CONTROL CONCEPTS INC.

INSTRUCTION MANUAL
MODEL 3629B

Model 3629B Table of Contents

Description	**1**
Model number Identification	**2**
Theory of operation	**3**
Specifications	**4**
Installation instructions	**6**
Electrical adjustments	**7**
Command signal connections	**8**
Installation drawings	**10**
Line and load connections	**15**
Troubleshooting	**16**
Fuse recommendations and spare Parts	**18**

DESCRIPTION:

The model 3629B is a phase-angle SCR controller which linearly controls, with respect to a command signal, the voltage applied to a three phase electrical load. The controller can be connected either *in-line* or *inside delta* configuration (See figures 21 & 22).

The 3629B controller can accept a 0 to 5Vdc command signal or a potentiometer control. The controller can be factory configured to accept a milliamp or other special command signal.

The command signal input terminals are electrically isolated from the line and load voltages, and the heat sink.

Other Features of the Controller:

1. **Adjustable current limit**, limits the load current to a desired value. This feature is useful for variable resistance loads, or loads that have a low resistance when cold. Lowering the current limit decreases the current at which the over current trip feature functions.
   Raising the current limit increases the current at which the over current trip feature functions.
2. **Over Current Trip feature,** latches the controller off, energizes a relay with form "C" contacts and lights an LED if the load current exceeds a preset value. The relay may be used to initiate an alarm and remove power.
3. **Connection of a remote reset switch,** which, if momentarily closed, deenergizes the O. C. T. relay and resets the circuit to allow the load voltage to ramp from zero to the desired value. The switch can also be used to provide "on-off" control. Closure of the switch immediately interupts the SCR operation and removes load voltage, but does not energize the over current relay.
4. **A shorted SCR detector,** lights an LED and energizes a relay with form "C" contacts if an SCR fails in the shorted mode. These contacts may be used to operate an alarm and remove system power.
5. **Transient protection,** a snubber circuit consisting of a non-inductive resistor in series with a capacitor, is connected in parallel with each SCR pair to protect against high frequency transients. An MOV (metal oxide varistor) is also connected in parallel with each SCR pair to protect against high voltage transients.
6. **Soft start,** causes the controller to increase power to the desired value at a rate equal to a time constant of approximately 0.2 seconds.
7. **Missing cycle detection,** if the power is momentarily interrupted, the load voltage is set to zero and then increased to the desired value at a rate equal to a time constant of approximately 0.2 seconds when power is reapplied.
8. **RMS voltage feedback,** allows the RMS value of the load voltage, to be linear with respect to the command signal.
   Average voltage feedback allows the average value the load voltage to be linear with respect to the command signal.
   External feedback may also be selected. Contact factory about your application.
9. **Seven status indicators** provide the following information:

A. **"LINE-OK"** LED when on, indicates that the phase rotation is correct and all three phases are applied.

B. **"COMMAND"** LED, the intensity of which, is proportional to the command signal.

C. **"LINE CURRENT"** 3 LED's, the intensity of which, is proportional to the magnitude of each of the three SCR currents.

D. **"OVER CURRENT"** LED, when on, indicates that the over current trip point has been reached and the SCRs are deenergized.

E. **"SHORTED SCR"** LED, when on, indicates that an SCR has failed in the shorted mode or is repeatedly missfiring.

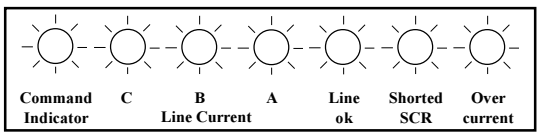


Figure 1. Status indicating LED's on 3629B .

MODEL NUMBER IDENTIFICATION:

3629B-(FB)-(VOLTS)V-(AMPS)A-CS-IL(Amps)-(SC)-(SP)

"3629B" Specifies a 3 phase, phase angle controller with Over Current Trip and Current Limit.

"(FB)"

V specifies RMS voltage feedback. (Desired for heating applications.)
A specifies Average voltage feedback. (Desired in some DC applications.)
E specifies external feedback.

"(VOLTS)"

specifies: supply voltage.
common choices are: 208, 240, 380, 415, 480 or 575 Vac.
Other voltages may be available, call factory for details.

"(AMPS)"

Specifies: current rating of the controller.
Frame sizes are: 50, 80, 120, 160, 200, 250, 300, 380, 425, 500, 600 or 750 Amps.

"CS"

Command signal. 0-5Vdc or Potentiometer input are standard.
This term can be used to specify mA input commands or non-standard voltage inputs which may be requested at time of order.
If a potentiometer is used, 1K ohm is recommended, up to 20K ohm is permissible.

IL"(Amps)"

Current limit. Adjustable range is 30 to 150% of frame current.
Useable range of 30 to 105%.
If not specified, current limit will be set to 105% of specified frame current.

"(SC)" Used to specify Special Calibration.

"(SP)" Used to specify Special Products.

Ordering examples:

3629B-V-480V-200A-4/20mA
This model number specifies a three-phase, 6 SCR, Phase-Angle controller, with true RMS voltage feedback, for 480 Volt operation at 200 Amps maximum and is factory modified to accept a 4/20mA command signal.

3629B-A-240V-160A-0/5V
This model number specifies a three-phase, 6 SCR, Phase-Angle controller, with average voltage feedback, for 240 Volt operation at 160 Amps maximum and accepts a 0 to 5Vdc command signal.

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 when turned on. SCRs 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, 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.

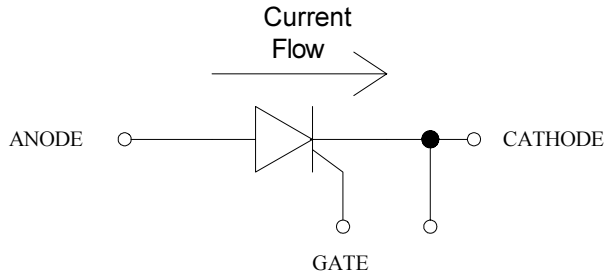


Figure 2. SCR symbol

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 3).

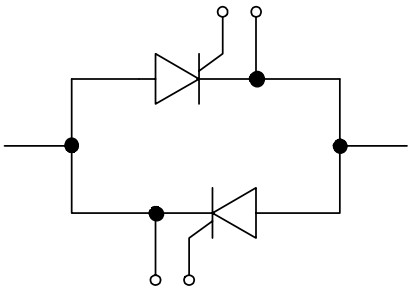


Figure 3. "AC Switch"

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 4). 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.

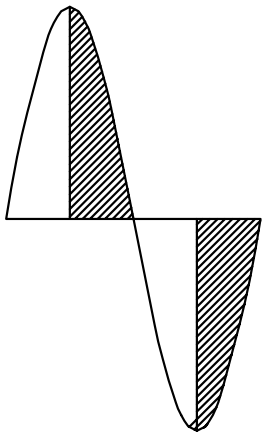


Figure 4A. SCR "ON" time, shown by shaded area, is varied to apply the desired load voltage.

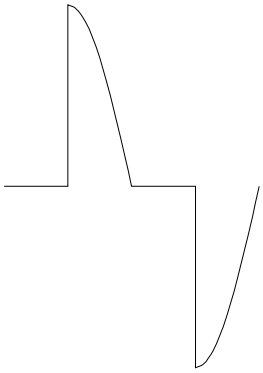


Figure 4B. Power is regulated by advancing or delaying the point at which the SCR's are turned on.

SPECIFICATIONS:

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

Control Mode:	Three-phase, in line, or inside delta, 6 SCR, phase-angle control of the RMS or average load voltage. External feedback is available.
Command Signal:	Input signal — Input Impedance: 4/20mA — 300 ohms 0-5Vdc — 100K ohms Potentiometer — 100K ohms (1K, 1/4watt pot recommended for optimum linearity, 20K permissible) The potentiometer is excited by 5Vdc, supplied by the circuit. Other input signals may be available. Check with factory for special applications
Control Range:	0 to 98% of line voltage.
Linearity:	Output will be linear within 2% of span over entire range of control.
Current Limit Range:	Useable from 30% to 105% of frame current as specified in the "(Amps)A" term within the model number. If no IL term is specified when ordering, then current limit is set to 105% of frame current rating.
Zero and Span Adjustments:	Multi-turn potentiometers allow zero and span adjustments of ±25% of span.
Dissipation:	Approximately 1.5 watts per amp of current per phase will be dissipated by the controller.
Supply Voltage:	208, 240, 380, 415, 480, or 575Vac, 3 phase, @ 50/60 Hertz. Other operating voltages may be available by special order.
Environment:	Operating temperature 0 to 55°C (32 to 132°F). Storage temperature: -40 to 85°C (-40 to 176°F). Humidity: 0 to 95%, non-condensing.
Electrical Isolation:	Heat sink to supply and load voltage 2500 volts peak. Control or command signal to supply and load voltage 1500 volts peak.
Status Indicators:	***LINE OK***: Indicates power on all three phases and correct phase rotation. ***COMMAND***: The intensity of this LED is proportional to the command signal. ***LOAD***: The intensitiy of these three LEDs is proportional to the current in each leg. ***SHORTED SCR***: Indicates when an SCR has failed in the shorted mode. ***OVER CURRENT***: Indicates excessive current has occurred.
Cooling:	Convection cooling on 50 amp unit. Forced air fan cooling on all others.

SPECIFICATIONS: (continued)

SCR Surge Current:	Peak 1 cycle surge current is: 50 Amp rating - 1,750 A Surge 80 Amp rating - 1,750 A Surge 120 Amp rating - 1,900 A Surge 160 Amp rating - 4,000 A Surge 200 Amp rating - 4,500 A Surge 250 Amp rating - 5,200 A Surge 300 Amp rating - 7,000 A Surge 380 Amp rating - 10,000 A Surge 425 Amp rating - 13,000 A Surge 500 Amp rating - 10,000 A Surge 600 Amp rating - 13,000 A Surge 750 Amp rating - 20,000 A Surge
SCR I^2T Rating:	50 Amp rating - 15,000 A^2S 80 Amp rating - 15,000 A^2S 120 Amp rating - 18,000 A^2S 160 Amp rating - 80,000 A^2S 200 Amp rating - 101,000 A^2S 250 Amp rating - 135,000 A^2S 300 Amp rating - 245,000 A^2S 380 Amp rating - 500,000 A^2S 425 Amp rating - 845,000 A^2S 500 Amp rating - 245,000 A^2S 600 Amp rating - 500,000 A^2S 750 Amp rating - 1,670,000 A^2S
SCR Voltage Rating:	Peak forward and reverse voltage rating 1400V.
SCR DV/DT Rating:	200 volts/usec minimum.
Loads:	Resistive, Variable resistance, Inductive, Capacitive, Transformer or Lamps.
Slew Rate:	200 milli-seconds. (Slew rate is the time required for the load voltage to change 63% of the value represented by the command signal. The current limit action will change the slew rate if the load current is greater than the current rating of the SCRs.
Frame Size:	The "(Amps)A" term within the model number specifies the maximum continuous RMS current rating at the maximum operating ambient temperature of 55°C.
SCR Gate Drive:	30 or 60 electrical degrees can be selected by the movement of a jumper on J5. See figure 5 on page 7 for location of this feature.

Loads:

INSTALLATION:

MOUNTING:

The 50 Amp model 3629B controller is convection cooled must be mounted with the fins aligned vertically on a flat surface so that air may pass over the fins. Although other model 3629B controllers are forced air cooled, it is recommended that all controllers be mounted vertically with power terminals on top.

Allow sufficient room between controllers for air to enter and exit. The controller should be protected from dust and dirt, and must be located in an environment that does not exceed 55°C.

TRANSFORMER TAPS:

Place the three spade connections on the transformer taps to correspond with the voltage to be applied. **NOTE: The transformer may fail if the connections to the tap are incorrect.**

POWER CONNECTIONS:

The line and load connectors on the various sizes of controllers are rated for use with copper conductors with 90°C or higher insulation. The ratings are calculated for use in a 55°C ambient environment. Multiple connectors are provided in larger controllers to use parallel conductors in each line and load.

See Fig. 21 and Fig 22 for the 'inline' and 'inside delta' line and load connections.

When inside delta is desired, a jumper must be placed between terminals 11 & 16 on the command signal input connector. (Fig. 8.) The customer must provide tie points for the extra line connections when using inside delta connections.

COMMAND CONNECTIONS:

Figures 6 & 7 on page 8 show the command signal connections. Note that R47 must equal 300W when applying a 4/20mA current command signal. (For location of R47, see fig. 5 on page 7.) Contact factory for value of R47 when using other signal ranges.

STARTUP:

Before applying power, determine that the transformer taps are in the correct position, that the power and load wiring is correct, and electrical connections are tight.

Set the command to zero and apply power to the controller. As the command signal is increased, the load voltage should start at zero and increase.

It is recommended that the load and the controller be protected with the proper rated fuses. See page 18 for details.

If the supply rotation is not correct, the status light **"line-OK"** will not light when power is applied. Reversing any two of the line leads will correct the problem.

WIRE TERMINAL TORQUE RECOMMENDATIONS

FRAME SIZE 50 & 80 AMPS (SCREWDRIVER)

GAUGE	INCH-LBS
8	20
6	35
4	35
2	50

FRAME SIZE 120 TO 425 AMPS (WRENCH)

WIRE SIZE	INCH-LBS
6	100
4	100
2	125
1/0	150
2/0	200
3/0	200
4/0	200
250MCM	250

FRAME SIZE 500 TO 750 AMPS (WRENCH)

WIRE SIZE	INCH-LBS
1/0	150
2/0	200
3/0	200
4/0	200
250MCM	250
350MCM	250
500MCM	300

CAUTION WHEN USING TRANSFORMER COUPLED LOADS

SCOTT-T TRANSFORMERS

Excessive voltage transients can occur when operating Scott-T transformers with an open or unloaded secondary. Controllers with higher rated SCR's are available for this application.

DELTA-WYE TRANSFORMERS

Do not use a Wye to Wye transformer.

Do not use a Delta-Wye transformer to power a 3-wire Wye load.

If one of the legs of a 3-wire Wye load would open, the SCR's on that phase would most likely be destroyed.

It is recommended that a Delta to 4-wire Wye transformer be used to power a 4-wire Wye load.

Please consult factory for more information.

ADJUSTMENTS:

The zero, span and current limit potentiometers are factory set, and should not require further adjustment.

If adjustments become necessary, the following procedure should be followed.
If you are using RMS feedback, you must use a true RMS meter for these measurements.

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. The span and zero adjustments may interact, therefore it may be necessary to repeat steps 1 and 2.

Rotating the current limit potentiometer <u>counterclockwise</u> reduces the value to which the load current is limited.

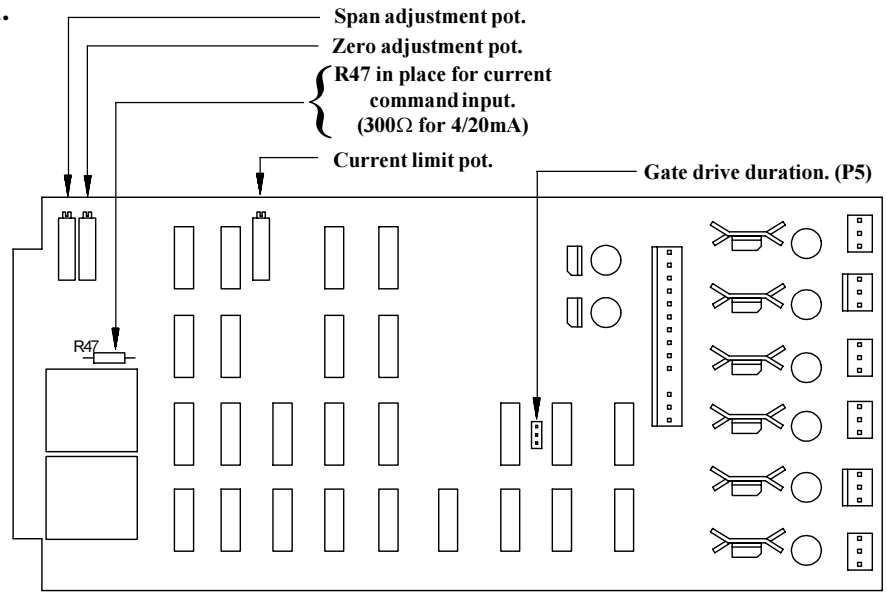
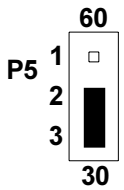


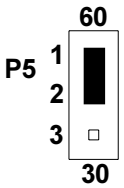
Figure 5. Location of adjustment potentiometers.

GATE DRIVE DURATION:

The duration of the gate drive is typically set at 30 electrical degrees. Jumper between (P5-2 to P5-3).



For loads with significant amounts of inductive or capacitive influence, such as a transformer coupled load, or a rectifier with a capacitor, the gate drive duration can be increased to 60 electrical degrees by moving the gate drive jumper to the position between (P5-1 to P5-2).



COMMAND CONNECTOR WIRING

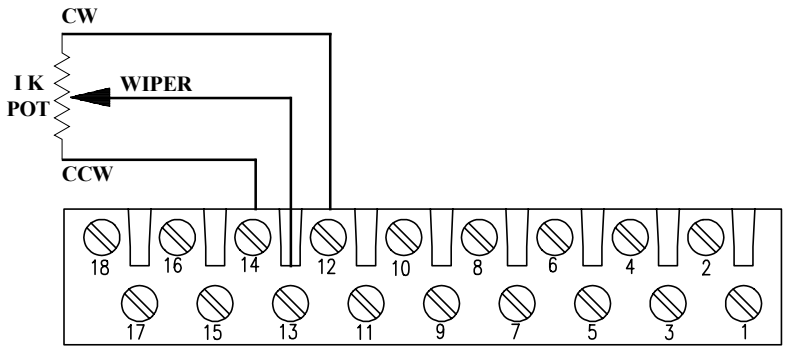


Figure 6. Potentiometer command connections.

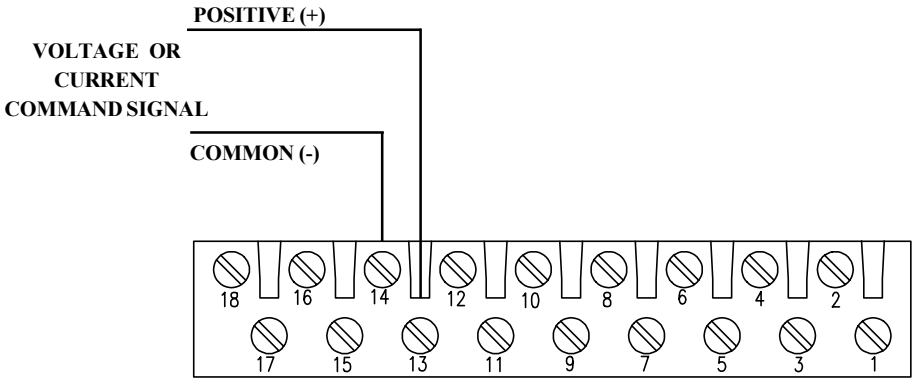


Figure 7. Voltage or current command connections.
R47 must equal 300Ω when using a 4/20mA current command.
See fig. 5 on page 7 for location of R47.

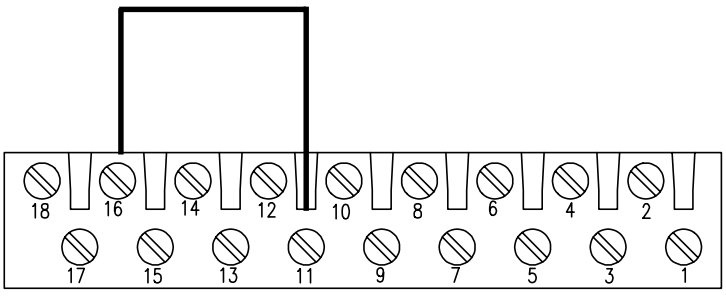


Figure 8. Add this jumper for inside delta operation.

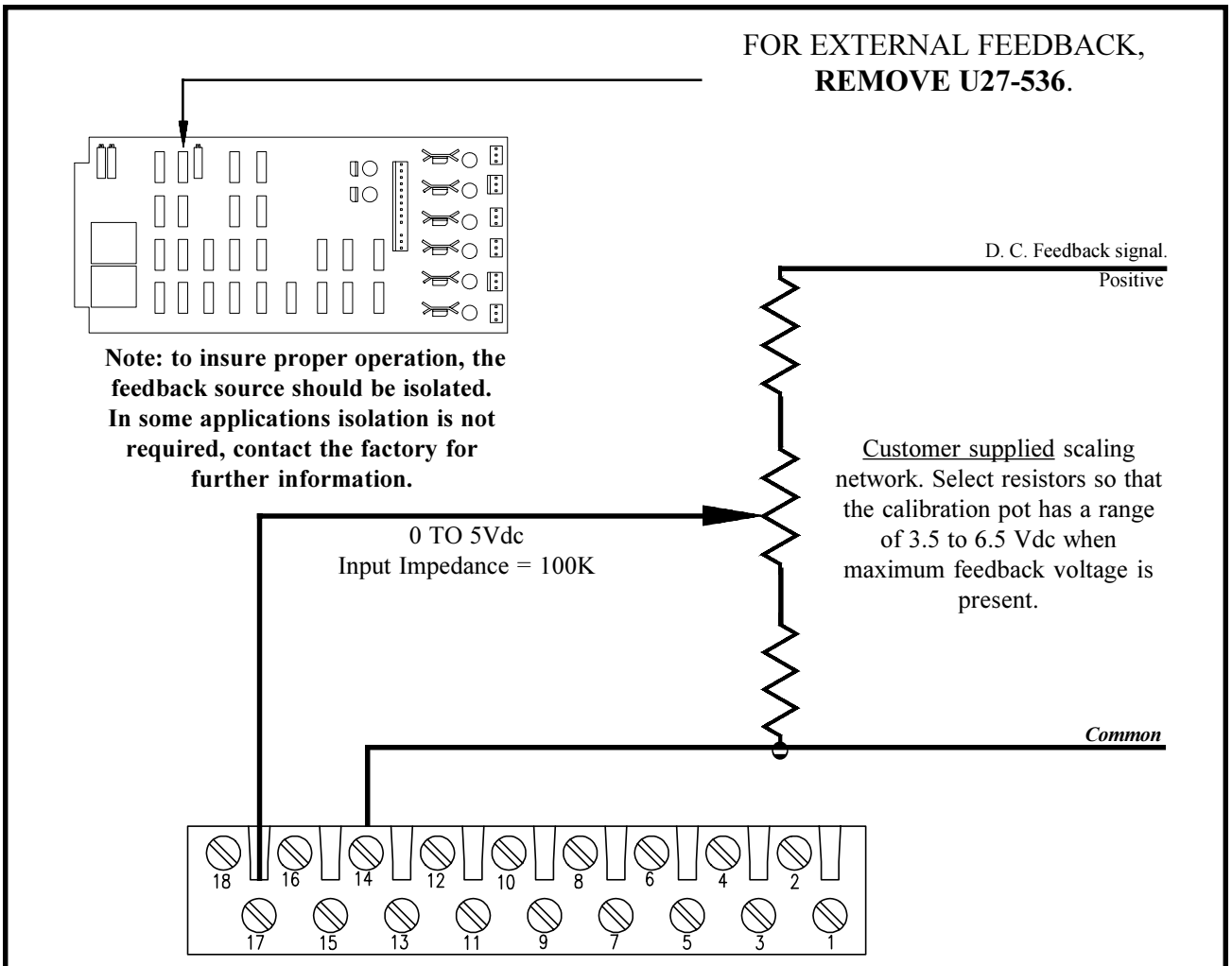


Figure 9. External voltage feedback.

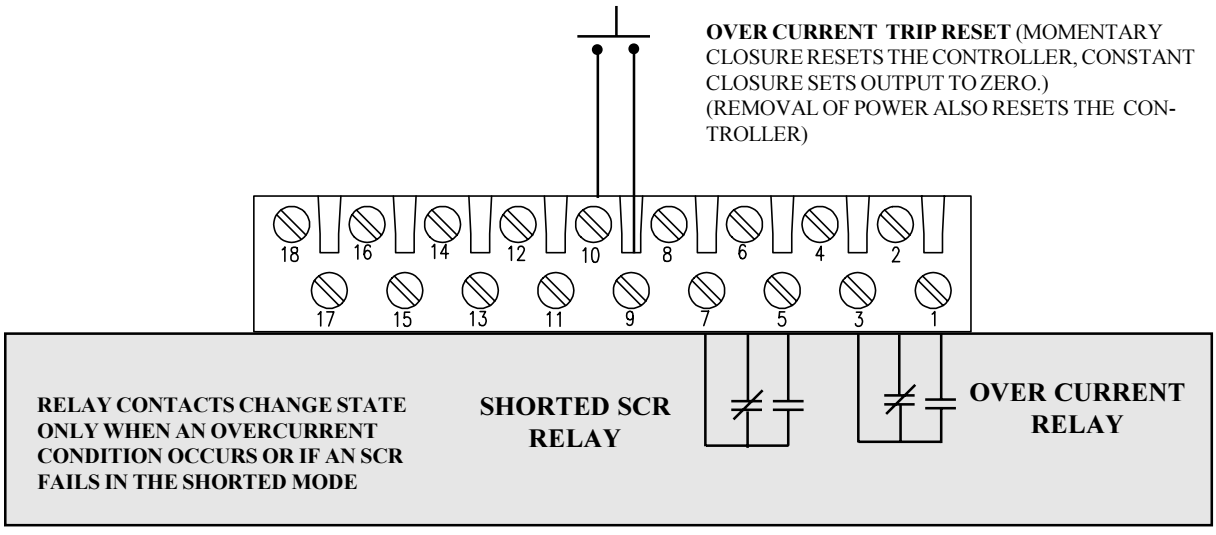


Figure 10. Shorted SCR, Over current relay and reset switch connections.

INSTALLATION DRAWINGS:

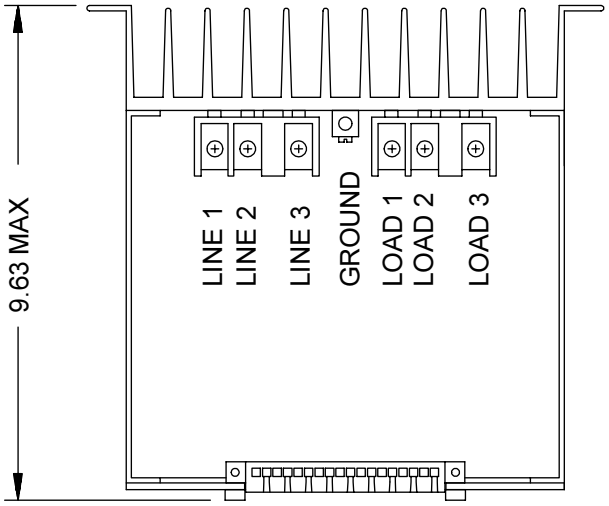
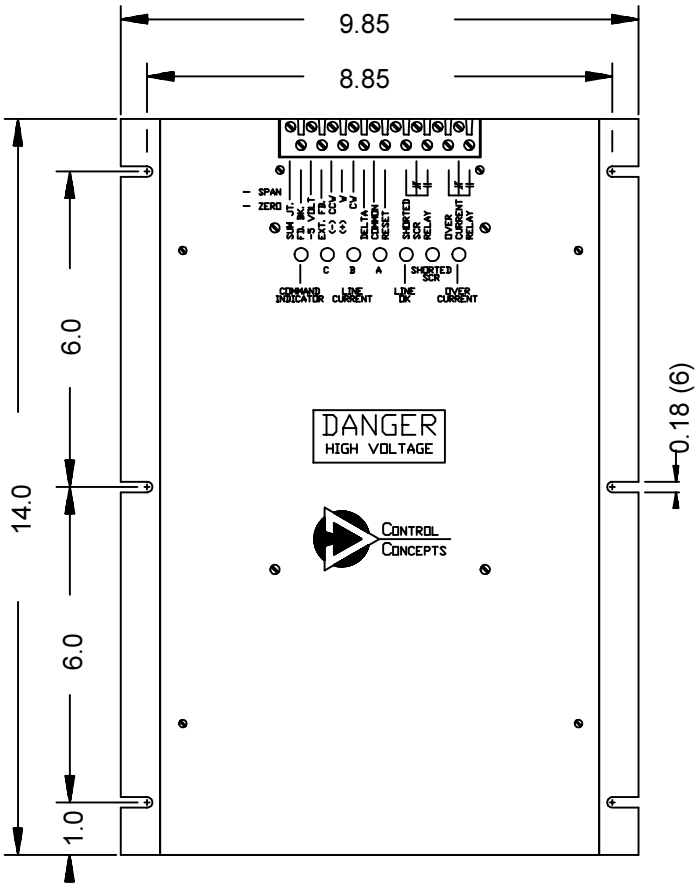


Figure 11. **End view of 50 Amp model 3629B controller.**



Note: The 50 amp controller does not have a fan, and requires convection cooling. This unit must be mounted on a vertical panel with the fins oriented vertically, so that air may pass between the cooling fins without restriction.

Figure 12. Top view of 50 Amp model 3629B controller.

INSTALLATION DRAWINGS:

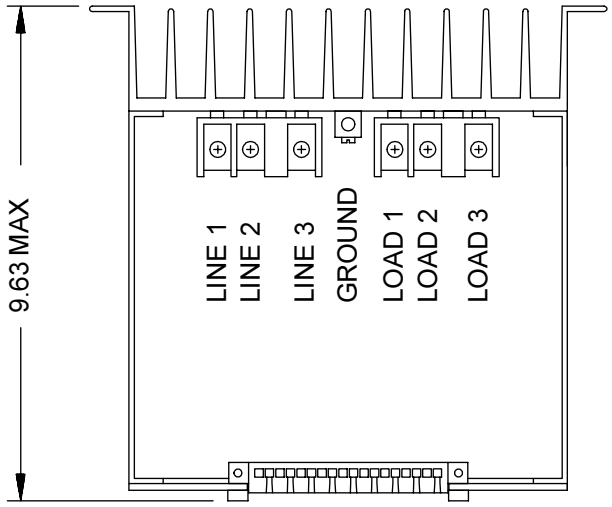


Figure 13. End view of 80 Amp 3629B controller.

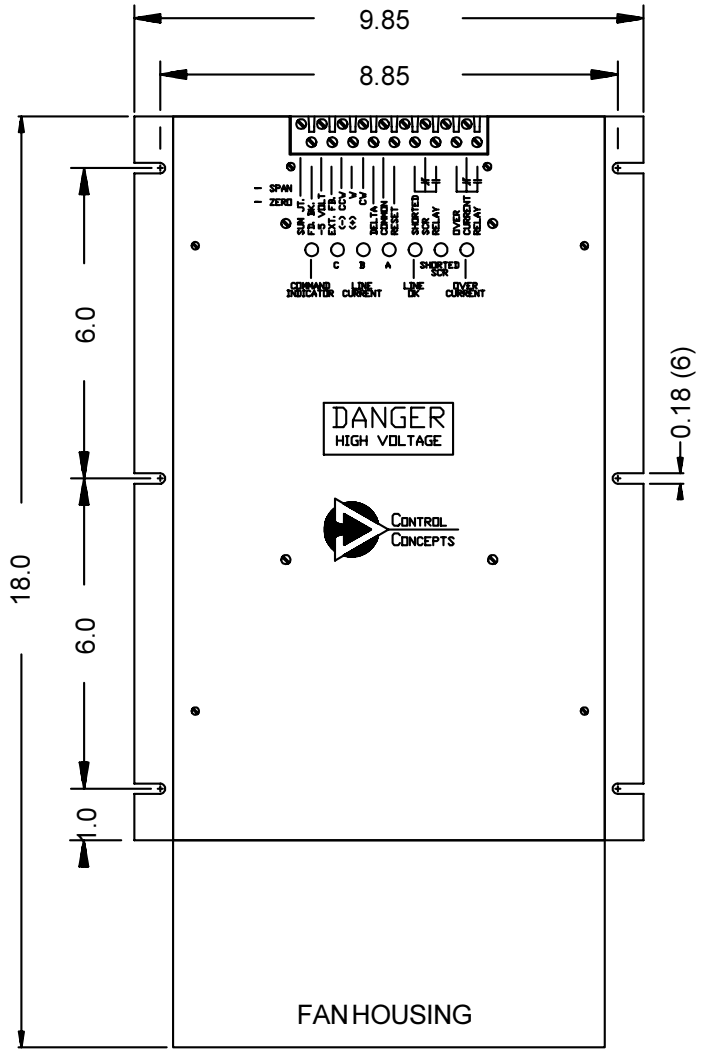


Figure 14. Top view of 80 Amp 3629B controller.

INSTALLATION DRAWINGS:

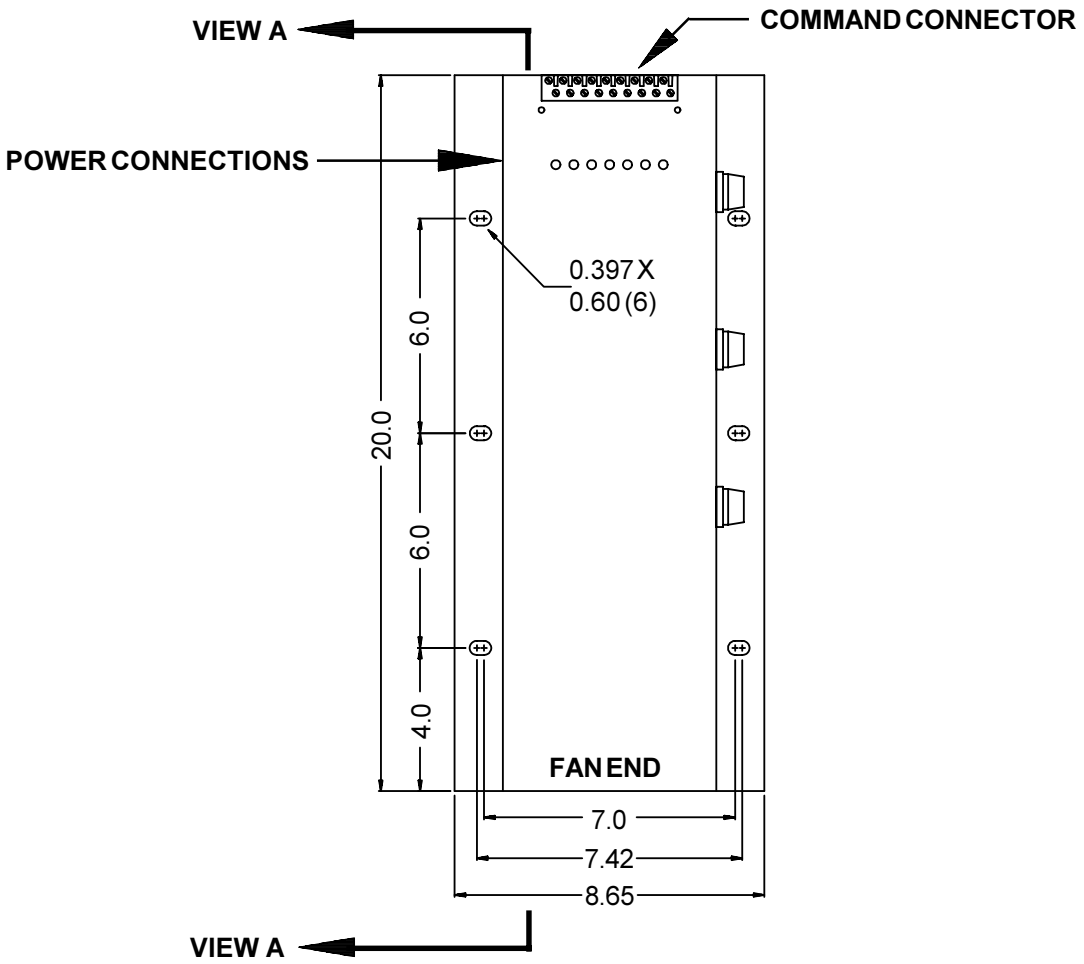


Figure 15. Top view of 120 & 160 amp 3629B controller.

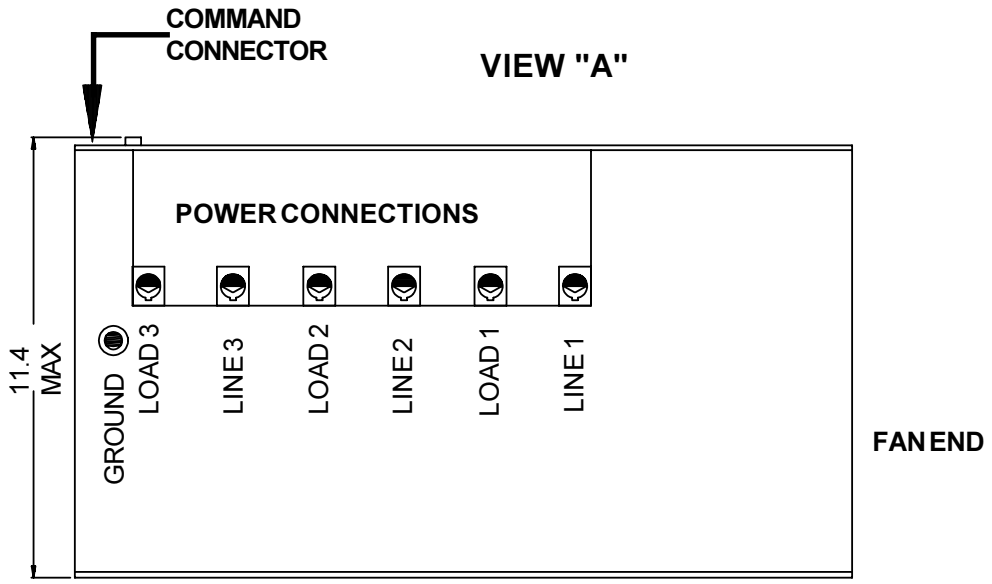


Figure 16. Left side view of 120 & 160 amp 3629B controller.

INSTALLATION DRAWINGS:

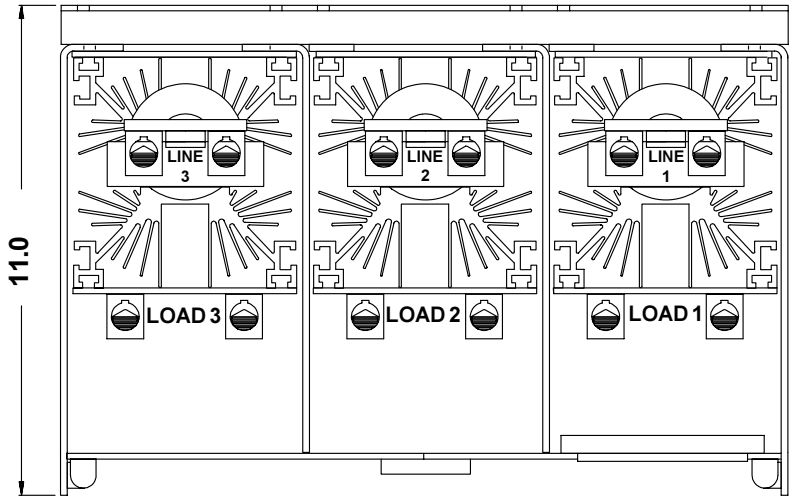


Figure 17. End view of 200 to 425 Amp 3629B controller

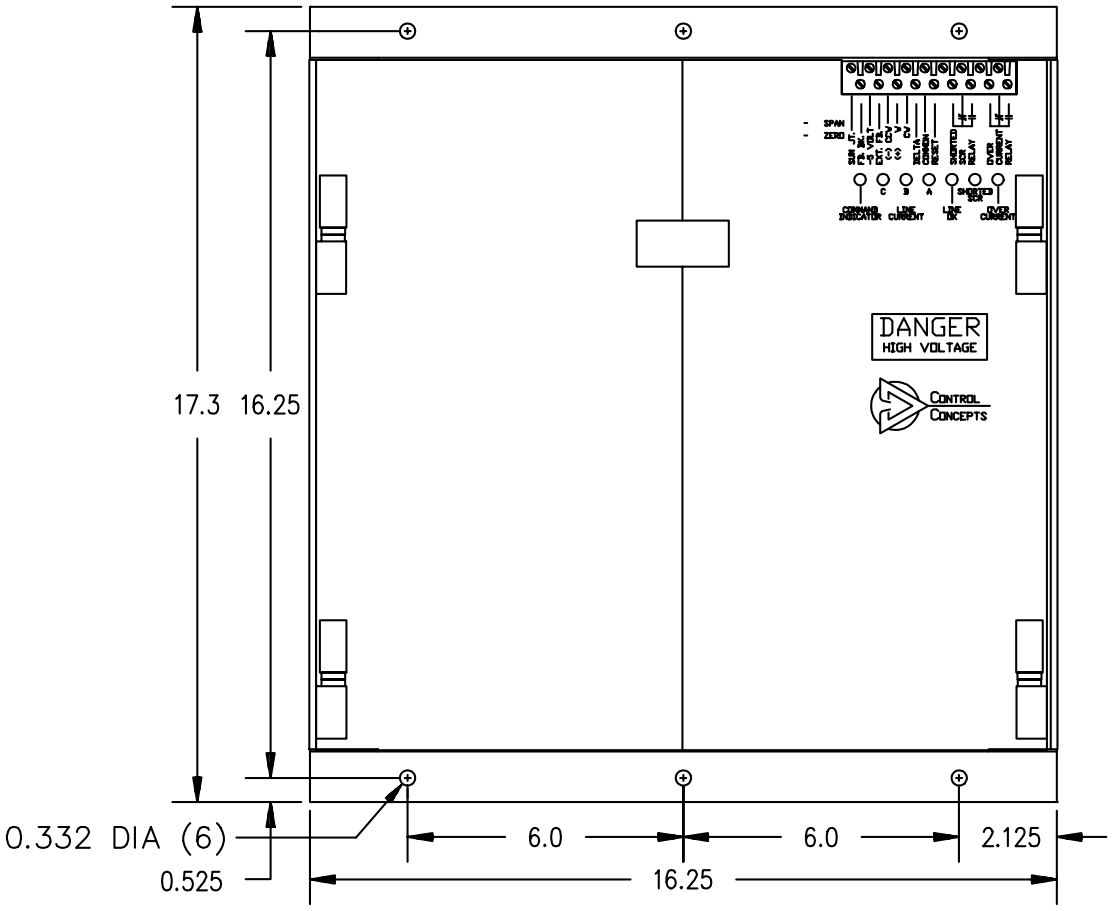


Figure 18. Top view of 200 to 425 Amp 3629B controller

INSTALLATION DRAWINGS:

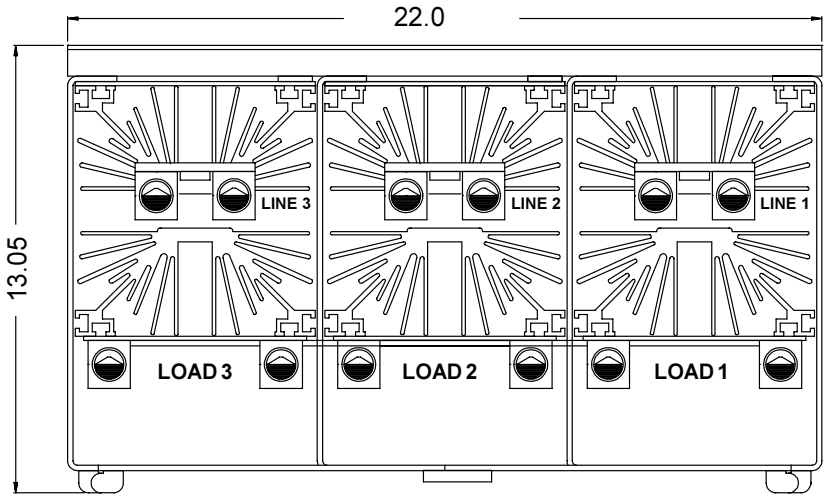


Figure 19. End view of 500 to 750 Amp 3629B controller

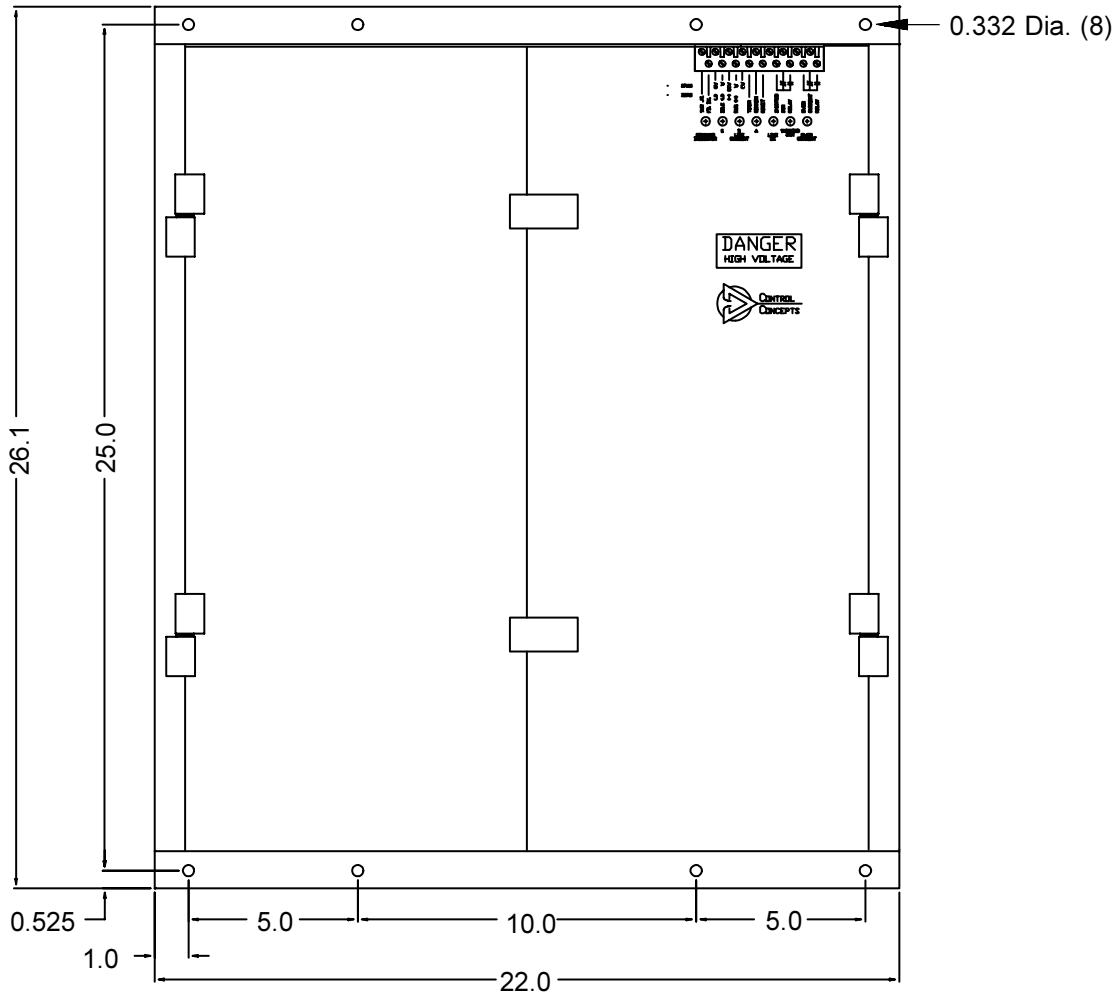


Figure 20. Top view of 500 to 750 Amp 3629B controller

ELECTRICAL HOOKUP:

**Note: It is recommended that the load and controller be protected by 3 class "T" fuses.
Bussmann type "JJN" or "JJS" fuses are suitable for this purpose.
Choose a fuse size approximately 120% of the current rating of the controller.**

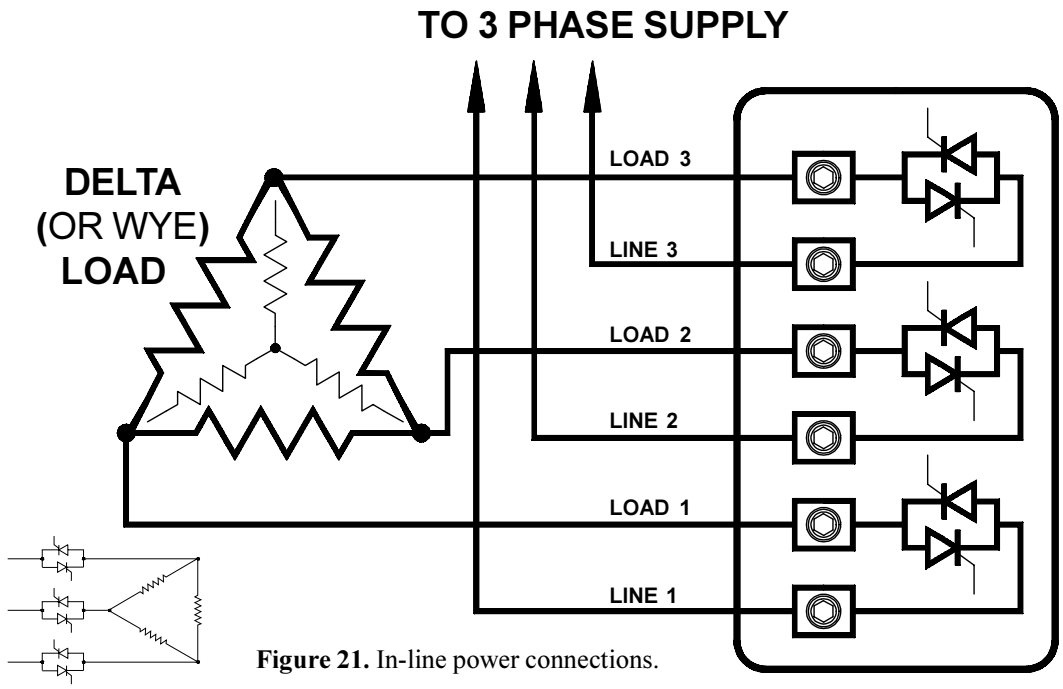


Figure 21. In-line power connections.

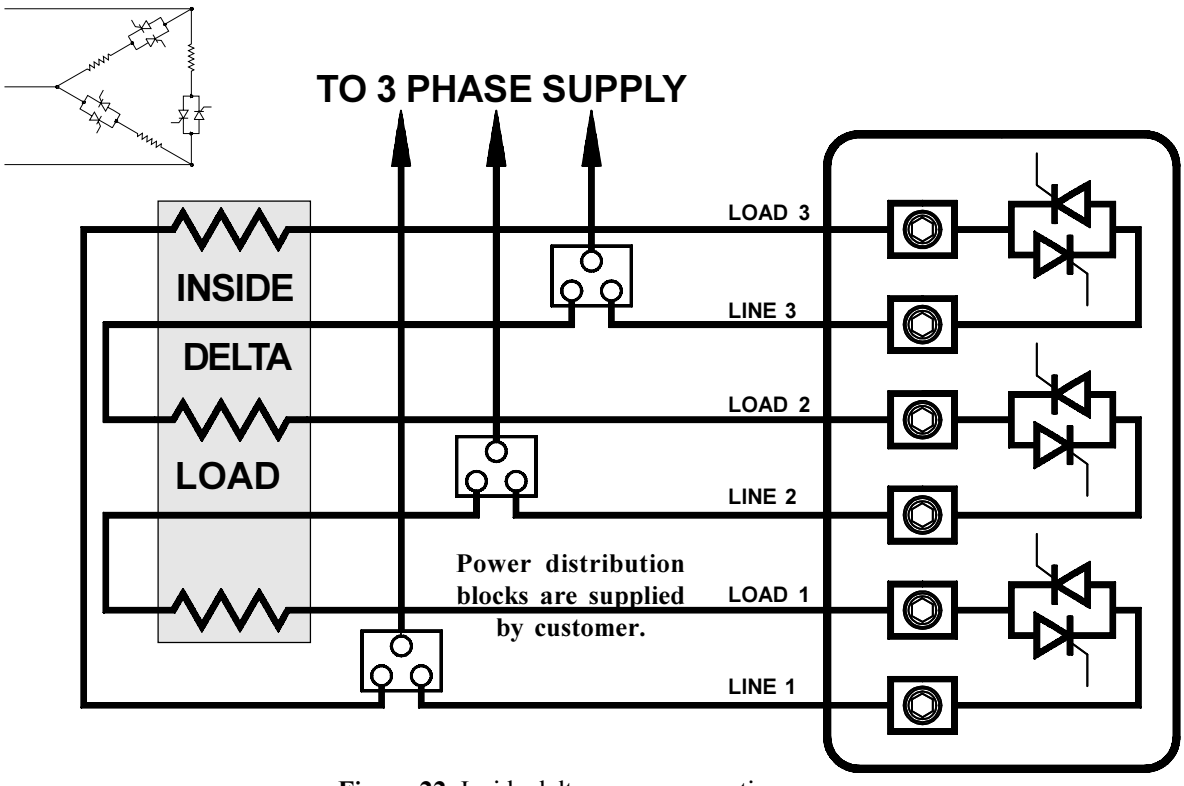


Figure 22. Inside delta power connections.

TROUBLESHOOTING:

CAUTION:

High Voltage exists on the controller, the circuit board. and other equipment located near the controller. Use extreme caution to avoid electrical shock. Except for voltage and current measurements, remove power before attempting to service this equipment.

Electrical measurements should be made by qualified personnel only.

NOTES	
	When using average feedback you will get more accurate results if you make your measurements with an average responding meter. For accurate readings when using RMS feedback, use only a true RMS responding meter. The controller must have a load capable of drawing at least 1 amp to operate properly. A circuit board with the same input specifications may be substituted for a questionable circuit to help identify the location of the problem. **When replacing circuit boards, do not remove resistors or wires from the plug-in connector.** Control Concepts has field service engineers who can help to determine the cause of controller problems. Please call (612) 474-6200 with any questions you may have. **It is recommended that replacement of the SCRs on 200 Amp and larger controllers be done by the factory because of the critical installation requirements .**
SYMPTOMS	**POSSIBLE CAUSES**
'LINE OK' LED IS NOT ON	**INCORRECT LINE ROTATION.** Exchange any two of the line input leads. **FUSES BLOWN.** Any two line fuses, or any two transformer fuses, when cleared, will cause a loss of power to the firing circuit. **INCORRECT WIRING TO THE CONTROL POTENTIOMETERS.** Remove the command connector containing the field wiring. If the "line ok" led comes on, there is a problem with the wiring. **POOR CONNECTIONS.** Check that the frame wiring connectors are plugged fully into the circuit board connectors.
'LINE OK' LED IS ON: NO LOAD POWER.	**NO COMMAND SIGNAL PRESENT.** Determine that a command (set point) signal is present between the CCW and W terminals on the command signal connector. **INCORRECT COMMAND WIRING.** On new installations, check all command wiring and confirm that polarities are correct. **OVER CURRENT TRIP RESET SWITCH IS CLOSED.** If a remote over current trip reset switch is used, check that the switch is open. If a remote switch is not used, check that the voltage on terminal 9 is at least 10 Volts with respect to terminal 10.

TROUBLESHOOTING: (continued)

SYMPTOMS	POSSIBLE CAUSES
'COMMAND' LED IS OFF. LOAD POWER AT MAXIMUM.	**SHORTED SCR.** **PROBLEM ON THE CIRCUIT BOARD.** Swap circuit boards to determine where the problem exists.
'COMMAND' LED IS ON LOAD POWER AT MAXIMUM.	**PROBLEM WITH THE COMMAND SIGNAL.** Remove the command connector. If load power and line current indicators go off, the problem is associated with the command signal. **PROBLEM ON CIRCUIT BOARD.** If, after removing the command connector, the command indicator remains on, the problem is probably associated with the circuit board.
LOAD VOLTAGE WILL NOT REACH MAXIMUM.	**INSUFFICIENT COMMAND SIGNAL.** Determine that the command signal is at maximum. **INSUFFICIENT LINE VOLTAGE.** Measure the voltage from phase to phase on the line and load terminals. If the voltage is correct at the load terminals but not at the load, check load wiring or external load fuses. **LOAD VOLTAGE IS LIMITED BECAUSE OF CURRENT LIMITING.** While measuring the load voltage, rotate the current limit potentiometer 1 turn counterclockwise. If the load voltage decreases the current limit is operating. (Return current limit potentiometer to original setting.) The current limit prevents excessive current when controlling variable resistance loads. It is recommended that the current limit not be changed until the load requirements and the controller ratings are thoroughly understood. **INCORRECT SPAN ADJUSMENT.** If the span adjustment pot is adjusted incorrectly, the controller may be unable to reach maximum output. **INCORRECT LOAD WIRING.** On new installations, check the load connections carefully. **FAULTY SCR OR CONTROL CIRCUIT.** With a digital voltmeter set on the 2000 VDC range, check for a DC voltage present on the load output terminals of the controller. More than 1Vdc between any of the three load outputs could be due to a faulty SCR or control circuit. If the line current indicators are on, the circuit may have failed. If one LED is bright and the others are dim, an SCR or its connections may have failed.

To test for a shorted SCR, power should be removed and the load disconnected from the controller. If the resistance between line 1 and load 1, line 2 and load 2, or line 3 and load 3 is less than 1000 ohms the SCR has failed.

RECOMMENDED SPARE PARTS:

FUSES:

The model 3629B does not have built-in line fuses. It is recommended that the load and controller be protected by using a class "T" fuse in each of the three line leads. Bussmann type "JJN" (300 Volts) or "JJS" (600 Volts) are suitable for this application.

Note: When fusing at more than 600 amps, a semiconductor type fuse is recommended.

Choose a fuse having a current rating of approximately 120% - 125% of the maximum load current anticipated.

Control Concepts, Inc. stocks a variety of class "T" and semiconductor fuses, as well as fuse blocks, for your convenience.

Consult Control Concepts factory for help to determine which type and size of fuse would protect your application best.

Three Bussmann Class CC type FNQ-R-1 fuses are used for transformer protection in the contoller, 1 in each phase.

On the 120 and 160 Amp units, the transformer protection fuses are serviceable from the side opposite the line and load connections. On all other units, the fuses are located inside.

The orientation of these class CC fuses is important. Although the fuse may be inserted either way, it will only make contact if oriented in the fuseblock correctly.

SCR MODULES:

Size of controller	Control Concepts stock number
50 & 80 Amps	28325-0395-514
120 Amps	28325-0410-514
160 Amps	28345-0413-514
200, 250, 300, 380, 425, 500, 600 & 750 Amps	**It is recommended that replacement of SCRs on 200 amp and larger controllers be done by the factory because of the critical installation requirements.**

REFERENCE DRAWINGS:

Firing circuit schematic.	D1000093
Frame wiring diagram, 50 & 80A.	CS1569
Frame wiring diagram, 120A.	CS1574
Frame wiring diagram, 160A.	CS1570
Frame wiring diagram, 200- 425A.	CS1571
Frame wiring diagram, 500- 750A.	CS1575

MANUFACTURED BY:

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