
**INSTALLATION, OPERATION and
MAINTENANCE MANUAL**

**MODEL RF3 30 THRU 1200A
SCR POWER CONTROLS**

**AMETEK HDR POWER SYSTEMS
3563 INTERCHANGE ROAD
COLUMBUS, OHIO 43204**

**TEL: 614-308-5500
TOLL FREE: 1-888-PWR-CNTL (797-2685)
FAX: 614-308-5506**



SCR Power Controls/Systems & Power Supplies

Dear Client:

On behalf of all of AMETEK HDR's employees, I want to take this opportunity to "thank you" for purchasing an AMETEK HDR Power Systems' SCR Power Control.

We believe AMETEK HDR represents the best overall solution to your SCR Power Control needs in the industry today. We do this by providing a quality manufactured, reliable unit with fast, on-time delivery and a competitive price.

All of our employees are dedicated to your success. If you have any questions, comments or concerns, please call me at 1-888-PWR-CNTL (797-2685).

Sincerely,

AMETEK HDR POWER SYSTEMS

A handwritten signature in black ink that reads "George A. Sites". The signature is written in a cursive style.

George A. Sites
Vice President

GAS/be

REVISION PAGE

Page **Change**

Revision

Date

NOTE: SPECIFICATIONS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

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DRAWING LIST

Outline & Mounting, RF3 30 Thru 225A.....	M2710124
Outline & Mounting, RF3 350 & 500A	M2710068
Outline & Mounting, 650A.....	M2710069
Outline & Mounting 800 Thru 1200A	M2710070
Schematic, RF3 30 Thru 225A	S2710062
Schematic, RF3 350 Thru 1200A	S2710068
Schematic, Firing Circuit	S2077000
Assembly, Firing Circuit	M2077000
Schematic, Overcurrent Trip (OC).....	S2091000
Assembly, Overcurrent Trip (OC).....	M2091000

NOTE: If full size drawings are required, contact HDR inside sales and request the required drawing by the drawing number listed above.

Section 1 - DESCRIPTION

1-1 MODELS COVERED

This manual covers the RF3 models rated 30 through 1200 amperes and its options.

1-2 GENERAL DESCRIPTION

The RF3 is a solid-state, three-phase, phase fired (PF) SCR power control which will operate on voltages up to 575 VAC. It accepts most all standard process command signals and regulates the output voltage. Zero and Span Multi-turn potentiometers are provided to ease calibration. The RF3 utilizes phase-lock loop technology to insure precise timing and noise immunity. The power SCR assembly consists of two SCRs connected back to back with a semiconductor fuse, R.C. Snubber and MOV protection per phase. Terminals are provided to ease installation. Diagnostic indicators are provided to aid troubleshooting.

1-3 APPLICATIONS

The RF3 provides infinitely variable firing angles for precise control of three-phase power to resistive or inductive loads. This is essential for transformer coupled loads or loads with great resistance changes due to temperature or start-up. The RF3 may also be used on straight resistive loads as well, but the lower power factor and higher harmonics may present a problem to other equipment mounted nearby. A zero fired model would be a better choice.

1-4 SPECIFICATIONS

Refer to Table 1 for specifications on the RF3 Power Control.

1-5 OVERCURRENT TRIP (OC)

An Overcurrent Trip (OC) is included. This is normally be used on loads which have instantaneous shorts that are self healing. The adjustment range is 25 to 200% and a Form C relay output is provided.

Table 1
Specifications for the RF3

CONTROL METHOD	- Phase firing of back to back SCRs per phase.
VOLTAGE RATINGS	- 120, 240, 400, 480, 575VAC, 3 Ph., 50/60 Hz.
CURRENT RATINGS	- 30, 60, 90, 120, 180, 225, 350, 500, 650, 800, 1000, 1200A
COMMAND SIGNAL	- 4-20ma, 0-5VDC/0-10VDC, manual control.
ISOLATION	- 2500Vrms from line/load to command signal, 500Vrms to ground.
LINEARITY	- Output voltage is linear to command signal.
FEEDBACK	- External 0-10 VDC
VOLTAGE REG.	- $\pm 1\%$ for $\pm 10\%$ line voltage change.
SCR PROTECTION	- Current surge, semi-conductor fuses; transient voltage, metal oxide varistor (MOV) and R-C snubber.
ADJUSTMENTS	- Zero and Span, multi-turn.
DIAG. INDICATORS	- Control power, command signal, blown fuse.
AMBIENT TEMP.	- Operating 0 - 50 °C, Storage -10 - 70 °C
WEIGHT	- 60 through 225A: 40 lbs. 350 and 500A: 60 lbs. 650A: 126 lbs. 800 through 1200A: 231 lbs.

1-6 OPERATION

The RF3 controls power by the switching action of two SCRs connected in a back to back configuration per phase. The gating of these SCRs is synchronized with the line frequency (either 50 or 60 HZ) by the phase locked loops built into the firing circuit. A soft-start feature is standard, which allows the RF3 to fire into the primary of transformers or to control power to heating elements which have a large resistance change during start-up. The output may be adjusted by the on-board multi-turn potentiometers or by a voltage or current signal from a process controller. Zero and Span controls allow the user to calibrate the SCR unit's output to the process command signal. Terminals are available for connection of a remote manual potentiometer.

<p>WARNING Hazardous voltages exist at the exposed heat sink and/or terminals unless the source is disconnected.</p>

1-7 DIAGNOSTIC INDICATORS

Five diagnostic indicators (LEDs) are provided: Control Power (Red), lights when control power is applied; Command Signal (Green), varies in brilliance with command signal; Blown Fuse (Yellow-3), lights when the corresponding semiconductor fuse blows.

NOTE: The blown fuse indicators are not operational on non-fused units.

Section 2 - INSTALLATION

2-1 MOUNTING

Prior to mounting, verify the voltage and current rating. The information is provided on the unit's nameplate. Determine the mounting dimensions from the outline drawing from Figure 3,4, 5, & 6. Mount the RF3 so that air flow is upward through the power controller. Ensure that air flow is unrestricted. Allow plenty of room.

2-2 LINE/LOAD POWER WIRING

Connect the line/load using appropriately sized and insulated wire/cable per NEC based on the voltage and current rating of the RF3. Refer to Figure 1. Cable lugs are provided on 30 through 225A rated units. Refer to Table 2 for lug sizes and torque information.

WARNING
Hazardous voltages exist at the power controller heat sinks and at the load at all times when the input voltage is connected. This condition exists even when the controller is set to deliver zero output.

<u>Model</u>	<u>Size Wire/Cable</u>	<u>Torque</u>
30A	14 to 2 AWG	40 to 50 in. Lbs.
60A	14 to 1/0 AWG	40 to 50 in. Lbs.
90/120A	14 to 2/0 AWG	100 to 120 in. Lbs.
180A	6 to 250 MCM	250 in. Lbs.
225A	6 to 250 MCM	325 in. Lbs.

NOTE: 75°C rated wire (minimum) is required for all power connections to the RF3.

WARNING
Branch circuit overcurrent protection is required to be provided in accordance with the national and/or local code of the inspecting authority or equivalent.

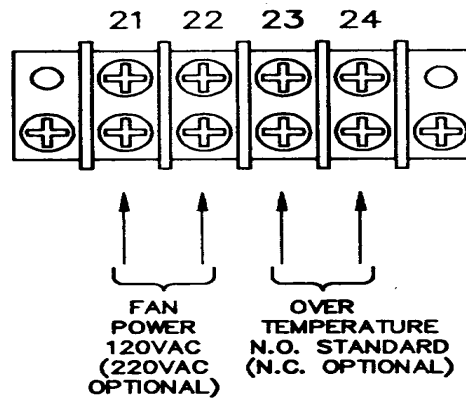
2-3 FAN AND THERMOSTAT WIRING

Fans and thermostats are supplied on all units above 90A. The user is responsible for supplying 120VAC for the fans. Fan power should be connected to terminals 21 and 22.

CAUTION
The application of fan power should precede or coincide with the turn-on of the line voltage source that is to be controlled by the disconnect.

Normally Open (NO) thermostats are standard on all units above 90A, Normally Closed (NC) thermostats may be specified. Normally Open or Normally Closed may be specified on the 30 or 60A models as an option. Thermostat connections are on terminals 23 & 24.

Figure 1
FAN AND THERMOSTAT TERMINALS



2-4 INPUT LINE VOLTAGE CHANGES

All units are shipped wired for the line voltage specified on the order. If some other voltage is required, it is a simple matter to change it. Open the door on the Power Control and locate transformer T1 and T2. Unsolder and move the white/black wire to the appropriate voltage tap on T1, move the yellow wire to the appropriate voltage tap on T2. Jumpers J1 and J2 must be removed for 50 Hz. operation.

CAUTION
Ensure that all power to the SCR Power Control has been disconnected prior to making any voltage changes.

Figure 2
LINE/LOAD POWER WIRING

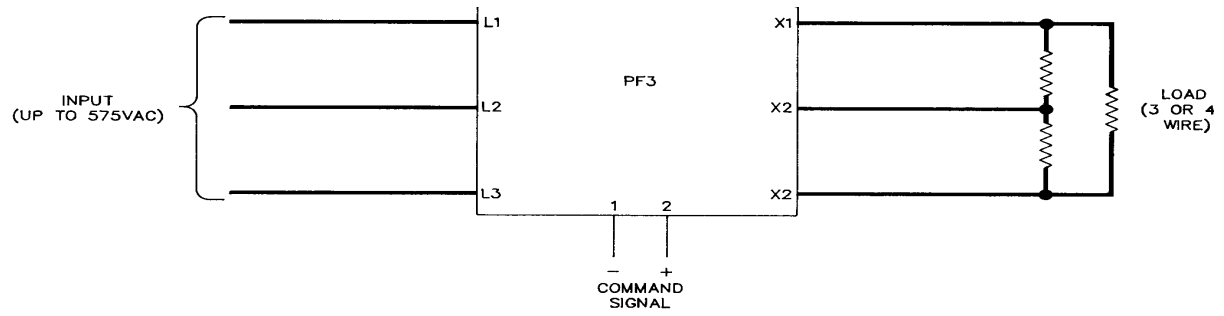


Figure 3
OUTLINE AND MOUNTING - RF3 30 THRU 225A

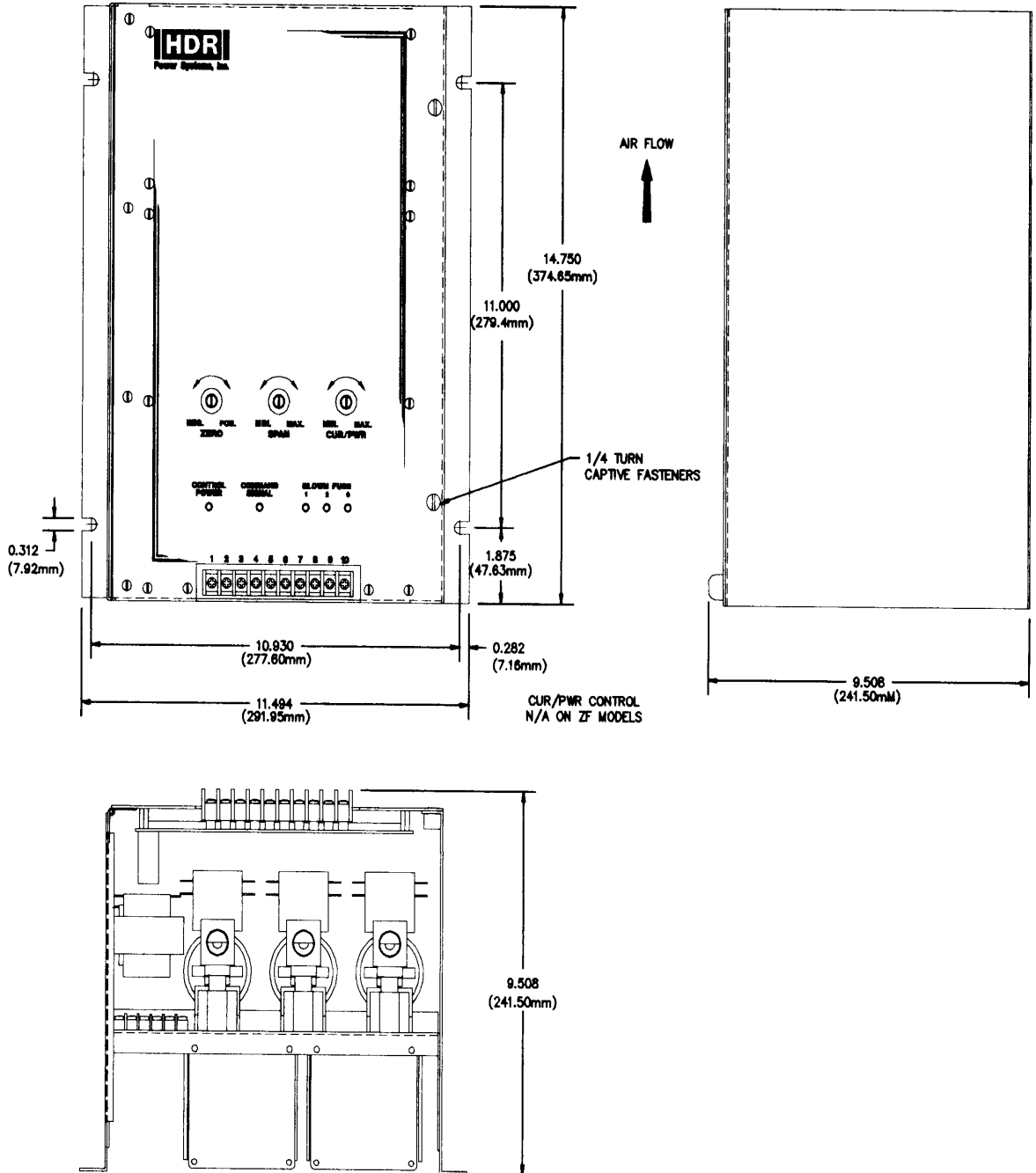


Figure 4
OUTLINE AND MOUNTING - 350 AND 500A

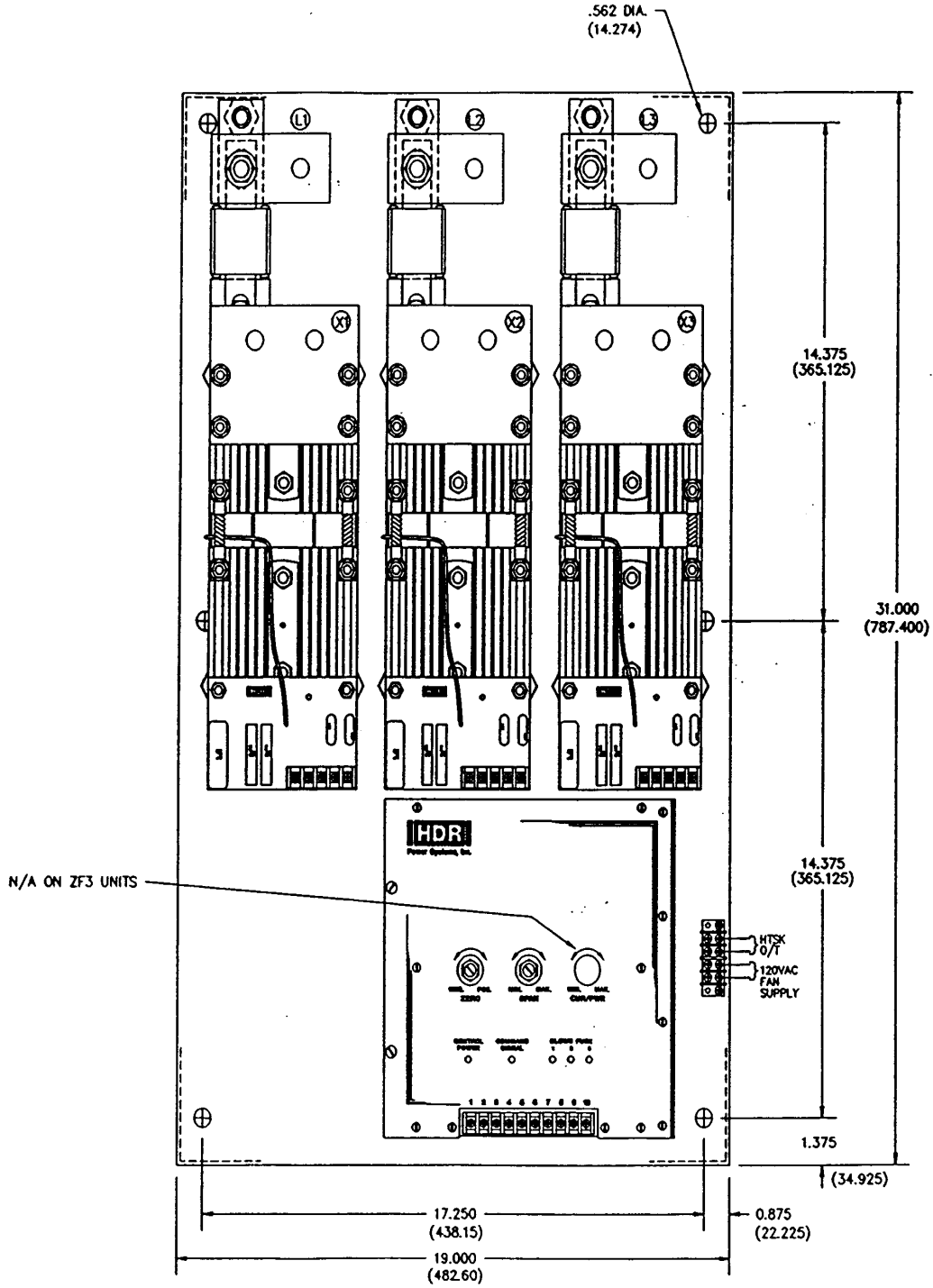


Figure 5
 OUTLINE AND MOUNTING - 650A

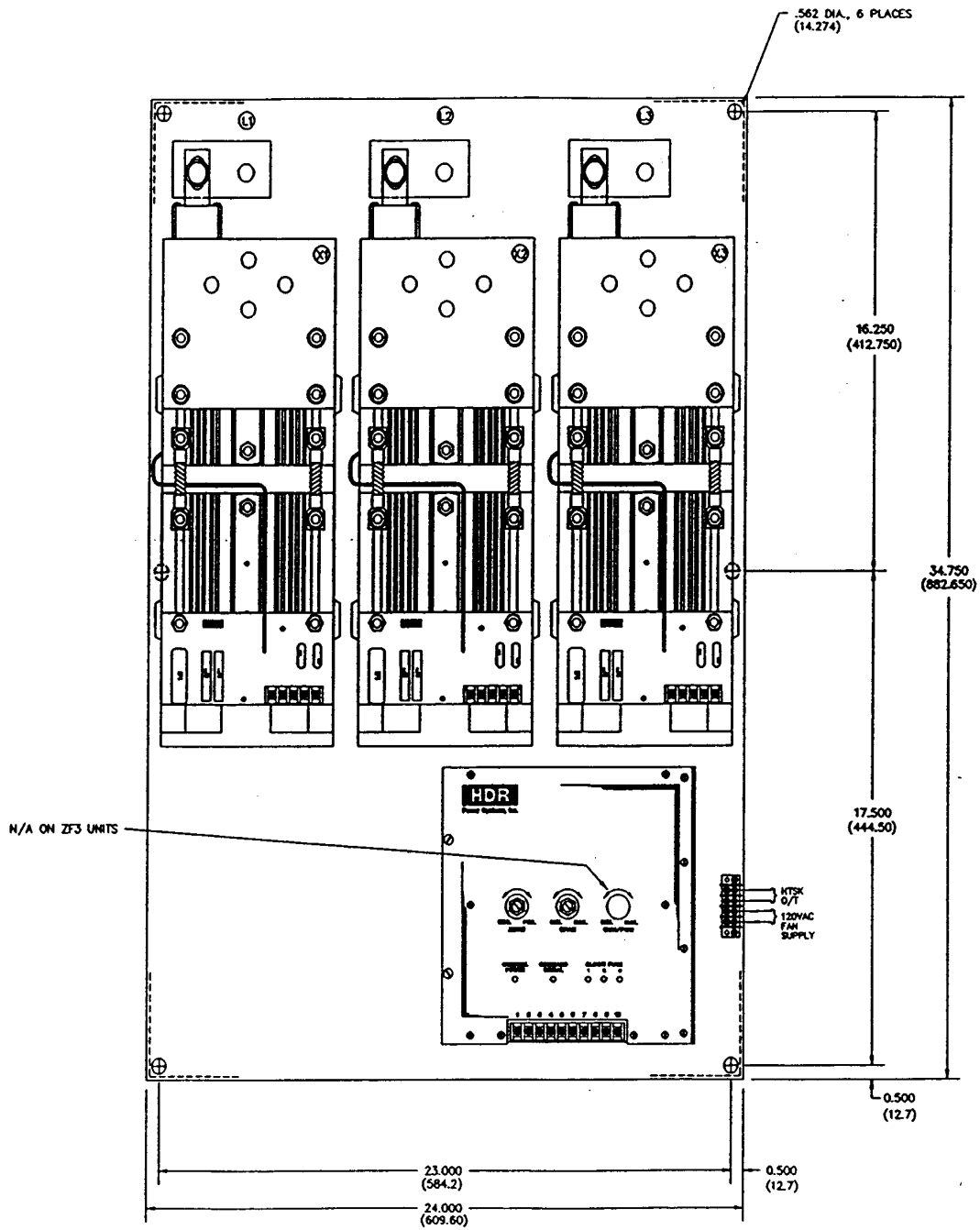
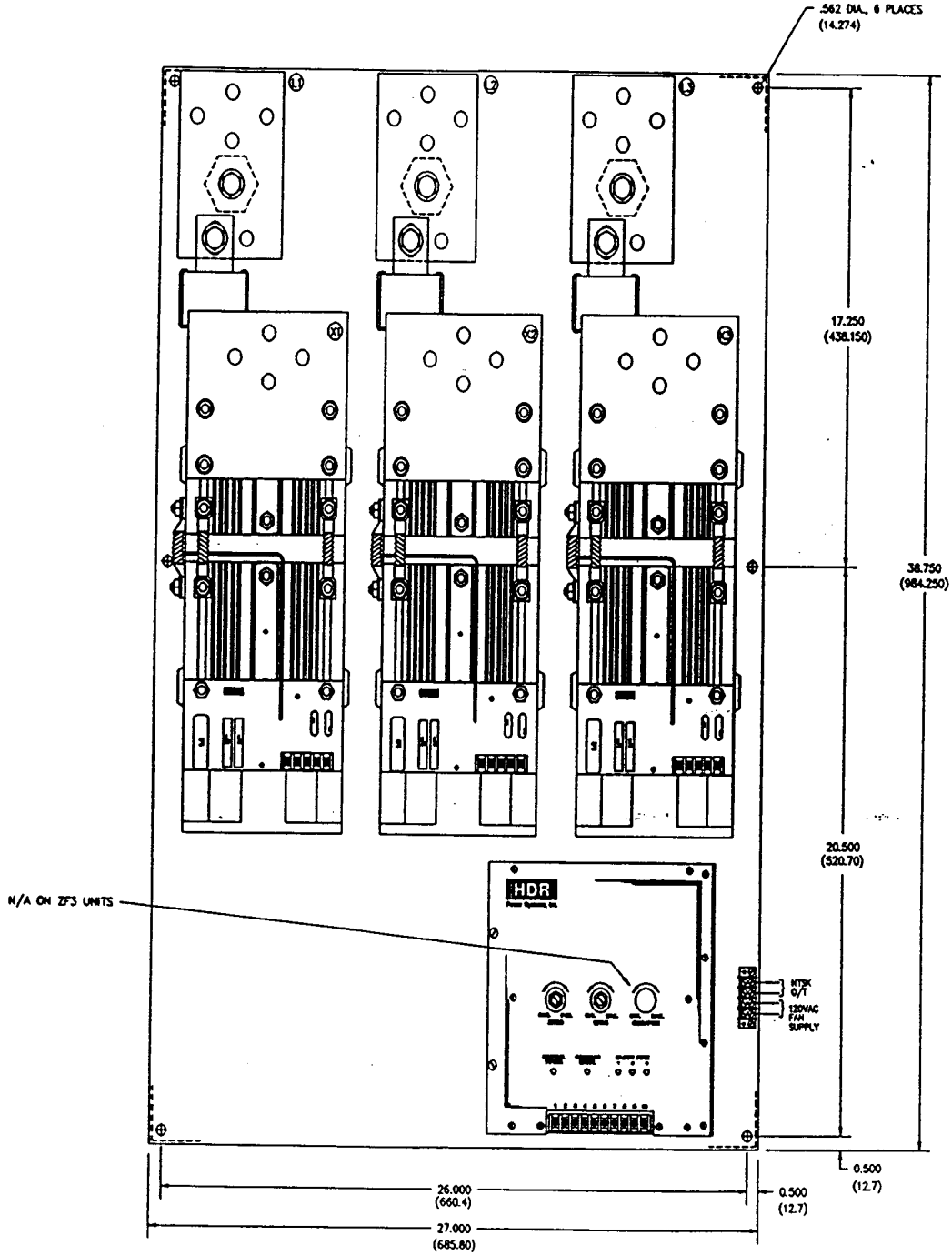


Figure 6
 OUTLINE AND MOUNTING - 800 THRU 1200A



Section 3 - COMMAND SIGNAL CALIBRATION AND WIRING

3-1 ZERO AND SPAN ADJUSTMENTS

All RF3s have both Zero and Span potentiometers used for matching the SCR Power Control and the Command Signal. The Zero control is for the low end input (min. output) adjustments while the Span Control is used for the high end input (max. output).

The Zero control has both the negative and positive voltage available making it usable as a manual or zero control. By turning the control clockwise, the output will increase proportionally to the adjustment. Turning it counter-clockwise will decrease or zero the output.

The Span control is used to adjust the maximum desired output. It will adjust for either a remote manual control or a command signal input. Clockwise adjustment increases the output while counter-clockwise adjustment decreases the output.

3-2 COMMAND INDICATOR

The Command Indicator is a green Light Emitting Diode (LED) located on the front cover of the unit. The brilliance of this LED will change with the Command Signal. The brilliance increases with an increased Command Signal and decreases with a decreased Command Signal.

3-3 ISOLATED AND NON-ISOLATED INPUTS

The RF3 has the capability of having either an isolated or non-isolated Command Signal input. It will always be shipped with an isolated input unless specified otherwise (known exception is a Manual Control input.) The standard input impedance is 500 ohms for isolated and 3000 ohms for non-isolated.

An isolated input can be changed to a non-isolated input by simply unsoldering jumpers J3 and J4 on the firing circuit and moving them to the non-isolated position on the firing circuit.

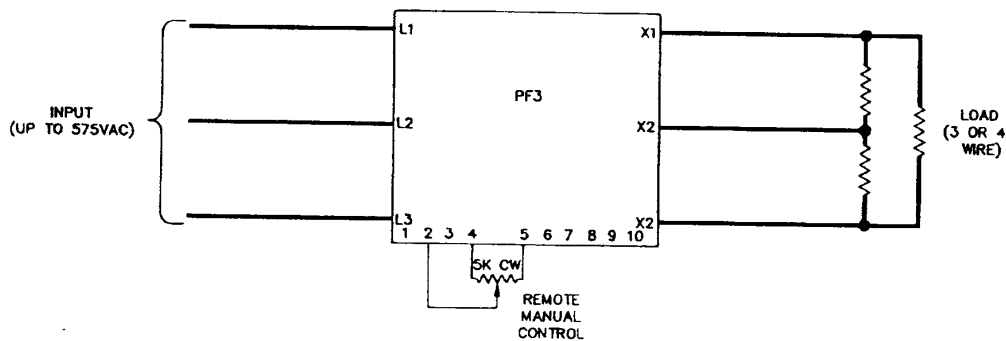
The isolated input works best with an offset Command Signal such as 4-20ma; however, it will work with both offset and zero based Command Signals. Zero based Command Signals may have a small amount of non-linearity (input to output) at the low end. This should not be a problem on closed loop systems.

3-4 REMOTE MANUAL CONTROL

Some applications only require a manual control input and not a closed loop input from a process controller. The RF3 is designed to accept a remote manual control input (refer to Figure 7 for connections.)

Adjustments are simple and quick, but first verify that the firing circuit is set up for non-isolated input and that R31 has been removed. Next start with the Remote Manual Control in the zero (counter-clockwise) position, apply power to the Power Control. Adjust the Zero Control so the Power Control's output just starts to come on, then adjust it counter-clockwise so the unit's output is at zero. Now adjust the Remote Manual Control to the full output (clockwise) position, and adjust the Span Control until the maximum desired output is reached. This procedure may have to be repeated due to some interaction between the Zero and Span controls.

Figure 7
REMOTE MANUAL CONTROL



NOTE: Use RMS voltmeter to monitor output voltage.
A load must be present when making adjustments.

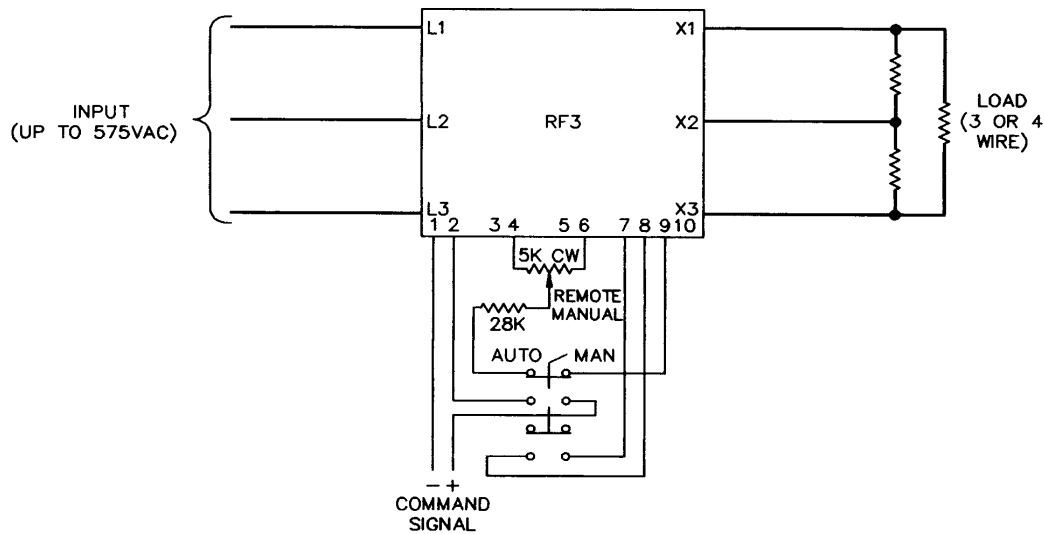
3-5 PROCESS COMMAND SIGNAL

Process command signals can be either offset or zero based as discussed earlier. Simply connect the command signal to terminals 1 (-) and 2 (+) on the firing circuit and adjust the Zero and Span controls. Adjustments are easy. Simply have the process controller's output set at minimum and adjust the Zero control so the unit's output is at zero. Next have the process controller's output set at maximum and adjust the Span control for the maximum desired output. As with the Remote Manual Control, some interaction between controls does exist so repeating this procedure may be necessary - see Figure 8 for connections.

3-6 AUTO/MANUAL CONTROL

On closed loop processes it may be desirable to be able to operate the RF3 manually. It has this capability designed into it. Connect the Command Signal, a Remote Manual control and an Auto/Manual switch in the Auto position. By switching to the Manual position, the Remote Manual control operates and the auto signal is disconnected.

Figure 8
Auto/Manual Control



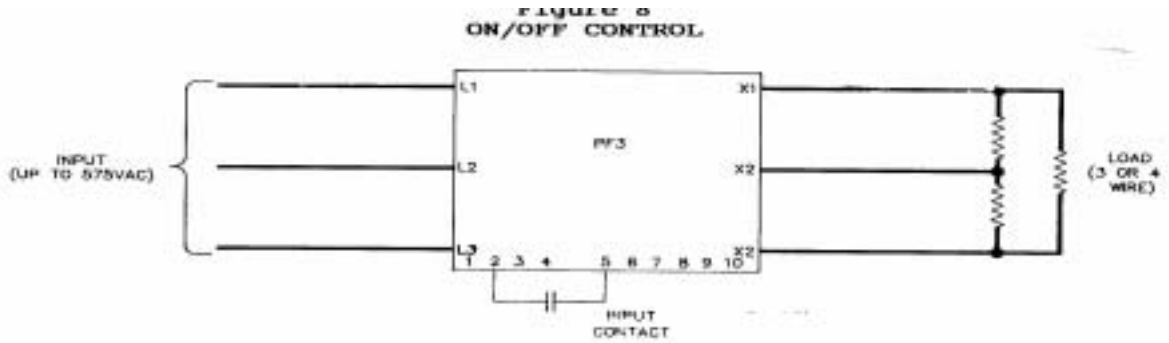
NOTE: Some non-linearity will occur with the Manual Control.

3-7 ON/OFF CONTROL

Some applications require that a simple ON/OFF type control be used. The RF3 can be used in these simple applications. It can be connected for turn on by a contact closure.

For on/off control, wire the contact according to figure 9. Once the wiring is complete, turn on the input power. Set the input contact to open and adjust the Zero control clockwise until the unit comes on, then adjust counter-clockwise until the unit just shuts off. Now set the input contact to the closed position and adjust the Span control clockwise until the unit's output is at the desired maximum output level. Repeating of this procedure may be necessary due to some interaction between the Zero and Span controls.

**Figure 9
ON/OFF CONTROL**

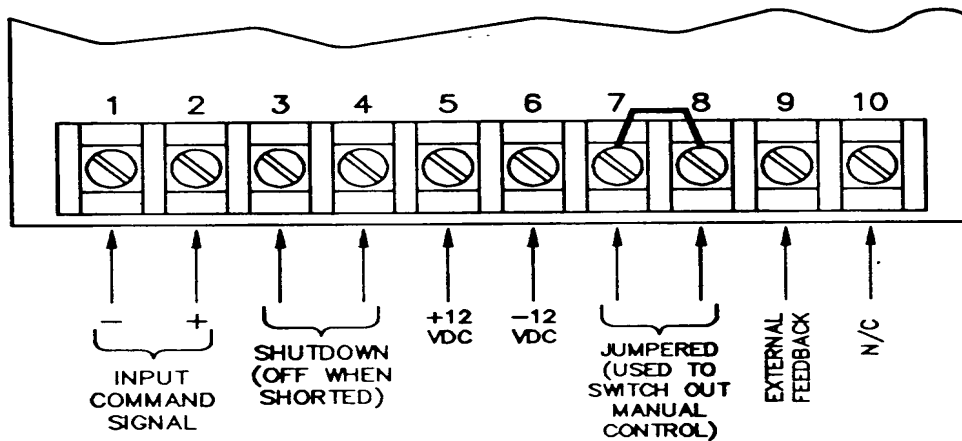


3-8 SHUTDOWN (DISABLE)

When it is necessary to shutdown or disable the output, it is a simple matter. Connect a dry contact closure between terminals 3 and 4 of the firing circuit. When it is closed, the power control will be shut off.

Figure 10

FIRING CIRCUIT TERMINALS



3-9 EXTERNAL FEEDBACK

An external feedback (0-10 VDC) is connected to terminals 4(-) and 9 (+). Ensure switch SW1 is in the “off” position when using an external feedback.

Section 4 - OVERCURRENT TRIP CALIBRATION

NOTE: The Zero and Span Controls should be adjusted prior to adjusting the O/C trip.

NOTE: All current transformers are shipped loose.

4-1 OVERCURRENT TRIP (OC)

This option is for those applications which do not require current limit or regulation, but is likely to suffer from instantaneous faults in the load.

The overcurrent trip adjustment is on the front of the unit. It's adjustment range is from 25 to 200% of the unit's current rating.

If adjustment is necessary, have the command signal set at maximum and adjust the overcurrent trip control as necessary until the unit shuts off. Re-adjust the control clockwise until the unit will operate properly.

Another feature of the overcurrent trip is an automatic reset. This is included with the current limit and current regulation. Open the unit and locate the auto reset switch and reset pushbutton. With this switch in the on position, the unit will continue to reset until the fault clears. If in the off position, the unit will remain shut off until the reset PB is operated. The auto reset switch will always be in the off position unless specified on the order.

All overcurrent trip includes a Form C relay output and provisions for a remote overcurrent reset PB. The relay output terminals are 39 and 40 for the N.C. and 40 and 41 for the N.O. The remote reset PB connects to terminals 37 and 38.

4-2 CURRENT TRANSFORMER CONNECTIONS

For the overcurrent trip, the remotely mounted current transformer (5A secondary) should be used connected to terminals 31 and 32 (Phase 1), 33 and 34 (Phase 2) and 35 and 36 (Phase 3).

Section 5 - MAINTENANCE

5-1 ENVIRONMENTAL CONCERNS

Always verify that the RF3 is mounted in a clean, dust free environment. Clean the heat sink and printed circuit board periodically so no dust and/or dirt accumulates on the unit. Dust and/or dirt on the heat sink fins can prevent proper airflow causing overheating of the semiconductors. Conductive dust and/or dirt can cause shorts or arcing, which can cause damage to the unit.

Always size your enclosure so that a 50 °C maximum internal ambient temperature is never exceeded.

5-2 LINE/LOAD POWER CONNECTIONS

Periodically turn the power off to the RF3 and check for corrosion and tightness of the power connections. If any corrosion is evident, clean the cable and connector and reconnect making sure to tighten according to our torque specifications in Table 2.

5-3 STATIC PRECAUTIONS WHEN SERVICING

When servicing the Firing Circuit or option Printed Circuit Board (PCB), damage can occur due to static electricity. Always use a wrist strap grounded through a 1 megohm resistor. Transport the PCB in a static shielding bag. Caution in handling the PCB can help prevent any further damage to the PCB.

If you are not familiar with static precautions, consult the factory for additional details.

5-4 TROUBLESHOOTING TYPICAL SYMPTOMS

Any one of the following symptoms usually indicate a problem with the RF3:

1. No output regardless of the input.
2. Full output regardless of the input.
3. Output is not variable from 0 to full.

Refer to Table 3 for help in troubleshooting. If you cannot diagnose the problem, call AMETEK HDR's Service Department.

Table 3
Troubleshooting the RF3

<u>Symptom</u>	<u>Cause</u>	<u>Solution</u>
1	Open Fuse	Disconnect power and check the fuse. Replace if faulty. If not, contact the factory.
2	Shorted SCR	Disconnect power and check the SCRs. Measure the resistance across each pair of SCRs and the resistance should be infinite in both directions. If a short is indicated, replace the defective SCR or return the unit to the factory. No feedback will cause this also.
3	Defective Firing Ckt.	Disconnect power and unplug the Firing Circuit. Order a replacement Firing Circuit or return the unit to the factory.

WARNING
Always disconnect the source prior
to attempting any servicing.

Section 6 - SERVICE AND SPARE PARTS

6-1 CUSTOMER SERVICE

If you have operational problems which cannot be resolved using this manual, please contact the Service Department at AMETEK HDR. Our normal work hours are 8 a.m. to 5:00 p.m., U.S.A. EASTERN TIME ZONE, Monday through Friday.

TELEPHONE: 1-888-PWR-CNTL (797-2685) OR 614-308-5500.

Our answering machine at 614-308-5500 will answer after hours and we will return your call the next working day.

FAX: 614-308-5506. 24 hours per day automatic answering.

6-2 SPARE PARTS

Inside Sales should be contacted for any spare parts orders whether routine or emergency during normal working hours. All after hours requirements should be called in on our 614-308-5500 answering machine. Please have as much information available as possible pertaining to the model number, serial number, order number and parts required. A purchase order number should be available.

6-3 WARRANTY

AMETEK HDR warrants that the equipment delivered will be free from defects in workmanship and material for a period of five years from the date of shipment. AMETEK HDR will repair or replace, at AMETEK HDR's option, any part found defective during proper and normal use, provided that written notice of the nature of the defect is received by AMETEK HDR within the five year warranty period and that the customer returns the part to AMETEK HDR freight paid both ways. This warranty is not transferable by the initial end user.

AMETEK HDR MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED (INCLUDING, WITHOUT LIMITATION, MERCHANTABILITY, FITNESS FOR PURPOSE, OR AGAINST INFRINGEMENT OF ANY PATENT) EXCEPT AS EXPRESSLY PROVIDED HEREIN.

THE REMEDY OF REPAIR OR REPLACEMENT IS CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND WILL SATISFY ALL OF AMETEK HDR'S LIABILITIES, WHETHER BASED ON CONTRACT, NEGLIGENCE, TORT, PRODUCT LIABILITY, STRICT LIABILITY, OR OTHERWISE. IN NO EVENT WILL AMETEK HDR BE LIABLE FOR INCIDENT OR CONSEQUENTIAL DAMAGES, NOR IN ANY EVENT SHALL AMETEK HDR'S LIABILITY EXCEED THE UNIT PRICE OF ANY DEFECTIVE PRODUCT OR PART.