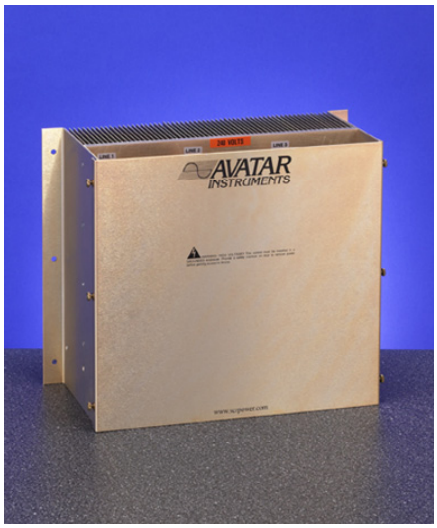
A3P
OPERATING MANUAL

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MADE IN USA

NRNT FILE # E350716

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Phone: (302) 703-6865 contact@avatarinstruments.com www.scrpower.com

INTRODUCTION

Congratulations on your purchase of an Avatar A3P 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 A3P. 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 throughout 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 & cUL 508 listed, CE Marked
- compact and light weight
- 100 % solid state circuitry
- over-rated SCR power modules
- over-sized heat sink
- full power ratings up to 50ºC (122ºF) ambient temperature
- optically isolated 4-20 mA input standard
- thermostats standard on fan-cooled units
- electrically isolated chassis and heat sinks
- gold alodined chassis and heat sink
- I^2T fusing and 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 A3P is a proportional, infinitely variable power controller capable of delivering 0-97% of the applied line voltage to directly connected electric heaters. ***It will not control transformers or motors.*** This is accomplished by phase angle firing three SCR's (one per phase). Modular construction allows for simple and solderless field serviceability. There are four field replaceable items:

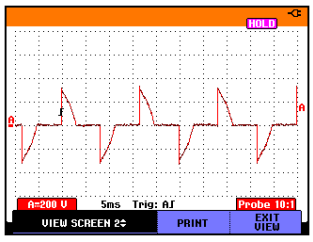
- printed circuit board
- fuses
- SCR/ diode packages
- MOV's (metal oxide varistors)

THEORY OF OPERATION

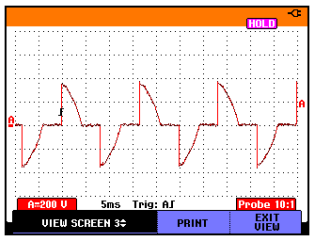
The standard input signal (4-20mA) is applied to the blue input terminal block, processed and series fed to three optical couplers. The output of each opto coupler controls the drive circuit for its associated phase which is then fed to its respective SCR. I^2T fuses connected in series with each phase input provides over current protection in the event of external wiring shorts, and or too large of a heater load. Additionally, a MOV (metal oxide varistor) is connected in parallel with each SCR/ diode, providing voltage spike protection to the controller. Diodes are used in series with the SCR for sound engineering factors: Diodes are stronger than SCRs. Diodes can take higher temperatures than SCRs. Diodes will not misfire.

PHASE ANGLE FIRED

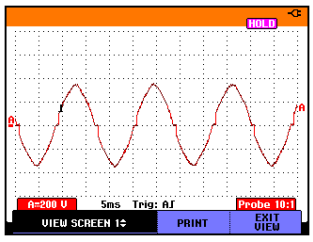
These controls proportionally turn on a percentage of each power line half cycle. This gives smooth, infinitely variable application of power to the heaters. Imagine a light dimmer and how it provides power to a light bulb. This method will provide the most precise control of heaters. Phase angle fired 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 or 120V RMS



99.5% output or 238.8V RMS

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. The ground/earth connection can be made to the A3P chassis mounting point on heat sink / side panel.

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 exceed 50 degrees C. Use this formula to calculate the minimum size enclosure required.

3 X 1.2 VOLTS X MAXIMUM HEATER CURRENT = TOTAL WATTS DISSIPATED

example: **3 x 1.2 x 60 amps = 216 watts that the *power controller has to dissipate***

Heat is the worst enemy to any electrical device, including power controllers. Orient heat sink fins and chassis channel 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. Fan cooled units should have fans on bottom facing up.

As a quick rule for spacing is take footprint measurement of SCR and use that as ideal spacing distance for SCR and other components.
Example; if the SCR is 12” x 12”, space other objects 6” above, 6” below & 6” side to side for best heat dissipation. Plastic wire duct is an insulator and blocks air flow.

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.

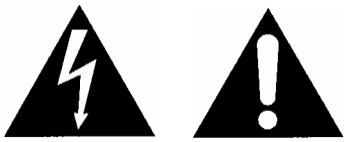
ELECTRICAL CONNECTIONS

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 diagrams (pgs. 10 - 15).

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 A3P controller must be installed in a metal enclosure for protection against electrocution. Remember, solid state devices are never "off" unless you physically disconnect the incoming electrical power to the SCR.

AC POWER INPUT:
Power input (AC MAINS) is connected to lugs labeled "LINE 1", "LINE 2", and "LINE 3" (see fig. 1 for correct wire size and torque specs.), phase rotation or orientation (i.e. ABC or ACB, etc.) is not critical.

LOAD CONNECTION:
Load connections are equally simple; connect the load/ heater to lugs labeled "HTR 1", "HTR 2", and "HTR 3" (see fig. 1 for correct wire size and torque specs). A3P's will accept delta or wye configured loads.

The I^2T Semiconductor fuses that are built into the SCR do **NOT** qualify as branch circuit protection. Separate branch circuit overcurrent protection is required. This overcurrent protection needs to be provided in accordance with both national and local codes of the inspecting authority.

NOTE: "wye" connected loads MUST NOT USE the "neutral" or 4th wire from the voltage source! Open Delta wiring will result in 50%-100% output only and should be controlled by a 3CP or (3) A1P controls instead.

The A3P is capable of driving unbalanced loads, but it is highly recommended to equally *BALANCE LOADS BETWEEN ALL THREE PHASES* to provide consistent tracking between all three phases. Phase angle fired SCRs will provide unbalanced voltages on unbalanced loads.

Check heater resistance to insure heater current will not exceed fuse ratings. Controllers DO NOT blow fuses - excess heater current does. Check for heater wiring shorts, loose connections, shorted load connections which will instantly blow expensive fuses.

INPUT CONTROL SIGNAL:
Connect the control signal to the blue terminal block labeled "4-20mA INPUT" observing proper polarity (positive to "+" and negative to "-"). **Terminal torque is 5 In-Lbs for mA input block.**
LED D2 (next to INPUT 4-20mA terminal block) will light up when mA signal is connected.
LED D2 gets brighter as signal increases. D3, D8 & D13 are not indicators, and do not glow.

THERMOSTAT for FAN FAILURE:
On all Avatar SCR Controls 150 Amps and above, fans are used to cool the SCR heat sinks. Avatar mounts a Snap-disc thermostat 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 trigger alarms or shut down a power contactor. See wiring diagrams for thermostat wiring (pgs. 12 and 13)

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, order with Soft Start Option. This option is designed to ramp power from 0-100% over a fixed time period. This time is 2 (S02) 5 (S05), 10 (S10) or 20 (S20) seconds depending on option ordered. 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 and Voltage Limit included with option.

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. Voltage limit range is from 100% to 40% RMS.

CURRENT LIMIT: The CL & CLP option is designed to monitor and limit the output current of the SCR. Avatar Instruments provides the current transformer(s) (CT) and hard wires them to the trigger board. Simply put the LINE 1 input wire through the current transformer located next to the LINE 1 set screw lug. On A3P controllers, put the LINE 1, LINE 2 & LINE 3 input wires through the CT's (as marked). Current limit works from 100% to 63% of name plate ratings. Make sure CT's are connected to Limit Board when power is on. Never disconnect CT leads and apply power as electric shock is possible.

Adjusting current limit: To set the current limit, connect an Amp-probe onto the HEATER 1 output wire. THERE MUST BE A LOAD CONNECTED FOR SCR TO FIRE. On SCR's with **"-CL"** option, the potentiometer adjustment is located on the PCB. With a full 20mA input signal, turn potentiometer counter clockwise (CCW) to reduce maximum output voltage to desired level. The **"-CLP"** option has a panel-mount potentiometer (3/8"), knob & scale. Turn the potentiometer counter clockwise (CCW) or lower on the 0-100 scale, to reduce maximum power output.

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.

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. Furthermore, 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
CURRENT CAPACITY: ..... see model description
CONTROL SIGNAL: ..... 4-20mA @ 6 volts DC
INPUT IMPEDANCE: ..... 300 ohms
4-20mA INPUT TERMINAL TORQUE RATING 5 in-lbs

LINEARITY: ..... < 5% deviation
TRACKING (phase to phase): ..... < 5% deviation (balanced loads)
RESPONSE TIME: ..... <12mS (std unit, non soft start)
COOLING:
30-80 amps……. convection
100-600 amps……... fan (120VAC)
THERMOSTAT: ..... 190ºF (fan cooled units only)
POWER DISSIPATION (Watts): ..... 3.6 x maximum current draw of heater load
DIMENSIONS: ..... see dimensional drawings

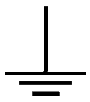
WEIGHT:	**NET**	**SHIPPING**
30 amp……...	7 lbs.	9 lbs.
40-80 amp…….	14 lbs.	15 lbs.
100 amp…….	18 lbs.	21lbs.
150-225 amp…….	45 lbs.	55 lbs.
250-350 amp…….	50 lbs.	65 lbs.
500 amp…….	70 lbs.	95 lbs.
600 amp..……	80 lbs.	105 lbs.

Wire Gauge and Torque Specifications for 90°C Temp Wire.
Use copper wire only.

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
30A	10AWG	35	10 AWG
40A	8AWG	40	1/0 - 14
60A	6AWG	45	1/0 - 14
80A	4AWG	45	1/0 - 14
100A	3AWG	50	1/0 - 14
150A	1AWG	180	250MCM - 6
200A	3/0 AWG	250	250MCM - 6
225A	3/0 AWG	250	250MCM - 6
250A	4/0 AWG	250	250MCM - 6
350	TWO: 3/0 AWG	250	TWO: 250MCM-6
500	TWO: 4/0 AWG	325	TW0: 350MCM-2
600	TWO: MCM320	325	TWO: 600MCM-2

fig. 1

Ground wire should be mounted to chassis of SCR. The hardware used to mount SCR to back plate/enclosure can be used for ground lug. Size of the ground wire should be able to supply enough current capacity to match line and load power levels. Use copper wire only. Follow NEC NFPA 70 National Electrical Code.



TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	POSSIBLE SOLUTION
Heater does not heat up	no power to A3P	verify correct input voltage between "LINE" lugs on A3P.
	blown fuse in A3P	check for shorted or grounded heater, oversize heater, only then replace fuse. For tungsten Lamps order soft start option.
	blown fuse on A3P-S-	as above plus - cold lamp switched on after start, loose connection to cold lamp.
	check voltage limit adjustment on A3P with soft start (A3P-S-)	If limit is set for minimum output (CCW), soft start could take over 60 seconds worst case.
	no control signal to A3P	verify 4-20mA signal is hooked up correctly (positive to "+" and negative to "-") on the source and A3P. verify signal presence by placing a milliamp meter in SERIES with one of the control wires.
	defective heater	check for output voltage between the three "HTR" terminals. If voltage is present, check wiring to the heaters and the actual heaters.
Heater is on full all the time	incorrect source signal	verify 4-20mA signal varies from 4-20mA.
	shorted SCR's in A3P	with power applied, measure voltage drop across "LINE 1" and "HTR 1", if voltage reading is less than one volt, the SCR's are damaged, using the same method, check LINE 2-HTR 2 and LINE 3 - HTR 3.
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.
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.

A3P SERIES SCR POWER CONTROLLERS

ORDERING CODES

A3P - _____-_____-_____-_____
Voltage Amperes Options Options

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
(60) 575-600 VAC 50/60Hz

LOAD IN AMPS:

30, 40, 60, 80, 100, 150
200, 225, 250, 350, 500, 600

OPTIONS:

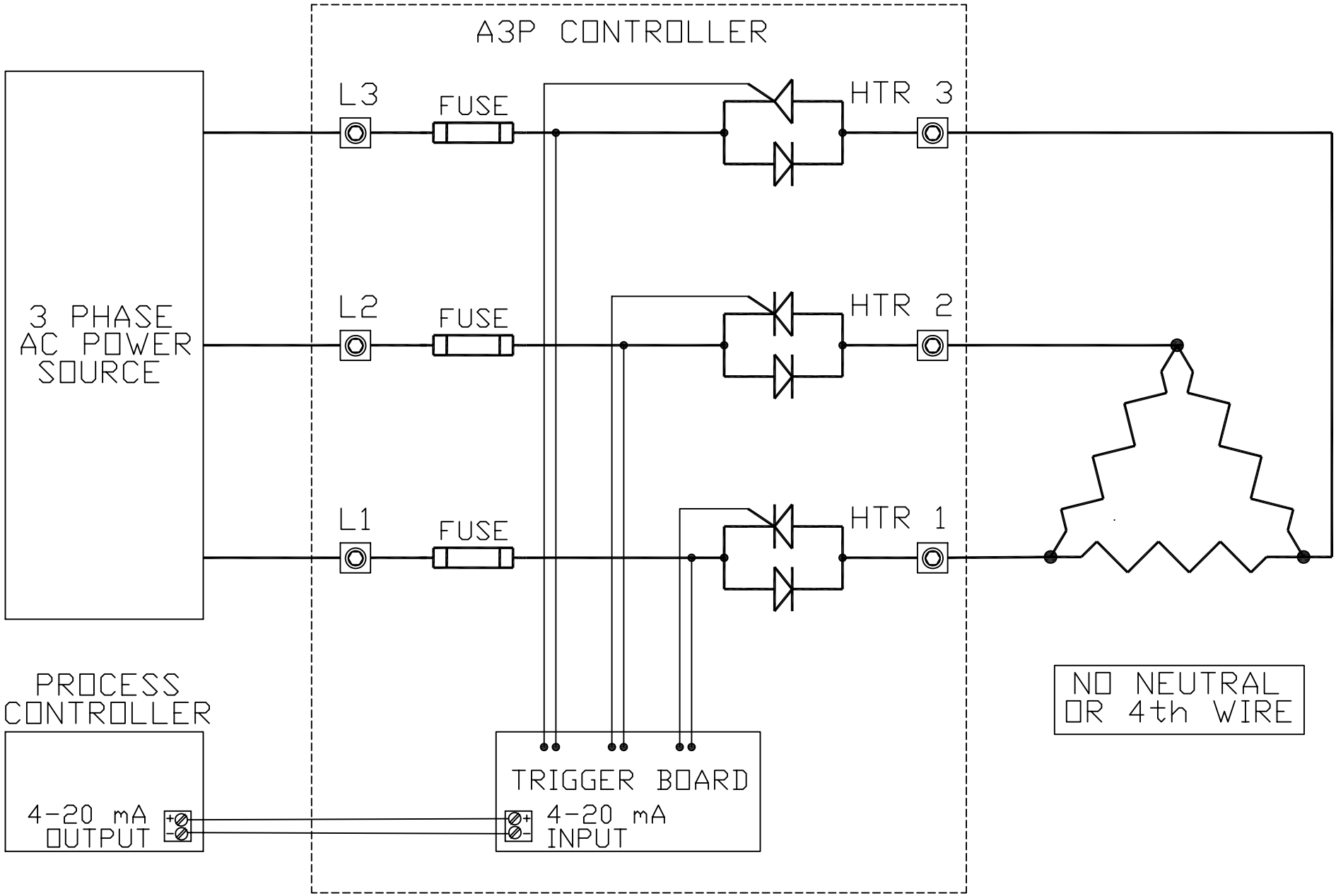
Soft Start
2 Seconds (S02)
5 Seconds (S05)
10 Seconds (S10)
20 Seconds (S20)
Note: Soft start gets voltage limit option.

Current Limit (CL)
(CLP) with panel mount potentiometer)

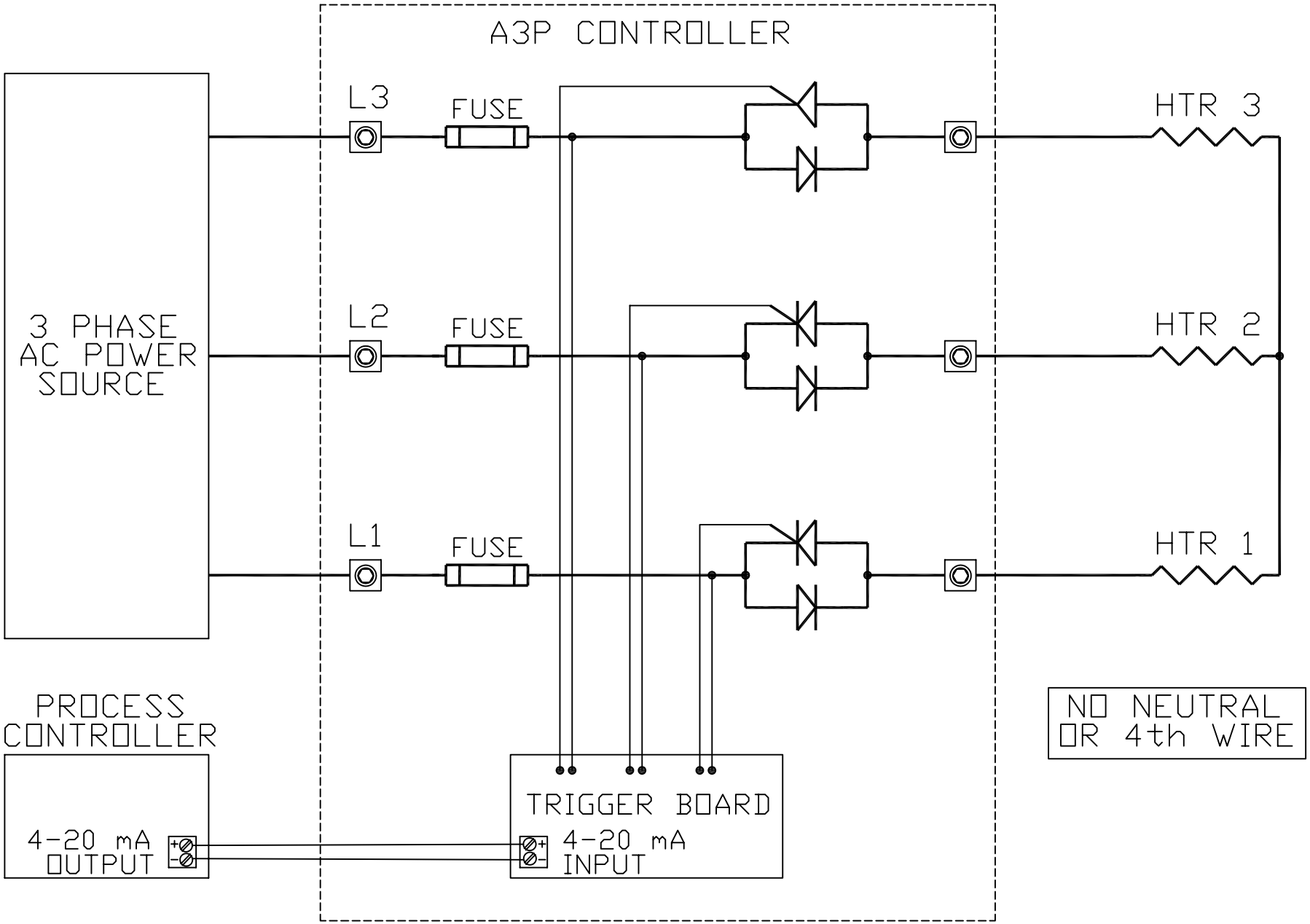
Voltage Limit
Standard 1 turn PCB (VL)
25 turn PCB (VL25)

Example: A3P-24-60-S05 is a 240VAC, 60 Ampere SCR with 5 second soft start

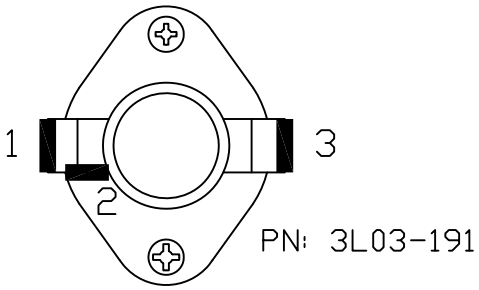
A3P WIRING DIAGRAM
(3 WIRE 3 LEG DELTA LOAD)

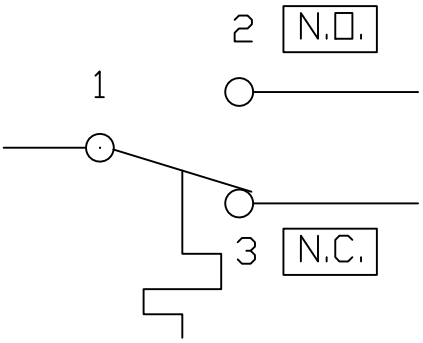


A3P WIRING DIAGRAM
(3 WIRE 3 LEG WYE LOAD)



OVERTEMPERATURE THERMOSTAT WIRING DIAGRAMS

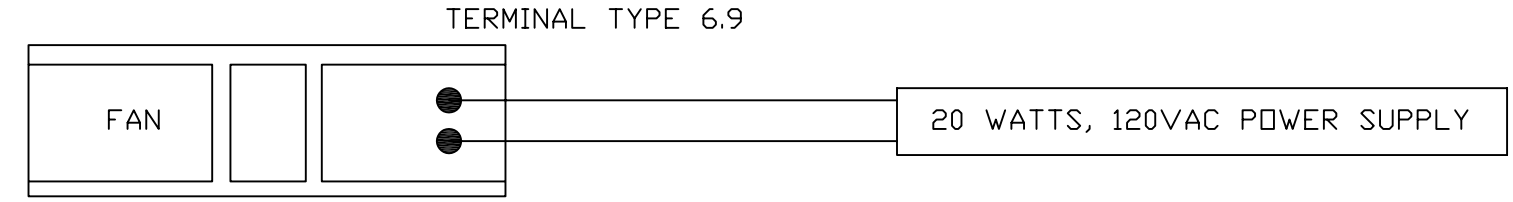




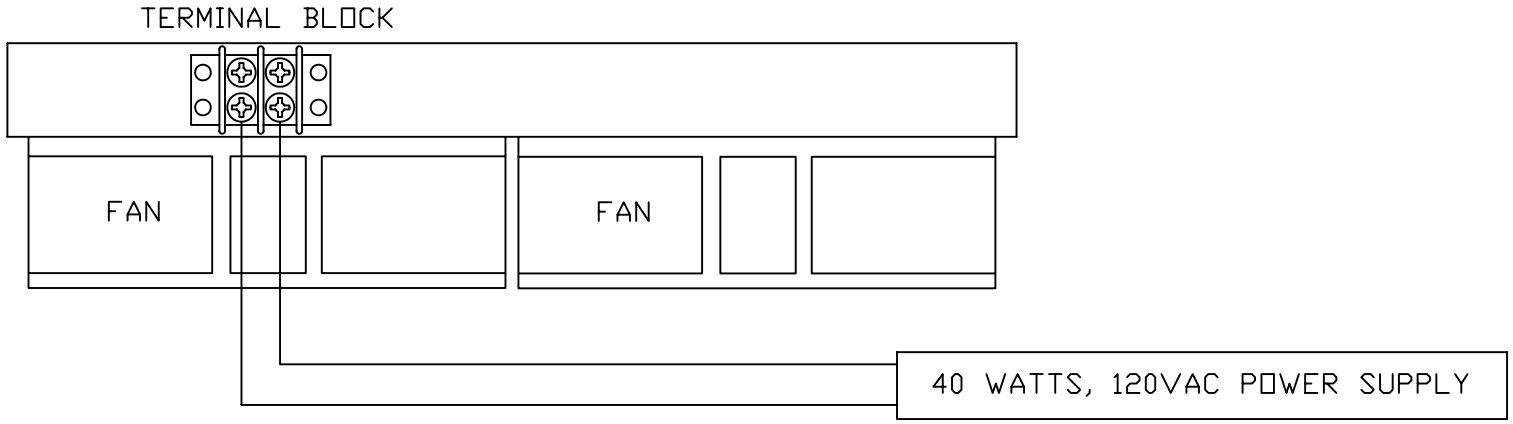
CONTACT RATINGS
1 & 2:
5.8A 120VAC
2.9A/240VAC
1 & 3:
10A/120VAC
5A/240VAC

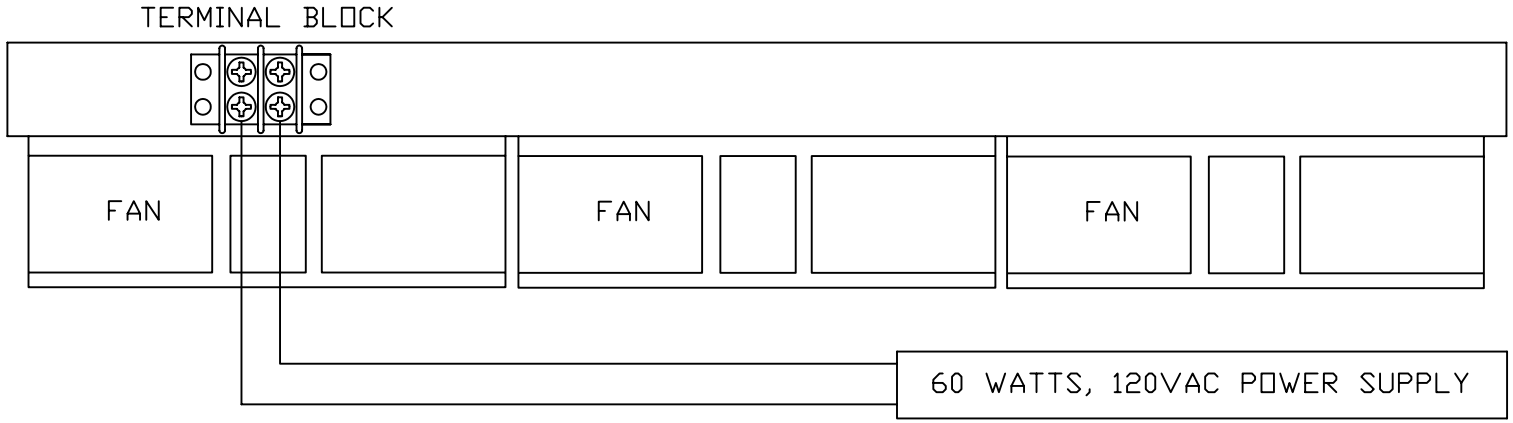
OPEN: 190F
CLOSE: 170F

FAN WIRING DIAGRAMS
100 thru 600 AMPS

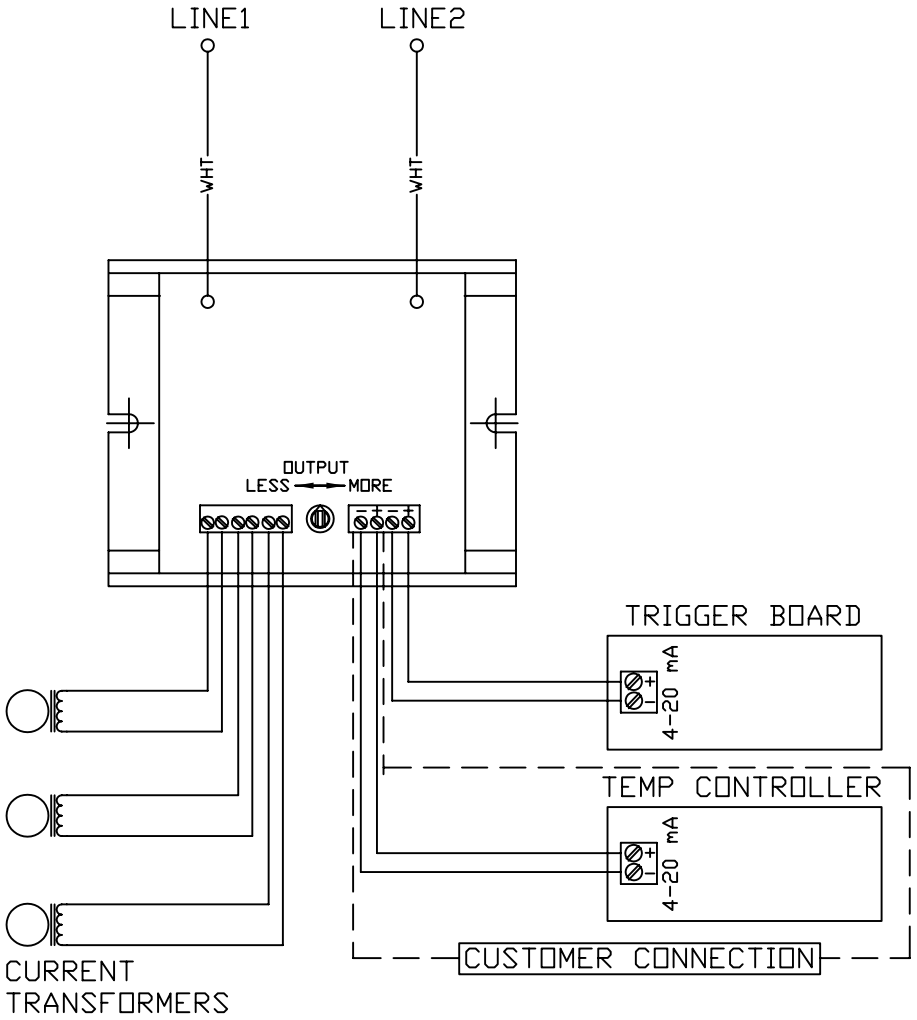


WARNING!
Fans MUST be ON when SCR power controller is on! Power to fans must be applied before or coinciding with the turn on of line voltage to the SCR power controller. *Failure to do so will damage SCRs and other components.*

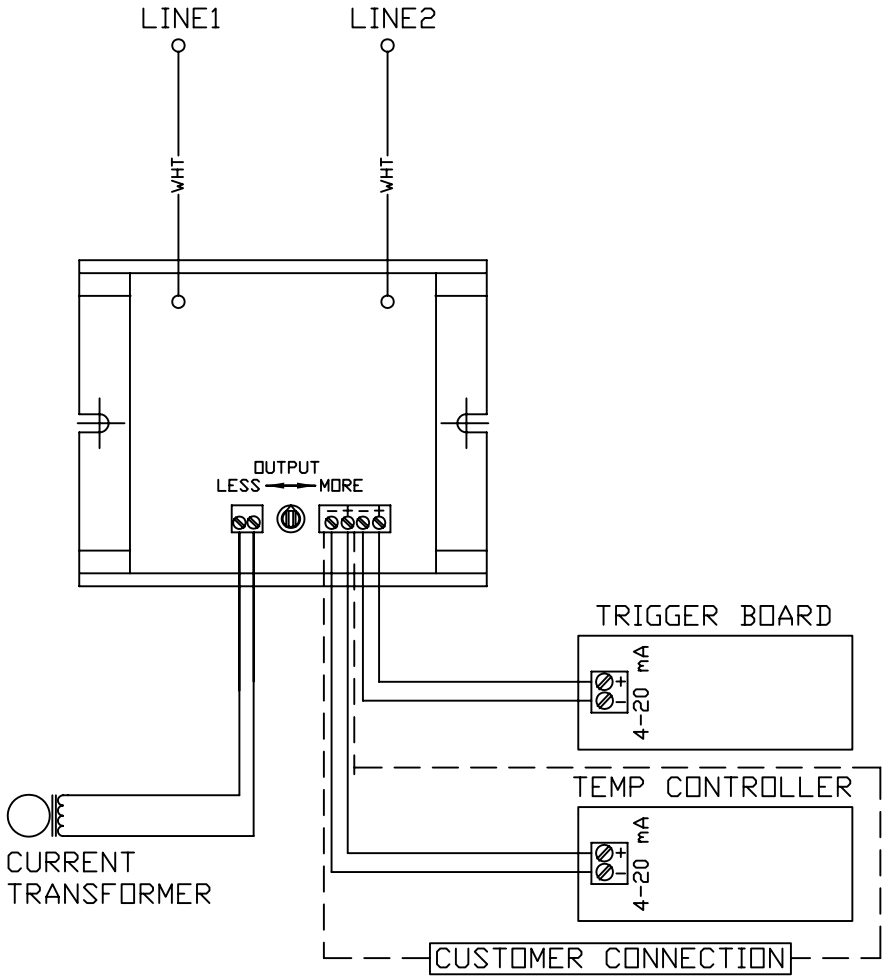




CURRENT LIMIT CARD
WIRING DIAGRAMS

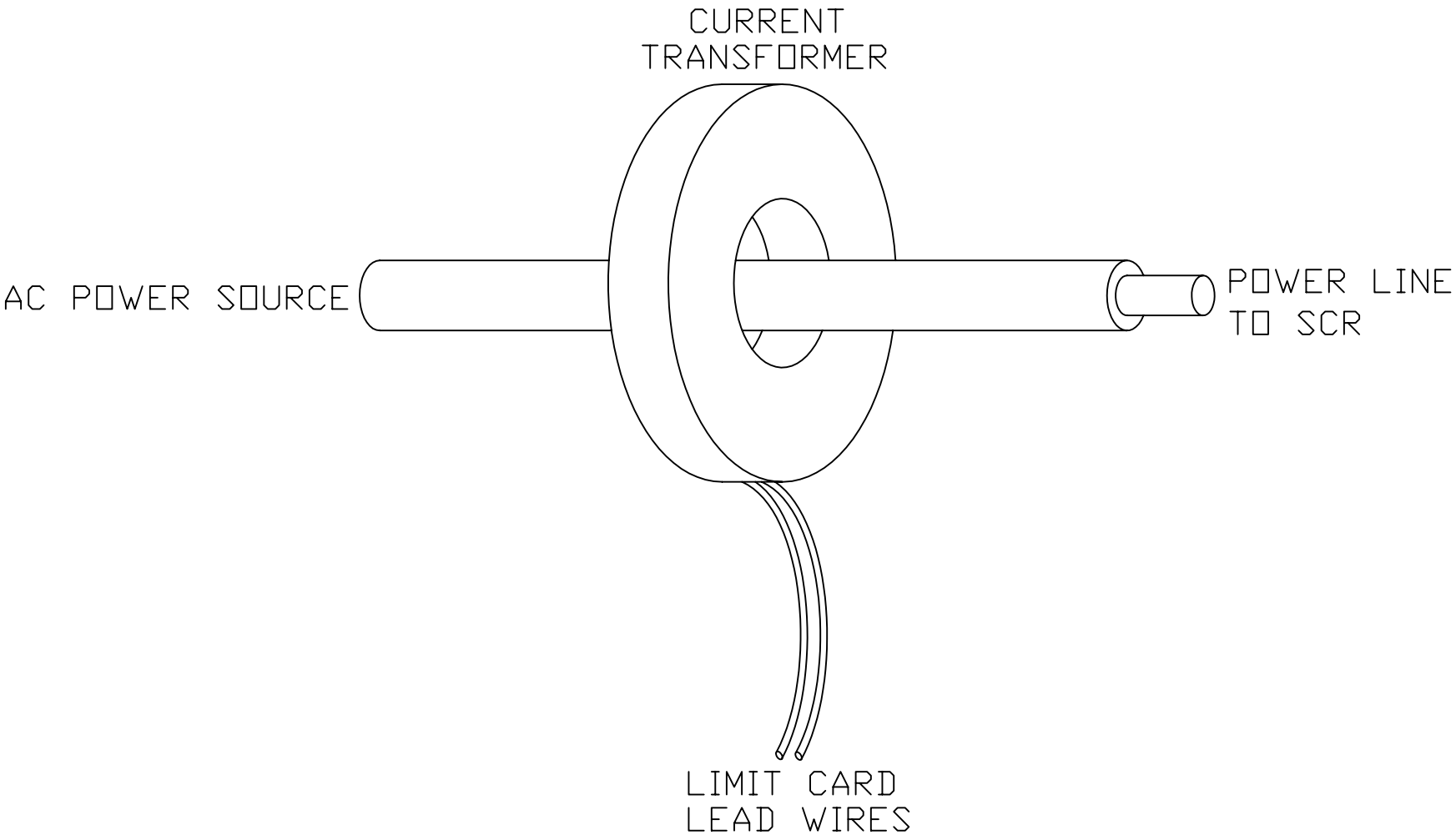


3 PHASE

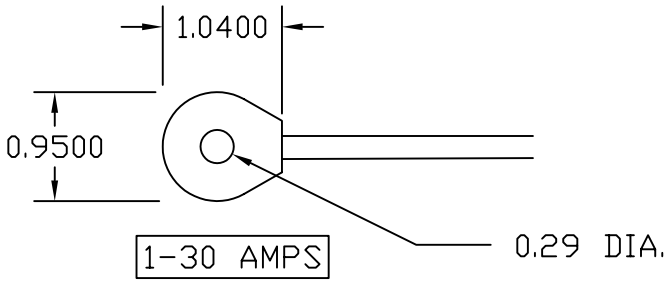


SINGLE PHASE

CURRENT TRANSFORMER
INSTALLATION DETAIL

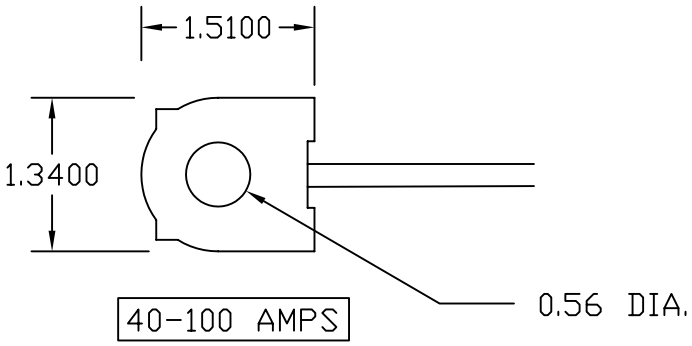


PHYSICAL DIMENSIONS
CURRENT TRANSFORMERS



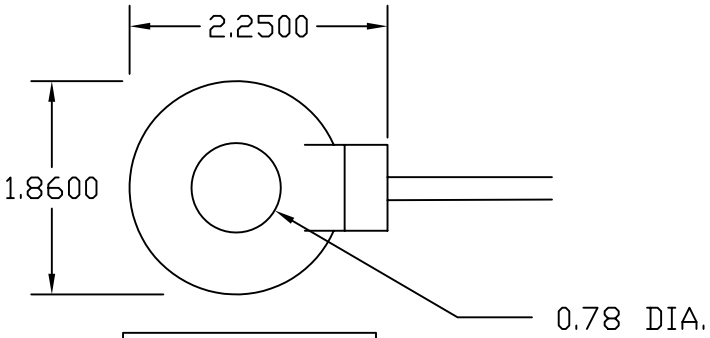
1-30 AMPS

M19-230 Turns



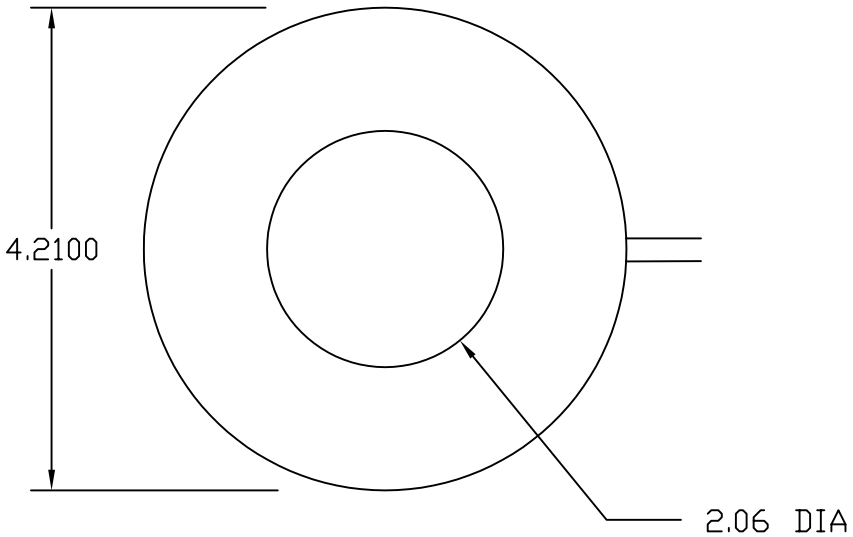
40-100 AMPS

M17-1000T



150-250 AMPS

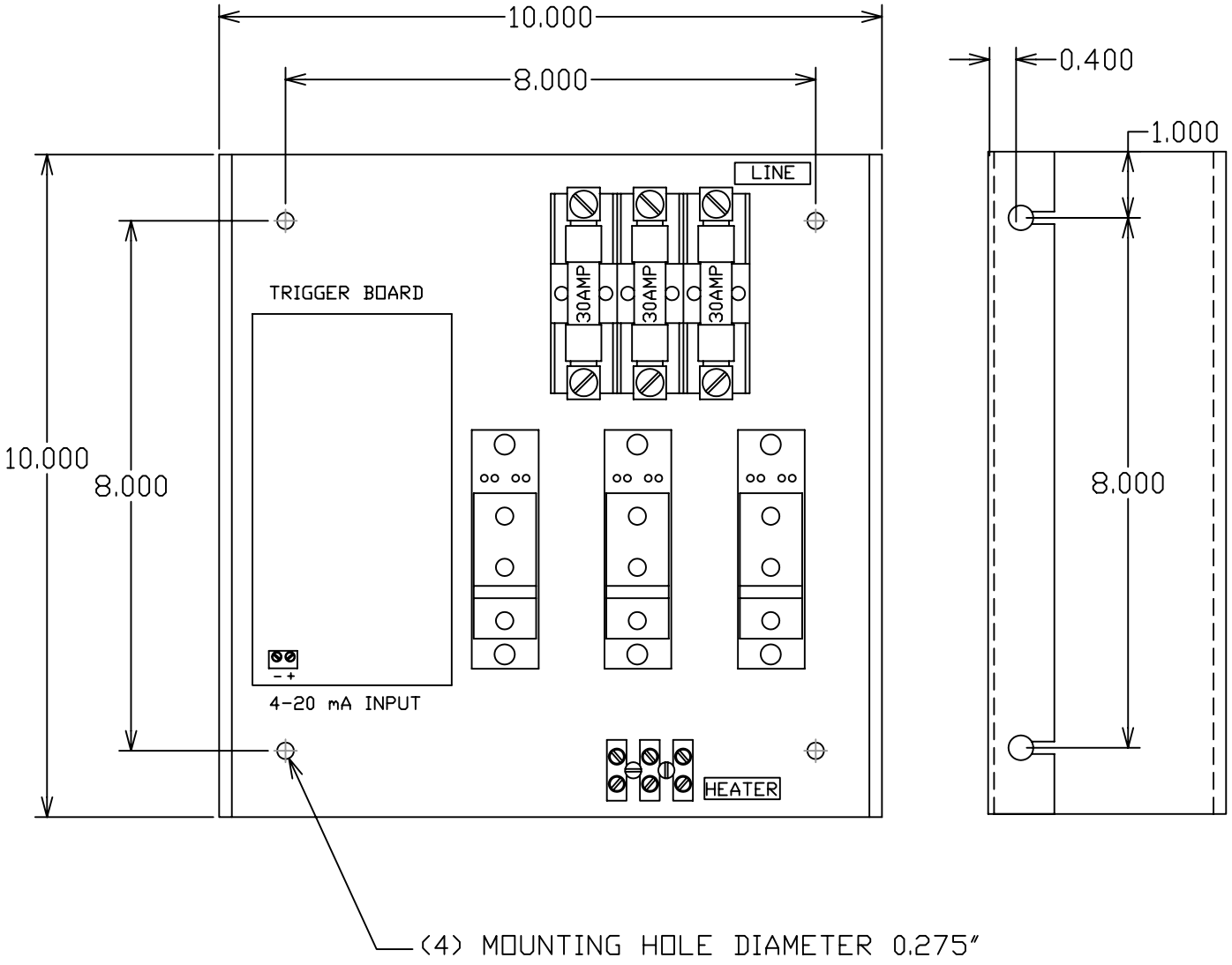
CR8459-2000N

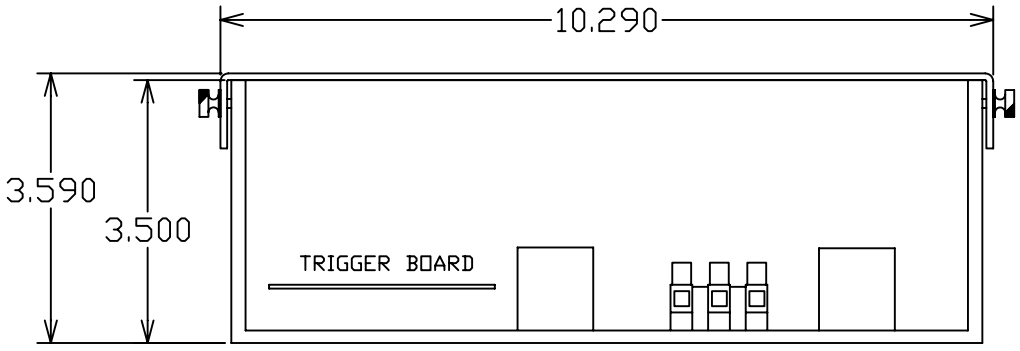


350-500 AMPS

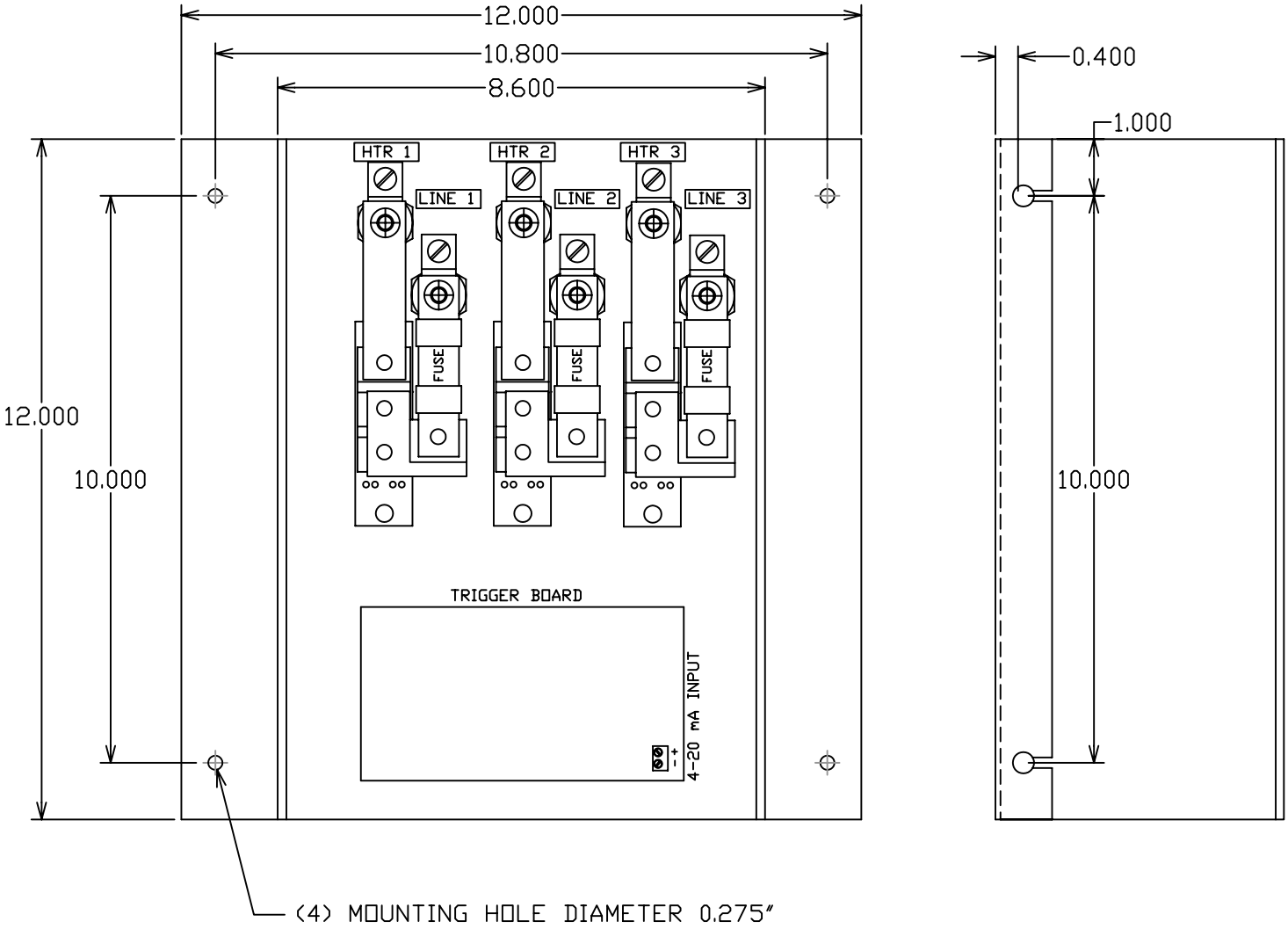
1500:1A

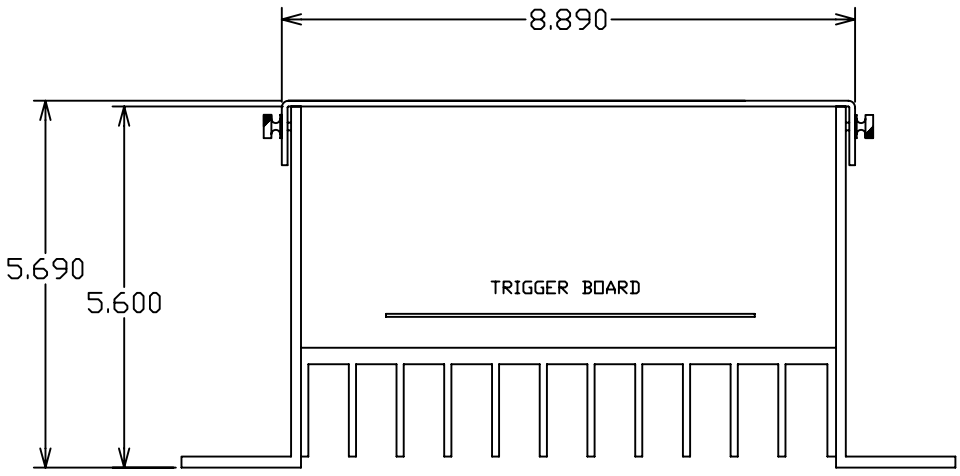
PHYSICAL DIMENSIONS
A3P - 30 AMP



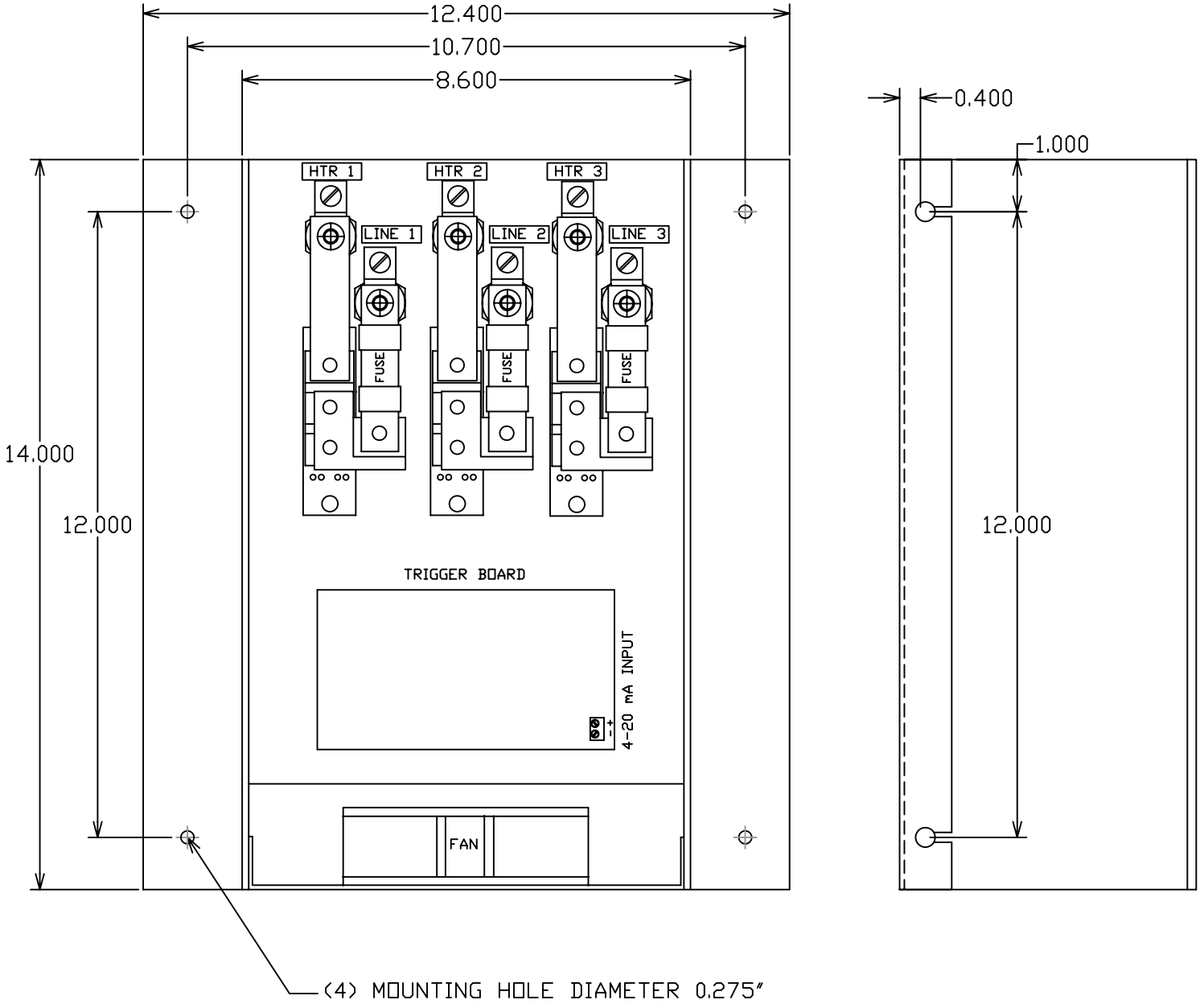


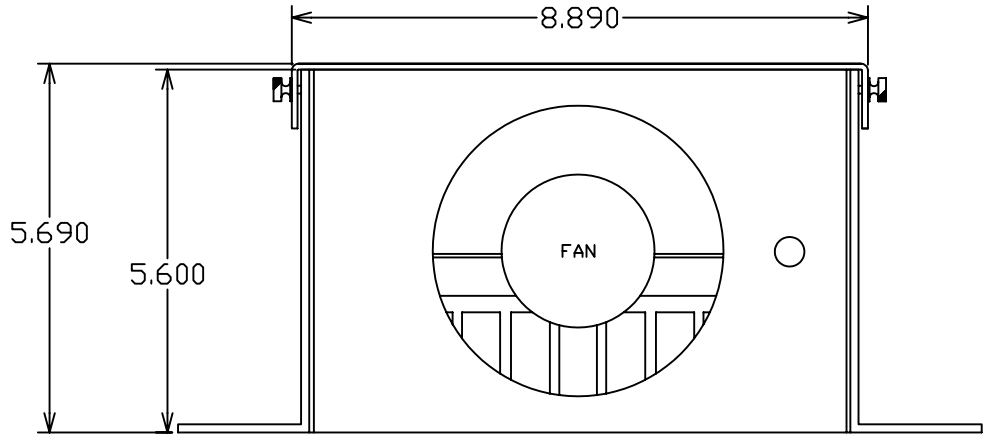
PHYSICAL DIMENSIONS
A3P - 40, 60 & 80 AMP





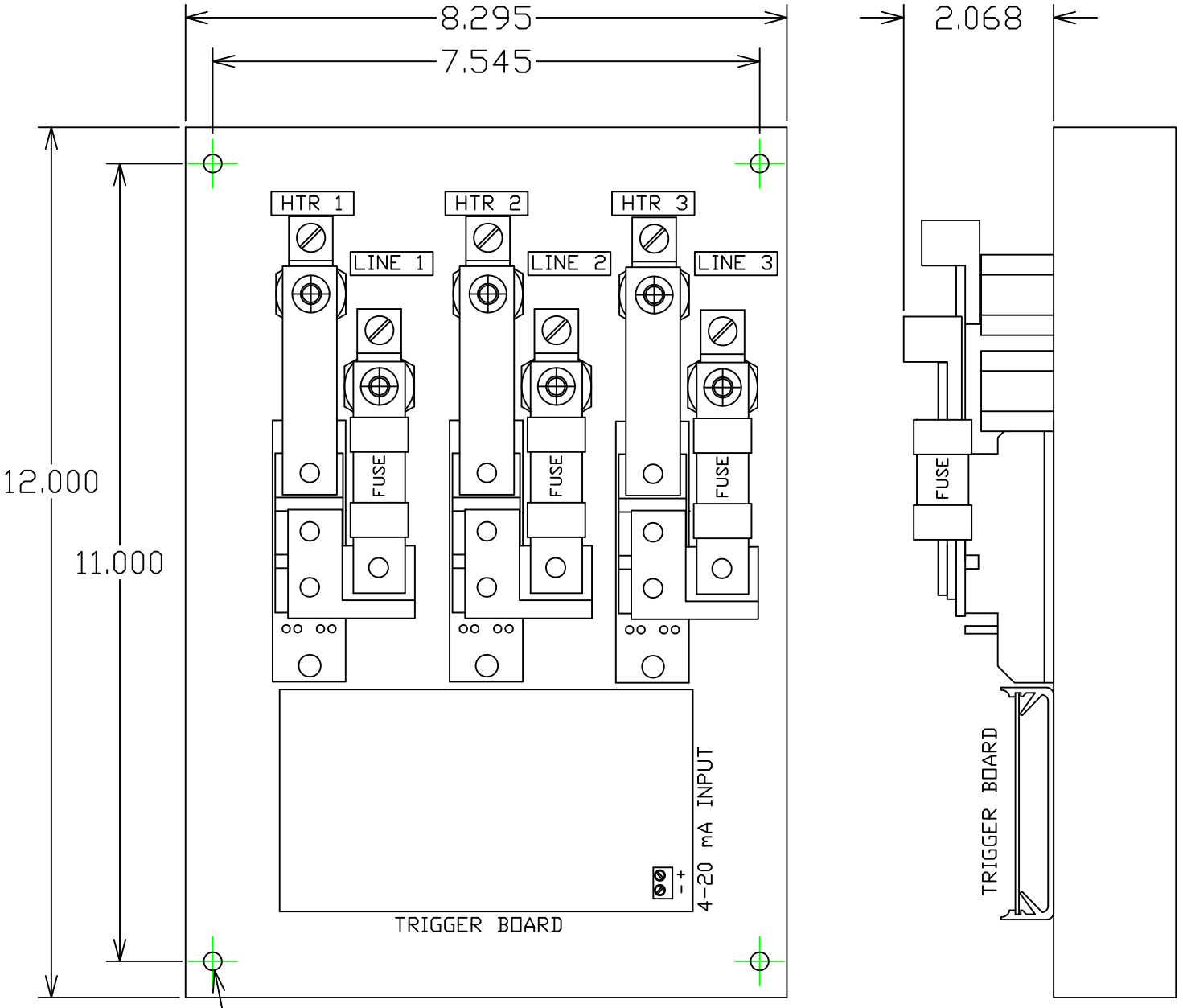
PHYSICAL DIMENSIONS
A3P - 100 AMP

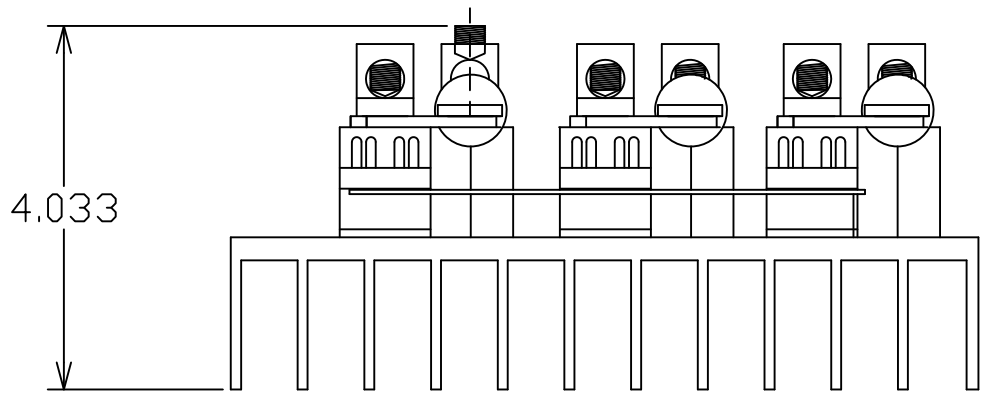




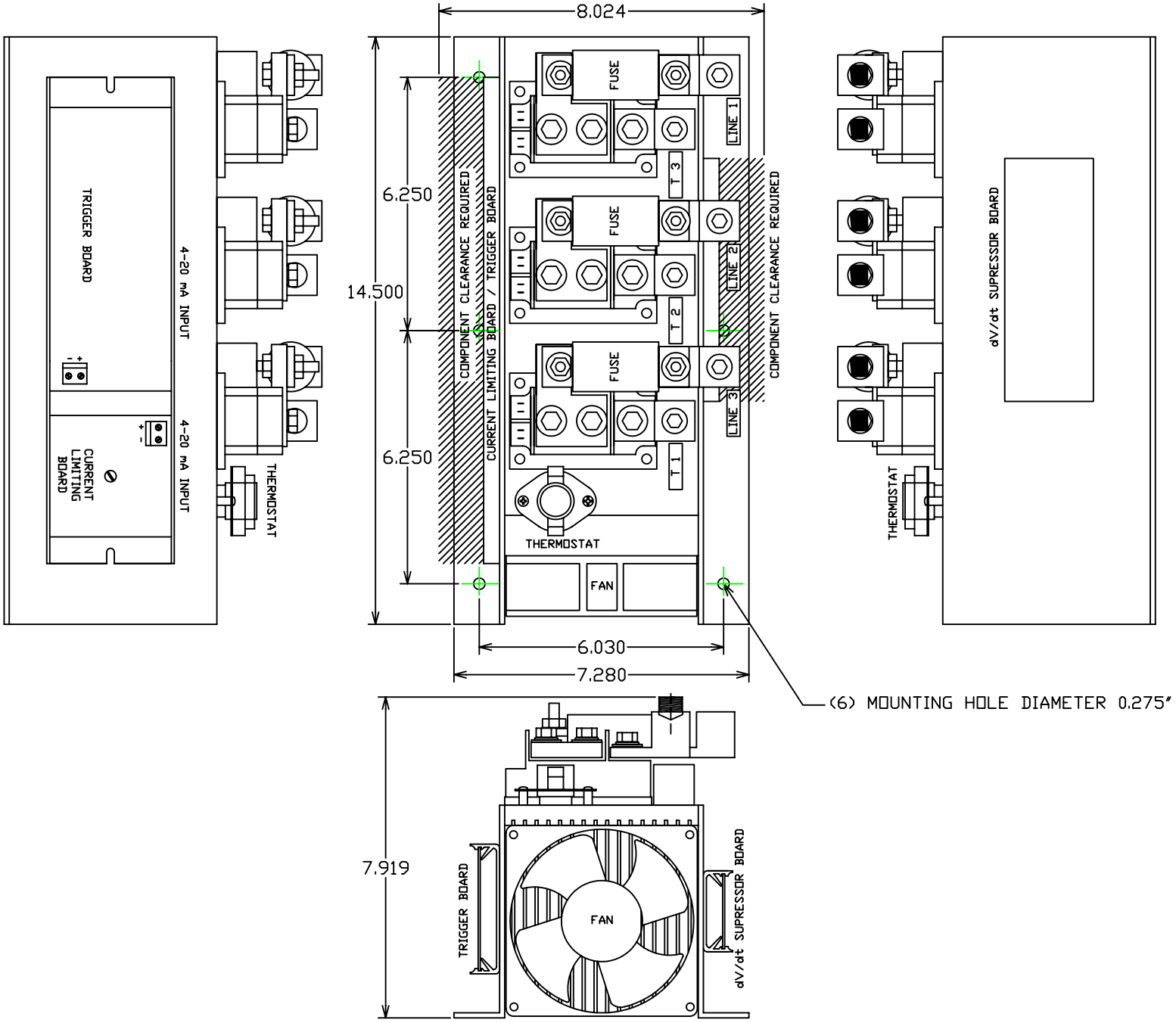
PHYSICAL DIMENSIONS

A3P - 40, 60, 80 & 100 AMP
THROUGH-HOLE MOUNTING (-TH)

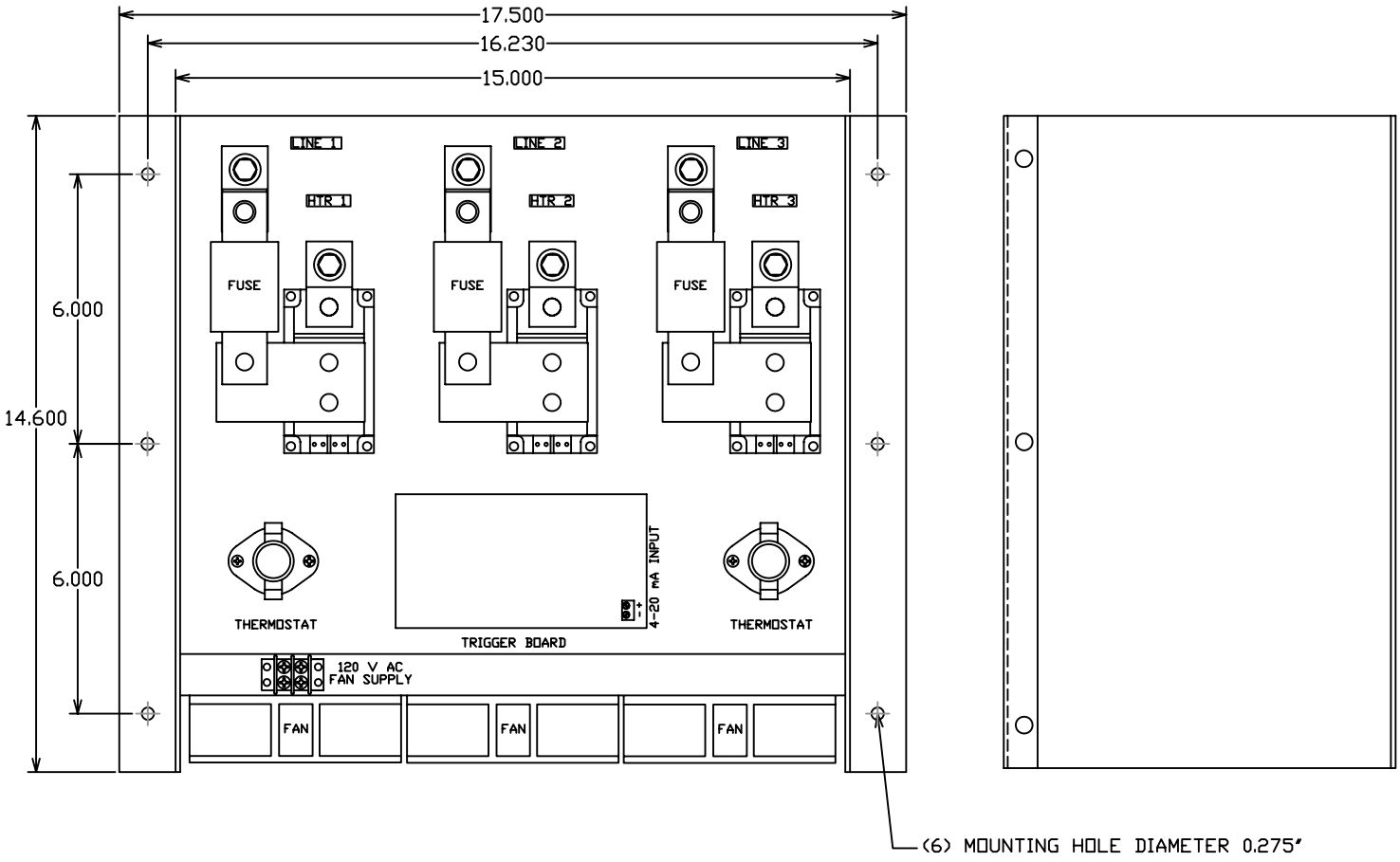


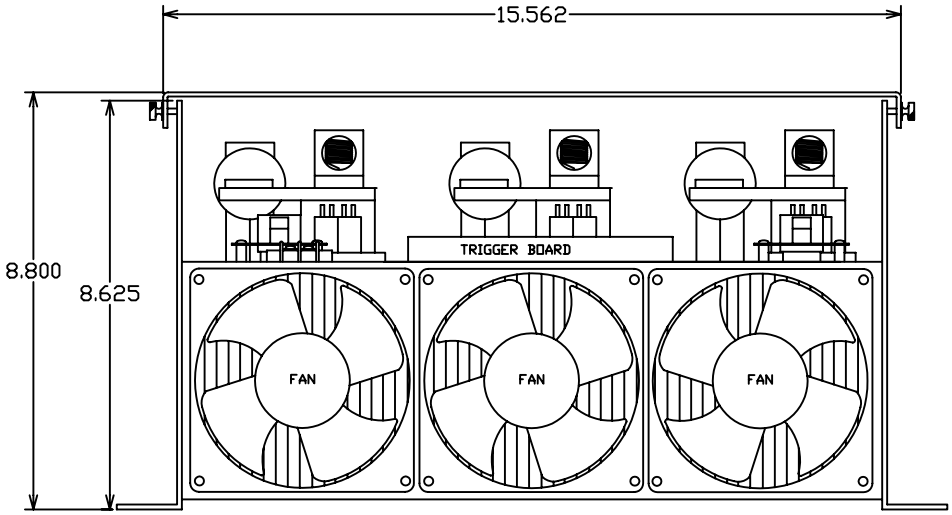


PHYSICAL DIMENSIONS
A3P - 150 AMP - COMPACT (-C)

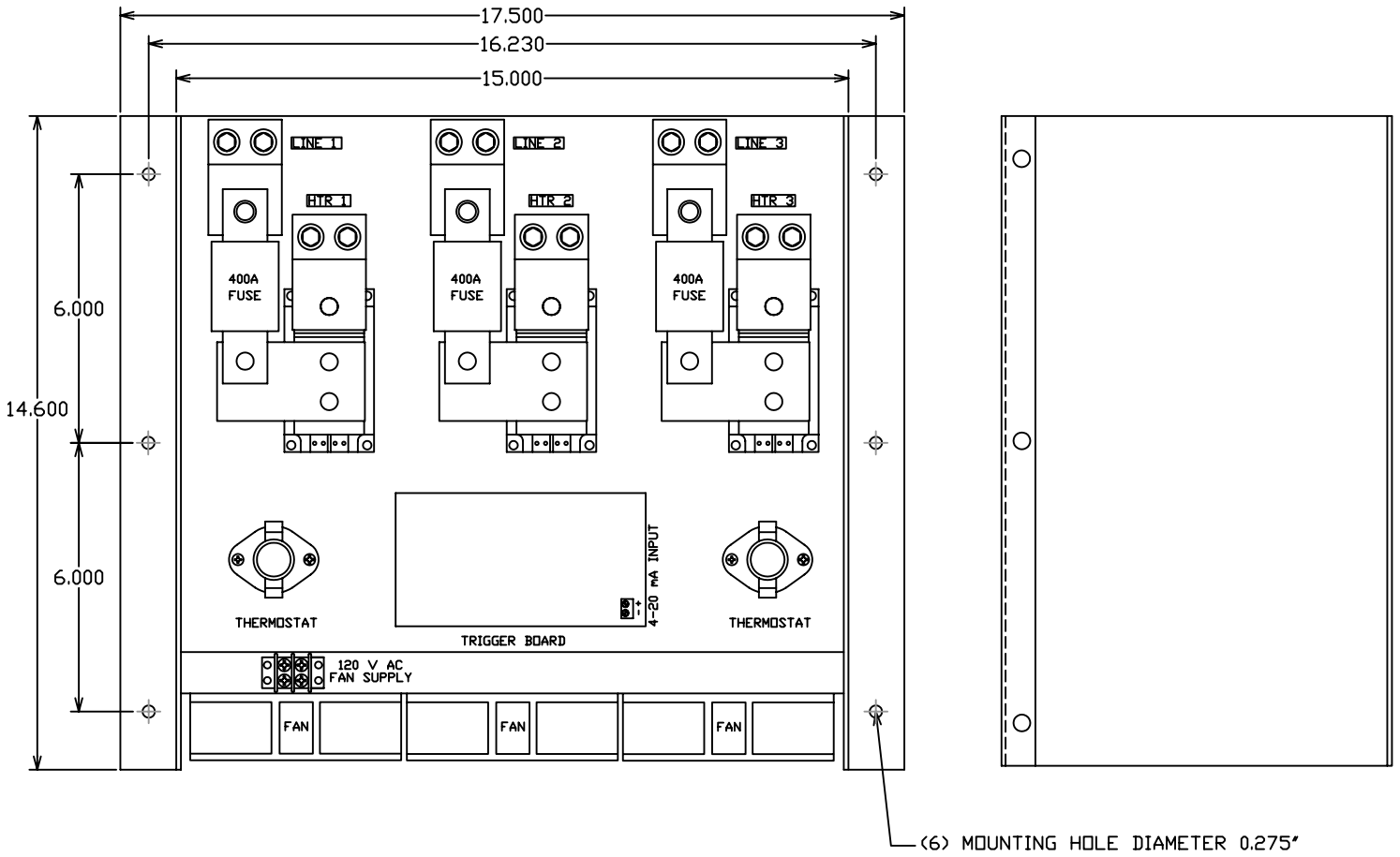


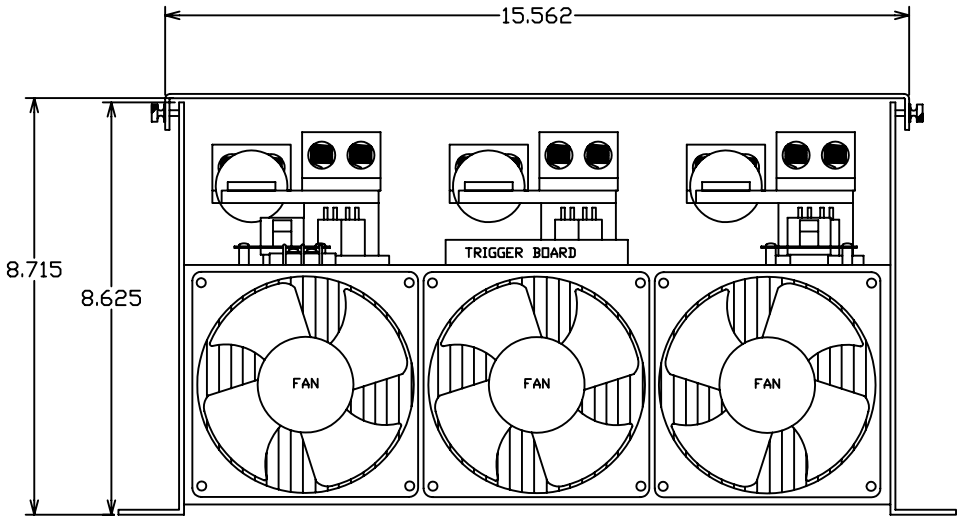
PHYSICAL DIMENSIONS
A3P - 150, 200, 225 & 250 AMP



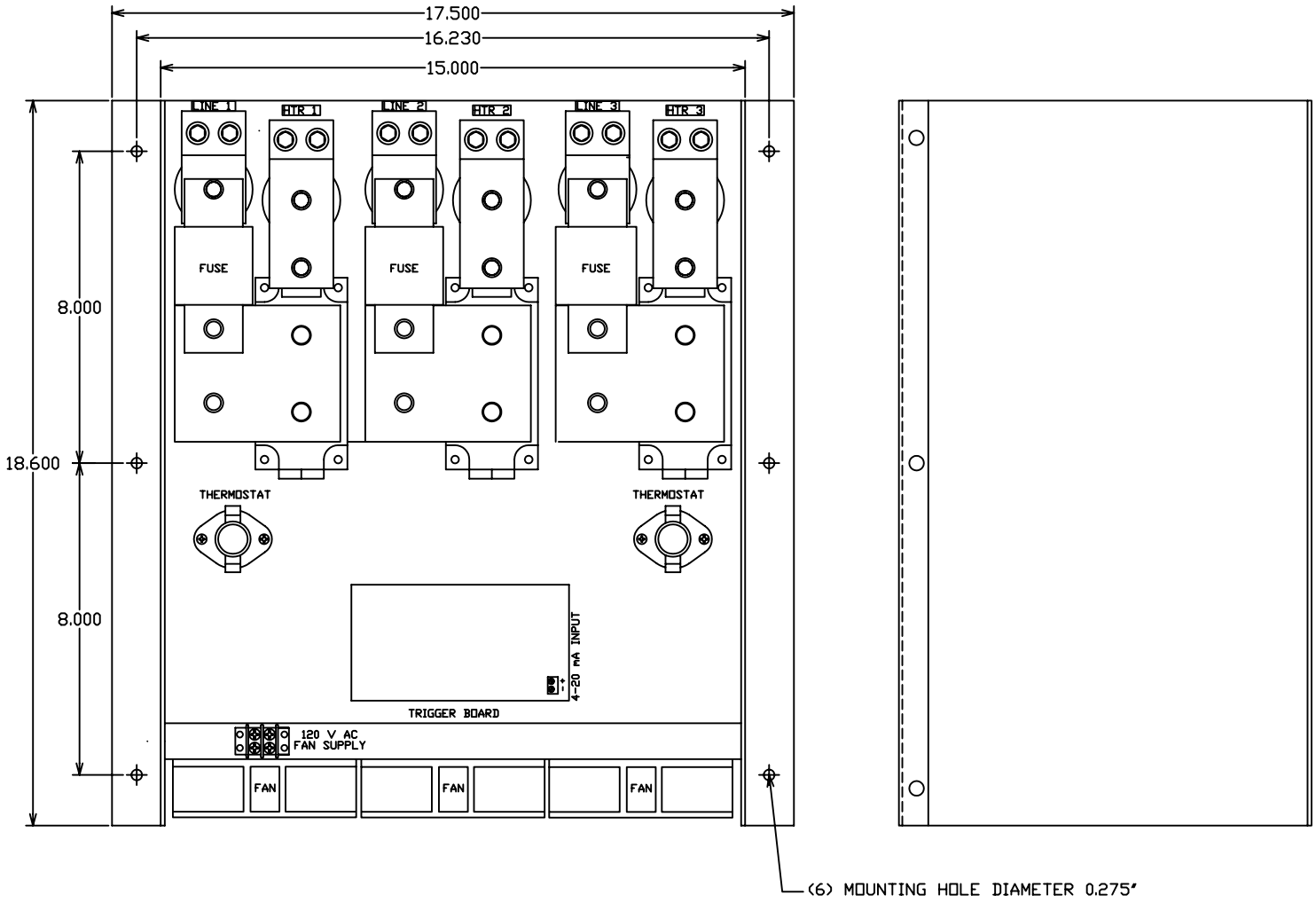


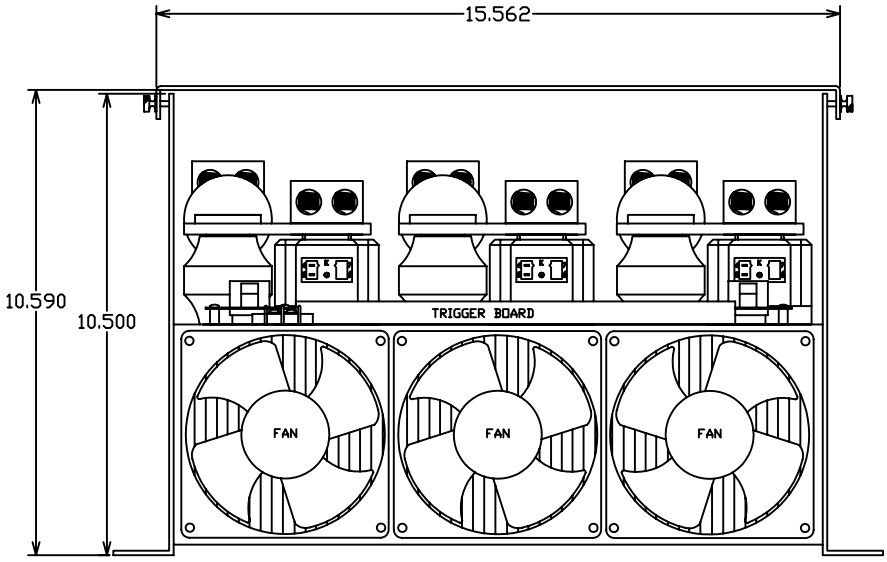
PHYSICAL DIMENSIONS
A3P - 350 AMP





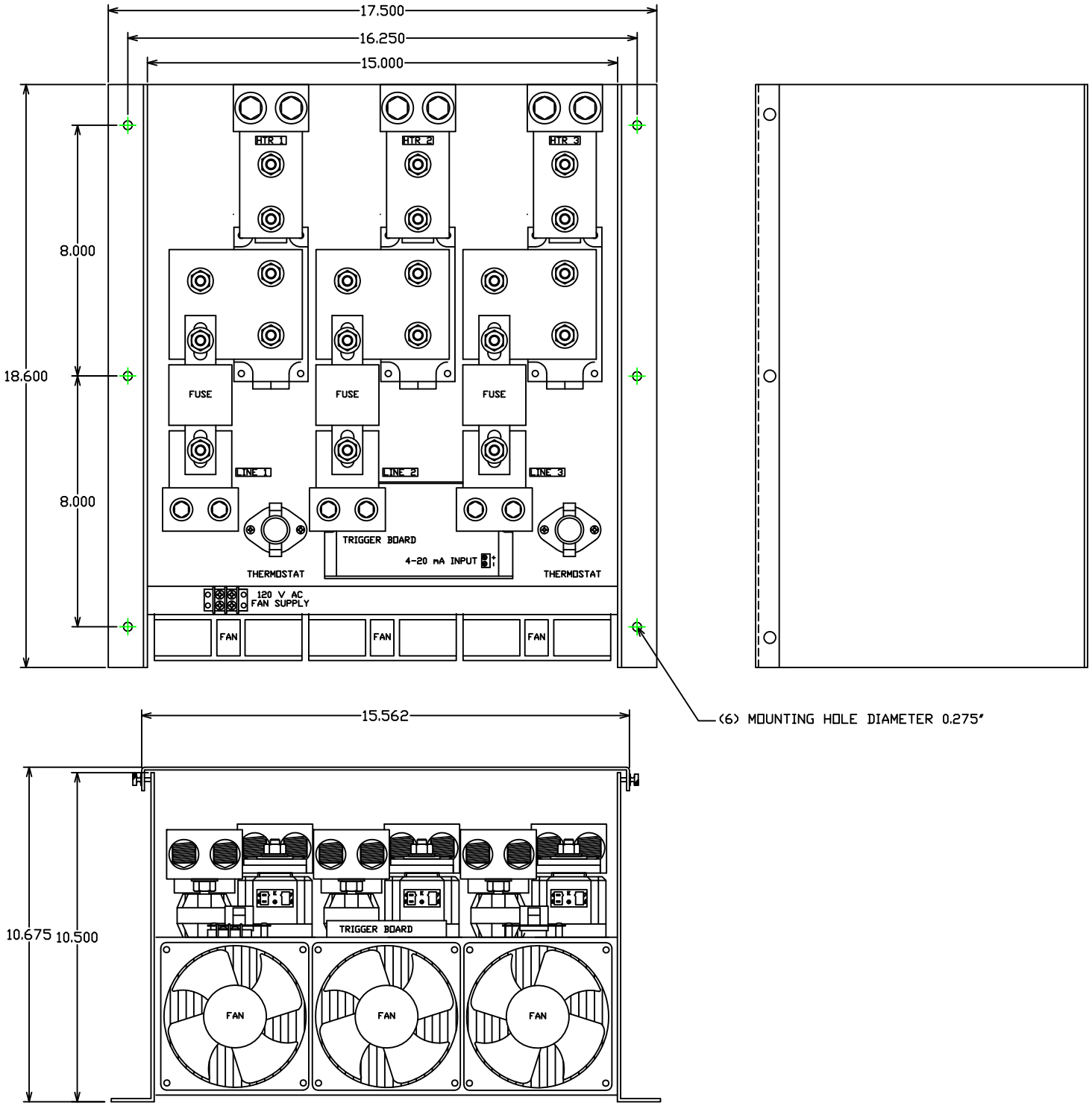
PHYSICAL DIMENSIONS
A3P - 500 AMP





PHYSICAL DIMENSIONS

A3P - 600 AMP



16587 Coastal Highway
Lewes, DE 19958
Phone 302-703-6865
Fax 302-703-6876

Declaration of Conformity

Avatar Instruments A Series SCR Power Controller

CE

Avatar Instruments, Inc.
16587 Coastal Highway
Lewes, DE 19958 USA

Declares that the following product A Series SCR Power Controllers

Model Numbers, voltage and current ratings:
A1P, A3P, A1Z, A3Z, A6Z - (12, 24, 27, 38, 48, or 60) – (30, 40, 60, 80, 100, 150, 200, 225, 250, 350, 500, 600 A)
Models available in Single Phase, Three Phase 2 leg control or Three Phase 3 leg control
All applicable options

Classification:	Electric Power Control, Utilization Categories AC-51, AC-55b, AC-56a Installation Category III, Pollution degree 2
Rated Voltage	24 to 480 Vac, 24 to 600 Vac
Frequency:	45 or 65 Hz

Environmental Rating: IP00 for mounting inside an enclosure

Meets the essential requirements of the European Union Directives by using the relevant standards show below to indicate compliance.

2014/30/EU Electromagnetic Compatibility Directive

EN 60947-4-1: 2019	Low Voltage Switchgear and Control gear: Part 4-1
EN 60947-4-3: 2020	Low Voltage switchgear and control gear Part 4-3: Contactors and motor-starters – AC semiconductor controllers and semiconductor contactors for non-motor loads
CISPR 11:2015	Limits and methods of measurement of electromagnetic disturbance characteristics (EMC) of industrial, scientific and medical (ISM) radio-frequency equipment, Amendment 1:2016

Third party testing conducted by Washington Laboratories, LTD.

Washington Laboratories, LTD
4840 Winchester Boulevard
Frederick, MD 21703

16587 Coastal Highway
Lewes, DE 19958
Phone 302-703-6865
Fax 302-703-6876

EN 60947-4-1: 2019:

IEC 61000-4-2:2008	Electrostatic discharge immunity
IEC 61000-4-3:2006	Radiated, radio frequency electromagnetic field immunity
IEC 61000-4-4:2004	Electrical fast-transient / burst immunity
IEC 61000-4-5:2006	Surge immunity
IEC 61000-4-6:2008	Immunity to conducted disturbances induced by radio-frequency fields
IEC 61000-4-11:2004	Voltage dips, short interruptions and voltage variations immunity

CISPR 11 Group 2, Class A

CISPR11 2015, A1 2016
CISPR11 2009, A1 2010

EN 55011 Radiated Emissions & Conducted Emissions – Radio-frequency disturbance characteristics – Limits and methods of measurement.

CAUTION: This equipment not intended for use in residential or medical environment.

For use in Class B environments, additional external filtering on power lines is **required.** Shielded cables may also be needed.

For use with Phase Angle Control, additional external filtering is **required** to pass Class A conducted Emissions. A Schaffner filter series FN3270-H or equivalent should be used as a line input filter with model A1P & A3P Phase Angle Fired SCRs.

A Schaffner FN2080-16-06 was installed at the AC power input during testing to be CISPR32 CE Class B compliant.

Contact Schaffner EMC, Inc. to find the proper filter for your specific application. Schaffner EMC Phone (USA) 732-225-9533, www.schaffner.com

Name of Authorized Representative: Paul Evalds

Title of Authorized Representative: President

Place of Issue: Lewes, Delaware USA
Date of Issue: March 2, 2022

Paul Evalds
Signature of Authorized Representative

www.avatarinstruments.com

CUSTOMER NOTES:

CUSTOMER NOTES:

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