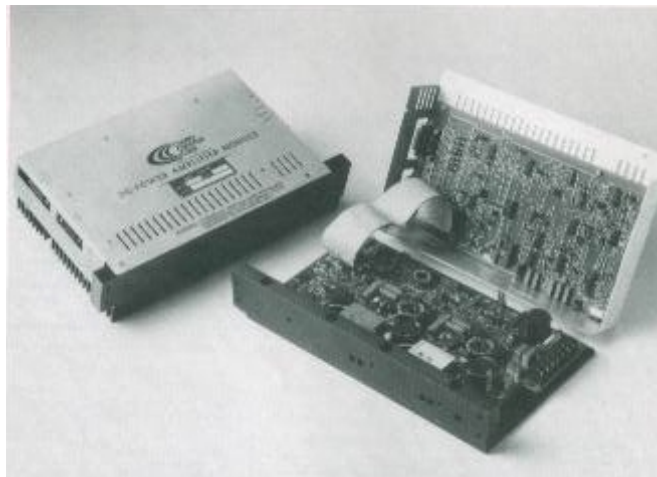




HIGH POWER PWM AMPLIFIERS



MODEL 220, 230, 220-10, 230-10

Chapter 1 Product Description

The Model 220 and 230 PWM Amplifiers are high-power amplifiers designed to drive magnetic resonance imaging (MRI) systems and other electromagnetic applications. The Model 220 and 230 amplifiers operate at a switching frequency of 71kHz. The carrier frequency combined with an internal LC filter make the amplifier appear linear over a frequency range from dc to 12 kHz.

The feedback system is switchable so the amplifier can function as either a voltage source or current source. A master/slave arrangement permits a single amplifier to share up to 20 additional units as slaves for a total peak power capability as high as 47kW.

Thanks to its high efficiency (94%) when driving a resistive load, the Model 220 and 230 amplifiers are highly suitable for driving magnets.

The high switching frequency (71kHz) of the Model 220 and 230 has allowed smaller output filters to be built into the amplifiers enclosure. This design saves power, heat and space while offering many of the advantages of linear amplifiers.

Features

- 71 kHz switching frequency eliminates audible noise
- DC output eliminates RFI and need from an external choke
- Performs like a linear amplifier
- Pulse width modulation for maximum efficiency
- Slave units may be paralleled to increase output to 31.5 kW
- FET output transistors for highest reliability
- High voltage power supply can vary over 4 to 1 range
- Variable current limiting adjustable from 0.5 to 12 amps
- Voltage or current source operation switch-selectable
- Four inputs, three of which are switch-selectable

Typical Applications

- Voice coil actuators
- High power control systems
- PM shake table
- MRI gradient coil drive
- Reactor magnetics
- High power microstep

Unpacking and Inspection

Verify that the model number(s) of the product match your order.

Technical Support

For technical support, you may contact us in several ways:

- Online at our web site: www.copleycontrols.com
- Email: sales@copleycontrols.com
- Tel.: (781) 828-8090
- Fax: (781) 828-6547

Chapter 2 Installation

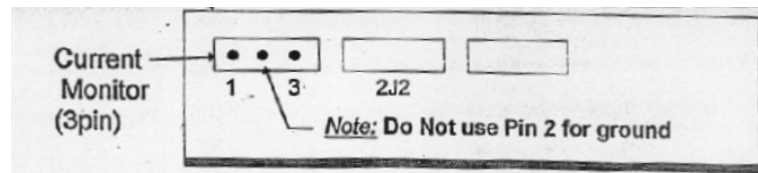
Refer to the following procedure when installing Model 220 and 230 Amplifiers.

1. Connect the high voltage, power ground and common outputs to common junction points as shown in Figure 1. Use the shortest possible leads of *equal length*.
2. Bypass the high voltage DC at the junction points with a 20,000 uF low series resistance capacitor to relieve the ripple load on internal capacitors. Use short leads (1 inch).
3. Mount all amplifiers on a common plate that serves as a ground bus.
4. If additional RF filtering is necessary, connect 1uF capacitors from each output to the cabinet, from the high voltage junction to the cabinet, and from the common junction to the cabinet. Use short leads (1/4 inch). Capacitors placed at 6 inch intervals along each main bus will also help further, using the wire inductance as part of the filter.
5. 15 pin D-Sub connector cables should be shielded. Ground the shield to the shells, 1P1-8 and to 2J2-8.
6. When mounting these units, please use "internal tooth". Utilize lock washers to break the anodized layer for efficient grounding.
7. To verify proper grounding, visually check the 1P1-15 phase lock signal. These should all be approximately 71kHz and Phaselock.
8. A spare PJ5 connector is included in the installation kit for your use.
9. The factory installed PJ5 Header has been preset to a gain of 5 (see Figure 4 on page 14).

10. The Model 220 and 230 has 2 Current monitors, a Positive Current Monitor and a Negative Current Monitor. The Current Monitor signals can be accessed via a 3-pin Molex connector, Pin 1 is the Positive (+) Current Monitor, Pin 3 is the Negative (-) Current Monitor.

All measurements should be taken with respect to ground (*Do Not Use Pin 2 of the Molex connector, this is not a ground signal*), use either the amplifier's case or 1P1 pin 8 (ground signal).

Scale factor:	Model 220	6V/18A
	Model 220-10	6V/ 22A
	Model 230	6V/15A



Pin 1 = Pos. (+) Current Monitor

Pin 2 = Status Output (Do **not** use for ground in current monitor measurement.)

Pin 3 = Neg. (-) Current Monitor

Chapter 3 Technical Specifications

The following table provide specifications for Models 220 and 230 in **servo applications**. Typical specifications tested @ 25 degrees C ambient +15.0V, -15.0V, +80V Model 220 or +160V Model 230.

Specification	220	230
Power Output		
Continuous Rating	+/-75V @ 12A, 0.9kW	+/-150V @ +/-10A, 1.5kW
Peak Rating		
2s min., unidirectional current changes	+/-75 V @ +/-18A	+/- 150 V @ +/-15A
4s min., bidirectional current changes		
Current Limit (adjustable)	0.5A to 12A	0.4A to 10A
Input Characteristics		
Inputs		3 differential 1 single-ended
Diff. input impedance		200k ohms
Max. input voltage		Diff. @ 16V either input Single-ended +/- 8V Greater with input attenuator
Input offset		Adjustable to zero
Gain		
Input diff.		0.50 V/V
Input single-ended		Customer selected components select gain
Servo Preamp		Customer selected components determine gain
Power Amp		
Current Source	2.35A/V	1.96A/V
Voltage Source	9.3V/V	18.6V/V
Bandwidth		
Power stage small signal		-3db @ 12kHz as current source 6 Ohm load -3db @ 1.2kHz as voltage source 6 Ohm load

Specification	220	230
Switching Frequency Output Ripple	71kHz 1% Pk @71kHz	
Parallel Operation	Up to twenty 220S or 230S may be paralleled with 220 or 230 respectively	
Remote Shutdown	Switch closures inhibit output.	
Amplifier Protection		
Overload	Current limiter	
Heatsink temp.	Shutdown 91 degrees Centigrade	
Latchoff	Until reapplication of 15V power or use of Reset button	
Overvoltage shutdown	Shutdown when high voltage supply is above 92V for 220 and 185V for 230	
Undervoltage shutdown	Shutdown when any supply is below minimum	
Monitoring Inputs		
Internal LED (no fault indicator)	When lit indicates amplifier is not shutdown due to excessive heatsink temperature or improper supplies.	
External LED (remote operation indicator)	When lit indicates amplifier is not shutdown due to excessive heatsink Temperature or improper supplies, and there is no inhibit switch closure	
Power Requirements		
Low voltage supply	+14.3V to 16V @ 300mA -14.3V to -16V @ 80mA	
High voltage supply	+20V to +85V @ 12A	+40V to 170V @10 A
Thermal Requirements		
Operating	Machined flat mounting surface should not exceed 60 ° C for amplifier power dissipation of 84W for 220, 100W for 230	
Ambient	0 to 50 ° C	
Storage	-30 ° C to +85 ° C ambient	

Technical Specifications

The following table provides specifications for Models 220-10 and 230/10 in **non-servo applications**. Typical specifications tested @ 25 degrees C ambient +15.0V, -15.0V, +80V Model 220 or +160V Model 230.

Specification	220-10	230-10
Power Output		
Continuous Rating	+/-75V @ +/-12A 0.9kW	+/-150V @ +/-10A 1.5kW
Peak Rating		
Unidirectional	100ms min, 75V @ 22A	100ms min, 150V @ 15A
Bidirectional	200ms min, 75V @ 22A	200ms min, 150V @ 15A
Current Limit (adjustable)	1-22A	1-15A
Input Characteristics		
Inputs		Differential
Impedance		150k ohms minimum
Max. input voltage		Diff. @ 16V either input
Input Offset		Adjustable to zero
Gain (Adjustable)	3.7 - 4.5 A/V	1 - 1.8A/V
Output Impedance	17 ohms in parallel with 4.4uF	50 ohms in parallel with 4uF
Bandwidth		
-3dB current source 4 ohm load		8kHz
Switching Frequency		71kHz
Parallel Operation		Up to 20 slaves may be paralleled at the output.
Harmonic Distortion (THD)		
200Hz, 4A rms into 4mH		0.15% max
Settling Time		
Load, 4mH with 0.35 ohms in series 0 to +/- 17A		+/- 1%, 2ms
Load, 200mH with 0.5 ohms in series 0 to +/- 12A		+/- 2%, 3ms

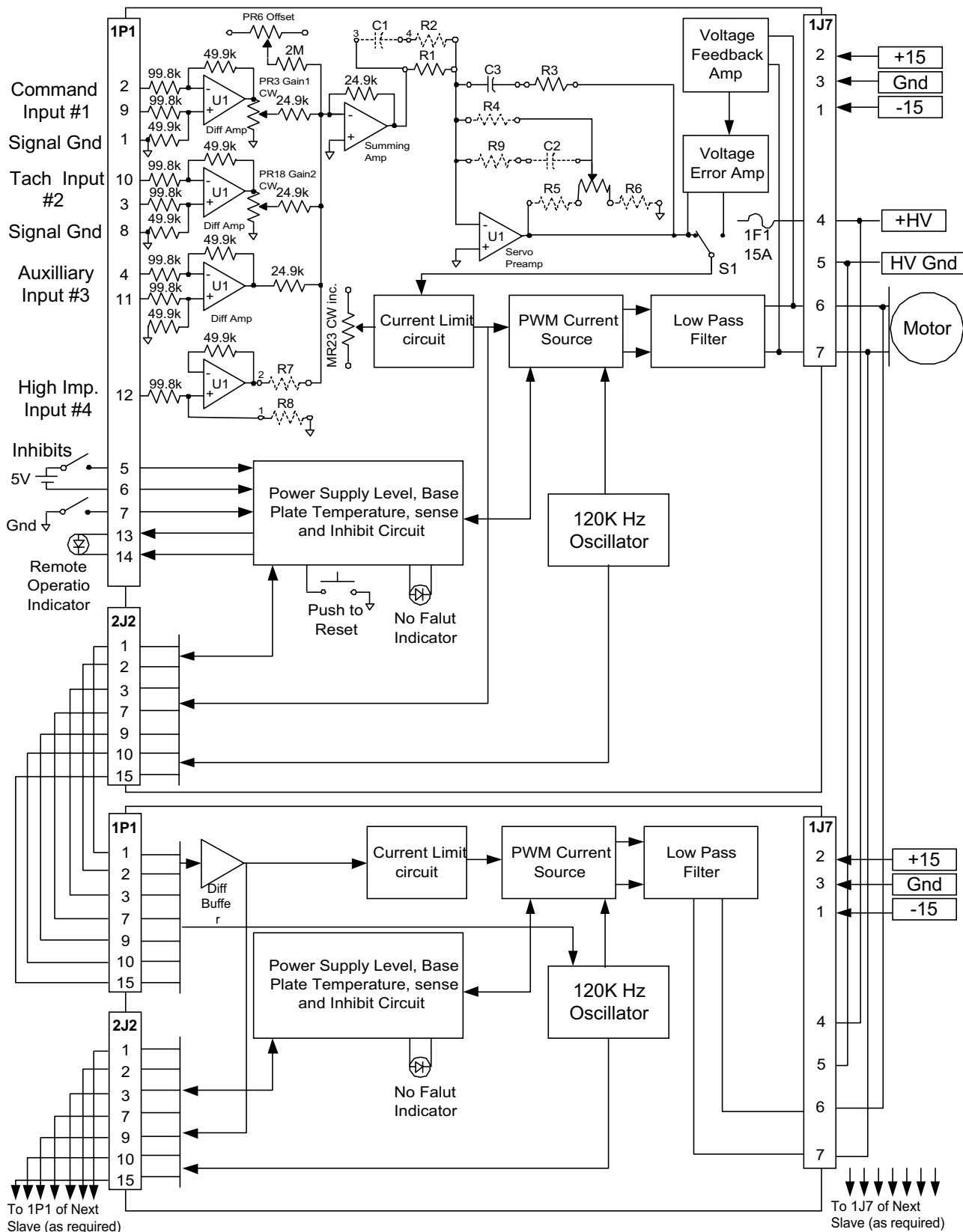
Specification	220-10	230-10
DC Drift		
Long term (after 4 to 8 hrs.)	2mA/ °C (@+/-12A)	1.4mA/ °C (@ +/-8A)
Noise		
Mostly 71kHz where L= load inductance	2mArms/L (mH)	4mArms/L (mH)
Current Monitor		
Single-ended (2kohm output)	+/-6V/22A	+/-6V/15A
Remote Shutdown		Switch closures inhibit output
Amplifier Protection		
Overload		Current limiter
Heatsink temp.		Shutdown 91 °C
Latchoff		Until reapplication of 15V power or depression of reset button
Overvoltage shutdown		Shutdown when high voltage supply is above 92V for 220-10and 185V for 230-10
Undervoltage shutdown		Shutdown when any supply is below minimum
Monitoring Inputs		
Internal LED (no fault indicator)		When lit, indicates amplifier is not shutdown due to excessive heatsink temperature or improper supplies.
External LED (remote operation indicator)		When lit indicates amplifier is not shutdown due to excessive heatsink temperature or improper supplies, and there is no inhibit switch closure
Power Requirements		
Low voltage supply		+14.3V to 16V @ 300mA -14.3V to -16V @ 80mA
High voltage supply		
220-10		+20 to 85V @ 12A
230-10		+40 to 170V @ 10A
Thermal Requirements		
Operating		Machined flat mounting surface should not exceed 60 °C for amplifier power dissipation of 84W for 220-10, 100W for 230-10
Ambient		0 to 50 ° C
Storage		- 30 to +85 °C ambient

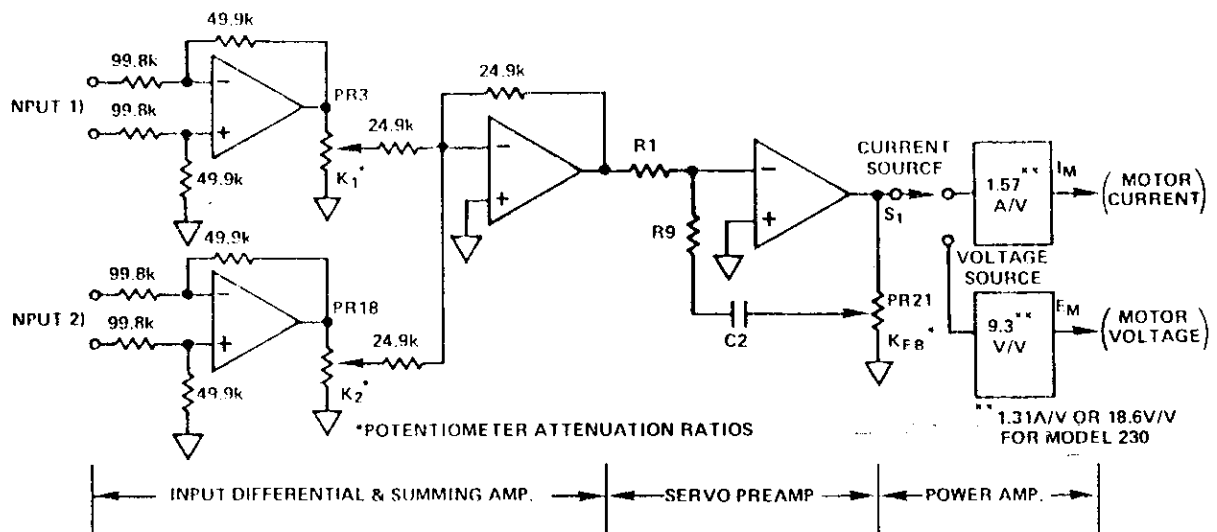
Appendix A **Technical Drawings**

This appendix contains drawings of the Model 220/230 PWM Amplifier including:

- a functional diagram,
- a typical amplifier transfer function, and
- outline dimensions.

Model 220, 230 PWM Switching Amplifier



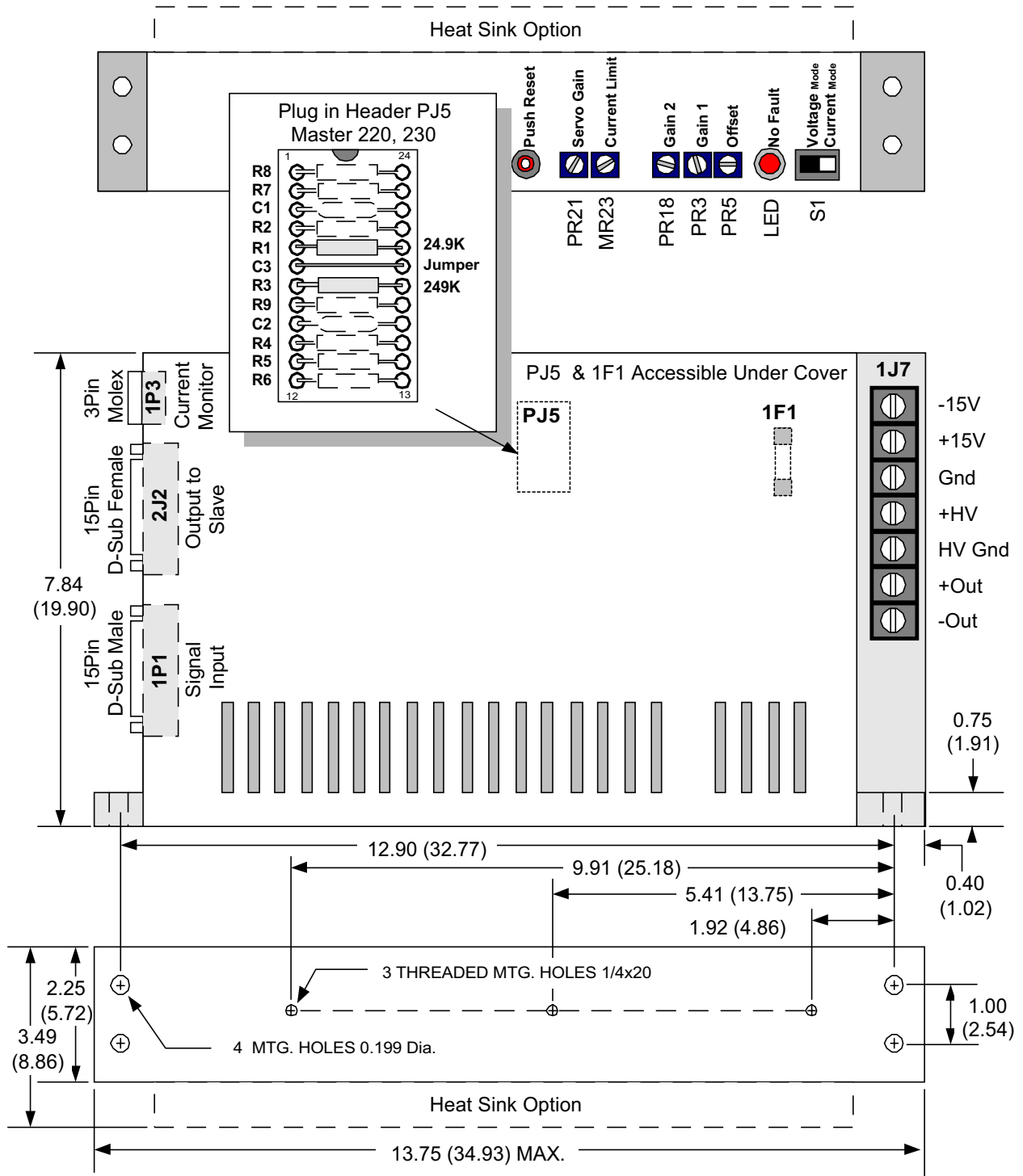


AS A CURRENT SOURCE $I_M = \frac{.785^{***} (R_9 C_2 S + 1) [K_1 E_1 + K_2 E_2]}{K_{FB} R_1 C_2 S}$

IN CURRENT SOURCE MODE GAIN INCREASES BY FACTOR (N+1)
WHERE N= NUMBER OF SLAVES

AS A VOLTAGE SOURCE $E_M = \frac{4.65^{***} (R_9 C_2 S + 1) [K_1 E_1 + K_2 E_2]}{K_{FB} R_1 C_2 S}$

*** 650A/V OR 9.30V/V FOR MODEL 230



Mating Connector: 1P1 (15Pin D-Sub, Female); 2J2 (15Pin D-Sub, Male)