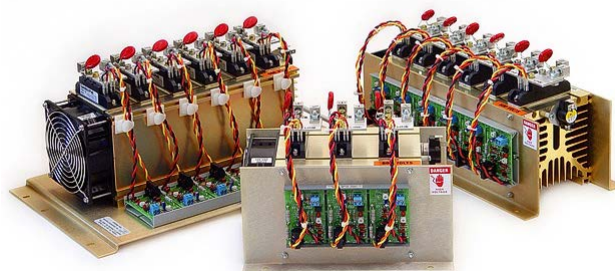




CP MULTI ZONE OPERATING MANUAL

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NRNT FILE # E350716

INTRODUCTION

Congratulations on your purchase of an Avatar CP series power control. This manual was designed to assist you in installing, operating and maintaining your new power control in a safe manner. Upon reading and following the instructions in this manual, you will be rewarded many years of trouble free service from your new CP. If reading manuals is not for you, it is essential that you at least read the captions followed by the safety warnings, they are located through out the manual and are very easy to identify.



indicates important installation, operating, servicing instructions



indicates dangerous voltage present and risk of electric shock

FEATURES

- UL 508 listed
- compact and light weight
- 100 % solid state circuitry
- over-rated SCR power modules
- over-sized heat sink
- full power ratings up to 50°C (122°F) ambient temperature
- optically isolated 4-20 mA input standard
- versatile “building block” custom configurations
- electrically isolated chassis and heat sinks to 600 Amps
- gold alodined chassis and heat sink
- MOV protection on all power SCR's
- SanRex, SemiKron, International Rectifier and Fairchild semiconductors
- double sided FR4 VO-94 rated glass epoxy PCB's

DESCRIPTION

The CP series SCR power controllers are multi-zone power controllers that can be configured for phase angle fired, zero voltage switched or on-off solid state contactor control of directly connected electric heaters. The CP will not control transformers or motors. This is accomplished by phase angle firing, or variable time based zero voltage switching a pair of inversely connected SCR's.

There are *NO* control transformers needed to power any of the trigger boards. There is no feedback connection needed for phase angle fired control. All of the circuit boards are loop (command signal) powered.

By using each dual SCR block as a separate single phase controller, the user can control up to eight separate heating zones using one physical platform. Or, control a pair of 3-phase, phase angle fired zones by linking three of the 6CP control boards 4-20mA signal inputs in series. (This could also be accomplished by using two A3P trigger boards).

Further, by using C6Z series controls, you can configure packages for three (3) 2-leg zero voltage switched, or (2) 3-leg zero voltage switched controllers in an incredibly small package. Again, by wiring up the trigger board 4-20mA signals in series, you can accomplish this in the field. Typically, Avatar Instruments A3Z or A6Z trigger boards would be installed at the factory.

By using the R120 option, the customer can use the 6CZ as a replacement for mechanical and mercury relays.

Avatar Instruments has provided custom multi-zone controllers to work on differing line voltages on a shared platform. With platforms going up to 1200 Amps, these devices are a versatile solution to demanding and unusual situations.

Modular construction allows for simple and solders less field serviceability. There are three field replaceable items:

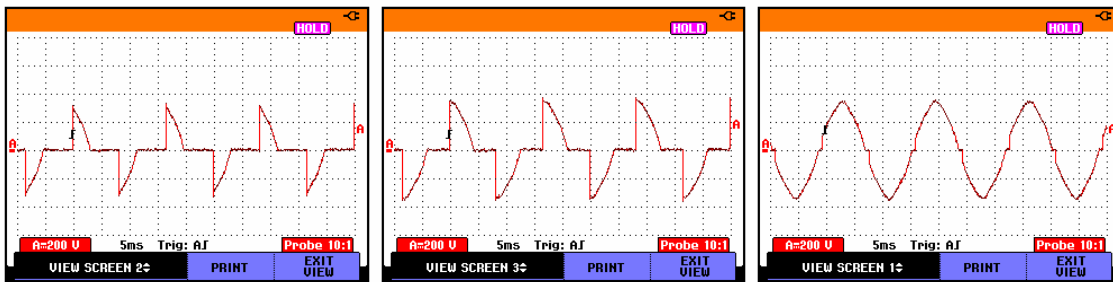
- Printed circuit board(s)
- Dual SCR package
- MOV (metal oxide varistor) - high powered models only

THEORY OF OPERATION

The standard input signal (4-20mA) is applied to the blue input terminal block, processed and fed to an optical coupler. The output of the opto coupler feeds the drive circuitry which is then fed to a pair of inversely connected SCR's. Additionally, an MOV (metal oxide varistor) is connected in parallel with the SCR's, providing voltage spike protection to the controller.

PHASE ANGLE FIRED (2CP – 8CP)

These controls proportionally turn on a percentage of each power line half cycle. This gives smooth, infinitely variable application of power to the heaters. Imagine a light dimmer and how it provides power to a light bulb. This method will provide the most precise control of heaters. Phase angle fired SCR's will respond the fastest to load change and provide maximum heater life. It is the most precise method of control. Phase angle firing can increase heater *life up to seven times depending on heater type*. Phase angle firing also allows options such as soft start, voltage limit and current limit. These options are not available with any other means of control. Graphs below shows phase angle fired voltage output on a 240V power line.



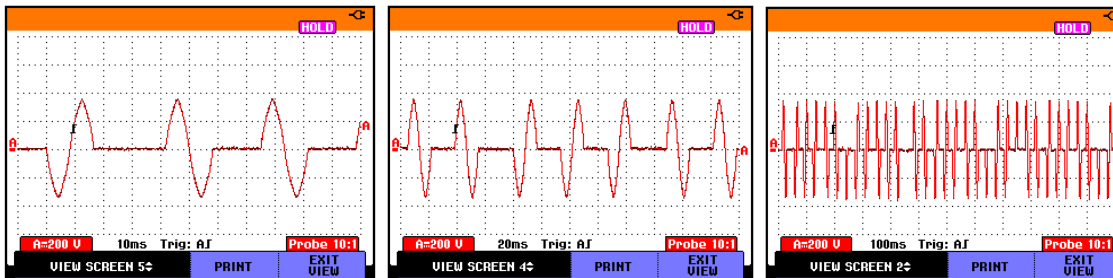
25% output or 60V RMS

50% output 120V RMS

99.5% output or 238.8V RMS

ZERO VOLTAGE SWITCHING (2CZ – 8CZ)

Zero voltage switching controls proportionally turn on and off each full cycle of the power line. By varying the number of AC power line cycles, the SCR provides power to the heaters. With a variable time base, the optimum number of cycles turned on/off is achieved. This method produces less RFI line noise than phase angle fired SCRs. Power factor is 100%, while harmonic distortion is limited. Chart below, left and center shows 25% power output using variable time base zero voltage switching.



Avatar Instruments variable time base SCR firing. Note how half cycles can be turned on and off providing 0.08 second resolution. The chart on the right shows 50% output.

INSTALLATION



WARNING: FIRE HAZARD!! Even the best electronic components CAN FAIL SHORTED, KEEPING FULL POWER ON! Provide a completely SEPARATE (redundant) OVER TEMPERATURE SHUTDOWN MEANS to switch power off if safe temperature is exceeded.



WARNING: HIGH VOLTAGE!! This control must be installed in a GROUNDED enclosure. Provide a safety interlock on door to remove power before gaining access to device.



This controller must be installed by a qualified electrician in accordance with any and all local and national electric codes including NEC and any other applicable codes.

First things first, do you have the proper controller for your application? Check the Avatar serial tag and verify the correct voltage/ ampere ratings and input control signal for your application.

After verifying you have the proper controller, the next most important item is adequate cooling/ ventilation. All Avatar power controllers are rated to deliver full power to their respective load(s) at an ambient temperature not to 50°C or 122°F. To calculate total power dissipated by the controller, all zones must be figured and added together. The example below is based on a three zone controller.

| |
|--|
| <p>1.2 VOLTS X MAXIMUM ZONE HEATER CURRENT = TOTAL WATTS DISSIPATED/ZONE</p> <p><i>example:</i></p> <p>ZONE 1 max. current = 40A</p> <p>ZONE 2 max. current = 35A</p> <p>ZONE 3 max. current = 65A</p> <p>1.2V x (40A + 35A + 65A) = 168.5 Watts Total Power Dissipated</p> |
|--|

Heat is the worst enemy to any electrical device, including power controllers. To aid in heat dissipation orient heat sink fins in a vertical position, providing adequate air flow above and below unit. The cooler the unit operates, the longer it will provide seamless, reliable service. Mounting direction on fan cooled units is not as critical. The dryer and cleaner, the better! Over time, a combination of moisture and contaminates will lead to failure due to corrosion and insulation breakdown (arcing and sparking).

If the controller absolutely must be installed in a harsh and corrosive environment, it is recommended that an air conditioned NEMA 4X or similar type of environmentally sealing enclosure be used during installation.

ELECTRICAL CONNECTIONS



Again, this work must be performed by a qualified electrician and in accordance with any and all local and national codes that may apply. Please refer to the "wiring diagram" (pg. 13 - 26).



To reduce the risk of electrocution, **TURN ALL POWER OFF** to wires that will be connected to the power control before making any connections. The standard CP controller is not provided with a cover; therefore it is highly recommended the controller be installed in a metal enclosure for protection against electrocution. **1200 Amp controls have heat sinks on line voltage!!**

AC POWER INPUT:

Power input (AC MAINS) is connected to lugs labeled "LINE" and one side of the heater(s). See wiring diagrams. (see fig. 1 for correct wire size and torque specifications)

LOAD CONNECTION:

Connect the load/ heater to lugs labeled "HTR" and AC power source. See wiring diagrams. (see fig. 1 for correct wire size and torque specifications) **NOTE:** *The CP series controls are capable of driving open delta or 4 wire "wye" connected loads.*

Check heater resistance to insure heater current will not exceed maximum rating of the power controller. For protection, use of sub cycle I²T semiconductor fuses on each zone is highly recommended.

INPUT CONTROL SIGNAL:

Connect the control signal to the blue terminal block labeled "4-20mA INPUT" observing proper polarity (positive to "+" and negative to "-"). Fan cooled units come standard with a thermostat switch mounted to the heat sink. The thermostat can be used for triggering alarms, aux. fans, etc. or wired in series with the input control signal providing over temperature protection. (see "A1P wiring diagram").

THERMOSTAT for FAN FAILURE:

Fan cooled CP's come standard with a Snap-disc thermostat mounted to the heat sink. If the fan fails, air is blocked or a safe ambient temperature is exceeded, the thermostat will activate. This thermostat can be used to break 4-20mA input signal, trigger alarms or shut down a power contactor. See wiring diagram for thermostat wiring.

OPTIONS

SOFT START: The soft start is made for applications where heaters have inrush currents. For use with Tungsten (T-3), Molybdenum or Graphite heaters. This option is designed to ramp power from 0-100% over a fixed time period. This time is 3 seconds with (S) option. If the input signal goes to 4mA (0%), the soft start will engage for the full length of time when the mA signal is reactivated. The soft start option will also restart if line voltage is interrupted to the SCR. Extra DV/DT Suppression board included with option. On soft start option CP controllers, use the "SPAN" potentiometer as a voltage limit.

VOLTAGE LIMIT: The voltage limit option (VL) is used to reduce the maximum output voltage applied to the heaters. The adjustment is located on the trigger board close to the 4-20mA input signal terminal. It is marked as "V-LIM". To set the voltage limit, connect a volt meter across HEATER 1 & HEATER 2. THERE MUST BE A LOAD CONNECTED FOR SCR TO FIRE. With a full 20mA input signal, turn potentiometer CCW to reduce maximum output voltage to desired level. This option comes as standard on soft start option.

SPACE DELIBERATELY LEFT OPEN

"R" RELAY OPTION: For 10-32 VDC or 120VAC Signal Input to turn CZ into On/Off controller, use "R" relay option. Call out as "-R32" or "-R120"

For manual control use Avatar model **MAP**. Isolated Potentiometer 4-20mA signal card.

For LINEAR 0-5 or 0-10 VDC Analog Signal use Avatar MAI milliamp interface card.

MAI-05V takes a 0-5VDC signal input and outputs 4-20mA.

MAI-10V takes a 0-10VDC signal input and outputs 4-20mA.

FUSES: Fuse kits are available from Avatar in dozens of sizes and configurations. Consult Avatar before ordering.

WARRANTY

All Avatar Instruments products carry a full five year, warranty from date of purchase, parts and labor warranty against component failure and defects in workmanship . In the event your controller fails to perform properly, **contact Avatar to obtain a return authorization number**. Controllers sent to Avatar for warranty service that have no apparent defect will be treated as a standard repair and a \$50.00 charge will be applied. Avatar will repair or replace any unit that failed due to defective parts or assembly. This warranty DOES NOT cover damage due to shipping, abuse, misapplication or operation beyond specified rating. Further more fuses and improperly fused SCR's are NOT COVERED by this warranty. Avatar is not responsible for any subsequent or other damage experienced in use of this device.

SPECIFICATIONS

INPUT VOLTAGE: see model description
OUTPUT VOLTAGE: 0-97% of input voltage phase angle
OUTPUT VOLTAGE: 0-99% of input voltage zero voltage
CURRENT CAPACITY: see model description
CONTROL SIGNAL:
4-20mA INPUT TERMINAL TORQUE RATING: 5 in-lbs
CP PHASE ANGLE:..... 4-20mA @ 1.5 volts DC per zone
INPUT IMPEDANCE: 75 ohms per zone
CP SOFT START:..... 4-20mA @ 40 volts DC per zone
INPUT IMPEDANCE: 200 ohms per zone
CZ ZERO VOLTAGE SWITCHED:..... 4-20mA @ 3 volts DC per zone
INPUT IMPEDANCE: 150 ohms per zone
LINEARITY: less then 15% deviation
RESPONSE TIME: 12mS (STD unit, non soft start)
COOLING: see dimensional drawings
THERMOSTAT: 190°F (fan cooled units only)
POWER DISSIPATION (Watts): 1.2 x maximum current
DIMENSIONS: see dimensional drawings

| Wire Gauge and Torque Specifications for 90°C Temp Wire | | | |
|---|------------------------------|----------------------------------|----------------|
| Power Control Maximum Current Rating/ Circuit | Copper Wire Only MINIMUM AWG | Wire Lug Torque Spec. (lbs./in.) | Lug Size |
| 10A | 12AWG | 35 | 10 AWG |
| 15A | 12AWG | 35 | 10 AWG |
| 20A | 12AWG | 35 | 10 AWG |
| 30A | 10AWG | 35 | 10 AWG |
| 40A | 8AWG | 40 | 2/0 - 14 |
| 50A | 6AWG | 45 | 2/0 - 14 |
| 60A | 6AWG | 45 | 2/0 - 14 |
| 70A | 4AWG | 45 | 2/0 - 14 |
| 80A | 4AWG | 45 | 2/0 - 14 |
| 100A | 3AWG | 50 | 2/0 - 14 |
| 150A | 1AWG | 150 | 250MCM - 6 |
| 200A | 3/0 AWG | 250 | 250MCM - 6 |
| 225A | 3/0 AWG | 250 | 250MCM - 6 |
| 250A | 4/0 AWG | 250 | 250MCM - 6 |
| 350A | TWO: 4/0 AWG | 250 | TWO: 250MCM-6 |
| 600A | TWO: MCM 350 | 325 | TWO: 600MCM-2 |
| 1200A | FOUR: MCM 350 | 325 | FOUR: 600MCM-2 |

Fig. 1

Please note: The above is the *minimum* wiring as per National Electrical Code – 2002 Table 310-16. Single insulated conductors.

TROUBLESHOOTING

| SYMPTOM | POSSIBLE CAUSE | POSSIBLE SOLUTION |
|--|--|---|
| Heater does not heat up | no power to CP | verify correct input voltage between "LINE" lugs on CP. |
| | blown fuse in CP | check for shorted or grounded heater, oversize heater, only then replace fuse. For tungsten Lamps order soft start option. |
| | blown fuse on CP-S- | as above plus - cold lamp switched on after start, loose connection to cold lamp. |
| | check voltage limit adjustment on CP with soft start (CP-S-) | If limit is set for minimum output (CCW), soft start could take over 60 seconds worst case. |
| | no control signal to CP | verify 4-20mA signal is hooked up correctly (positive to "+" and negative to "-") on the source and CP. verify signal presence by placing a milliamp meter in SERIES with one of the control wires. |
| | defective heater | check for output voltage between the "HTR" terminals. If voltage is present, check wiring to the heater(s) and the actual heater(s). |
| Heater is on full all the time | incorrect source signal | verify 4-20mA signal varies from 4-20mA. |
| | shorted SCR's in CP | Disconnect the 4-20mA signal. With power applied, measure voltage drop across "LINE 1" and "HTR 1", if voltage reading is less than one volt, the SCR's is damaged. |
| Process will not stabilize - control signal oscillates | incorrect tuning of temperature controller, bad sensor location or lag | set proper rate, reset, and prop band on temperature control, speed up sensor. |
| Heater is on 25-50% all the time | Short to ground | Heater or power wiring has a short to ground, effectively bypassing SCR. Use Meg-Ohm to find short or breakdown in wire insulation. |

CP SERIES MULTI ZONE SCR POWER CONTROLLERS

ORDERING CODES

C _____ - _____ - _____ - _____ - _____ - _____
Zones Firing Voltage Amperes Options Options

ZONE DESIGNATIONS

2, 3, 4*, 5*, 6*, 8**

*Up to 100 Amps only

**Up to 20 Amps only

METHOD OF FIRING

Phase Angle Fired (P)

Zero Voltage Switched (Z)

VOLTAGE DESIGNATIONS

(12) 120 VAC 50/60Hz

(24) 208-240 VAC 50/60Hz

(27) 277 VAC 50/60Hz

(38) 380 VAC 50/60Hz

(48) 480 VAC 50/60Hz

(57) 575 VAC 50/60Hz

(60) 600 VAC 50/60Hz

(012) 12VAC 50/60Hz

(024) 24VAC 50/60Hz

(048) 48VAC 50/60Hz

LOAD IN AMPS:

10, 15, 20, 30, 40, 50, 60, 70, 80, 100,

150, 200, 225, 250, 350, 600, 1200

Ordering Note: 150-1200 Amp units only available in 2 or 3 legs.

PHASE ANGLE OPTIONS:

Soft Start

3 Seconds (S)

Voltage Limit

Standard 1 turn PCB (VL)

25 turn PCB (VL25)

ZERO VOLTAGE SWITCHED OPTIONS:

R Option

10-32 VDC on-off command signal (-R32)

120 VAC on-off command signal (-R120)

3-PHASE CONTROL OPTIONS:

2-leg zero voltage switched A3Z style, add “-2Z” to part number.

Example: 6CZ-48-70-2Z has six SCR packs, controlling three 2-leg 3-phase heater loads.

3-leg zero voltage switched A6Z style, add “-3Z” to part number.

Example: 6CZ-48-70-3Z has six SCR packs, controlling two 3-leg 3-phase heater loads.

3-leg phase angle fired, A3P style, add “3P” to part number.

Example: 6CP-48-70-3P has six SCR-diode packs, controlling two 3-phase heater loads.

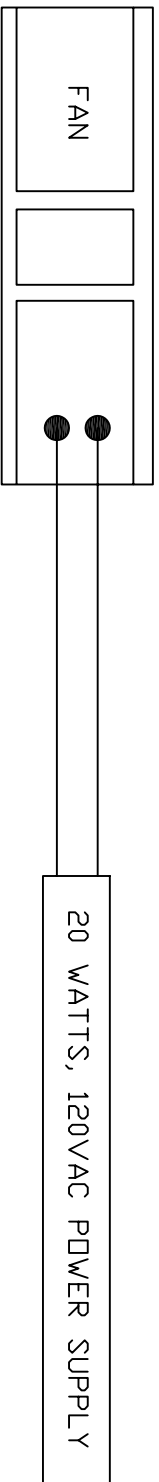
For 4-wire 3-phase angle fired, use standard single phase controlled leg, wiring the three control circuit cards 4-20mA command signal in series.

Ordering Example: 6CP-48-70-VL25 is a six zone, single phase (per zone), phase angle fired, 480VAC, 70 Amp SCR power controller.

FAN WIRING DIAGRAMS

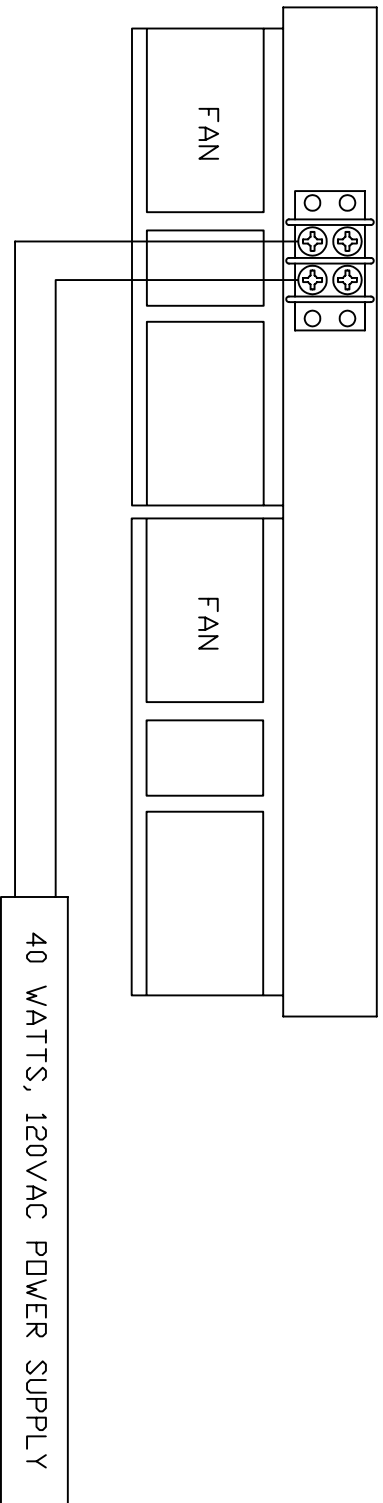
100 thru 600 AMPS

TERMINAL TYPE 6.9

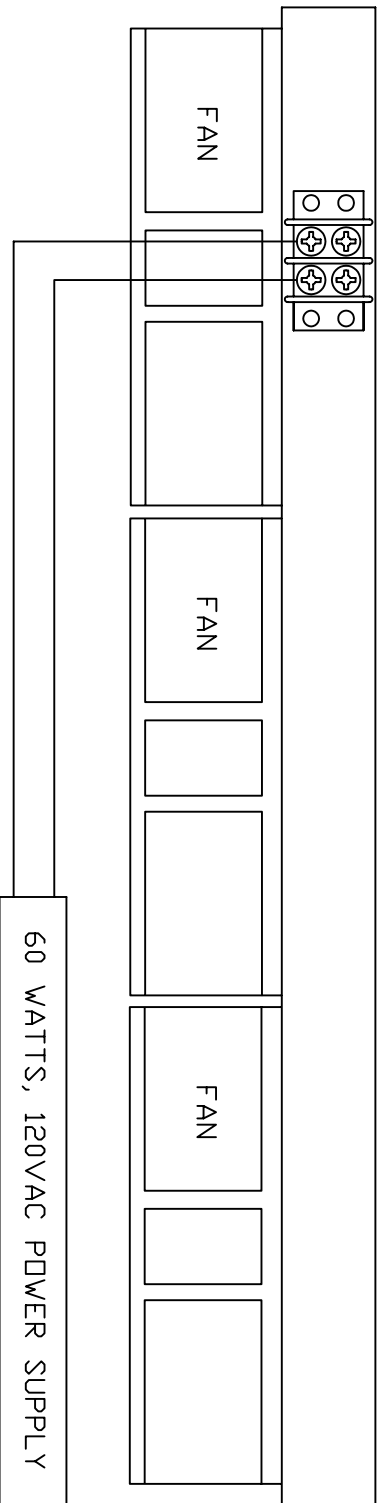


WARNING!
Fans MUST be ON when SCR power controller is on!
Power to fans must be applied before or coinciding with the turn on of line voltage to the SCR power controller. *Failure to do so will damage SCRs and other components.*

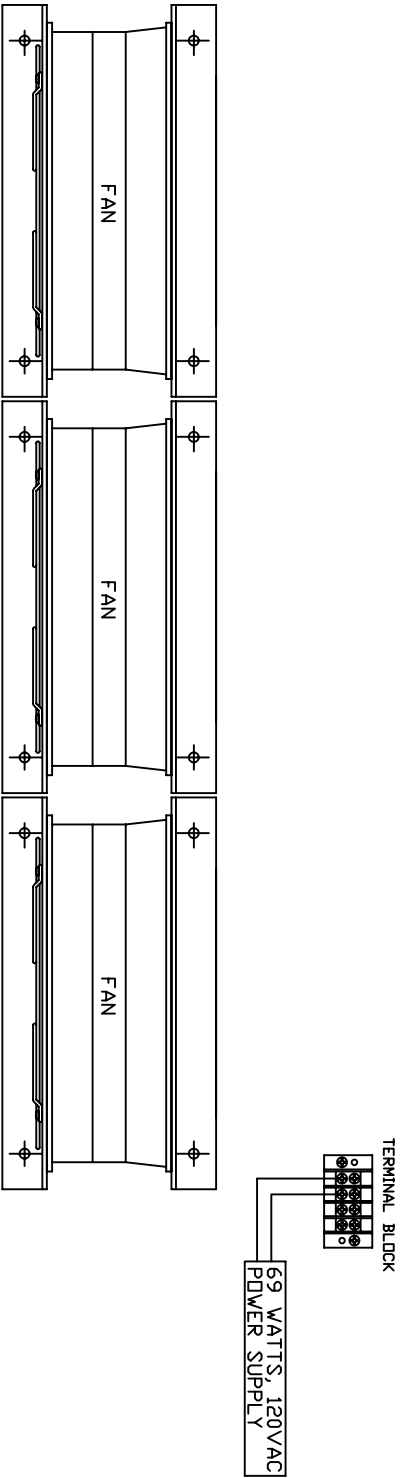
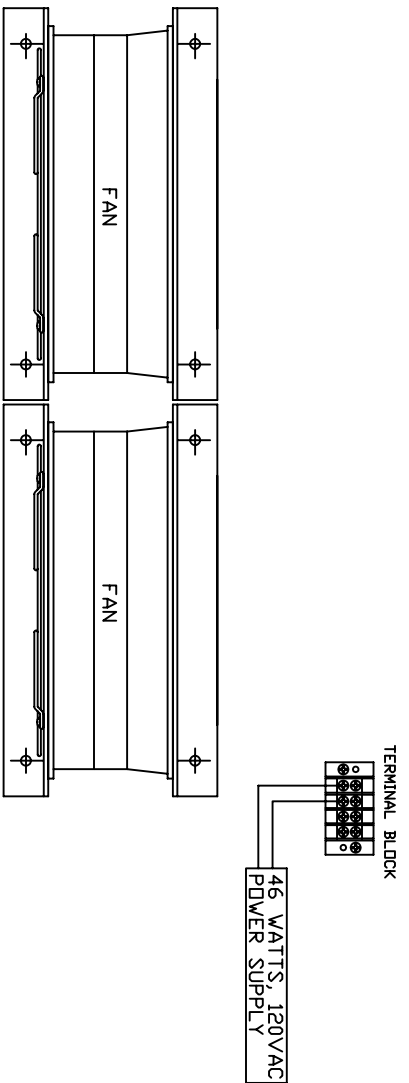
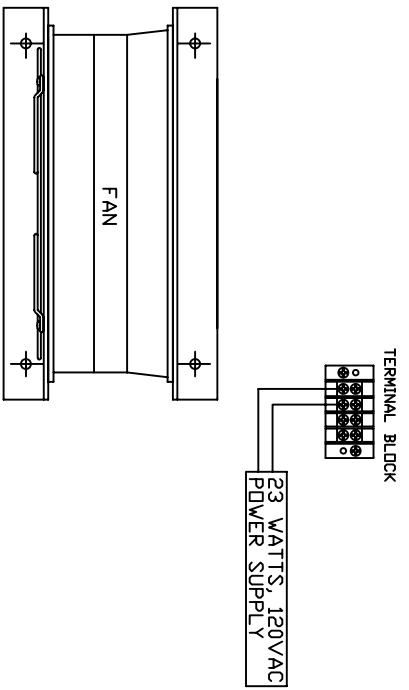
TERMINAL BLOCK



TERMINAL BLOCK



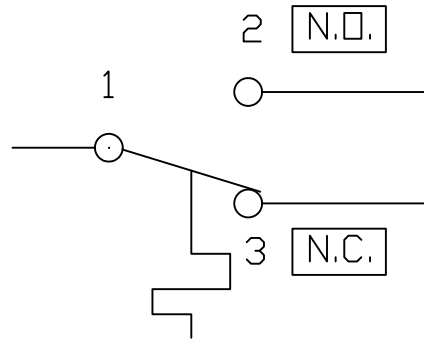
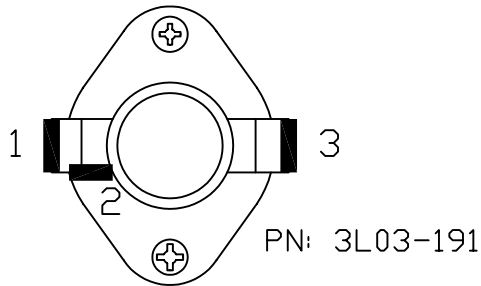
FAN WIRING DIAGRAMS 1200 AMPS



WARNING!

Fans MUST be ON when SCR power controller is on!
Power to fans must be applied before or coinciding with the turn on of line voltage to the SCR power controller. Failure to do so will damage SCRs and other components.

OVERTEMPERATURE THERMOSTAT WIRING DIAGRAMS

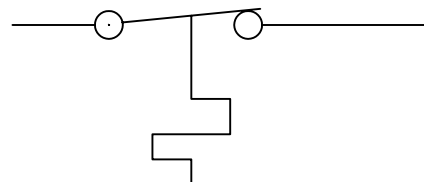
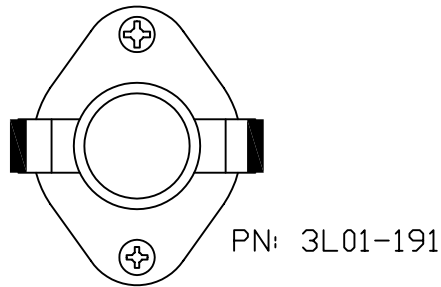


CONTACT RATINGS

1 & 2:
5.8A 120VAC
2.9A/240VAC

1 & 3:
10A/120VAC
5A/240VAC

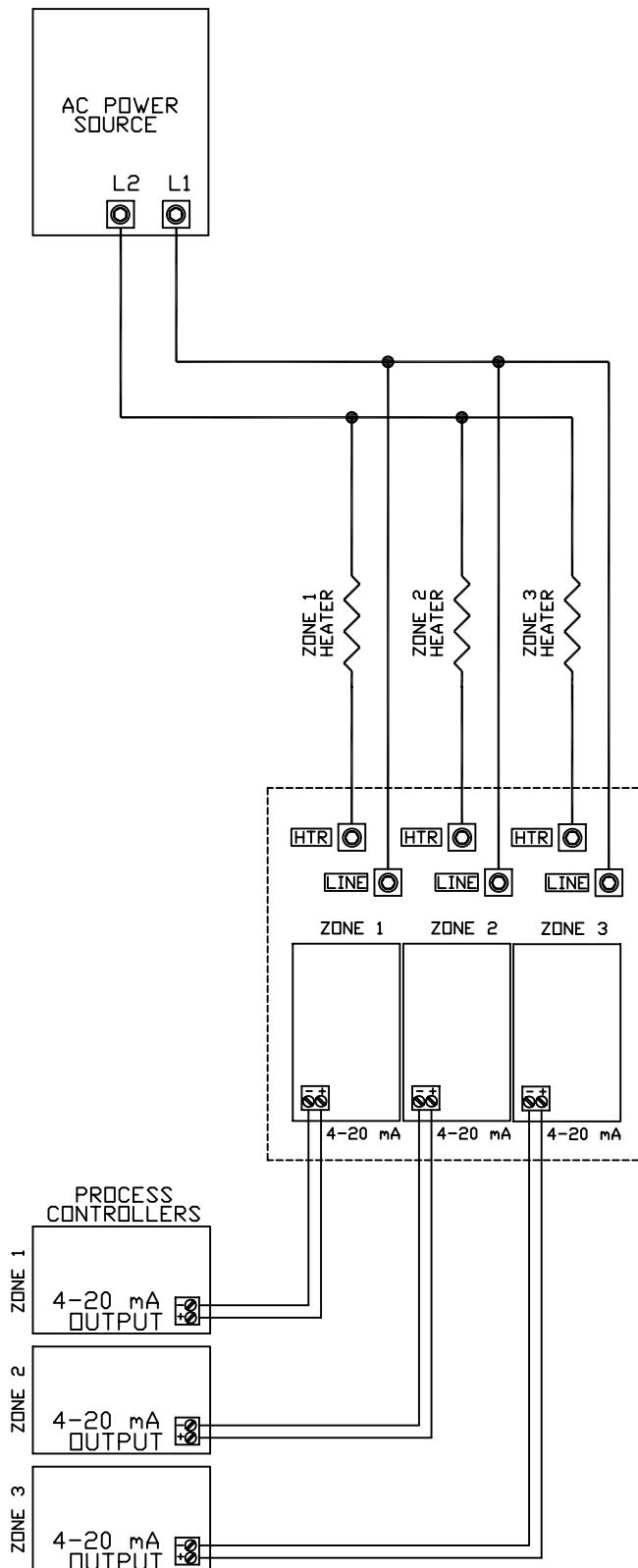
OPEN: 190F
CLOSE: 170F



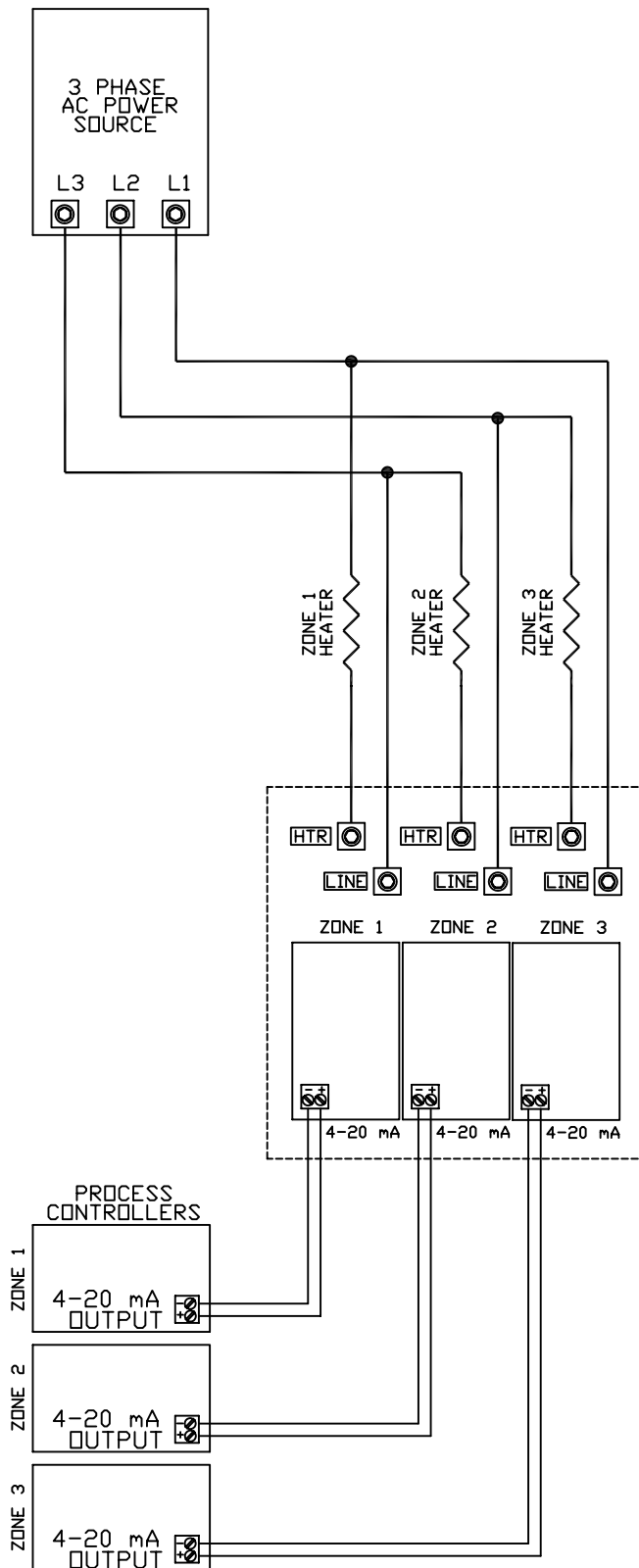
CONTACT RATING:
10A/120VAC
5A/240VAC

OPEN: 190F
CLOSE: 170F

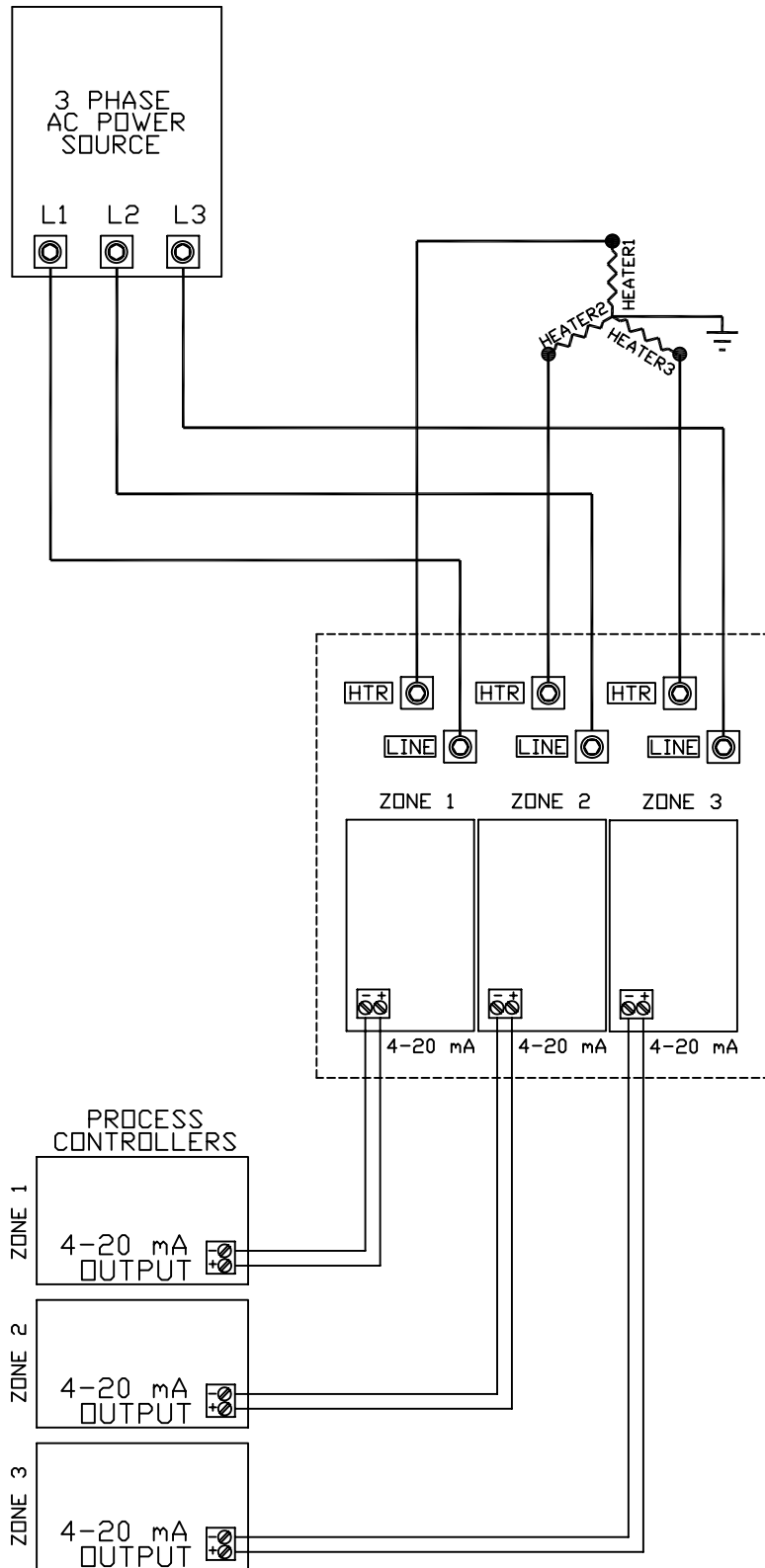
3CP WIRING DIAGRAM (3 Zone, Single Phase)



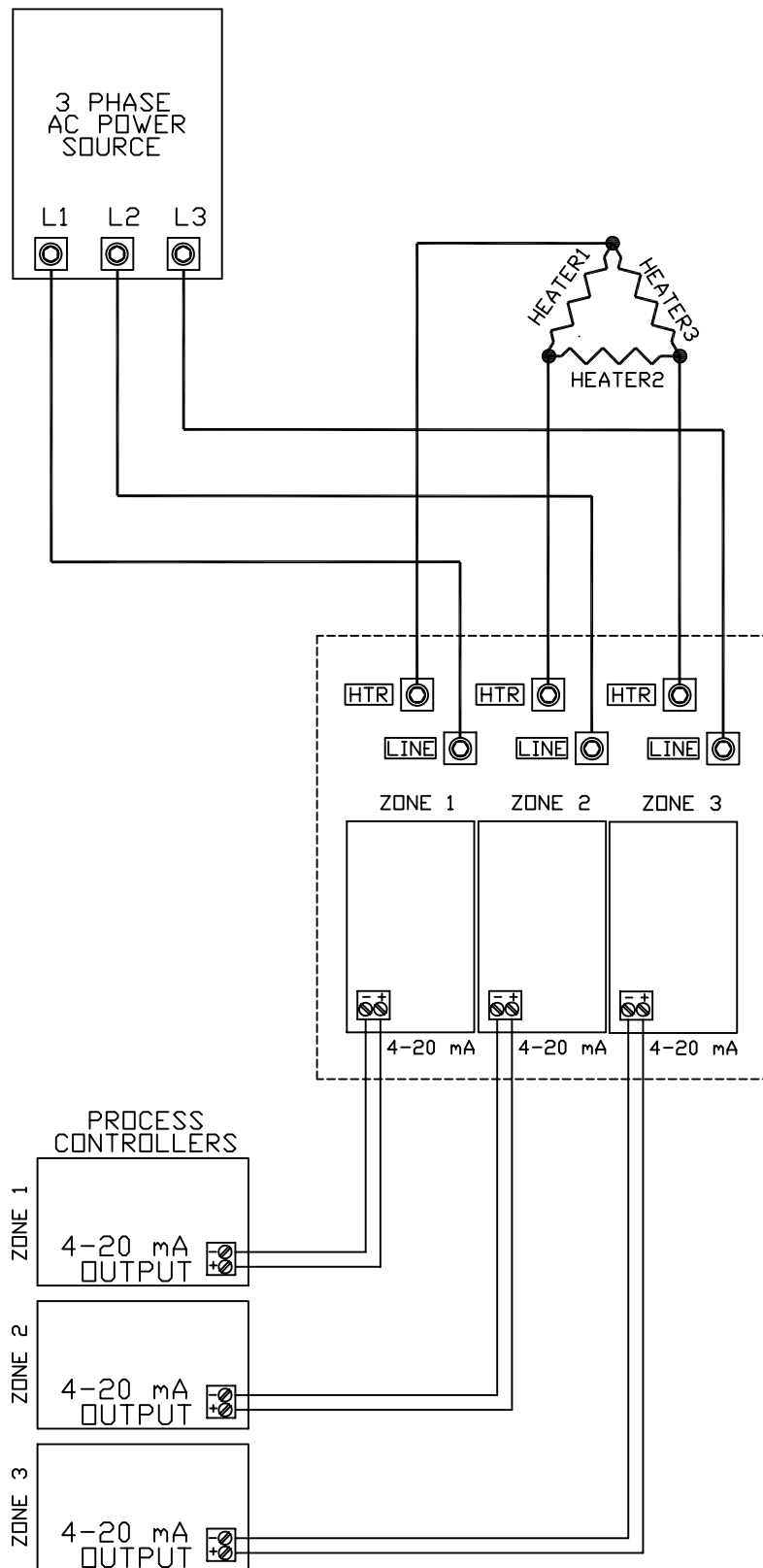
3CP WIRING DIAGRAM (3 Zone, 3 Phase)



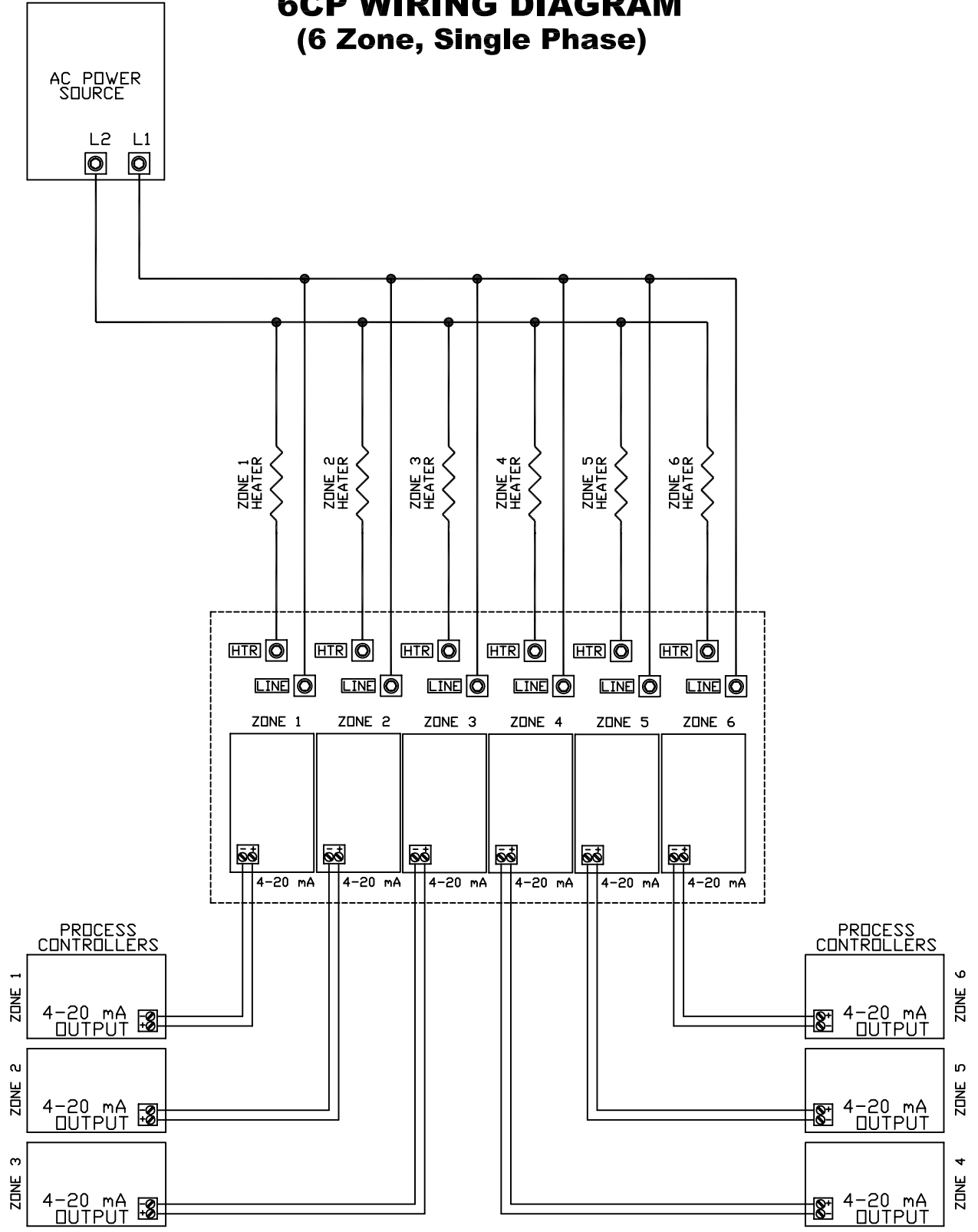
3CP WIRING DIAGRAM (3 Phase, 3-Leg Wye Connection)



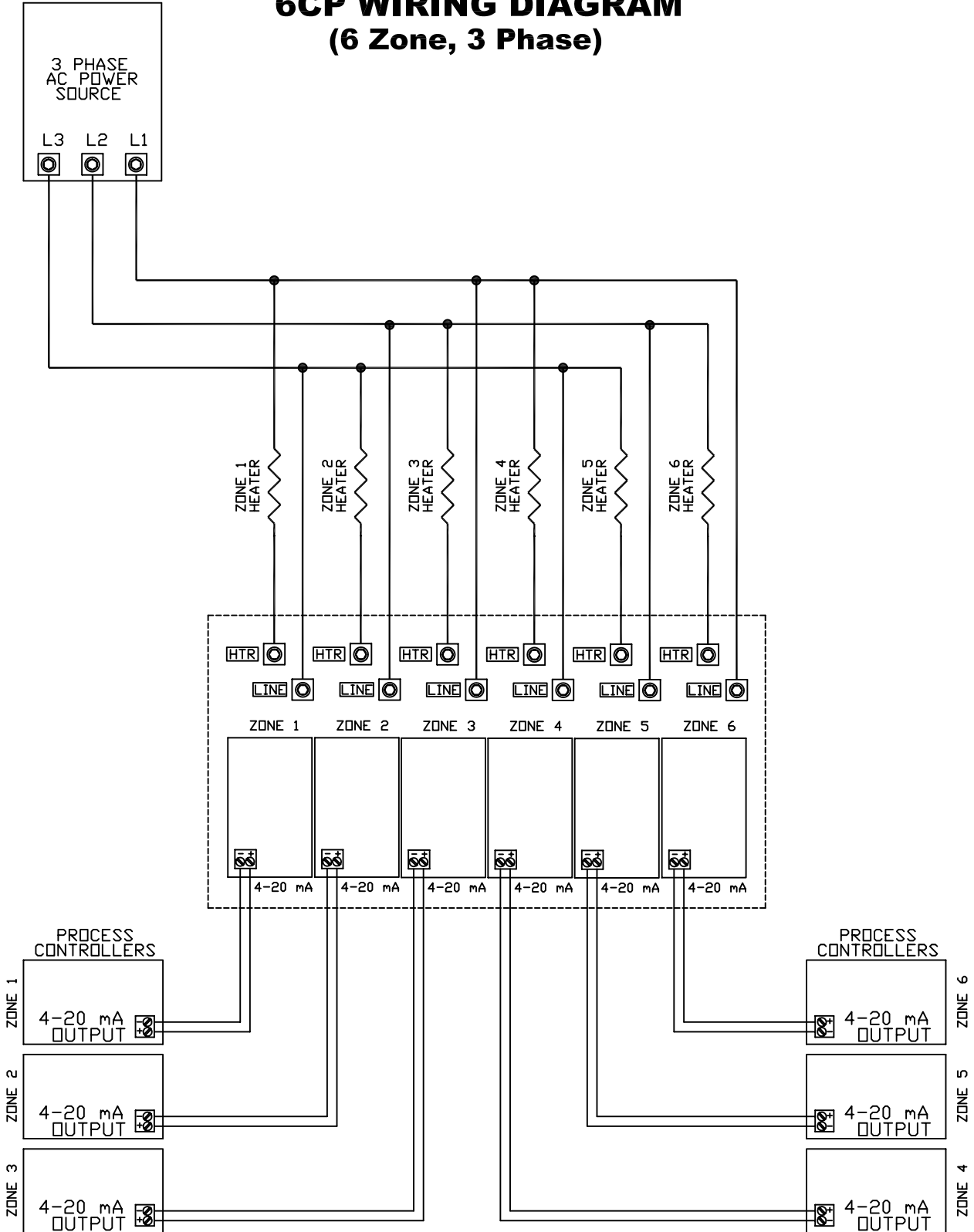
3CP WIRING DIAGRAM (3 Zone, 3 Phase, 3-Leg Delta Connection)



6CP WIRING DIAGRAM (6 Zone, Single Phase)

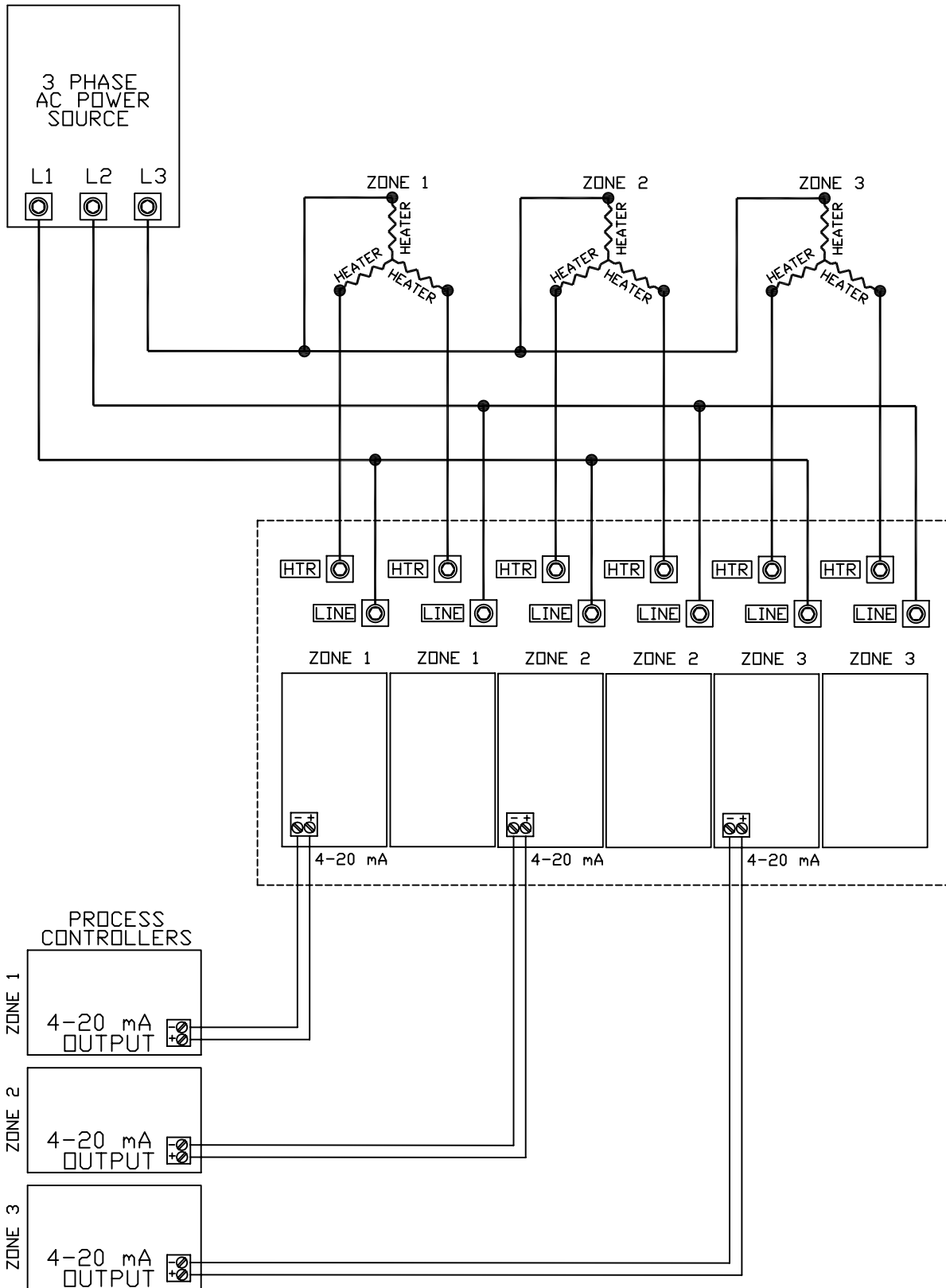


6CP WIRING DIAGRAM (6 Zone, 3 Phase)

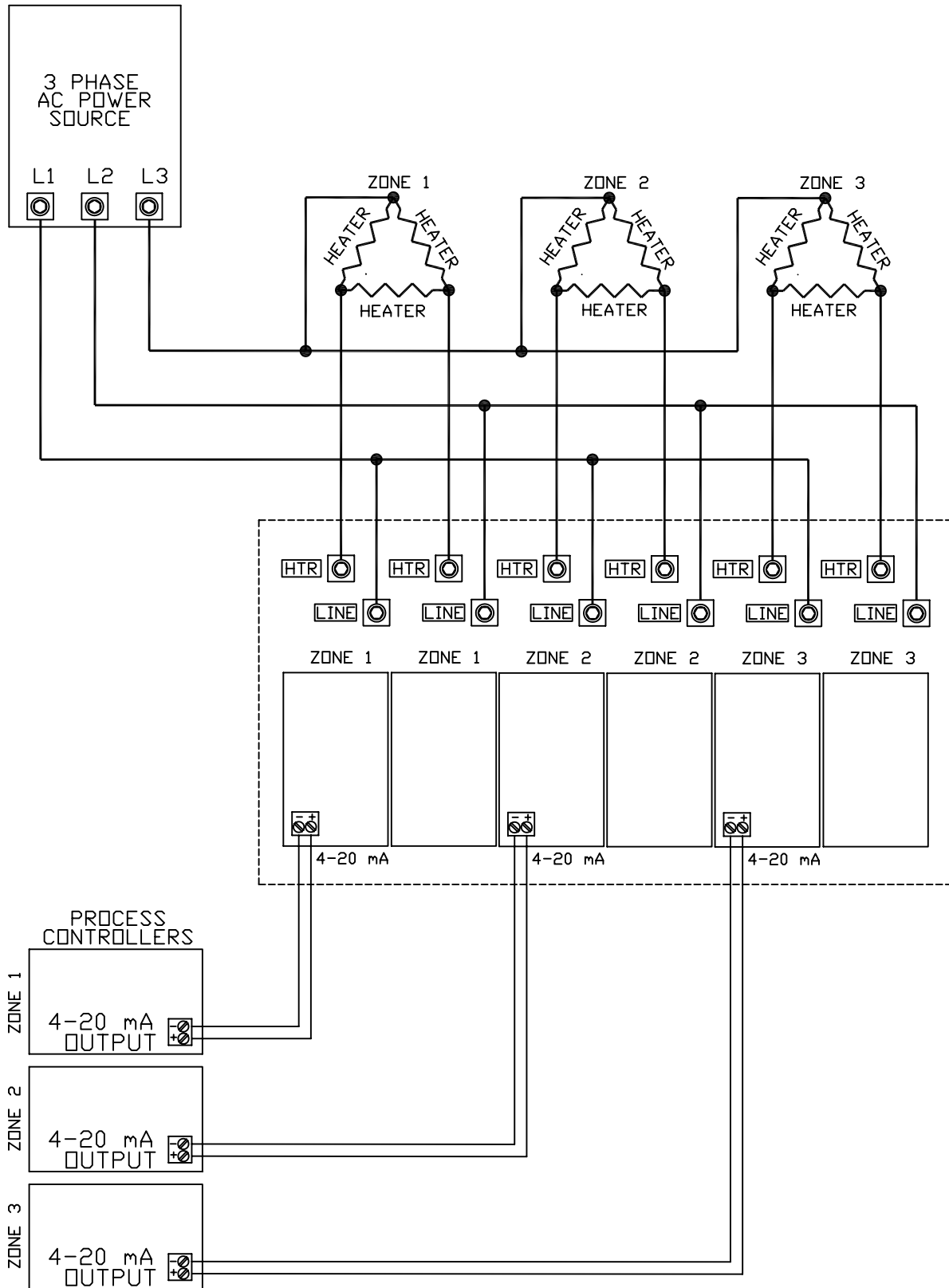


6CP WIRING DIAGRAM (3 Zone, 3 Phase, 2-Leg Wye Connection)

NOTE: Zero-cross Firing ONLY

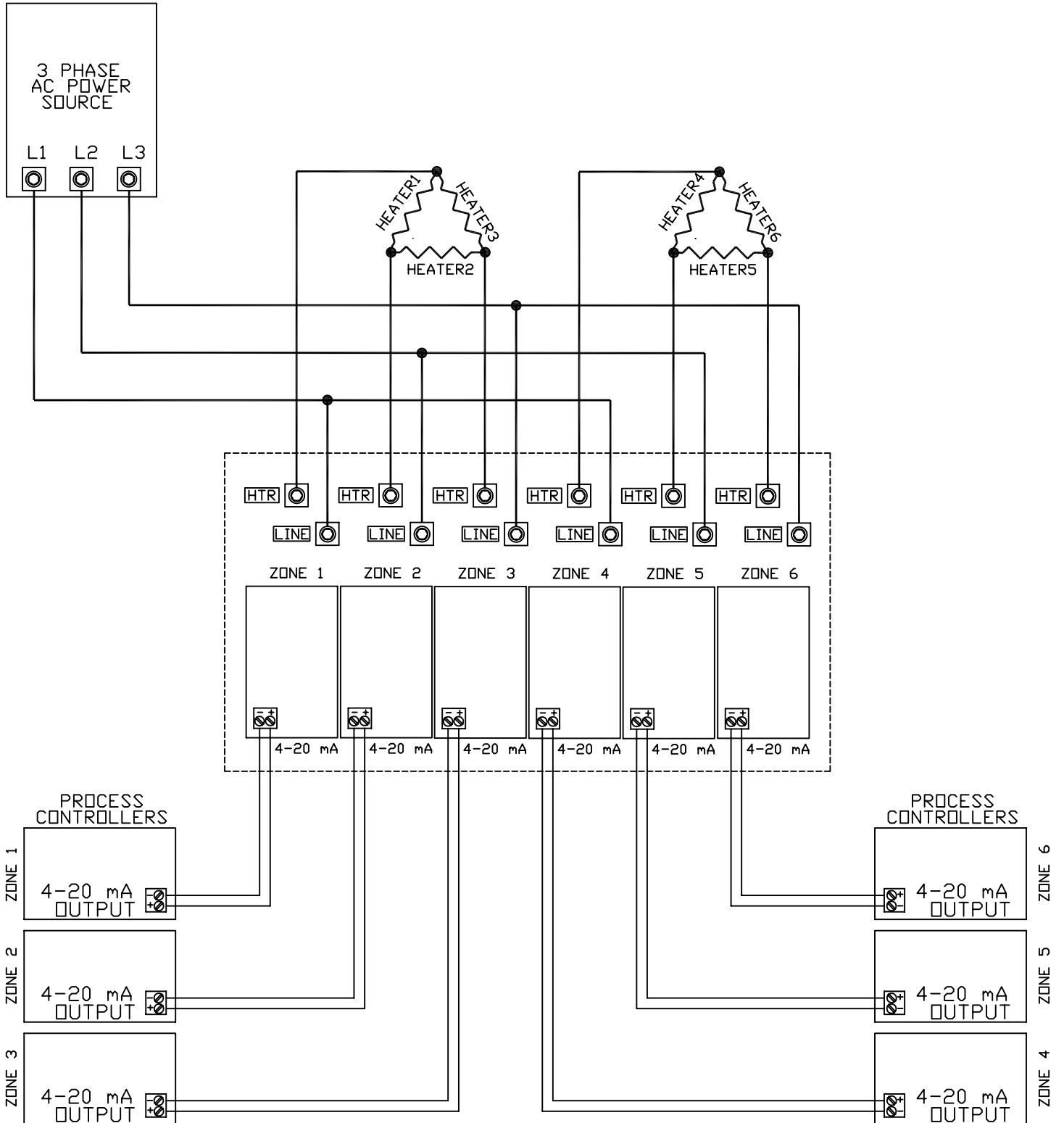


6CP WIRING DIAGRAM (3 Zone, 3 Phase, 2-Leg Delta Connection)



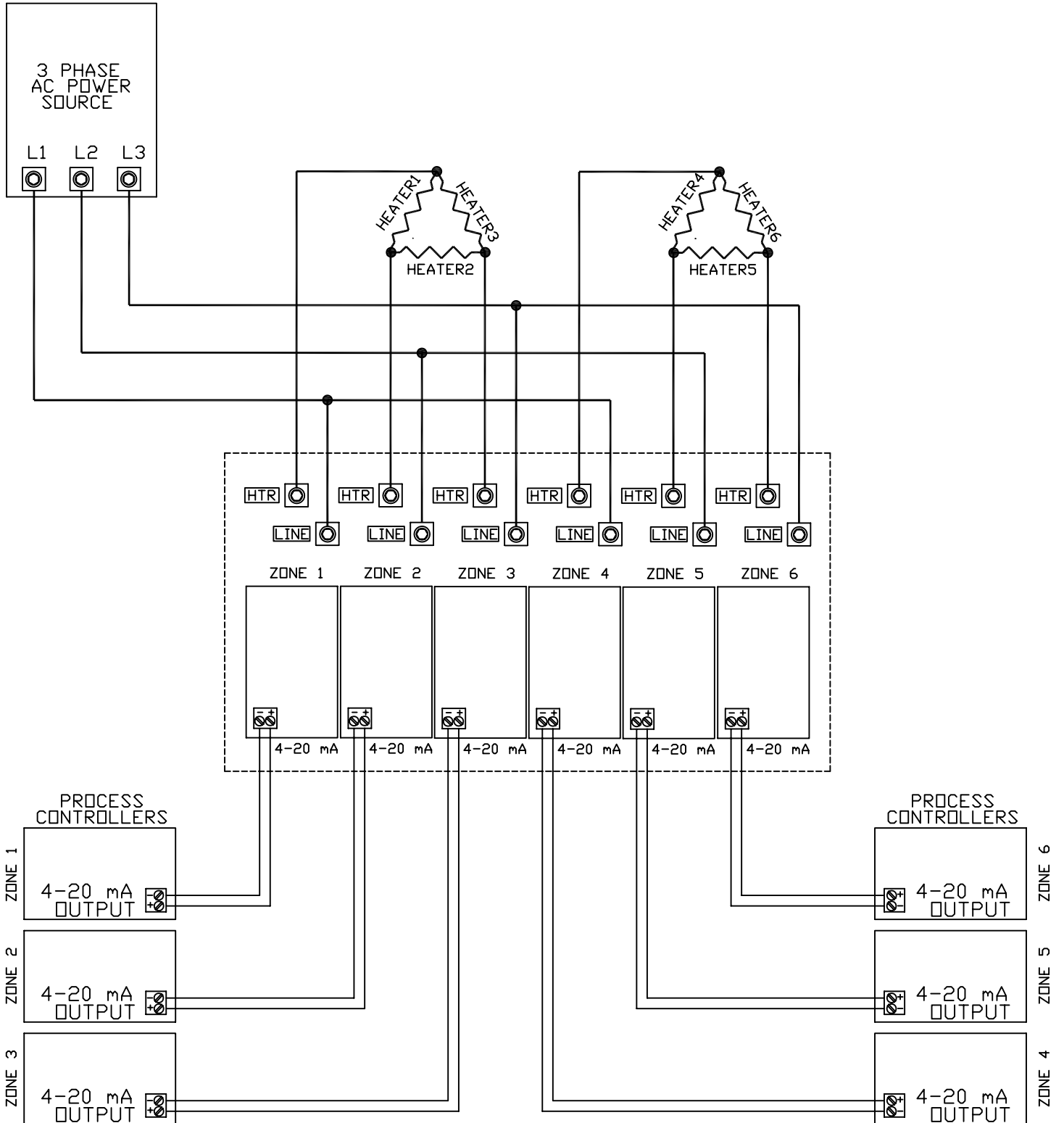
6CP WIRING DIAGRAM (6 Zone, 3 Phase, 3-Leg Delta Connection)

NOTE: Zero-cross Firing ONLY



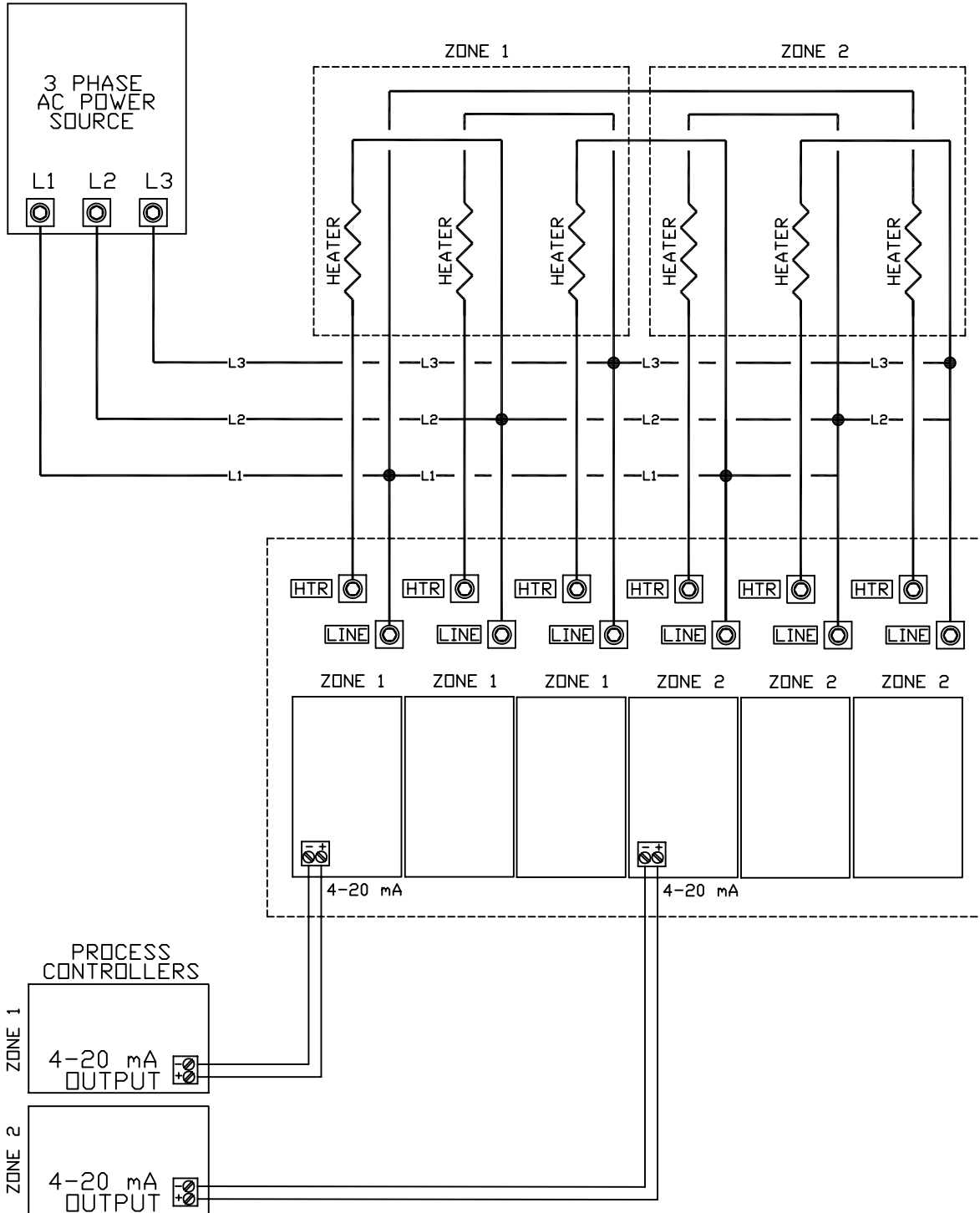
6CP WIRING DIAGRAM (6 Zone, 3 Phase, 3-Leg Delta Connection)

NOTE: Zero-cross Firing ONLY



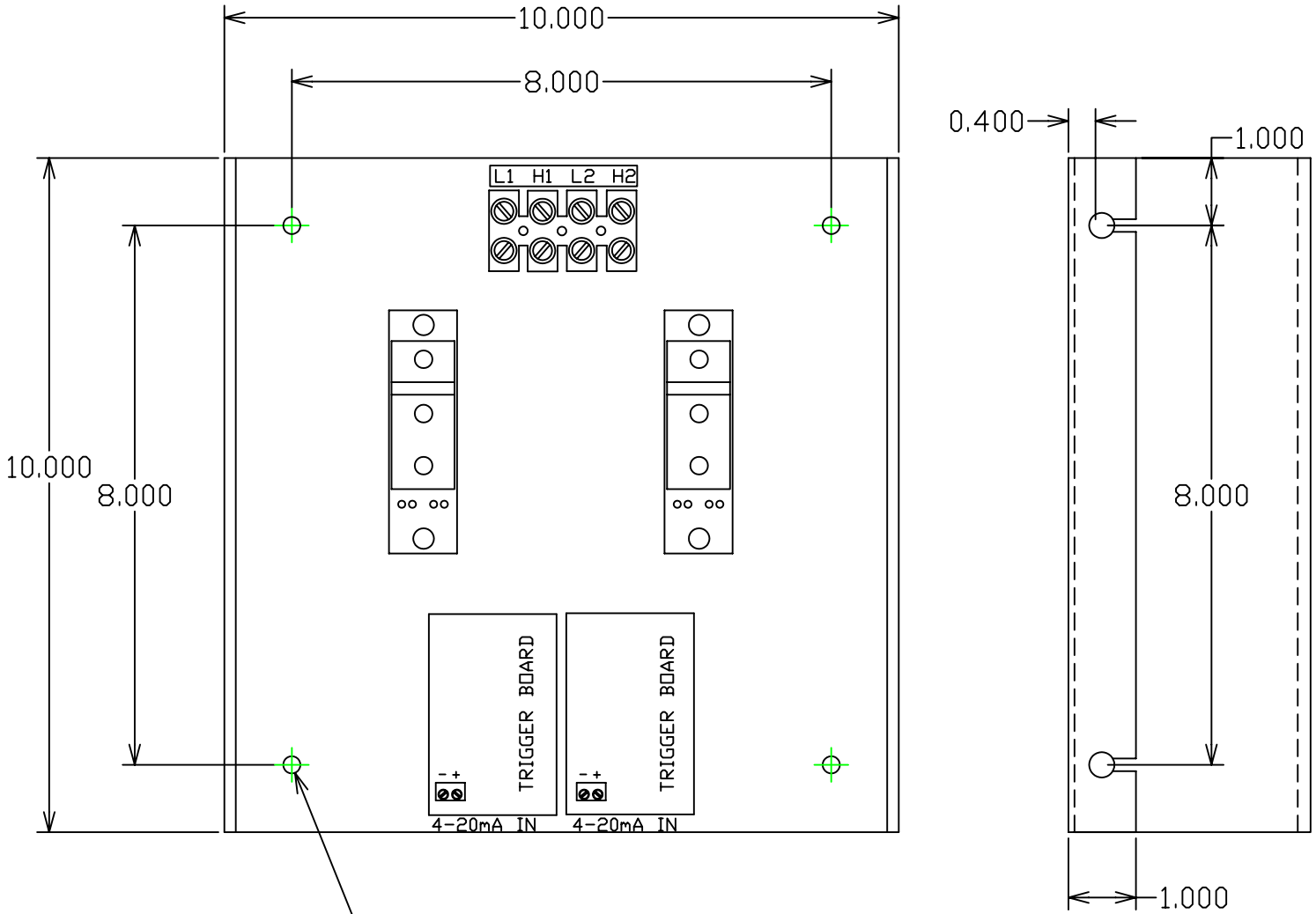
6CP WIRING DIAGRAM (3 Phase, 2 Zone Inside Delta Connection)

NOTE: Zero-cross or Phase-Angle Firing

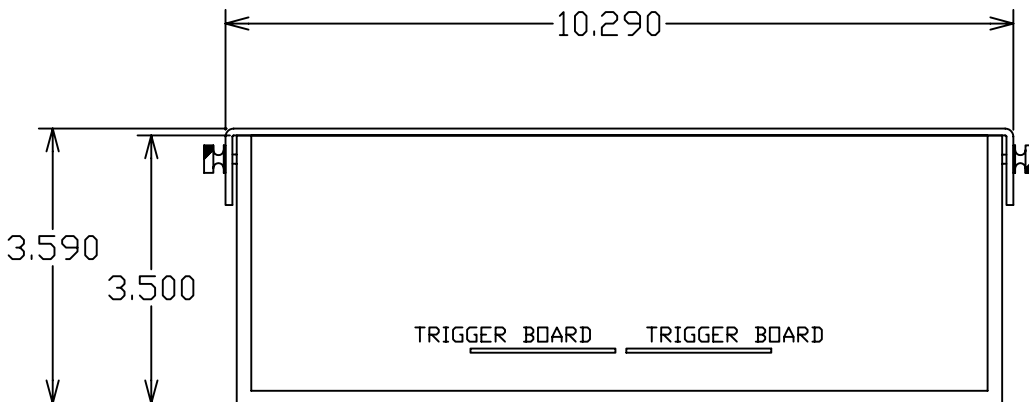


PHYSICAL DIMENSIONS

2CP - 30 AMP

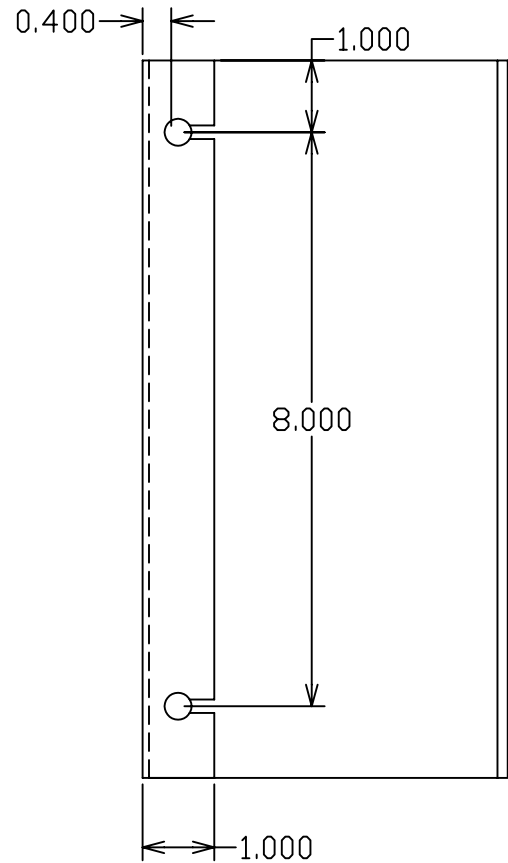
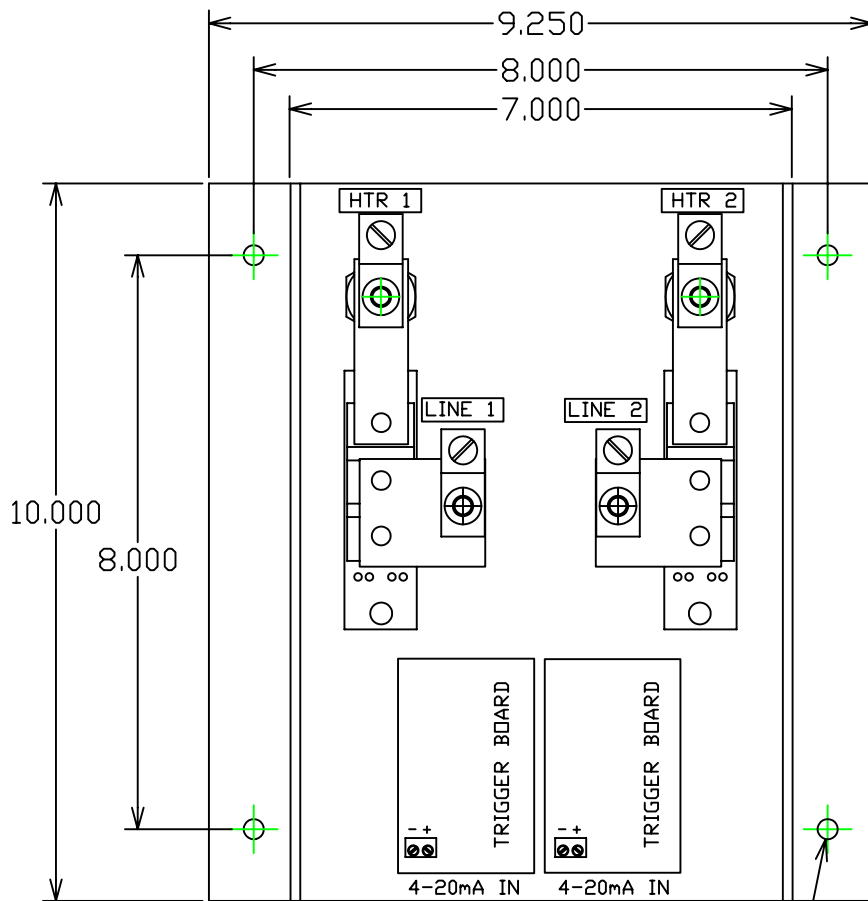


(4) MOUNTING HOLE DIAMETER 0.275"

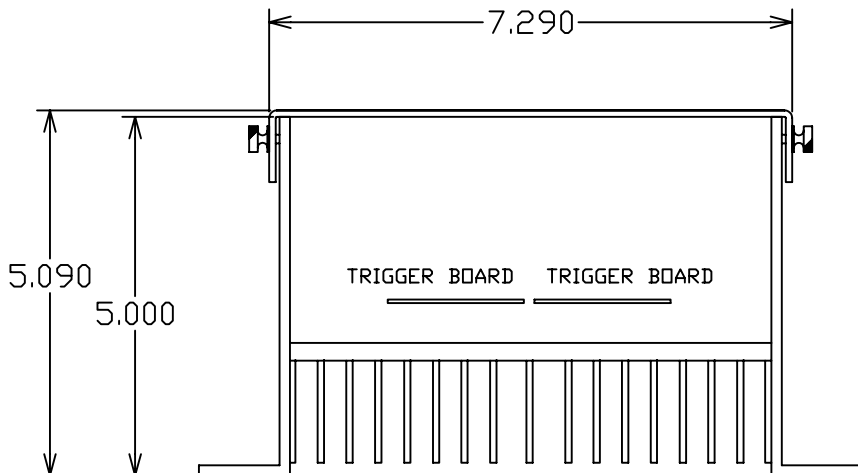


PHYSICAL DIMENSIONS

2CP - 40 & 60 AMP

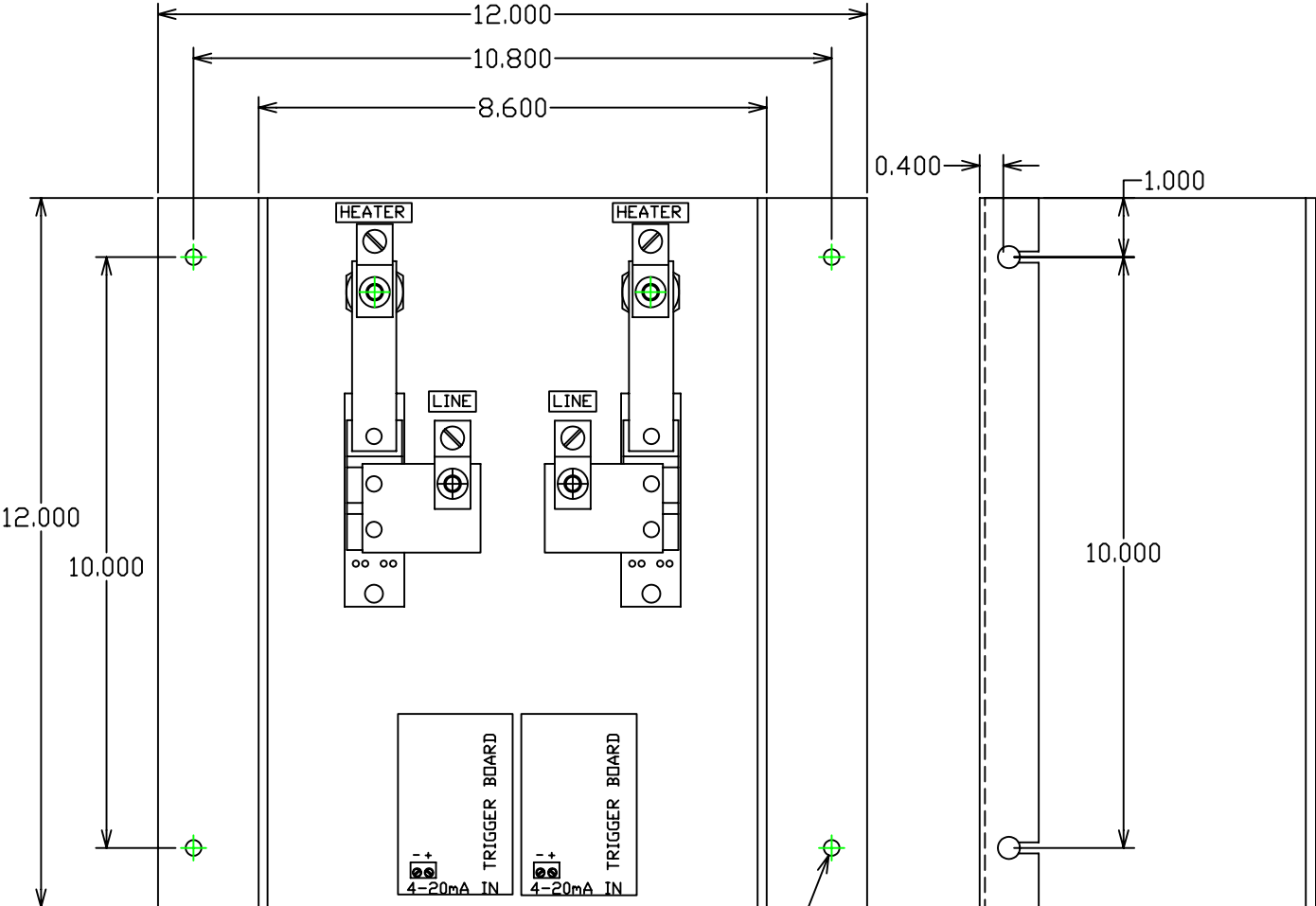


(4) MOUNTING HOLE DIAMETER 0.275"

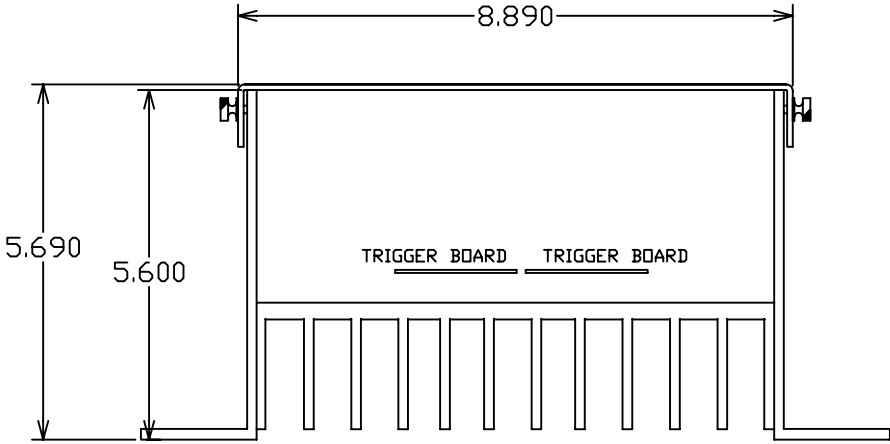


PHYSICAL DIMENSIONS

2CP -80 & 100 AMP

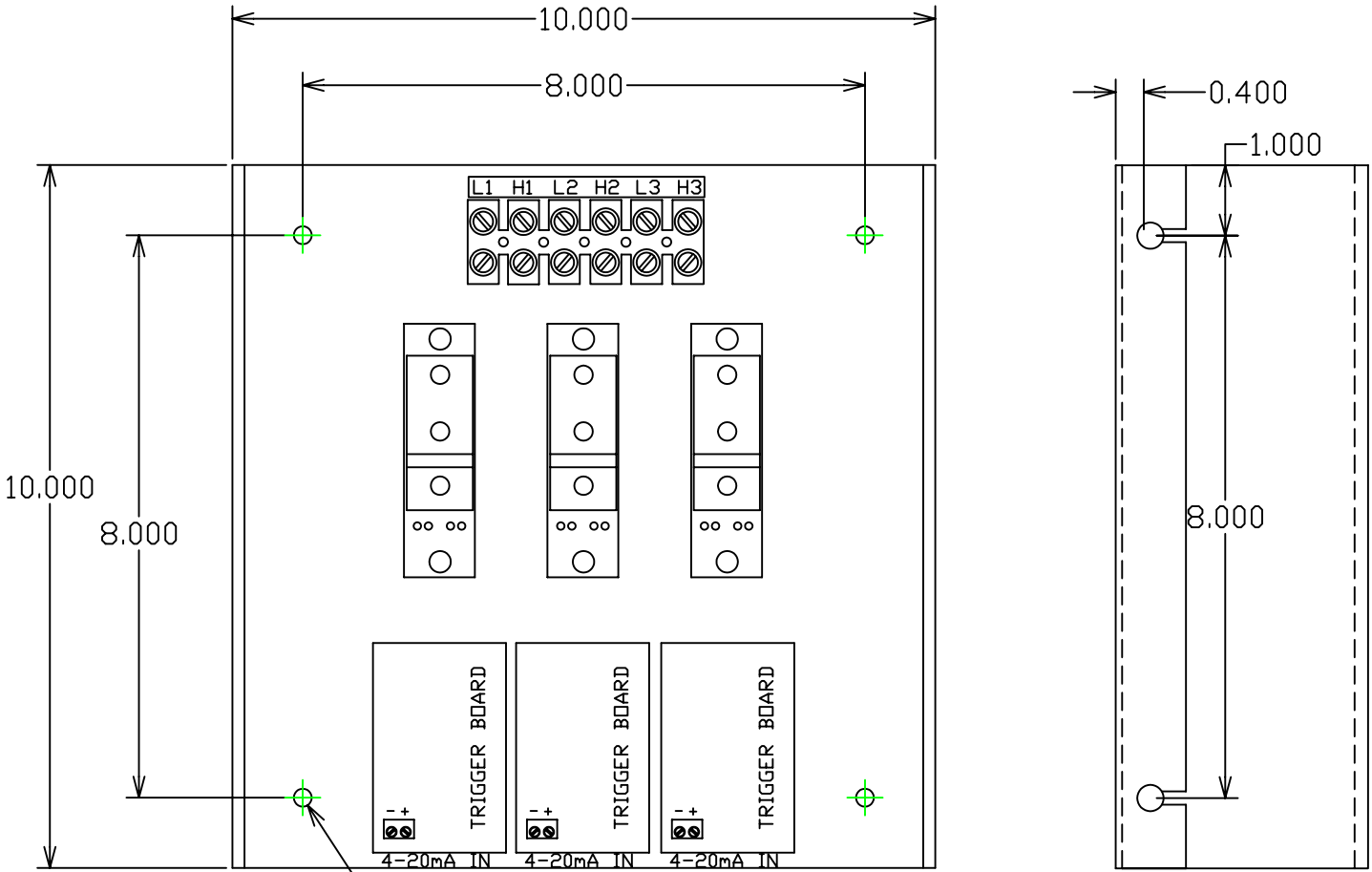


(4) MOUNTING HOLE DIAMETER 0.275"

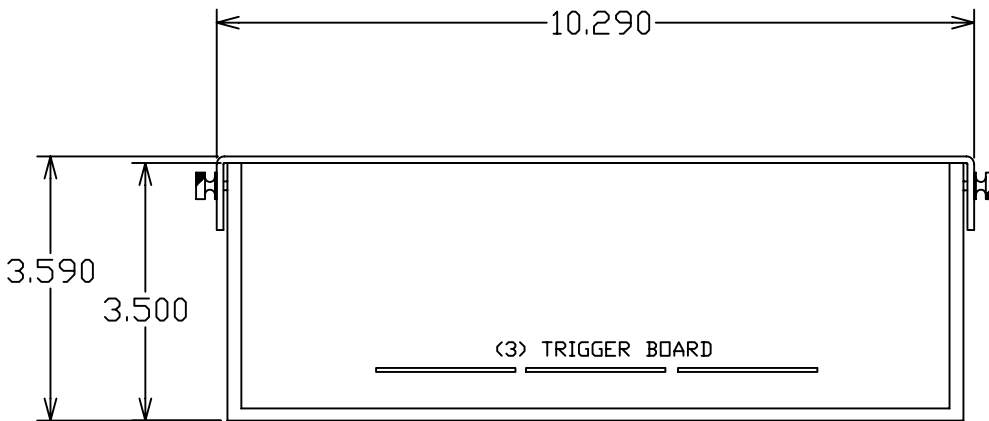


PHYSICAL DIMENSIONS

3CP - 30 AMP

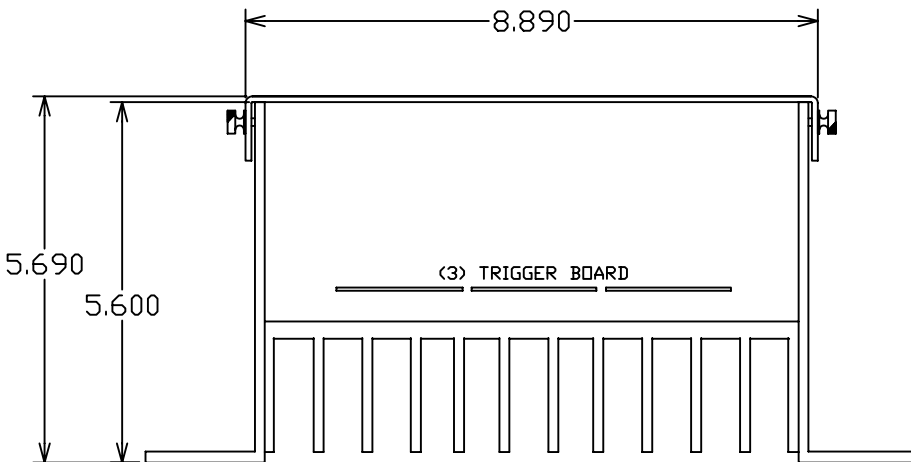
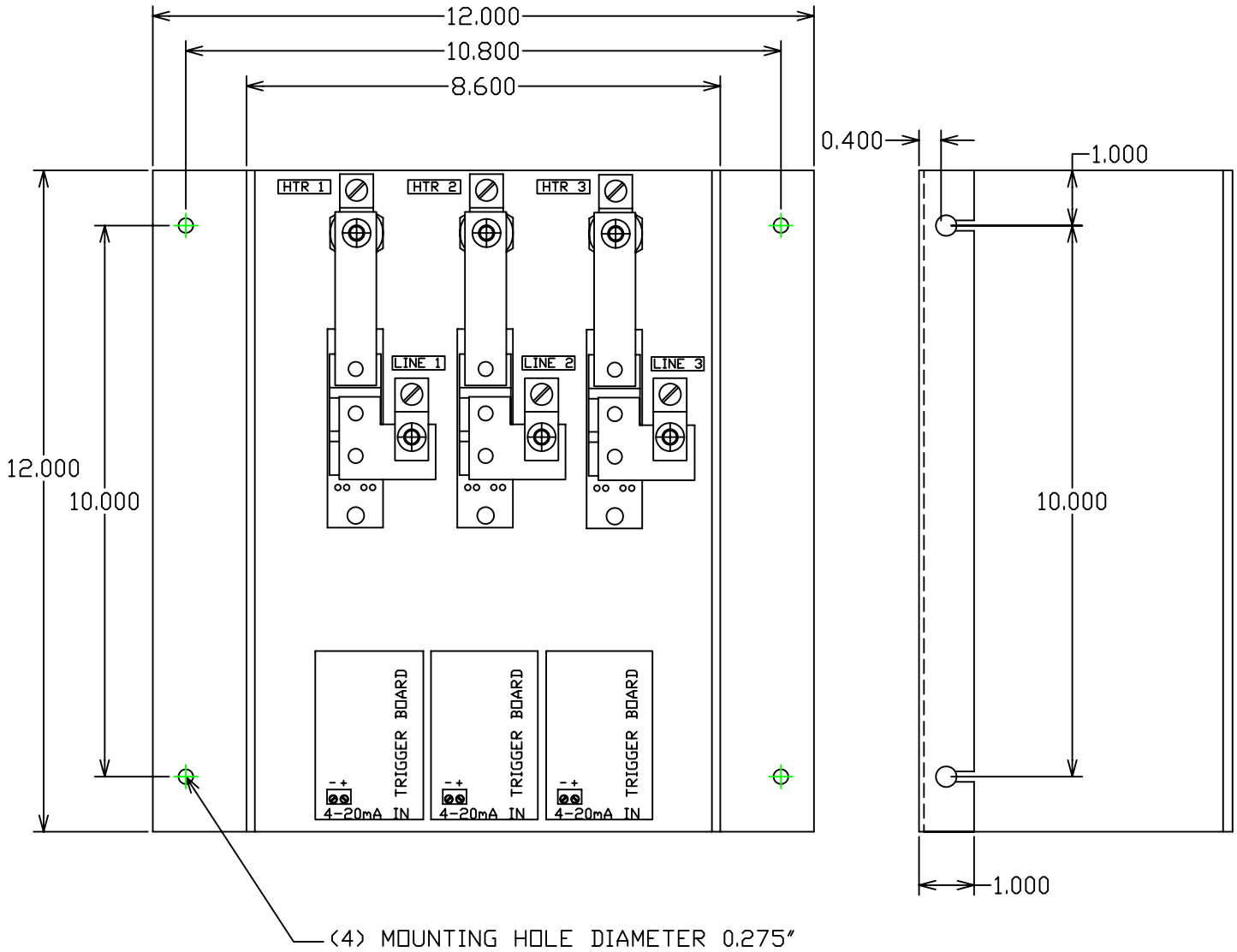


(4) MOUNTING HOLE DIAMETER 0.275"



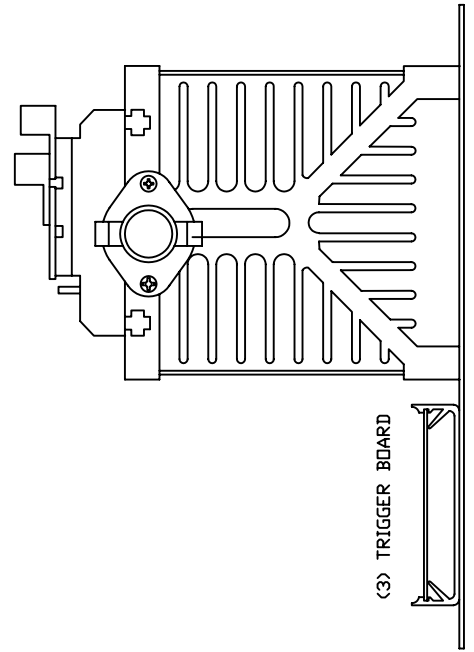
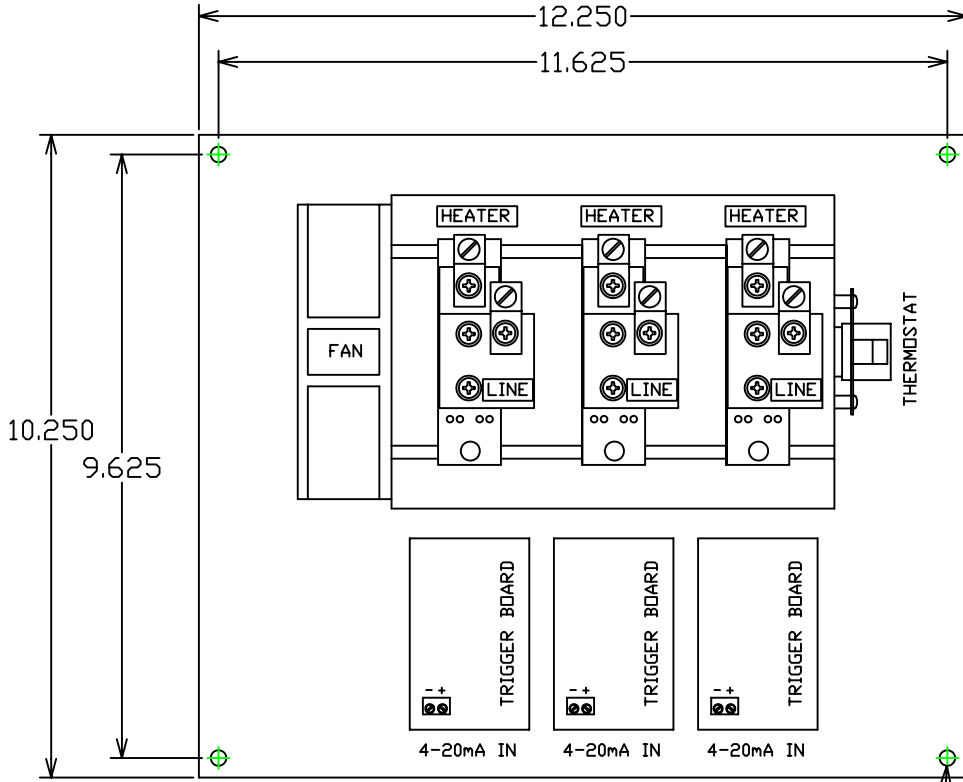
PHYSICAL DIMENSIONS

3CP - 40 & 70 AMP

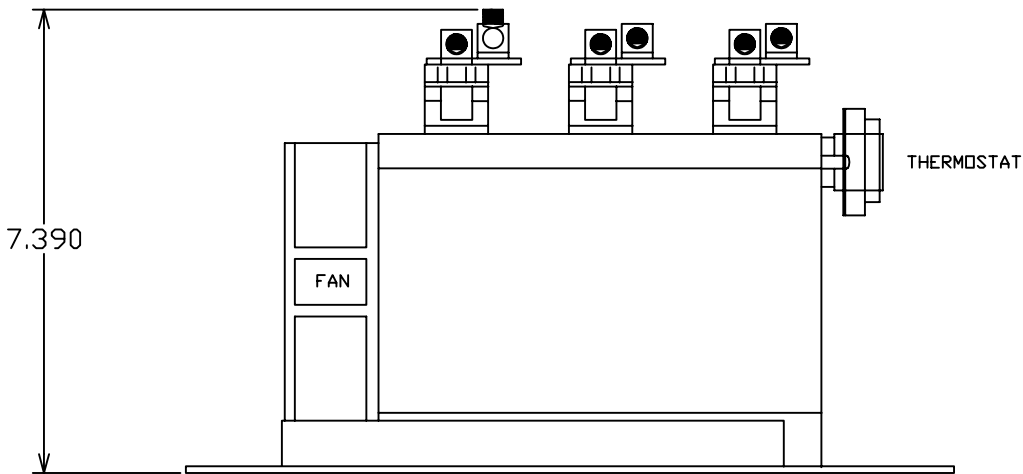


PHYSICAL DIMENSIONS

3CP - 100 AMP

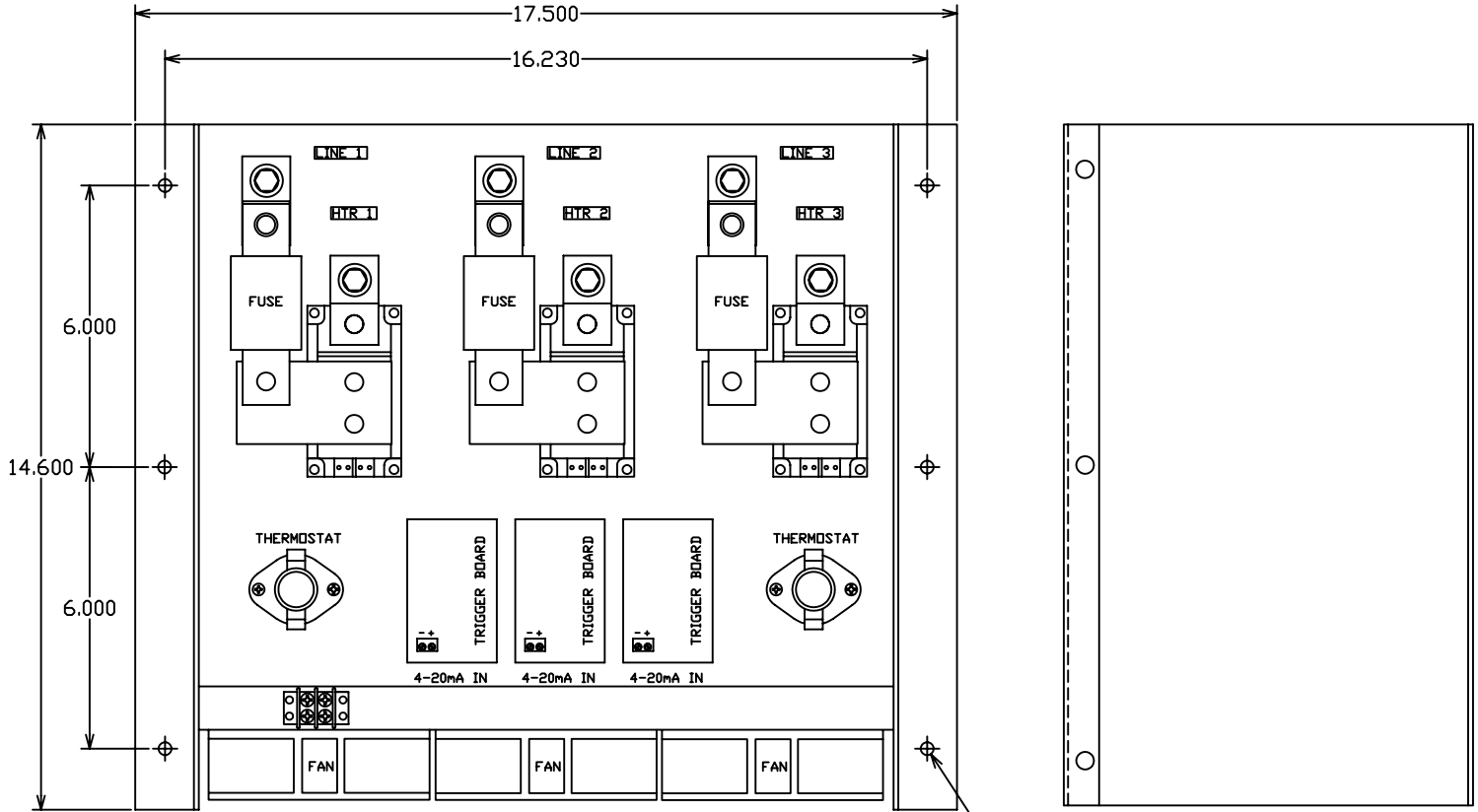


(4) MOUNTING HOLE DIAMETER 0.25"

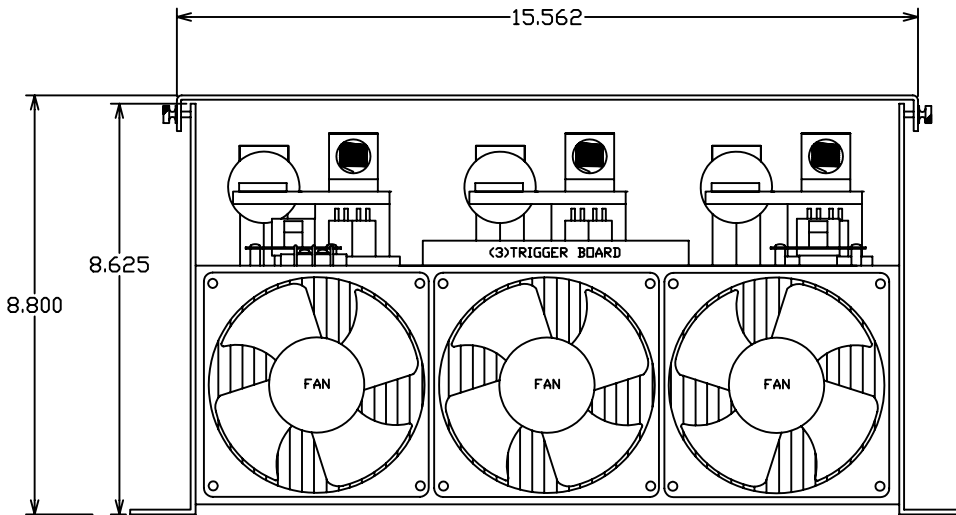


PHYSICAL DIMENSIONS

3CP - 150, 200, 225 & 250 AMP

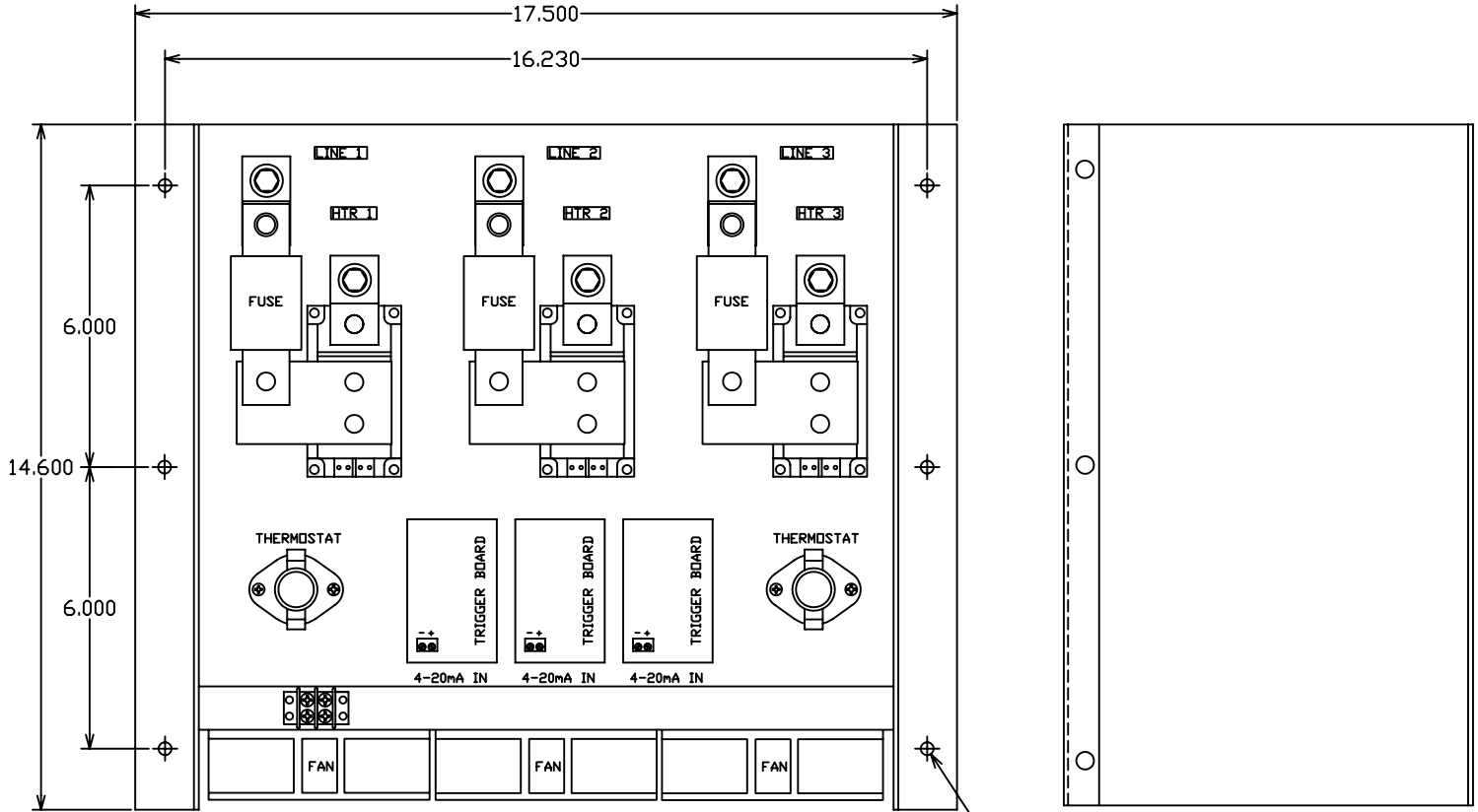


(4) MOUNTING HOLE DIAMETER 0.25"

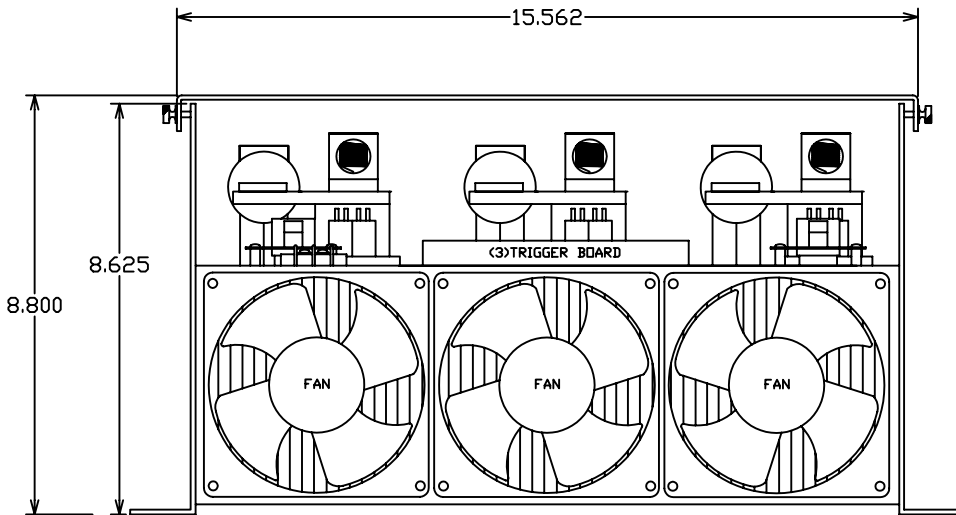


PHYSICAL DIMENSIONS

3CP - 150, 200, 225 & 250 AMP

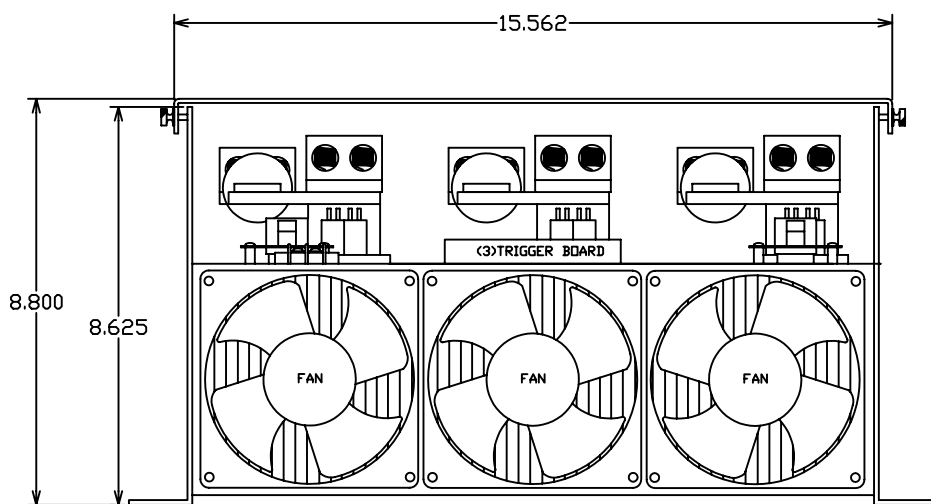
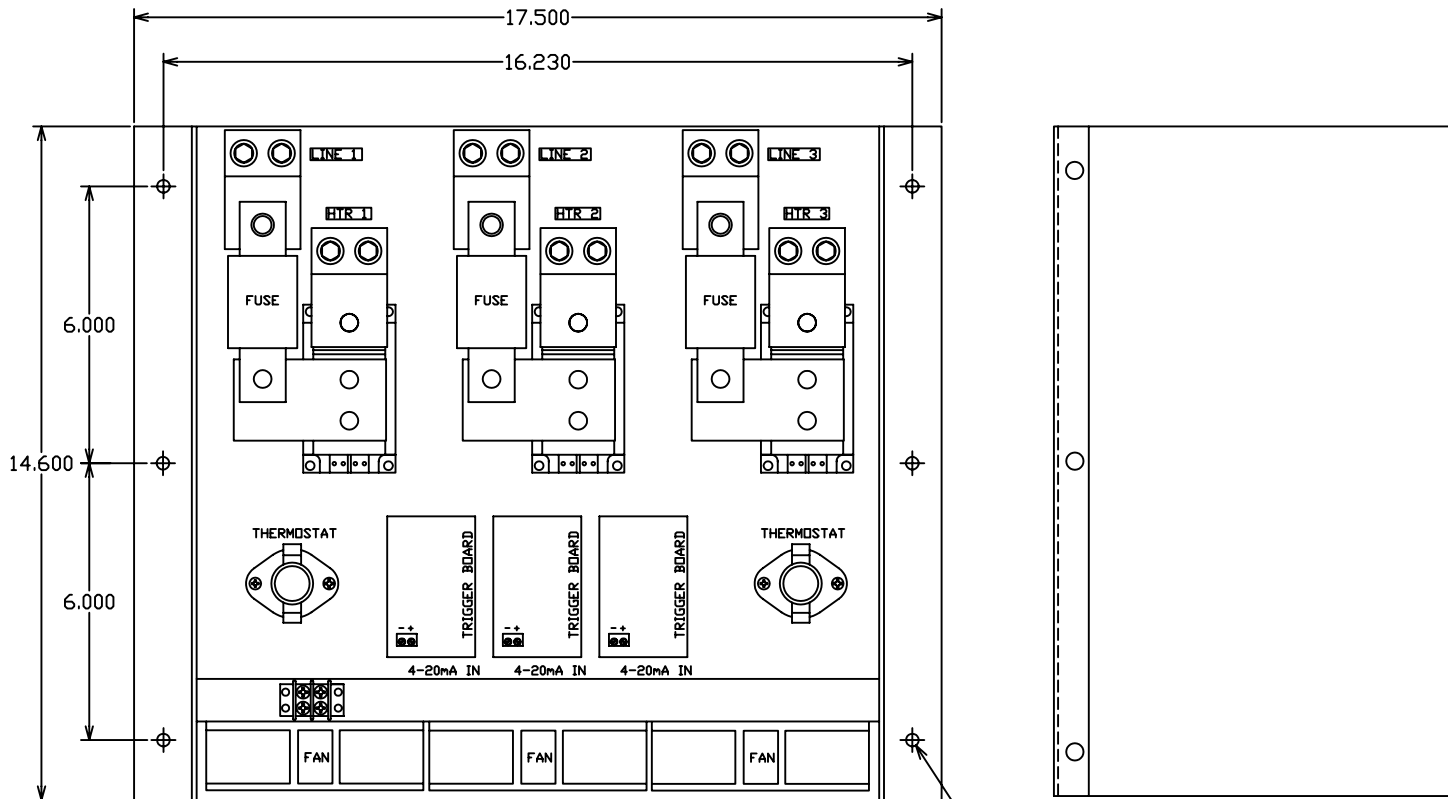


(4) MOUNTING HOLE DIAMETER 0.25"



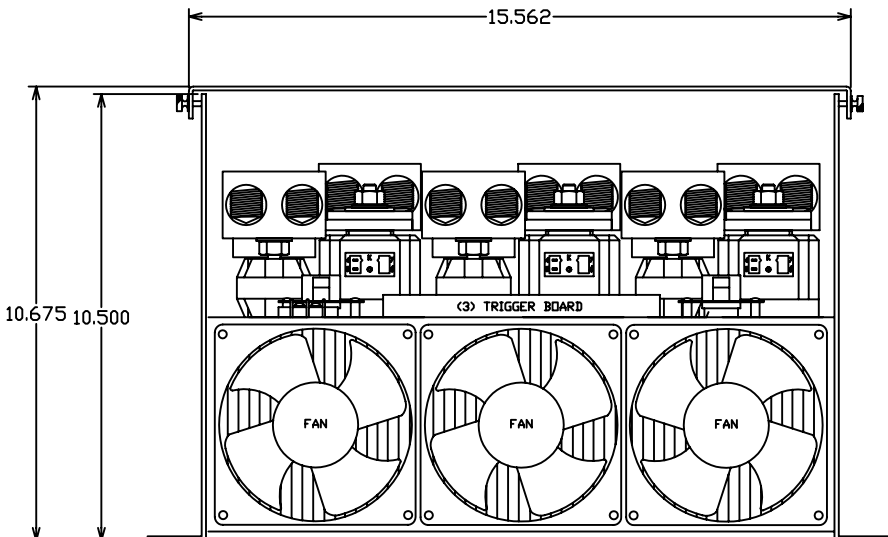
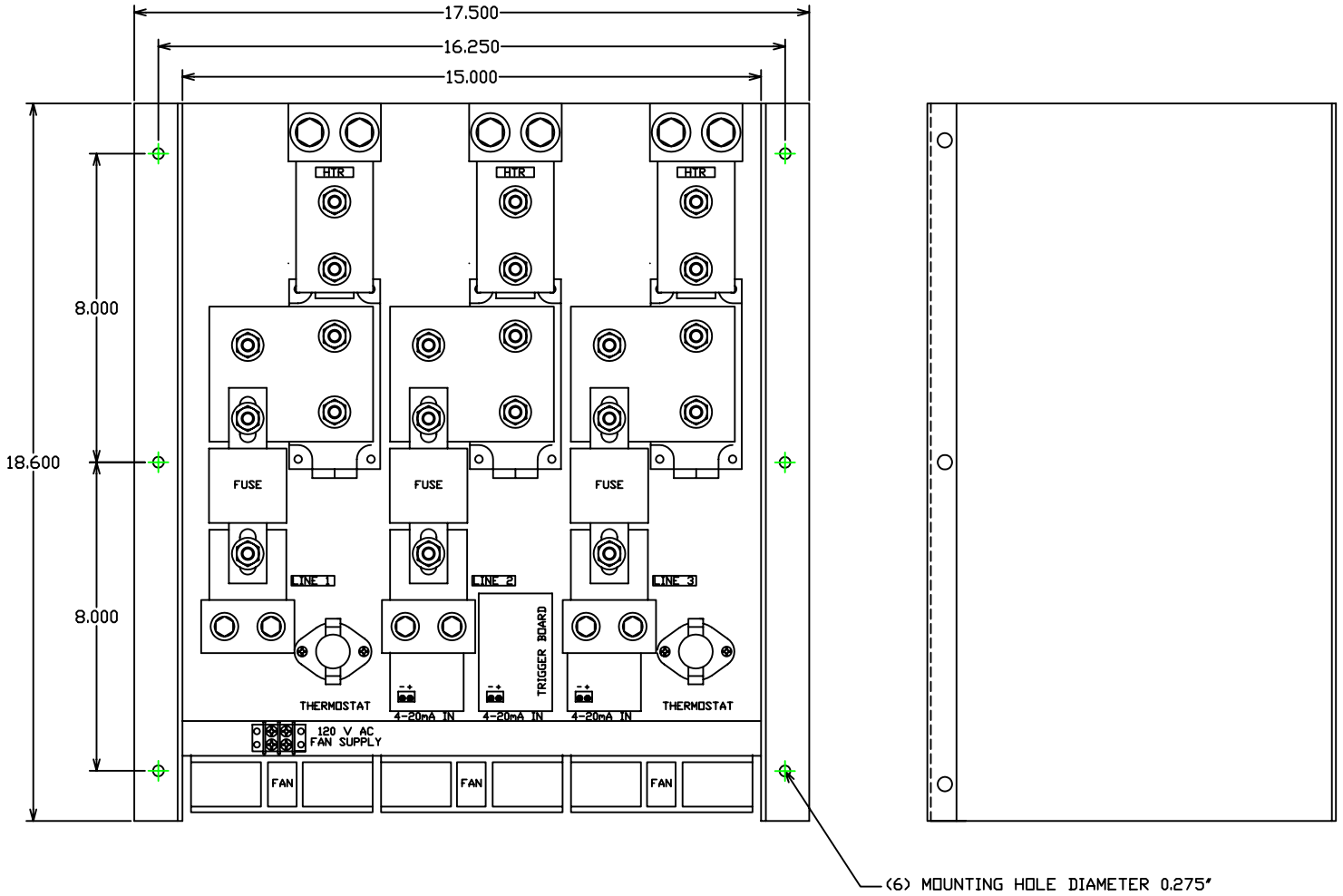
PHYSICAL DIMENSIONS

3CP - 350 AMP



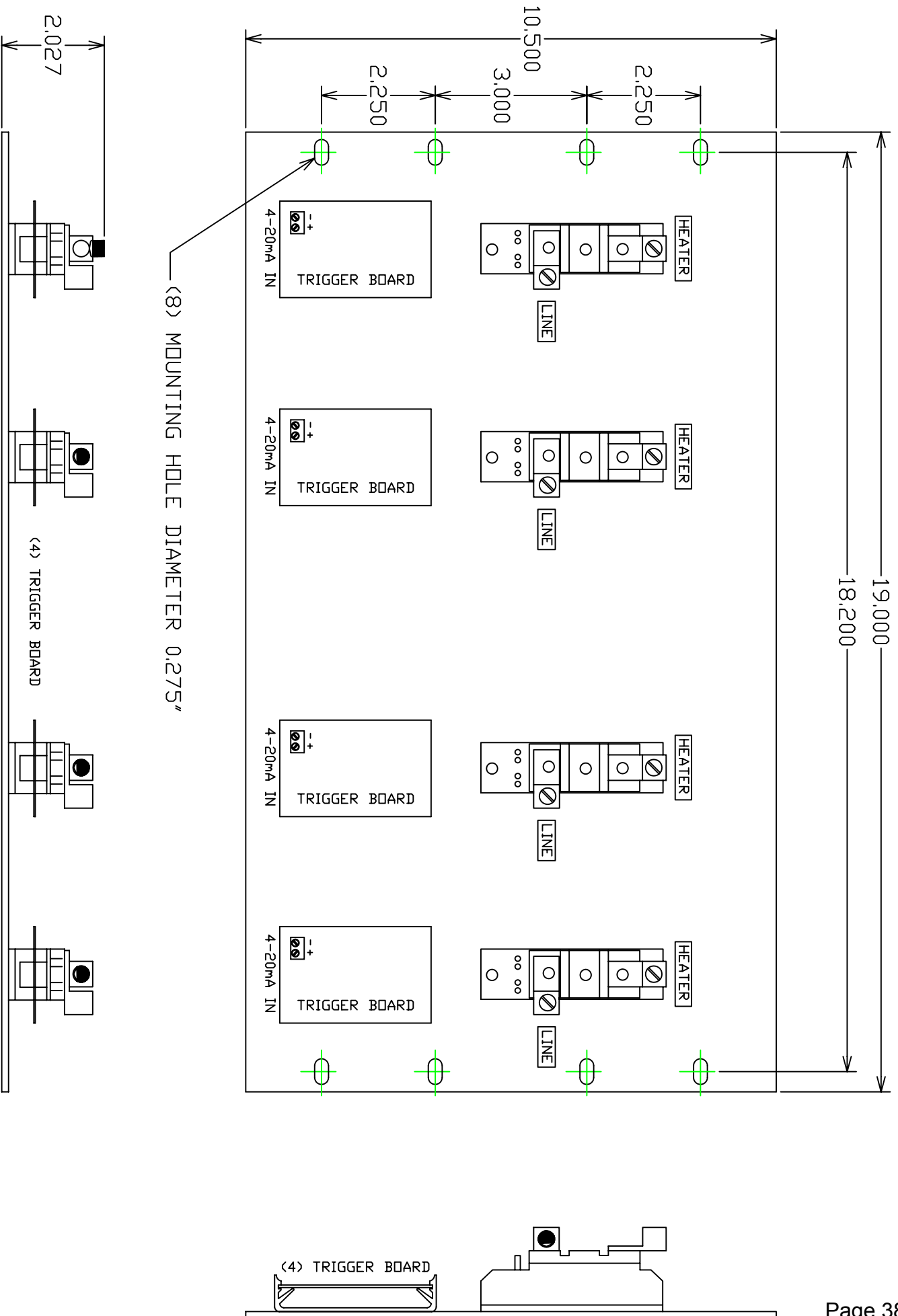
PHYSICAL DIMENSIONS

3CP - 600 AMP



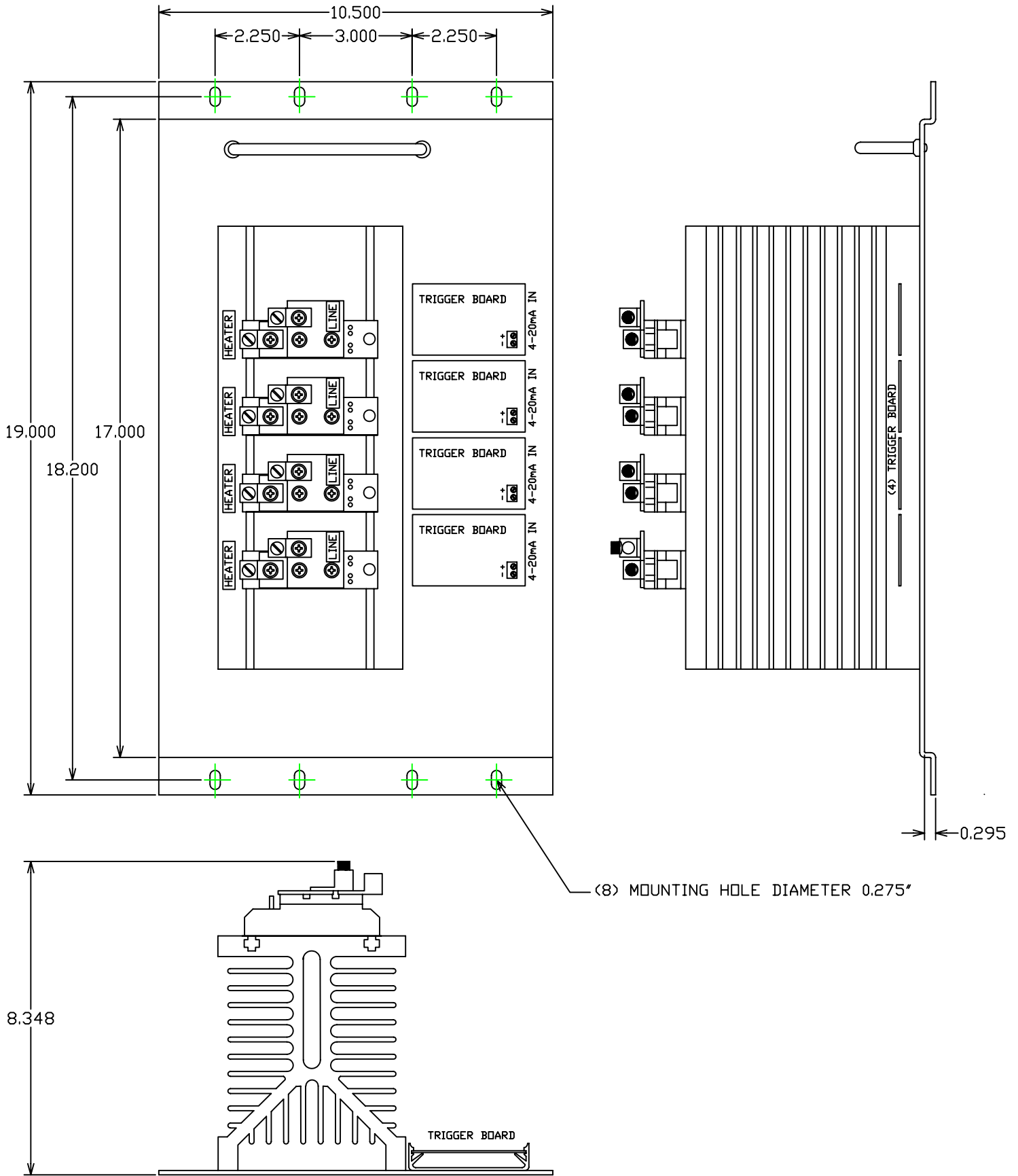
PHYSICAL DIMENSIONS

4CP - 15 AMP



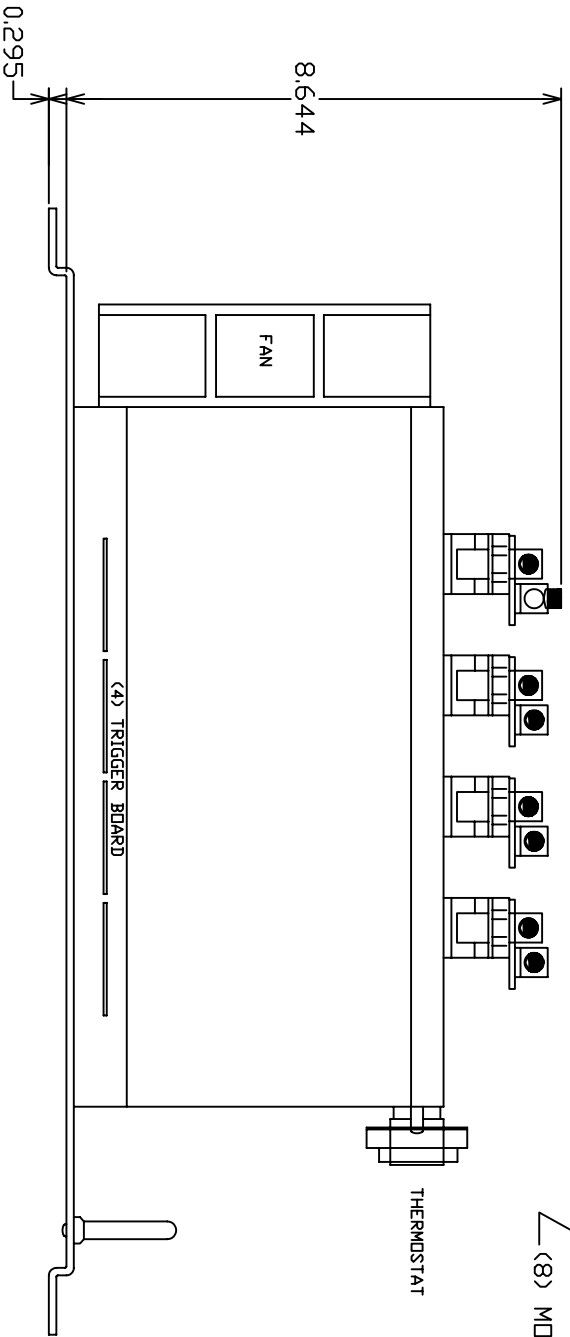
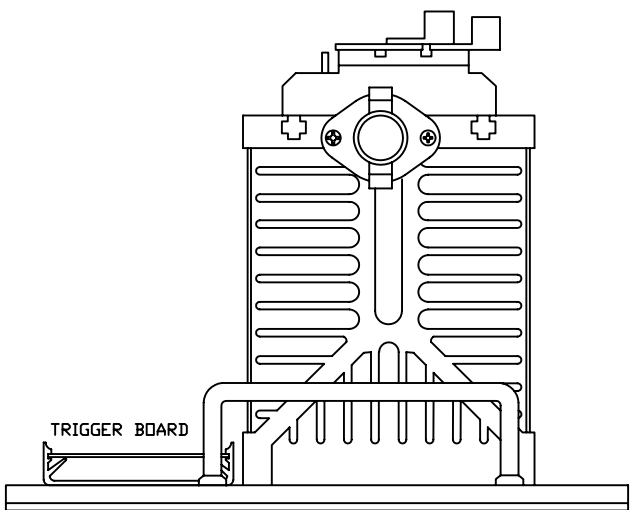
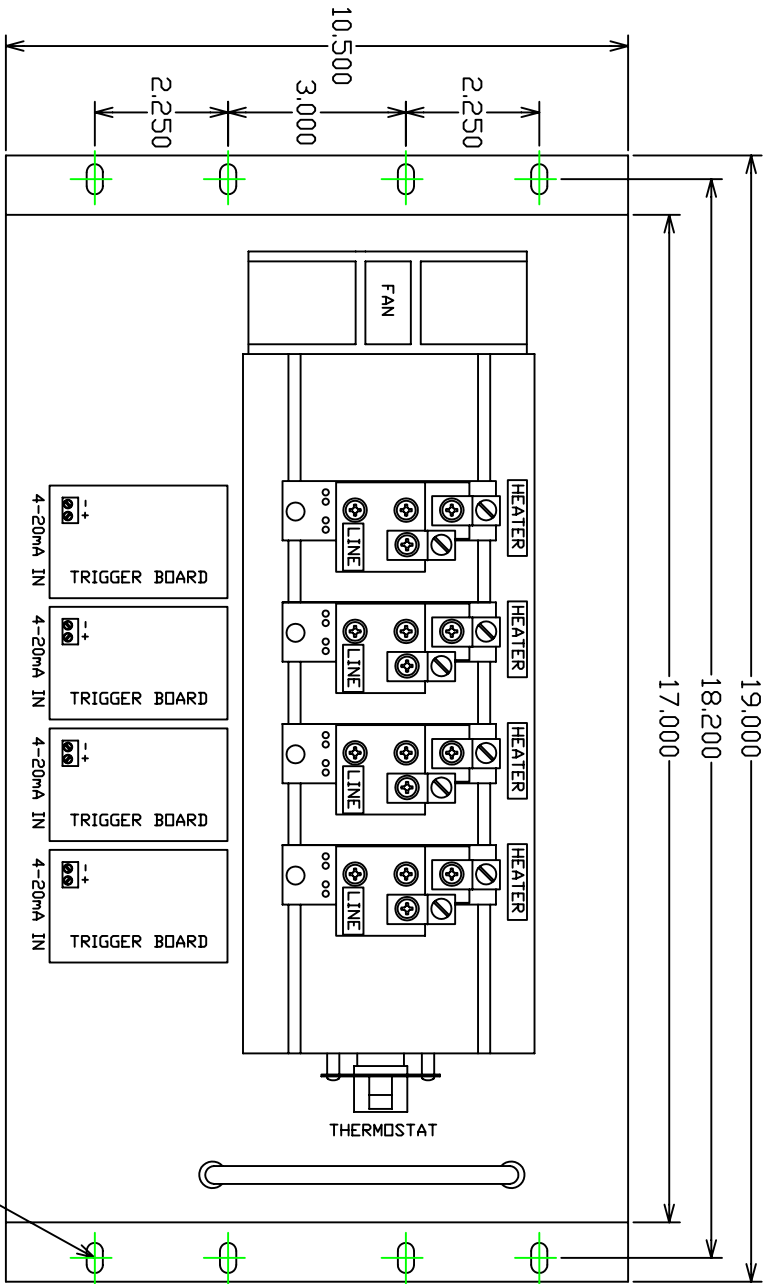
PHYSICAL DIMENSIONS

4CP - 30 AMP



PHYSICAL DIMENSIONS

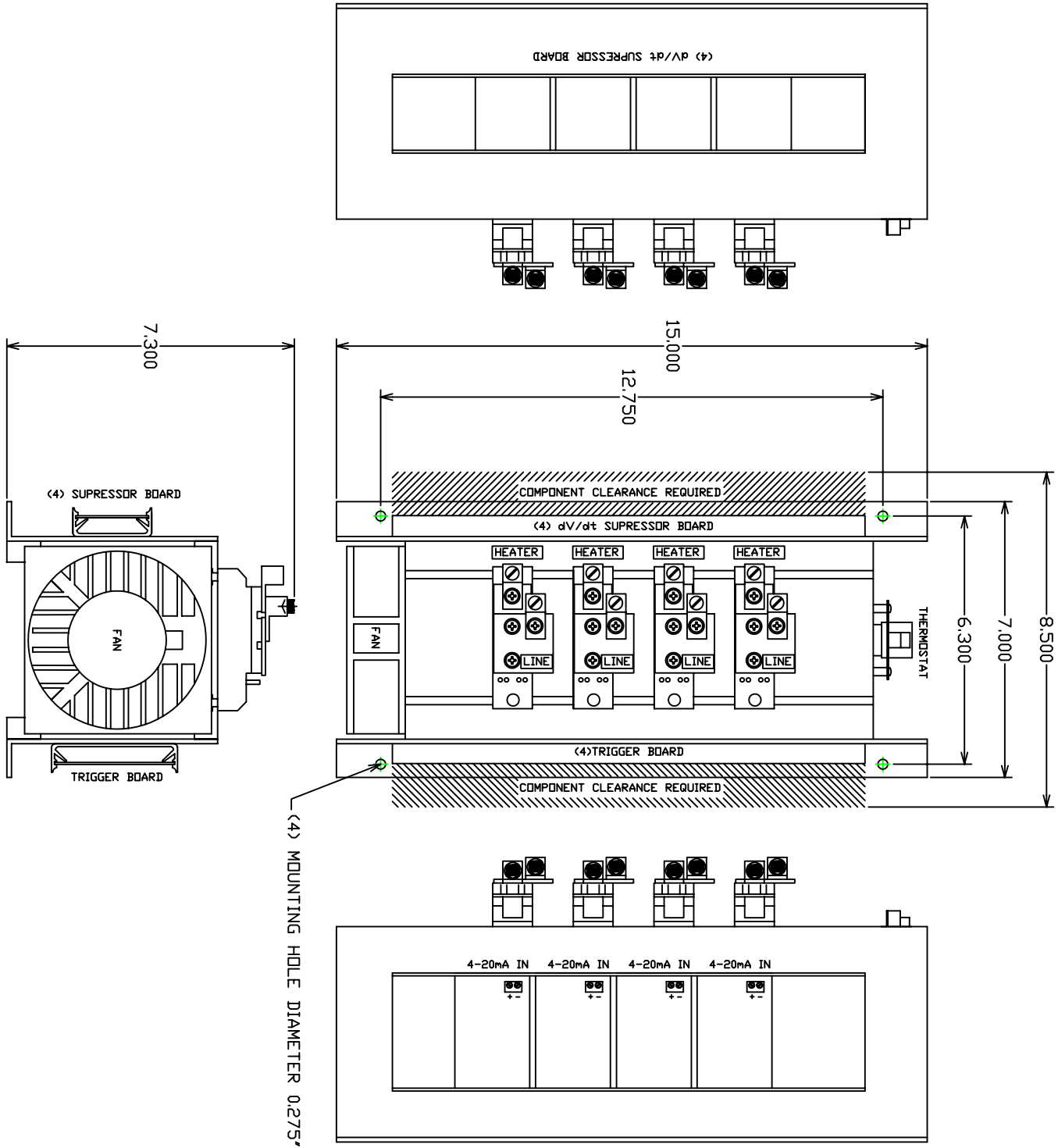
4CP - 40, 50, 70 & 100 AMP



PHYSICAL DIMENSIONS

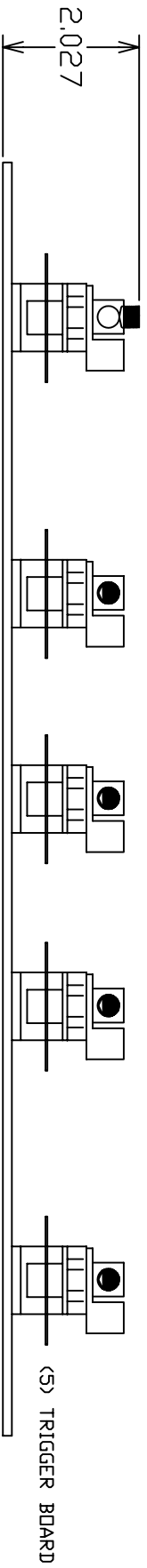
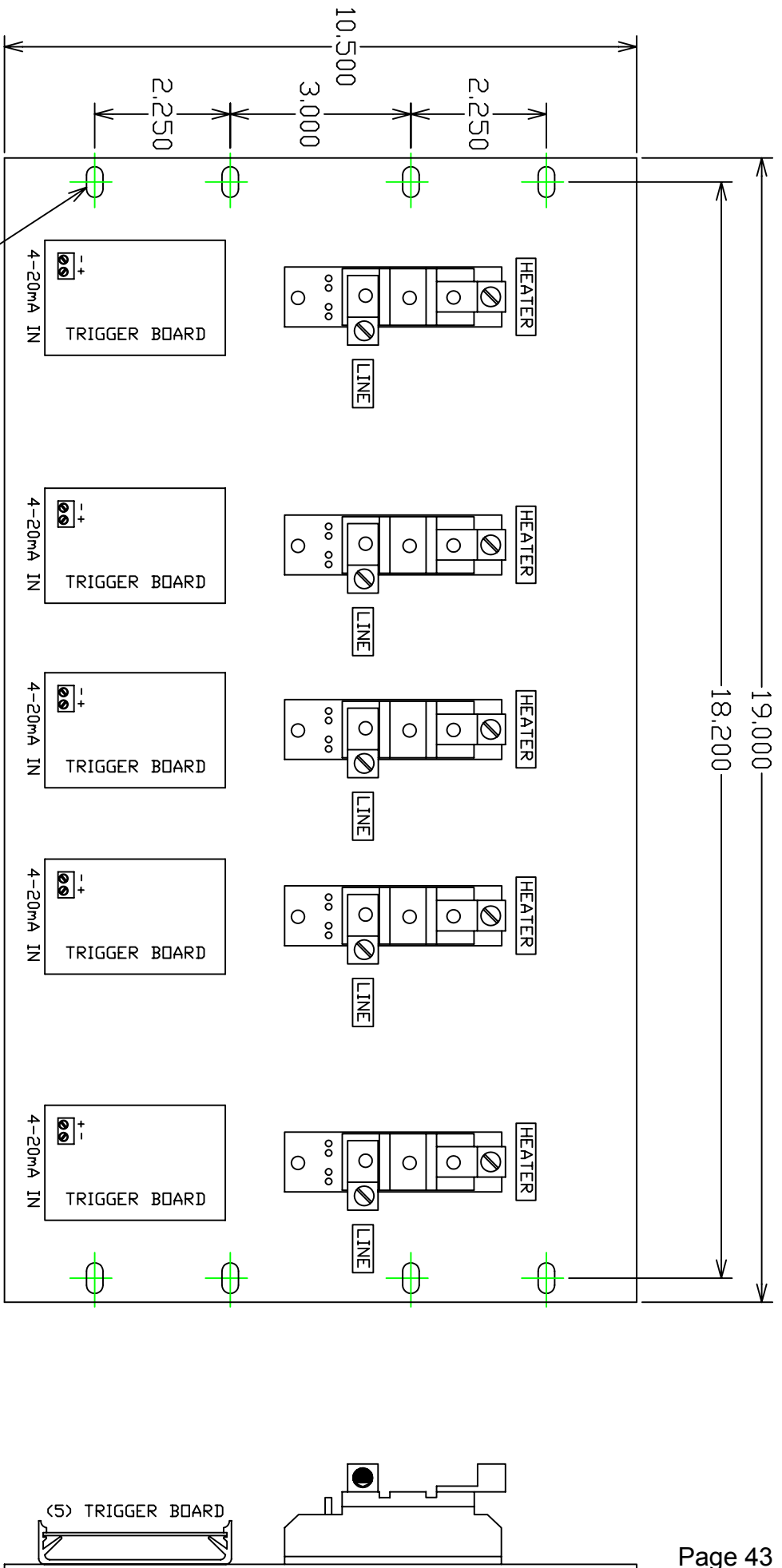
4CP - COMPACT

20, 30, 40, 50, 70 & 100 AMP



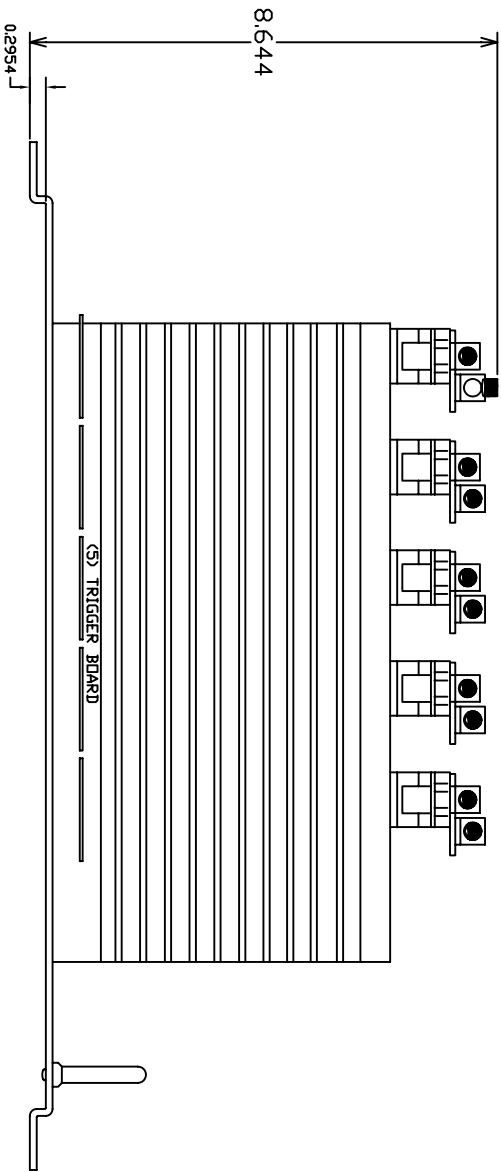
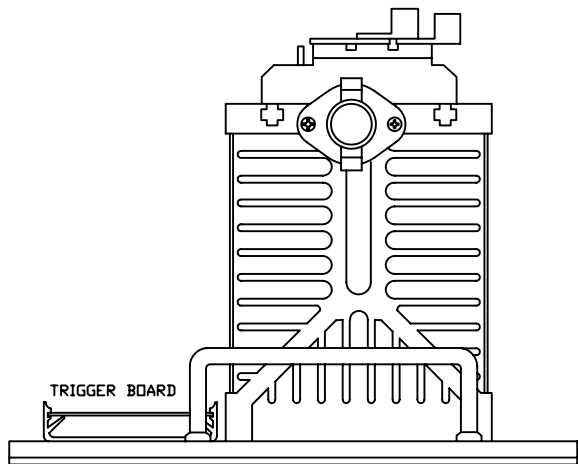
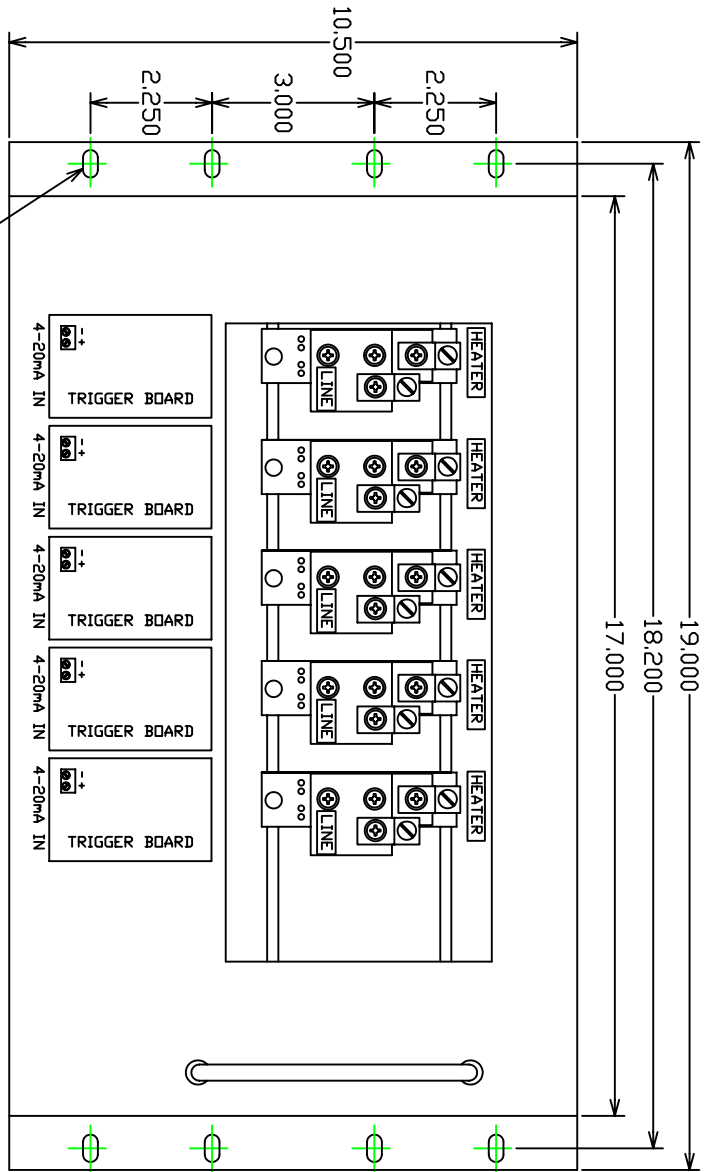
PHYSICAL DIMENSIONS

SCP - 15 AMP



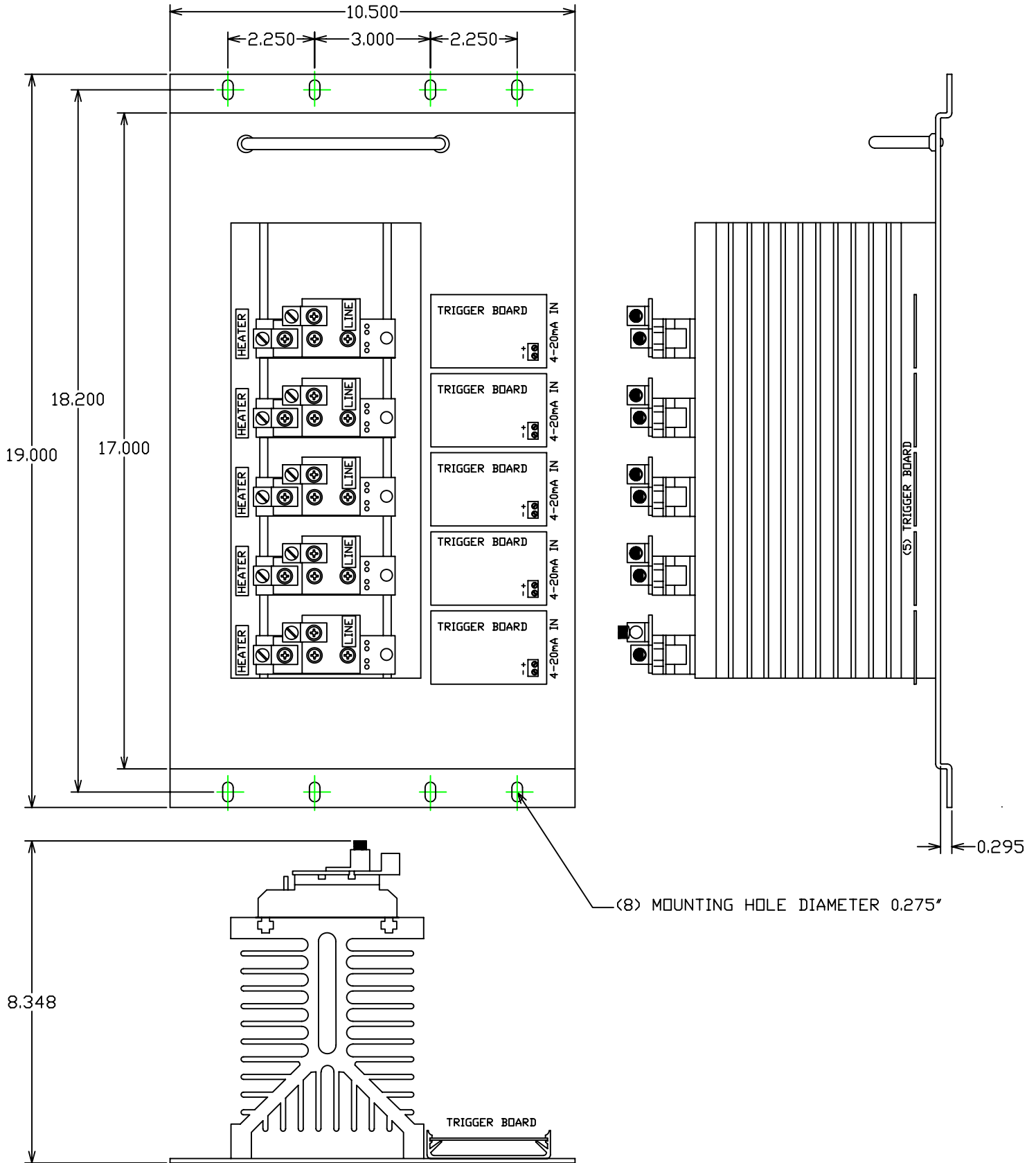
PHYSICAL DIMENSIONS

SCP - 20 AMP

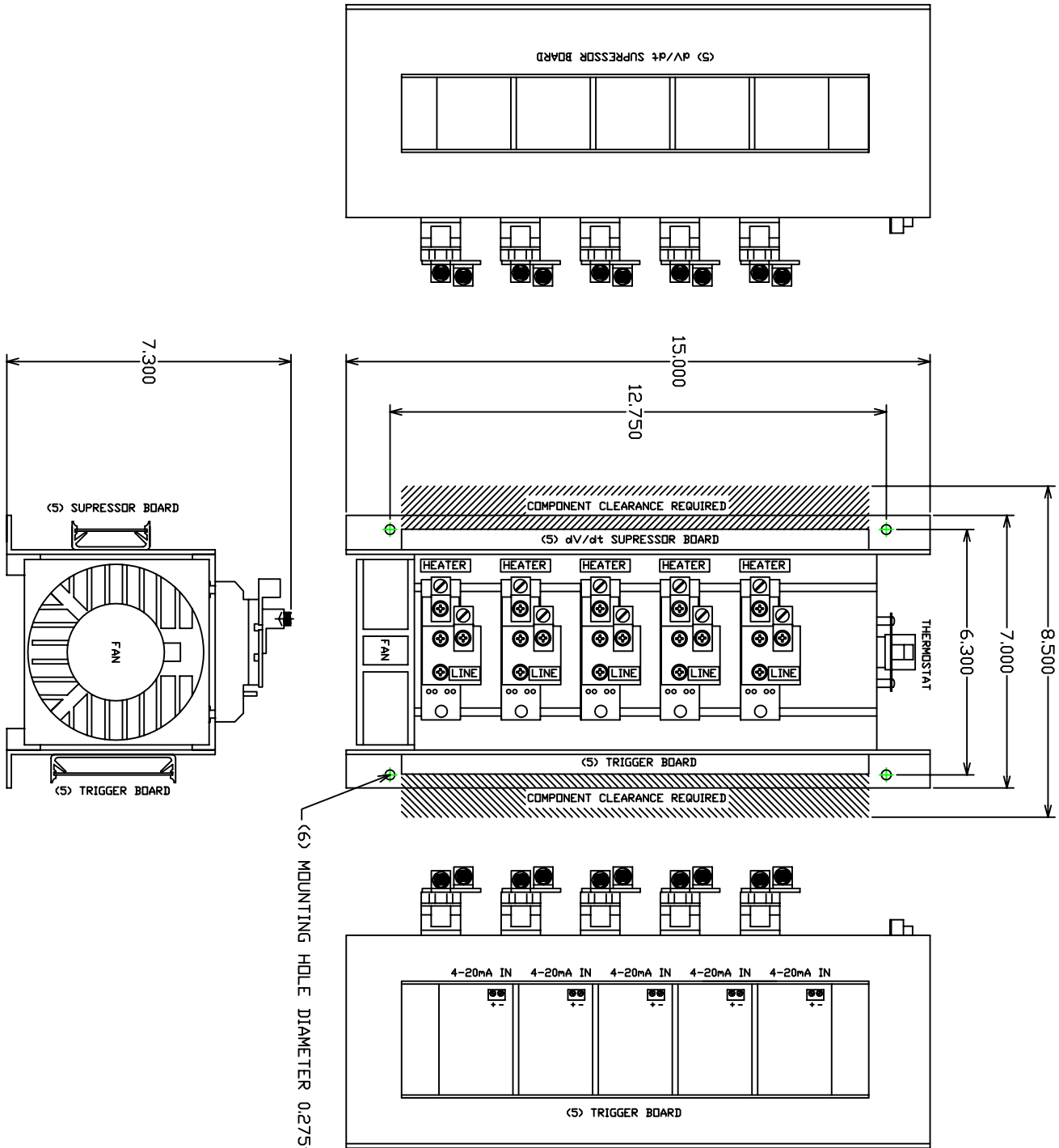


PHYSICAL DIMENSIONS

5CP - 30 AMP

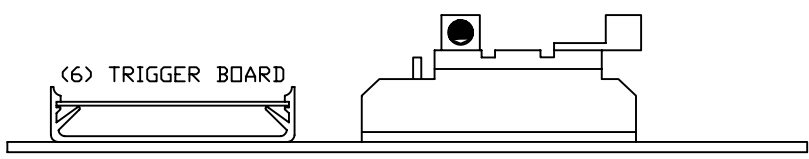
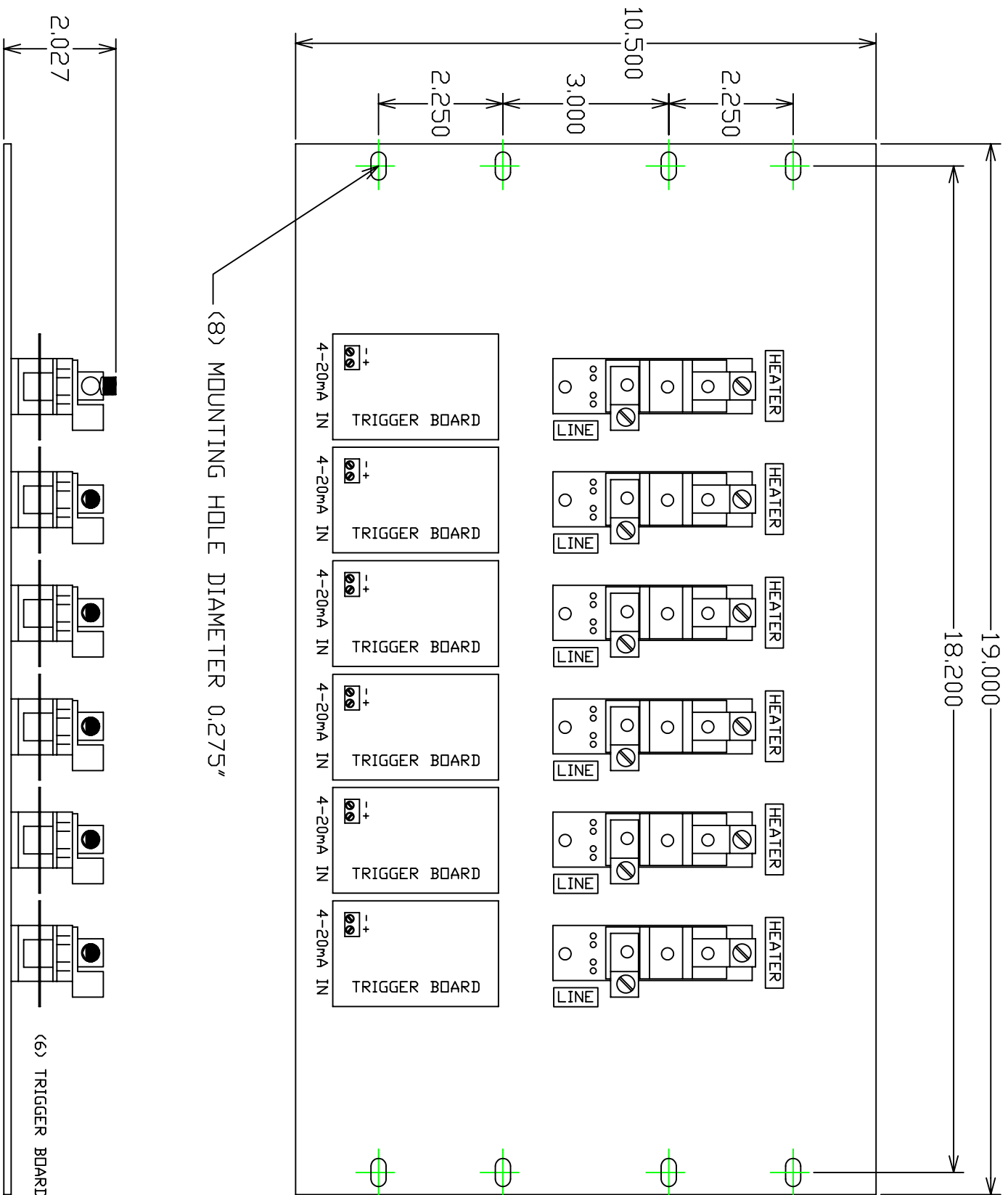


PHYSICAL DIMENSIONS
FCP - COMPACT
20, 30, 40, 50, 70 & 100 AMP



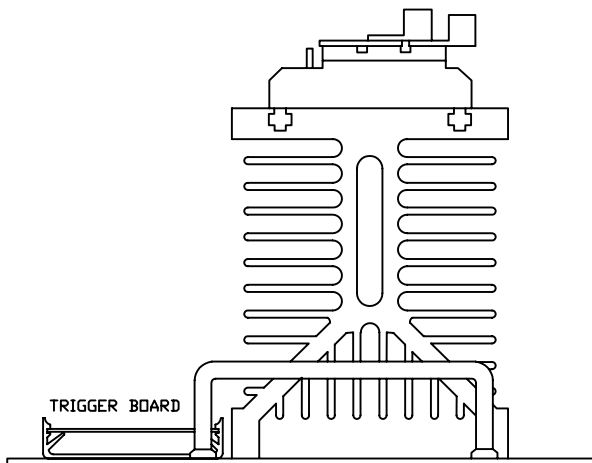
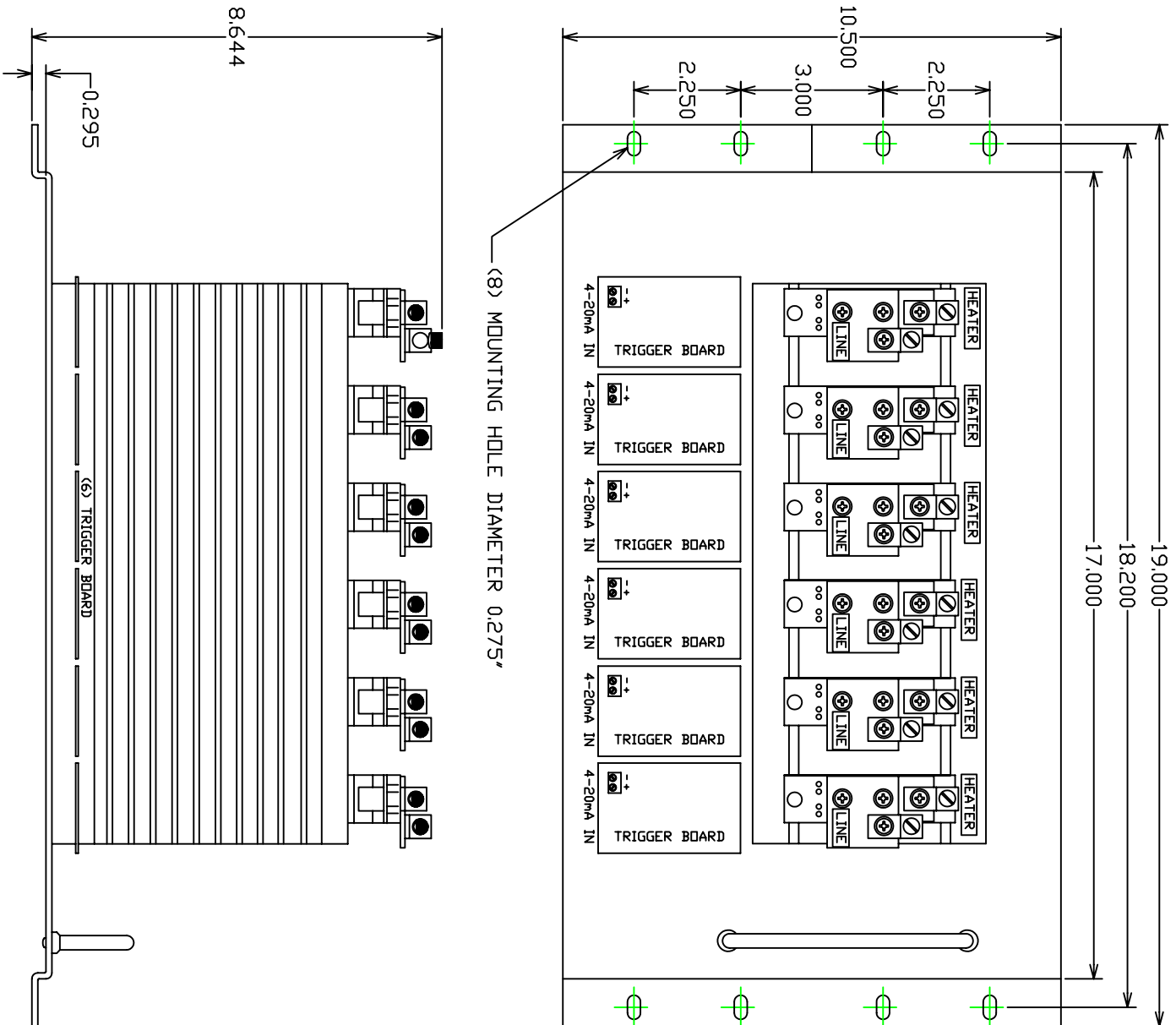
PHYSICAL DIMENSIONS

6CP - 15 AMP



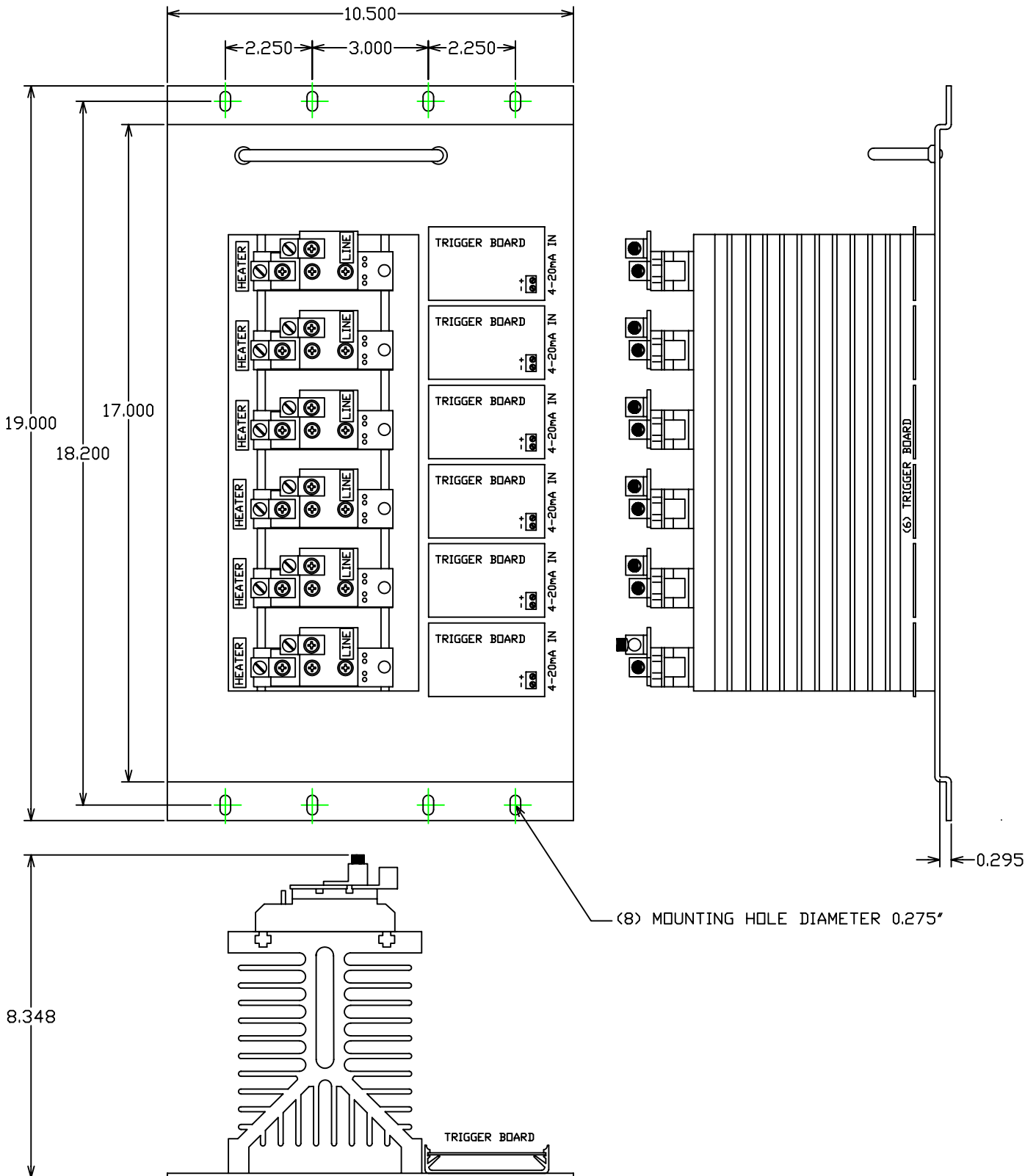
PHYSICAL DIMENSIONS

6CP - 20 AMP

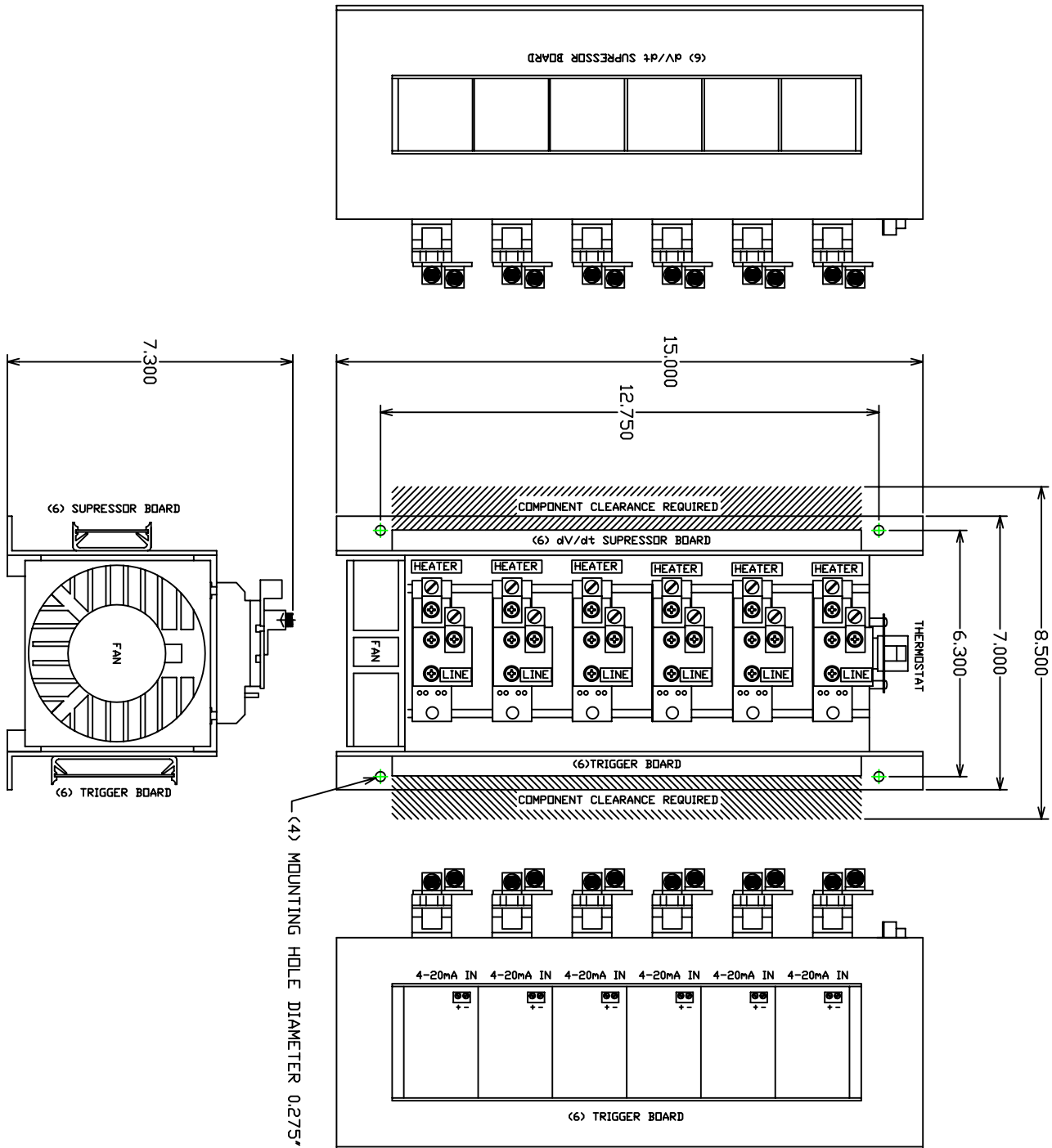


PHYSICAL DIMENSIONS

6CP - 30 AMP

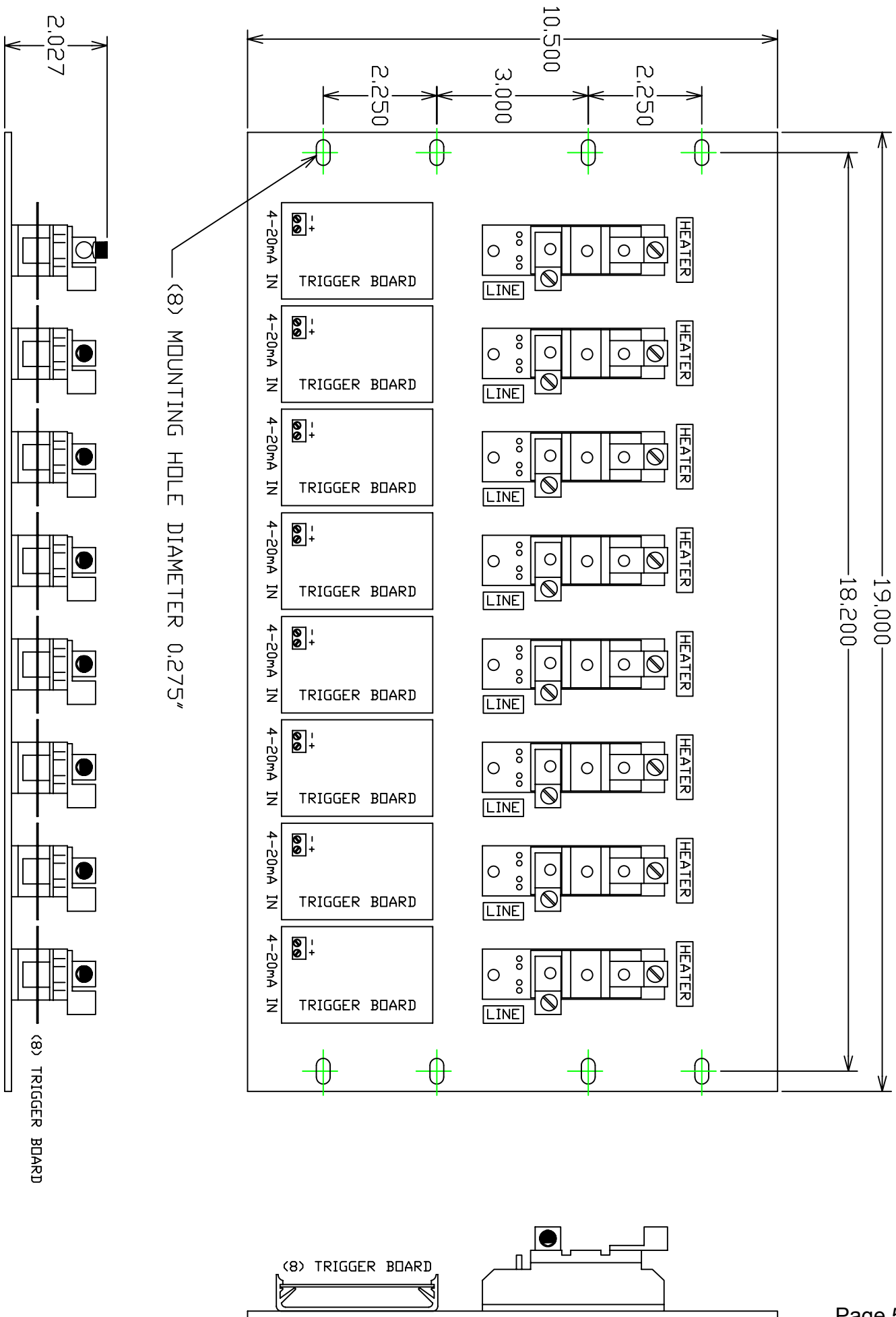


PHYSICAL DIMENSIONS
6CP - COMPACT
20, 30, 40, 50, 70 & 100 AMP



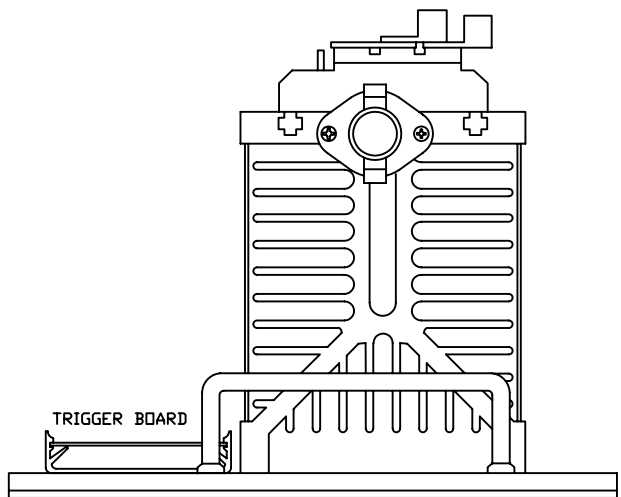
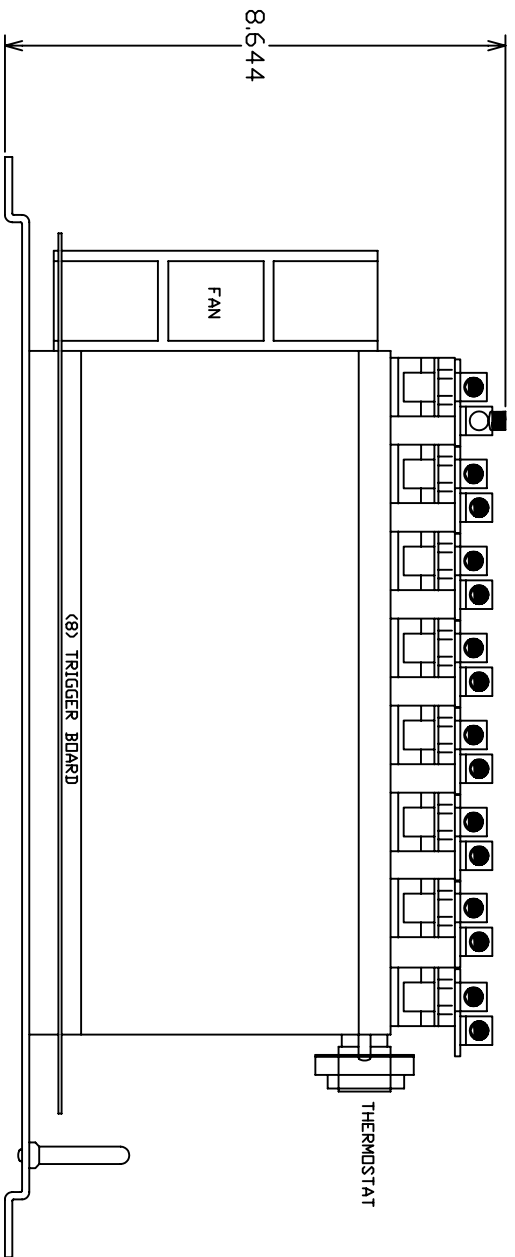
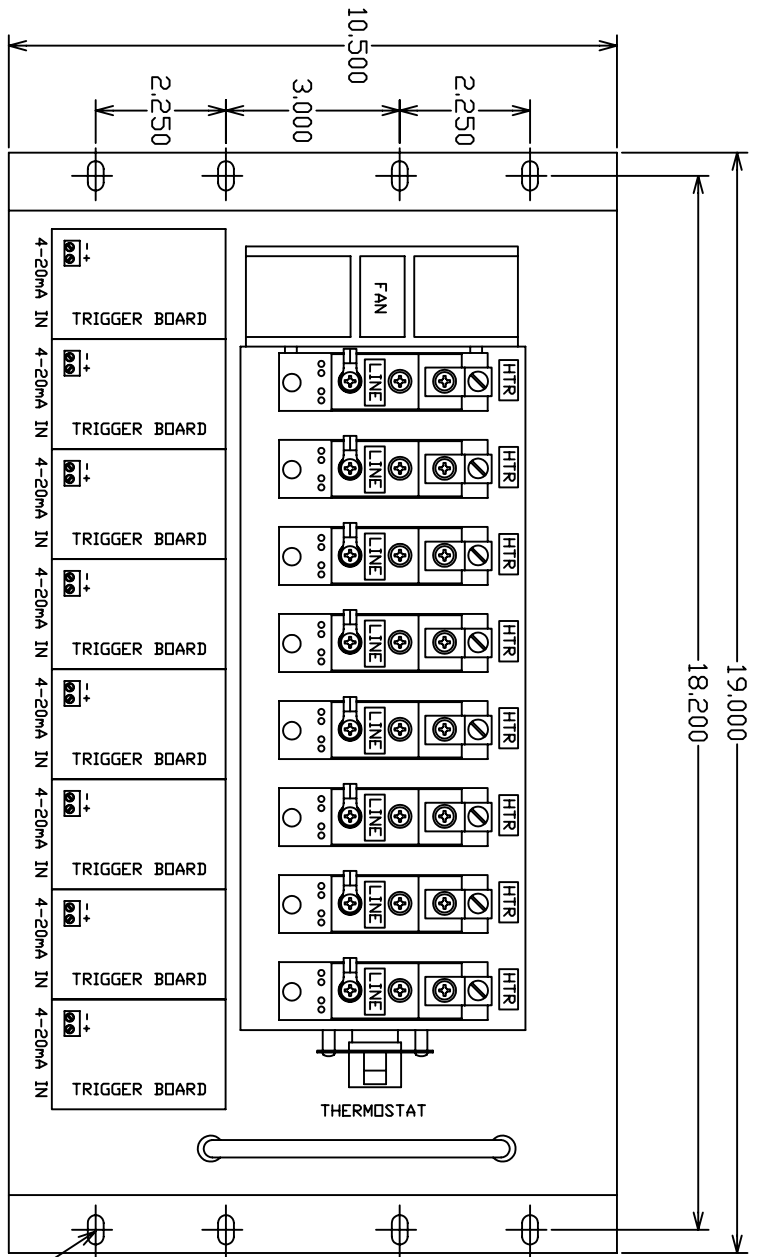
PHYSICAL DIMENSIONS

8CP - 15 AMP



PHYSICAL DIMENSIONS

8CP - 20 AMP



(8) MOUNTING HOLE DIAMETER 0.275"