line 2 terminals
3. Determine that the command signal is present and that electrical connection is made between the lead wires and the plug-in connector.
3. Determine that 10 Vdc is present between terminal 6 and terminal 4 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. (Determine that correct transformer tap is selected.)

No load power, command indicator functions correctly.

1. Remove system power and visually inspect circuit board for damage.
2. Check load connections.
3. Measure voltage across load. If voltage exists, check load.

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 corresponding line and load terminals should be less than 2 Vdc. If the voltage is greater than 2 volts, the SCR module has probably failed.
3. Check the Zero and Span potentiometer adjustments. (Page 6.)
4. Determine that load has not aged beyond its useful life. (Silicon Carbide.)

Full or partial load power, command indicator is off.

1. If the voltage between the line and load terminals is zero, the SCR has likely failed.

2. Remove system power and remove circuit board from the controller. Reapply system power. The SCR has failed if voltage still exists across the load.
 3. If load voltage no longer exists when the circuit card is removed, the card has failed.
- Full load power, command indicator is on, command signal is at minimum.
1. If the command indicator remains on with zero command signal the circuit board has failed.
(A convenient method to apply zero command is to remove the input connector from the controller.)
 2. If load power goes to zero when the input connector is removed, determine that the command signal is at minimum and correctly wired.

REPLACEMENT PARTS

Replacement SCR Modules:

Frame size	Control Concepts Sub Assy
50 & 80Amps 120A 160A	SCR/TT91-14 SCR/TT105-14 SCR/TT132-14

Replacement Firing circuit:

1027A-FC-X/XmA

1027A-FC

X/XmA

= firing circuit.

= specifies the milliamp control signal. (for example "4/20mA")

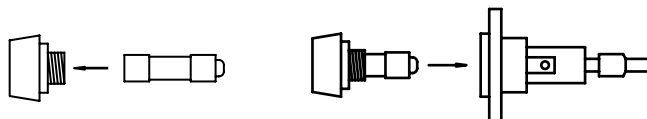
**It is recommended that the controller and load be
protected by Class T fuses:**

Frame size	Fuse size	Control Concepts Part No.
50A 80A 120A 160A	60A 100A 150A 200A	42110-0460-360 42110-0460-410 42110-0460-415 42110-0460-420

Replacement control transformer fuses

Class CC, Type R

Frame size	Fuse size	Control Concepts Part No.
50 & 80Amp 120 & 160Amp	1/4A 1/2A	42130-0460-2025 42130-0460-205



Place flat end of fuse in cap, then insert into holder.

MANUFACTURED BY



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