

MODEL 1600-EM10-01

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

The model 1600-EM10 consists of up to 10 single-phase, phase-angle and/or zero-cross, or up to 5 zones of two-leg, three phase, zero cross SCR power controllers on a single heat sink assembly. The assembly is intended for mounting on the exterior of an enclosure containing a "cut out" such that the electronics and power connections are inside the enclosure and the heat dissipating fins of the heat sink are external to the enclosure. Each of the power controllers is rated for continuous operation and each linearly controls the voltage applied to a load proportional to the command or control signal applied to its firing circuit. Some circuits also have line voltage compensation which maintains the RMS value of the load voltage constant independent of line voltage variations.

SPECIFICATION

CONTROL MODE	Single phase; Phase-angle or zero-cross depending on the firing circuit.
COMMAND SIGNAL	See limited firing circuit profiles, pages 3, 4, & 5.
CONTROL RANGE	0 to 97% of line voltage.
LINEARITY	RMS load voltage is linear within 2% of span of the command signal.
ZERO AND SPAN ADJUSTMENT	User adjustable over range of +/- 20% of span.
ISOLATION	Dielectric strength input/line & load voltage/heatsink 2500V _(RMS) Insulation resistance input/line & load voltage/heatsink 10 ¹⁰ ohms. Maximum capacitance input to output 8pf.
COOLING	Convection
MOUNTING	Must be mounted on vertical surface with fins vertical. Units may be mounted adjacent to each other. Heat sink is electrically isolated.
LINE VOLTAGE	120, 240, 480 or 575 Vac +10%,-20% 50/60 Hertz.
DIAGNOSTIC INDICATOR	The intensity or rate of an LED varies as a function of the command signal. Feature provides a quick means to check controller operation.
PHYSICAL	Weight: 20 pounds. Dimensions: Refer to installation drawing.
ENVIRONMENT	Operating: 0 to 55° C (32 to 131° F) Storage: -40 to 80° C (-40 to 176° F) Humidity: 0 to 95% Non-condensing
DV/DT AND TRANSIENT VOLTAGE PROTECTION	200 volts/usec minimum A dv/dt snubber and a metal oxide varistor (MOV) are provided to protect against high frequency transients (dv/dt) and voltage spikes.
DISSIPATION	1.5 watt per amp of controlled current
RECOMMENDED FUSING	Special semiconductor fuses are not required. It is advised that the controller and load be protected with fast acting class 'T' fuses such as Bussmann type JJN (300V) or JJS (600V) fuses. Control Concepts maintains an inventory of fuses and fuse holders for your convenience. It is recommended that a fuse rated 120 to 125% of maximum load current be selected.

SURGE CURRENT RATING				KW RATINGS *			
Continuous RMS rating	RMS 1 Second	Peak 1 cycle (Non-Repetitive)	I ² t rating	240 Vac		480 Vac	
				1 Phase	3 Phase	1 Phase	3 Phase
10	145	750	2345	2.40	4.16	4.80	8.31
20	145	750	2345	4.80	8.31	9.60	16.63
30	145	750	2345	7.20	12.47	14.40	24.94
40	280	1000	4150	9.60	16.63	19.20	33.25
50	280	1000	4150	12.00	20.78	24.00	41.57

* **NOTE:** The three phase numbers are for two leg **WYE** or **DELTA** configuration only. If **INSIDE DELTA** configuration is used, the power is equal to three times the single phase ratings.

INSTALLATION

MECHANICAL:

The controller is intended to be mounted vertically on the exterior surface of an enclosure with a “cut out” to allow the electronics to be in the interior of the enclosure. The sketch on page 7 shows the suggested cutout dimensions.

ELECTRICAL:

All wiring must be per local electrical codes. The supply and load terminals will accept up to # 6 wire. The terminals for the circuit transformer and control signals accept wire up to # 18. The terminals for the control signals and circuit transformer are plug-in type and may be removed by pulling perpendicular to the circuit card.

CAUTION: Do not over tighten the connector screws.

NOTE: It is recommended that the controller and the load be protected with fast acting class “T” fuses such as BUSSMANN type JJN or JJS. (Control Concepts Inc. stocks fuses and fuse blocks for your convenience.)

1 amp slow blow fuses are recommended for the reference transformer. The assembly should be connected to earth ground using the ground terminal provided. See individual firing circuit manual for detailed connection and control signal information.

TRANSFORMERS:

A common installation error has been that of the circuit transformer being connected across the SCR module rather than from the supply. See page 9.

Zero-cross controllers:

One transformer can be used to power several zero-cross circuits regardless of phase.

Phase-angle controllers:

One transformer can be used to power several Phase-angle firing circuits provided they are all on the same phase and the transformer is powered from the same electrical source that they control.

CAUTION. If the command signal is a current signal, (i.e. 4/20mA) the circuits must be isolated by using either separate transformers or isolating the current command signal.

ZERO AND SPAN ADJUSTMENTS

The zero and span adjustments have been factory adjusted to provide zero load voltage when the minimum command signal is applied and to provide rated output voltage to the load when the maximum command signal is applied. Further adjustment of these settings should not be required. If it becomes necessary to readjust the zero and span settings the following procedures should be followed.

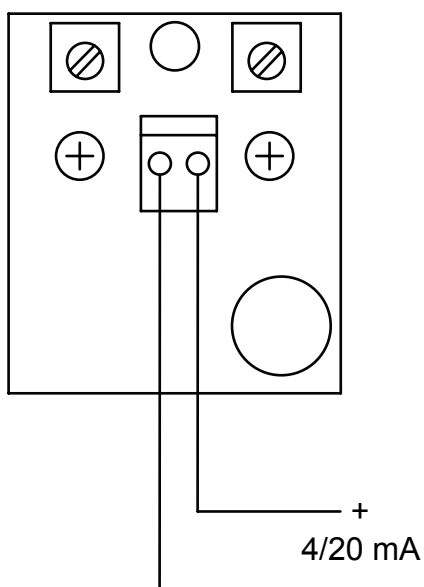
Adjust the zero potentiometer with the minimum command signal applied such that the load voltage is just zero. (Clockwise rotation of both the span and zero potentiometer increase the load voltage) Adjust the span potentiometer with the maximum command signal applied such that load voltage equals the rated voltage of the controller. It may be necessary to repeat these steps due to interaction that can occur.

NOTE: Voltage and/or current measurements should be taken with meters that provide true RMS readings due to the waveforms provided by the SCR controller.

The models 1021A, 1022, 1025 and 1031 controllers have line voltage compensation, therefore if the supply voltage is above the nominal rating, the controller will supply the nominal rated voltage to the load. For example, if a controller rated for 240 volt operation is supplied from a 260 volt supply and the maximum command signal is applied, the controller will supply only 240 volts to the load, thereby eliminating the effects of line voltage changes.

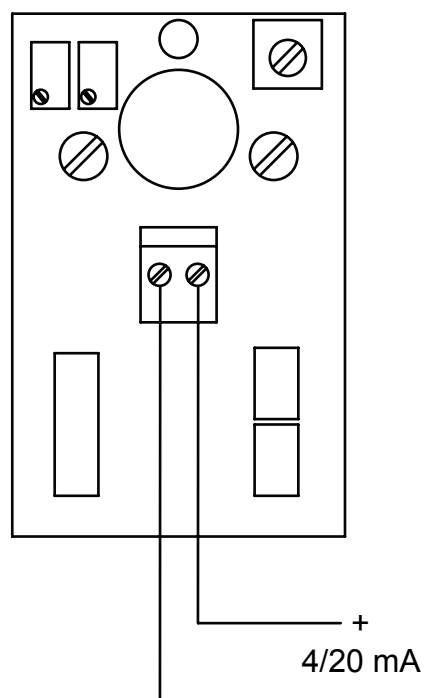
FIRING CIRCUITS

1020-FC (Zero Cross)



Command signal:	4/20mA
Input impedance:	7 volt maximum
Control range:	0 to 100%
Zero and Span adjustment:	+10% typical
Control mode:	Distributive zero-cross; single or three-phase
Features:	Circuit powered by 4/20mA signal

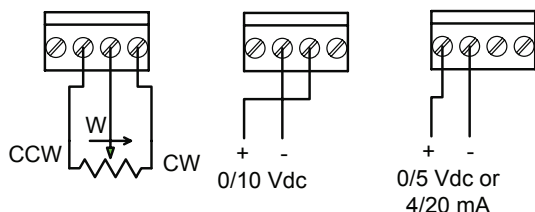
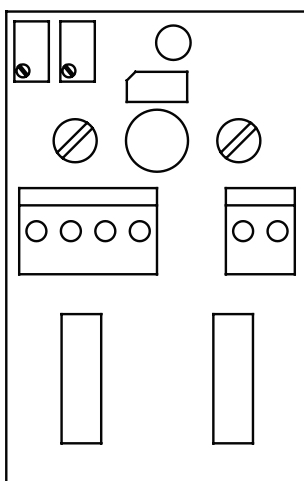
1023-FC (Zero Cross)



Command Signal	4/20mA
Input impedance	Series circuit consisting of a diode, a 7.5 volt zener and a 200 ohm resistor. @ 4mA input, voltage required is 8.8 volts, @ 20mA, voltage required is ~2 volts.
Control range	0 to 100%
Zero and span adjustments	+20%
Control mode	Time proportioning, cycle time is field adjustable from 1 to 10 seconds.
Features	Circuit is powered by 4/20mA signal

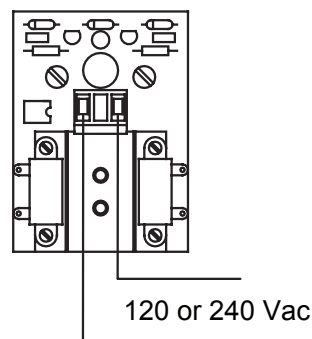
FIRING CIRCUITS (Continued)

1021A-FC (Zero Cross)



Command Signal	Input Impedance
0/5Vdc	100K
0/10 Vdc	200K
Potentiometer	200K (Circuit supplies 10Vdc to Pot)
4/20mA	300 Ohms. (Model 1021-4/20mA)
Control range	0 to 100%.
Zero and Span adjustment	+20%.
Circuit power	24Vac +20% 50/60 Hertz.
Control Mode	Distributive zero-cross; single or three-phase.
Features:	Line voltage compensation.

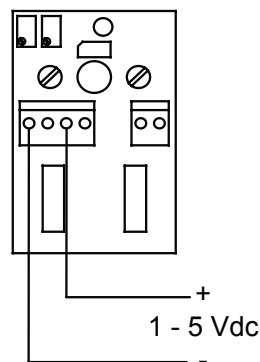
1026-FC (Zero Cross)



Model Number	Command Signal	Input Impedance
1026-120-FC	120Vac +20%	2000 ohms
1026-240-FC	240Vac +20%	4000 ohms

The 1026 circuit accepts ON-OFF 120 or 240 Vac control signals from solid state switching devices and is used to operate DC (type D) input SCR modules. The circuit provides the proper loading for triacs and other solid state switching devices to insure proper turn-on of the solid state switch and to insure that leakage from the solid state switch does not cause false operation of the SCR module.

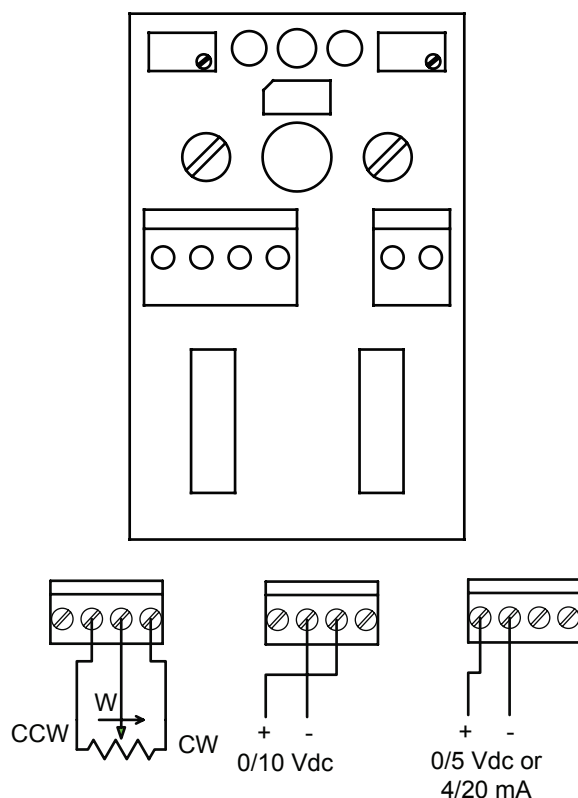
1031-FC (Zero Cross)



Command Signal:	1 to 5Vdc. 100K Input Impedance.
Control range:	0 to 97 %.
Zero and Span adjustment:	+20%.
Circuit power	24Vac +20%, 50/60 Hz.
Control Mode	Distributive zero-cross, single or three phase.
Features	Line voltage compensation.

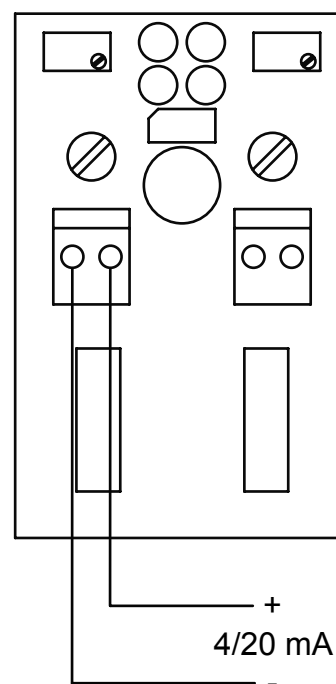
FIRING CIRCUITS (Continued)

1022-FC (Phase angle)



Command signal	Input Impedance
0/5Vdc,	100K
0/10Vdc	200K
Potentiometer	200K
(1k recommended, 20k permissible.)	
(Circuit provides 10Vdc to potentiometer.)	
Control range:	5 to 97% 0.25% to 94% power
Zero and Span adjustment:	+20% of span.
Circuit power	24Vac +20% 50/60 Hertz
Linearity:	The RMS load voltage is linear within 2% of the command signal.
Features:	Soft start and missing cycle detection. Line voltage compensation.

1025-FC (Phase angle)



Command Signal:	4/20mA (35mA max.)
Input Impedance:	200 ohms.
Control range:	5 to 97% voltage. 0.25% to 94% of power.
Zero and Span adjustment:	+20% of span.
Circuit power	24Vac +20% 50/60 Hertz
Linearity:	The RMS load voltage is linear within 2% of the command signal.
Features:	Soft start and missing cycle detection. Line voltage compensation.

INSTALLATION DRAWINGS

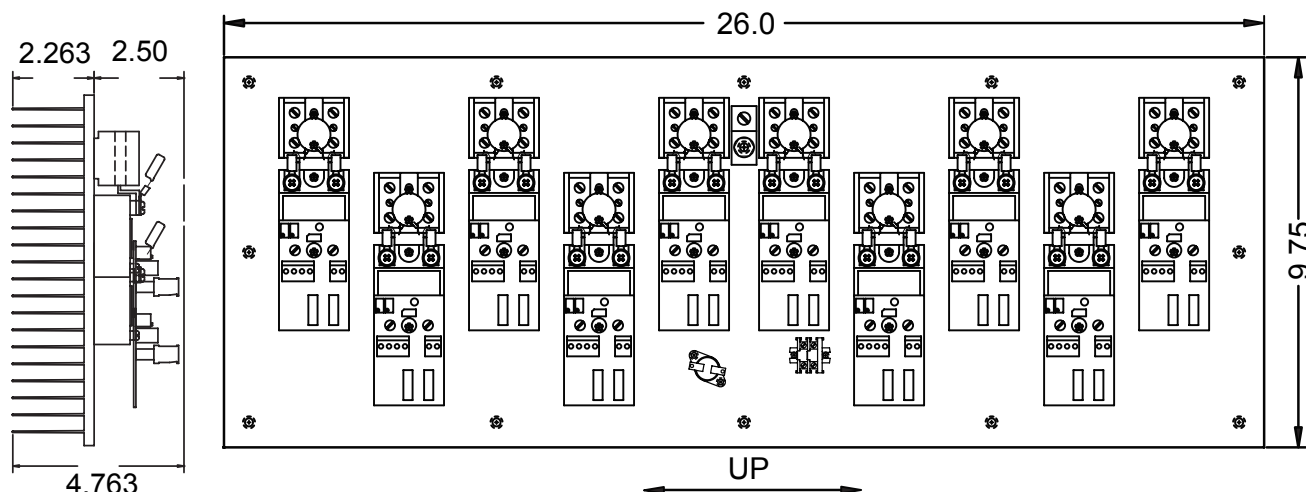


Figure 1. Model 1600-EM10-01 with 10 zones.

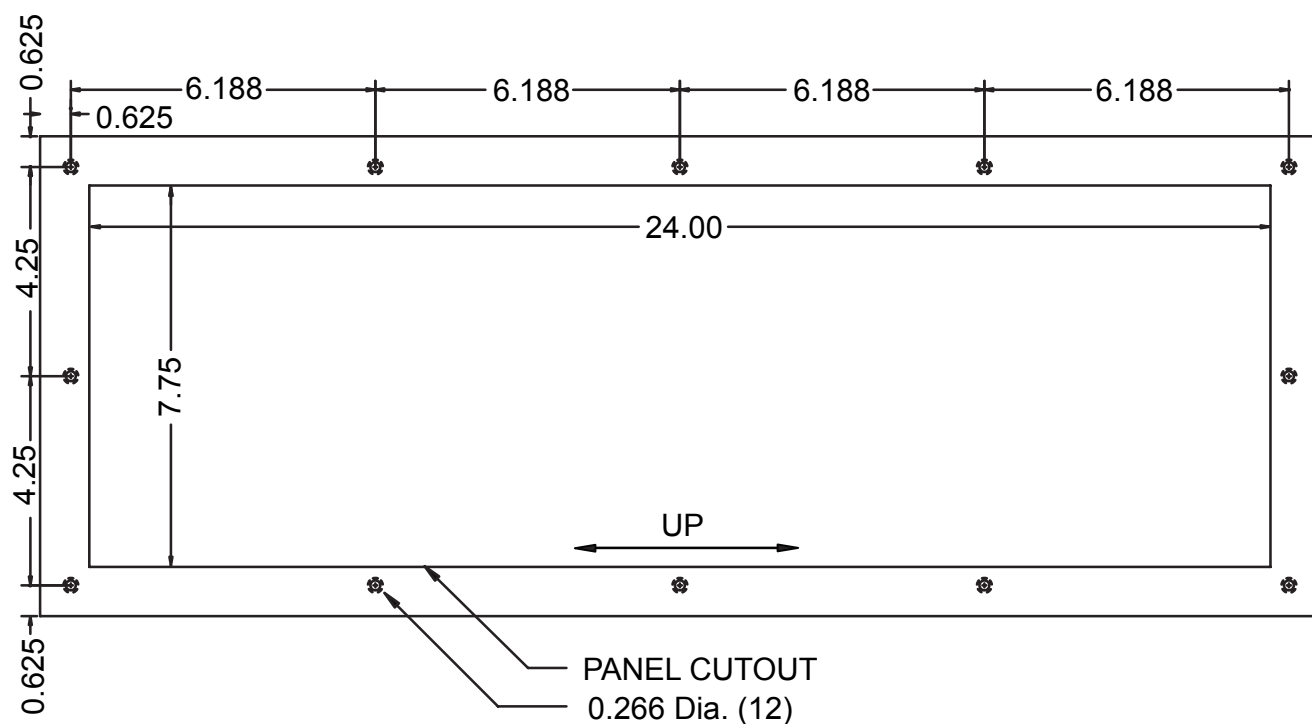


Figure 2. Panel Cutout dimensions.

RECOMMENDED TIGHTENING TORQUE USD CONNECTORS:	
WIRE SIZE (AWG)	TORQUE
14 - 10 GA	35 IN-LBS
8 GA	40 IN-LBS
4 - 6 GA	45 IN-LBS
2 - 3 GA	50 IN-LBS



RECOMMENDED TIGHTENING TORQUE FOR GREEN CONNECTOR:	
WIRE SIZE (AWG)	TORQUE
12 TO 26GA	5.0 IN-LBS



ELECTRICAL CONNECTIONS

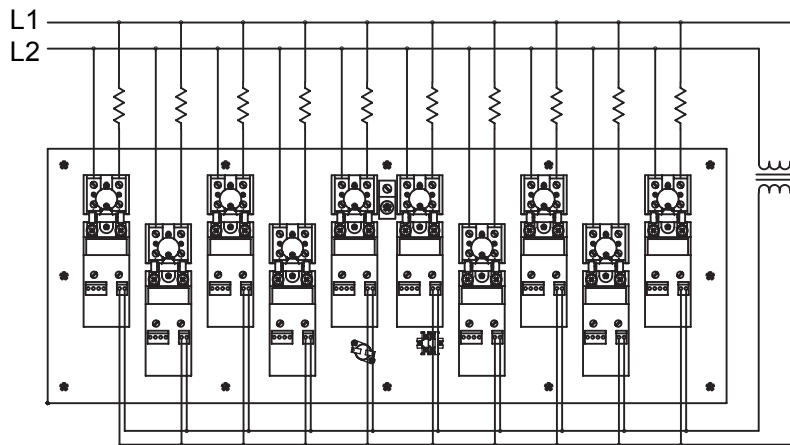


Figure 3. 10 individual loads on a single phase line.

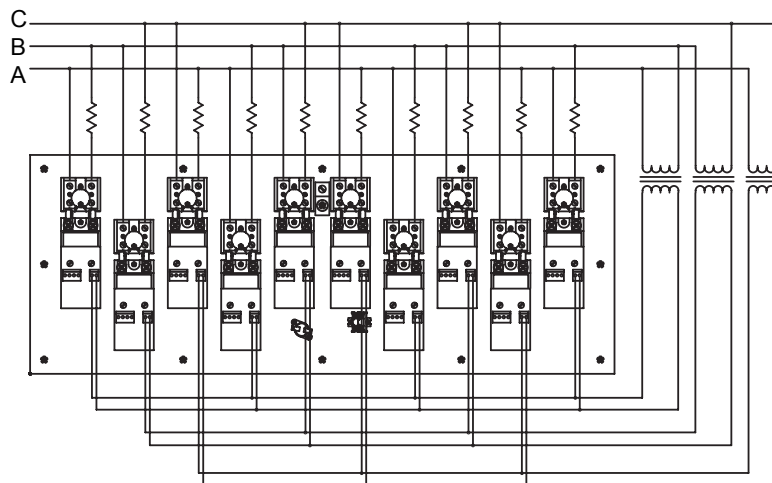


Figure 4. Individual loads distributed on a 3 phase line. (Phase Angle)
Zero-Cross controllers can all be powered from one transformer. No phasing required.

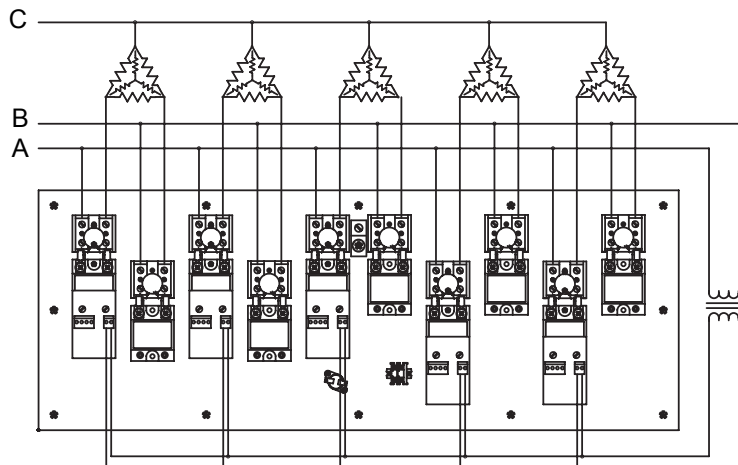


Figure 5. Two leg control of three-phase loads. (Zero Cross)

THEORY OF OPERATION

THE SCR

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

The SCR has two states, ON and OFF, and allows current to flow in only one direction when turned on. SCRs can remain in the off state even though the applied potential may be up to 1600 volts. In the on state, they can pass several thousand amperes. When a small signal is applied between the gate and cathode terminals, the SCR will turn on within 10-100 microseconds. Once turned on, it will remain on until the current through it is reduced below a very low value, referred to as the holding current.

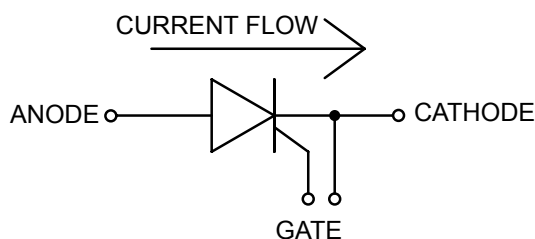


Figure 6. SCR symbol

Zero-Cross: (synchronous)

The term Zero-Cross, when describing the operation of an SCR, is derived from the fact that the SCR is turned on only when the instantaneous value of the sinusoidal waveform is zero. In Zero-Cross operation, power is applied for a specific number of continuous cycles and then removed for a specific number of cycles to achieve the desired load power in the same manner as power would be controlled with a mechanical switching device. Unlike mechanical switches, the SCR has no inherent wear out mode, therefore the frequency of the on-off power cycles can be extremely fast, providing better process control and extended heater life.

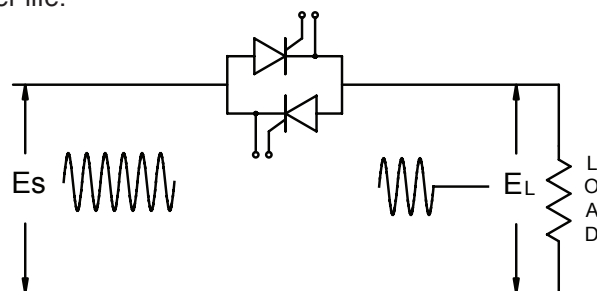


Figure 7. Zero Cross Control

Phase-Angle (random)

Load voltage is phase-angle controlled by turning the appropriate SCR on for a portion of each electrical half cycle as shown below. The waveform shown as E_L represents the "ON" time of the SCRs in each half cycle and therefore represents the voltage waveform applied to the load. The load voltage can be varied with infinite resolution from 0 to 100% of the supply voltage by varying the time the SCRs are on within each electrical half cycle. Circuit tolerances limit the maximum load voltage to about 97% of the supply voltage.

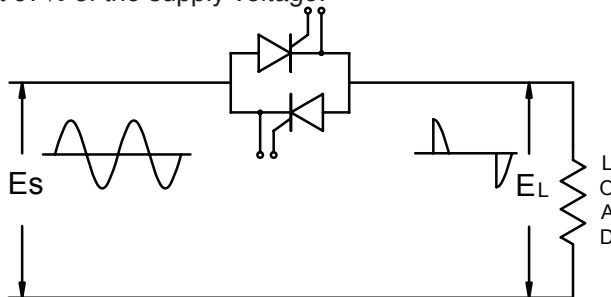


Figure 8. Phase-Angle Control

MODEL NUMBER IDENTIFICATION

1600-EM10-01-TS87/(x)16XX-V-A-U/(x)10XX-FC-(CS)

1600-EM10-01 _____
Specifies the basic 26" heat sink assembly with ground lug.

TS87 (Optional) Specifies a thermostat with single _____
pole, normally-closed contacts that open if
the heat sink temperature exceeds 87°C.

(x) Specifies the quantity of SCR modules. _____

16XX 1651 = Zero-Cross SCR modules _____
1652 = Phase-Angle SCR modules

V Specifies the voltage rating of the SCR _____
module. 120, 240, 480 or 575Vac.

A Specifies the current rating of the SCR _____
module. 10, 20, 30, 40, or 50 Amps.

U Specifies USD block power termination. _____

(x) Specifies the quantity of firing circuits. _____

10XX-FC Specifies the type of firing circuits used to _____
control the operation of the SCR module.
See pages 4, 5 & 6 for information about firing circuits.

CS Specifies the command signal _____

Available Command Signals*

Model Number	Command
1020, 1025	4/20 mA
1021A, 1021B, 1022	0/5 V, 0/10 V, POT

*Consult factory for more options.

Example:

1600-EM10-01-TS87/(10)1651-24-50-U/(10)1020-FC

Specifies a 26 inch heatsink assembly with an 87°C thermostat, 10) phase-angle SCR modules rated 240 V at 50A. USD block termination and 10) model 1020 firing circuits.

TROUBLESHOOTING

CAUTION: High voltage exists on the supply and load terminals of this controller and may exist on other equipment located near the controller. Use extreme caution to avoid electrical shock.

The LED located on the controller circuit can be used to aid in determining problems. The intensity or rate of the LED varies proportional to the command signal and therefore should be proportional to the load voltage.

THE FOLLOWING ARE SYMPTOMS AND POSSIBLE CAUSES:

NO LOAD POWER, LED not ON:

Determine that the command signal is applied to the controller. Determine that 24 volts is applied to the circuit (except 1020, 1023 and 1026).

LED intensity or rate can be varied:

Determine that all fuses are "OK". If the voltage across the SCR module is equal to the line voltage, the SCR module has probably failed.

NOTE: If a replacement SCR module is ordered specify the voltage and current rating of the controller and the serial number of the failed unit.

LOAD POWER IS MAXIMUM AND CANNOT BE REDUCED:

LED is on:

Determine that the command signal can be adjusted to zero. Disconnect the command signal by removing the plug-in connector. If the LED is remains on, the circuit card has probably failed.

LED is off:

Remove the 24Vac plug in connector. If the load still has power, the SCR module has probably failed as a short allowing full power to be applied to the load. To determine if the SCR module has shorted, remove power and then disconnect the line and load connections. Measure the resistance across the line and load terminals on the SCR module. If the resistance is less than 10,000 ohms, the module has likely failed.

LOAD VOLTAGE SNAPS ON:

On a phase-angle controller, determine that the primary of the circuit transformer is connected to the same supply as the controller and load.

MAXIMUM LOAD VOLTAGE CANNOT BE OBTAINED:

On phase-angle circuits determine that the primary of the circuit transformer is connected to the same supply as the controller and load. Typically this problem is caused in both phase angle and zero-cross controllers by the primary being connected across the load and line connection at the controller.

NOTE:

If a replacement parts are required, please include the voltage and current rating of the controller as well as the full model number and serial number of the controller with the order. This will assist in determining the correct replacement parts.

REFERENCE DRAWINGS

Assembly dwg: DS1770
Panel cutout: D1000776
Manual(s) for individual firing circuits as applicable.

MANUFACTURED BY



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