MODELS 4122P, 4212P
"PIN" VERSIONS FOR PC BOARD MOUNTING

FEATURES

- ***Mounts on customers printed circuit boards.***
- ***Flexibility!*** **Internal 40-pin socket configures amp with no soldering**
- **Separate current limits: Continuous, peak, and peak-time**
- **No integrator windup when disabled**
- **Fault protections: Short-circuits from output to output, output to gnd Over/under voltage Over temperature Self-reset or latch-off modes**
- **3kHz Bandwidth**
- **Wide load inductance range: 0.2-40 mH.**
- **Surface mount technology construction, lower part count.**
- **Optional output filter for reduced PWM noise to adjacent circuits**

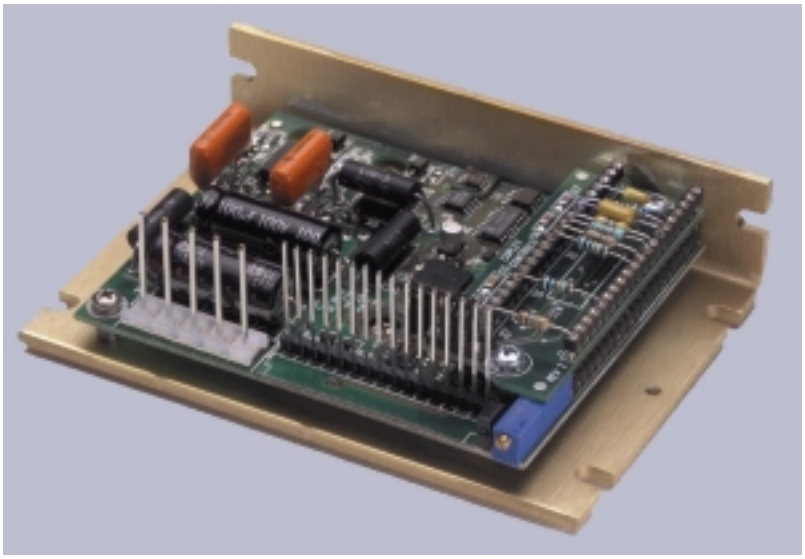
APPLICATIONS

- **X-Y stages**
- **Robotics**
- **Automated assembly machinery**
- **Magnetic bearings**

THE OEM ADVANTAGE

- **Minimize cabling for lowest cost products**
- **Uses industry-standard connectors for solderless installation**

MODEL	FEATURES
4122P	+24~90VDC, 10/20A, Standard 0-100% modulation
4212P	+24~90VDC, 6/12A, Standard 0-100% modulation



FEATURES

These versions of the 4122 & 4212 models and their variants use extended pins that interface with printed circuit board mounted connectors for direct mounting of the amplifier to customers pc boards.

The active logic-level of the amplifier Enable input is jumper selectable to GND or +5V to interface with different control cards. /Pos and /Neg enable inputs remain ground active for fail-safe operation.

Mosfet H-bridge output stage delivers power in four-quadrants for bi-directional acceleration and deceleration of motors.

An internal solderless socket holds 17 components that configure the various gain and current limit settings to customize the amplifiers for a wide range of loads and applications.

Header components permit compensation over a wide range of load inductances to maximize bandwidth with different motors.

Individual peak and continuous current limits allow high acceleration without sacrificing protection against continuous overloads. Peak current time limit is settable to match amplifier to motor thermal or commutation limits.

All models are protected against output short circuits (output to output and output to ground) and heatplate overtemperature.

With the /Reset input open, output shorts or heatplate overtemperature will latch off the amplifier until power is cycled off & on, or until the /Reset input is grounded.
For self-reset from such conditions, wire /Reset to ground and the amplifier will reset every 200ms.

Pins models also accept the "F" option card that has output 'edge' filters that reduce the noise coupling of PWM outputs to adjacent cabling and circuitry.

The output filter card option uses the same connectors as the popular 300 series models (303, 306, 306A and variants) for easy upgrading to the 4xx2 models.

The filter is a dual section L/C/R that slows down the switching 'edges' (the rise and fall times of the outputs) for greatly reduced coupling of PWM noise to nearby cables and circuits.

MODELS 4122P, 4212P
"PIN" VERSIONS FOR PC BOARD MOUNTING

TECHNICAL SPECIFICATIONS

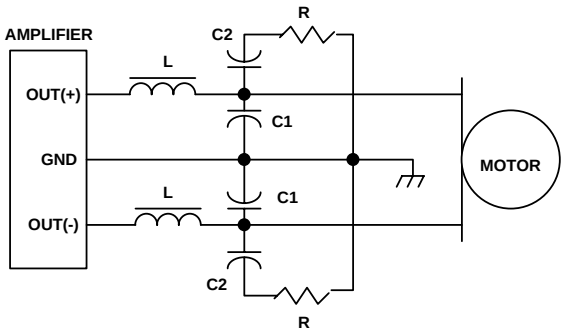
Test conditions: 25°C ambient, Load = 200µH. in series with 1 Ω., +HV = maximum normal value

MODEL		4122P	4212P
OUTPUT POWER			
	Peak power	±20A @ ±80V	±12A @ ±120V
	Peak time	0.5 sec unipolar from 0A, 1 secs. after polarity reversal	
	Continuous power	±10A @ ±80V	±6A @ ±120V
OUTPUT VOLTAGE		±Vout = ±HV*(0.97) - (Ro)*(Io)	
		Ro = 0.2	Ro = 0.1
LOAD INDUCTANCE		Selectable with components on header socket: 200 µH to 40mH	
BANDWIDTH	Current mode:	3kHz with 200µH load at maximum supply voltage, varies with load inductance and RH15, CH16 & CH17 values	
PWM SWITCHING FREQUENCY		25kHz	
REFERENCE INPUT		Differential, 94K between inputs, ±20V maximum	
GAINS			
	Input differential amplifier	1:1 (Volt / Volt)	
	PWM transconductance stage	Ipeak / 6V (I peak = peak rated output current; 6V measured at Current Ref J2-9)	
LOGIC INPUTS			
	Input voltage range	0 to +24V	
	Logic threshold voltage (LO to HI transition)	2.5V (Schmitt trigger inputs with hysteresis)	
	/Enable (Internal jumper JP1 reverses logic)	LO enables amplifier, HI disables (Default function with JP-1 on pins 2-3. For +5V enable and GND inhibit, move JP1 to pins 1-2)	
	Time delay on Enable	0.9 ms after Enable true to amplifier ON, <1ms to disable	
	/POS enable, /NEG enable	Gnd enables positive or negative output currents. +5V or open inhibits (<1ms delay) (Setting of JP-1 has no effect on ground-active level of /POS and /NEG enable inputs)	
	/Reset	LO resets latching fault condition, ground for self-reset every 200 ms.	
	Input resistance	10K pull-up to +5V, R-C filters to internal logic	
POTENTIOMETER			
	Balance	Use to set output current or rpm to zero. RH1 = 10 MΩ for Balance function, RH1 = 100kΩ for Test function	
LOGIC OUTPUT			
	+Fault (/Normal)	HI = Overtemp OR output short OR power NOT-OK, OR NOT-Enabled; LO = Operating normally AND enabled	
	HI output voltage	+5V (33kΩ pullup resistor to +5V) +50V maximum	
	LO output voltage	<0.5V typical, 1.25V @ 250mA max, Ro = 5Ω (mosfet on resistance)	
INDICATOR (LED)			
	Normal	Green: ON = Amplifier Enabled AND Normal (power OK, no output shorts, no overtemp) Red = Fault (NOT Normal, see +Fault output above)	
ANALOG MONITOR OUTPUTS			
	Current Ref (current demand signal to pwm stage)	±6V @ demands ±Ipeak	
	Current Monitor (motor or load current)	±6V @ ±Ipeak (1kΩ, 33nF R-C filter)	
DC POWER OUTPUTS		±15VDC each output in series with 10kΩ	
PROTECTIVE FEATURES (Note 1)			
	Output short circuit (output to output, output to ground)	Latches unit OFF	
	Overtemperature	Latches unit OFF at 70°C on heatplate	
	Undervoltage shutdown @	<20V	<20V
	Overvoltage shutdown @	>92VDC	>129VDC
POWER REQUIREMENTS			
	DC power (+HV) Transformer isolated from power mains	+22 to +90VDC	+22 to +125VDC
	Watts minimum	2.5W	2.7W
	Watts @ Icont	25W	41W
THERMAL REQUIREMENTS			
	Storage temperature range: -30 to +85°C; operating temperature range: 0 to 70°C baseplate temperature Notes: 1. Heatsink optional (add "H" to model number) 2. Fan = forced air over unit @ 400 linear feet/minute		
MECHANICAL			
	Amplifier case size	4.3 x 3.0 x 1.0 in. (109 x 76.2 x 25.4 mm.) + Pin height.	
	Heatsink	Adds 1.50 in. (38.1 mm) to amplifier 1.0 in. dimension. Same length as amp.	
	Weight	0.43 lb (0.2 kg.) for amplifier alone; heatsink adds 0.78 lb. (0.35 kg)	
CONNECTORS			
	Amplifier	J1 (Power & motor): 5 Pins (Methode# BA-2900-105) 0.20" centers, 1.070" long. J2 (Signal): 16 Pins (Methode# BA-2899-116) 0.1" centers, 1.070" long.	
	PC board mounting	Mating to J1: (MIL-MAX 0366-0-15-01-23-01-10-0) Mating to J2: (Molex: 22-14-2164)	

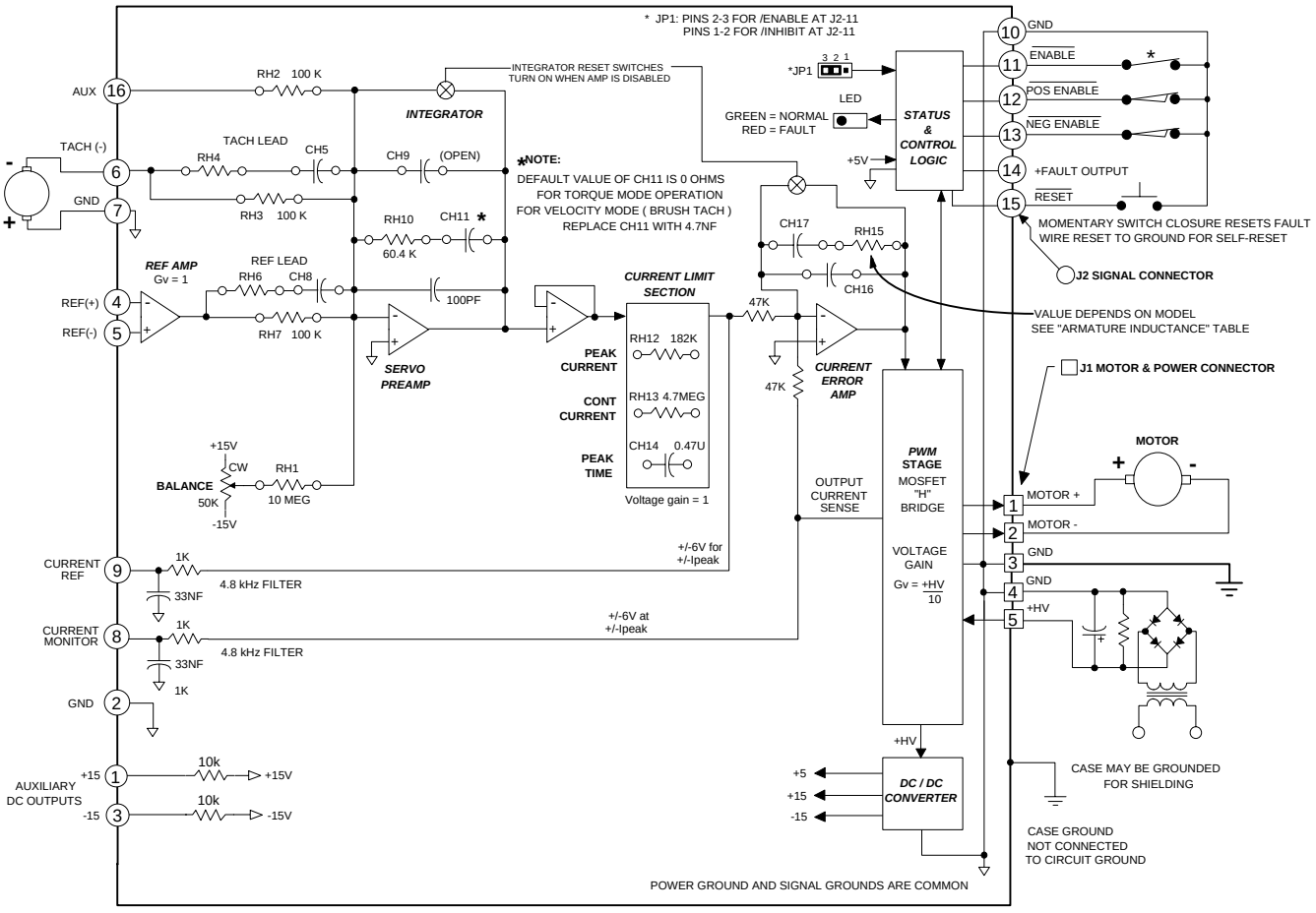
NOTES

1. Latching faults disable amplifier until power is cycled off-on, or /Reset input is grounded. Non-latching faults re-enable amplifier when fault condition is removed. Overtemperature and short-circuits are latching faults, under or overvoltage faults are non-latching. If /Reset input is grounded, amplifier will auto-reset from latching faults every 200ms.

FILTER OPTION DIAGRAM



FUNCTIONAL DIAGRAM



CONNECTORS AND PINOUTS

J1: MOTOR & POWER CONNECTIONS

Pin	Signal	Remarks
1	Motor (+)	Amplifier output to motor (+) winding
2	Motor (-)	Amplifier output to motor (-) winding
3	GND	Power supply return. Connect to system ground at this pin.
4	GND	Power supply return. Connect to system ground at this pin.
5	+HV	+HV DC power supply input

J2: AMPLIFIER BOARD CONNECTIONS

Pin	Signal	Remarks
1	+15V	+15V in series with 10kΩ
2	Gnd	Signal ground
3	-15V	-15V in series with 10kΩ
4	Ref (+)	Differential input positive terminal for Reference voltage
5	Ref (-)	Differential input negative terminal for Reference voltage
6	Tach (-)	Negative terminal of brush tachometer
7	Gnd / Tach (+)	Signal ground, or positive terminal of brush tachometer
8	Curr Mon	Output current monitor: ±6V output at ±peak output current
9	Curr Ref	Current demand signal to PWM stage: ±6V demands ±peak current
10	Gnd	Signal ground
11	/Enable	Amplifier enable input: enables or inhibits PWM switching at outputs Default: Gnd enables amplifier, open or +5V inhibits (JP1 @ 2-3) For controllers that output +5V to enable amplifier, move internal jumper JP1 to pins 1-2 (Gnd will inhibit, +5V or open will enable)
12	/Pos Enab	Gnd to enable output current in one polarity, open or +5V to inhibit Typically used with grounded, normally closed limit switches.
13	/Neg Enab	Gnd to enable output current in opposite polarity, open or +5V to inhibit. Typically used with grounded, normally closed limit switches.
14	/Normal	Current-sinking when amplifier enabled and operating normally. Goes to +5V when amplifier disabled or fault condition exists.
15	/Reset	Ground to reset overtemp or output short circuit latching faults. For automatic reset of faults every 200mS, ground permanently.
16	Aux	Single-ended auxiliary input.

BALANCE POTENTIOMETER

Default position: centered. Functions to bring output current (in torque mode) or output velocity (in tachometer mode) to zero with reference input voltage at zero, or control system output at zero. Normal range is ±1% of full scale with 10Meg resistor in header location RH1. To use the pot as a wide range set-point adjustment, install a 150kΩ resistor at RH1. Now, full CW or CCW will have the effect of a ±10V signal at the reference inputs.

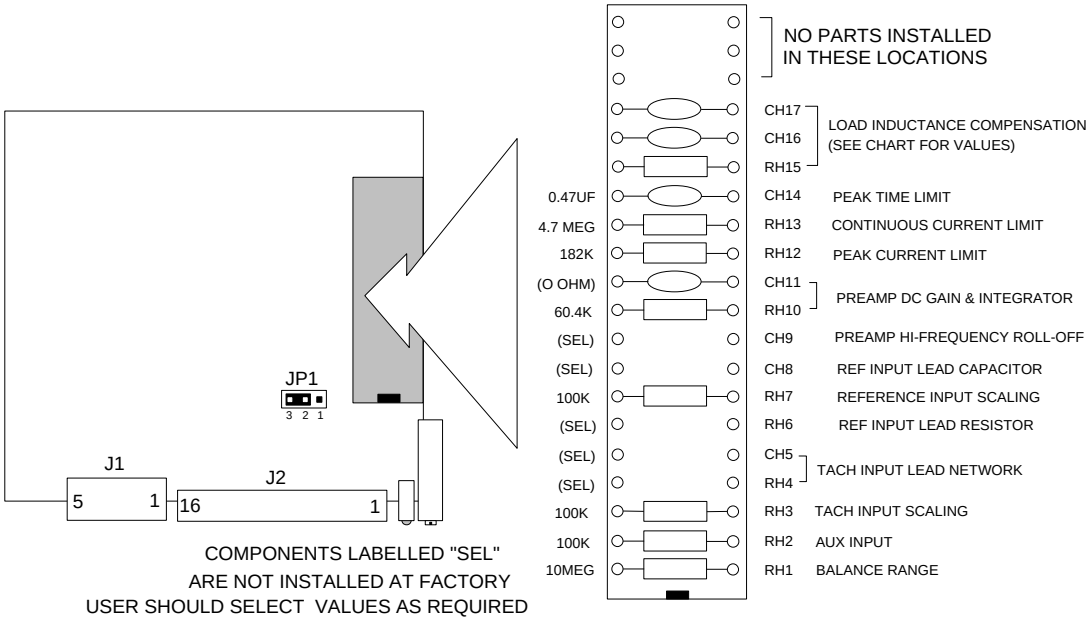
STATUS LED

Dual color, red/green.

Color	+HV	/Enable	Short	Overtemp
Green	Normal	Active	None	Normal
Red	Too low or too high	X	X	X
	X	Inhibited	X	X
	X	X	Output short	X
	X	X	X	Too hot
Note	1, 5	2, 5	3, 5	4, 5

Notes:
1. +HV normal >20V and <92V for model 4122P, >20V and <129V for model 4212P
2. /Enable is ground-active for JP1 on pins 2-3 (default). To reverse function, switch JP1 to pins 1-2.
3. Shorts detected by overcurrent circuit are between outputs, or from outputs to ground.
4. Overtemperature faults occur when heatplate temperature is >70°C
5. +HV and /Enable cause momentary amplifier shutdown, operation is restored when +HV is within normal limits and /Enable input is active. Output shorts, and overtemperature faults *latch-off* amplifier. Thus amplifier will remain off until power is cycled on/off, or /Reset input is grounded momentarily. If /Reset input is wired to ground, output short and overtemperature faults will self-reset every 200ms.

COMPONENT HEADER



COMPONENTS LABELLED "SEL"
ARE NOT INSTALLED AT FACTORY
USER SHOULD SELECT VALUES AS REQUIRED

ARMATURE INDUCTANCE

Model Load (mH)	4122P			4212P		
	RH 15	CH17	CH16	RH15	CH17	CH16
0.2 to 0.5	80.6k	2.2 nF	390 pF	69.8 k	2.2 nF	390 pF
0.6 to 1.7	***200k***	***680 pF***	***220 pF***	***100 k***	***1 nF***	***330 pF***
1.8 to 4.8	402k	680 pF	180 pF	301 ***k***	470 pF	100 pF
5 to 14	806k	680 pF	150 pF	698 ***k***	330 pF	82 pF
15 to 45	1.5M	470 pF	100 pF	1.21M	220 pF	82 pF

Note: Values in ***bold & italics*** are factory installed standard. Values shown are for 90V (4122P) and 125V (4212P). At lower supply voltages RH15 may be increased and CH17 decreased.

PEAK CURRENT LIMIT (AMP)

4122P	4212P	RH12 (Ω)
20	***12***	***182k***
16.7	10	56k
13.3	8	30k
10	6	18k
6.7	4	9.1k
3.3	2	3.9k

CONTINUOUS CURRENT LIMIT (AMP)

4122P	4212P	RH13 (Ω)
10	***6***	***4.7Meg***
7.4	4.4	7.15Meg
5.7	3.4	10Meg

PEAK CURRENT TIME-LIMIT (SEC)

Tpeak	CH14 (µF)
1	***0.47***
0.8	0.33
0.5	0.22
0.3	0.15
0.2	0.10
0.1	.047

Notes on Current Limits:

1. Values in ***bold & italics*** are factory installed standard.
2. Peak times double after polarity reversal.
3. Peak current limit should be set greater than continuous current limit. If Ipeak < Icont then peak overrides continuous limit and Icont = Ipeak. Minimum setting for peak current is 0% of peak rating.
4. Continuous current sense is for average current. Symmetrical waveforms with zero average value may cause overtemperature shutdown of amplifier or motor damage due to high I^2R losses.
5. Times shown are for 100% step from 0A with default value of RH13 (4.7 Meg). When changing RH13, peak times will change. Set RH13 for continuous current limit first, then pick CH14 based on waveforms at Curr Ref (J2-9).

APPLICATION INFORMATION

IMPORTANT! ALWAYS REMOVE POWER WHEN CHANGING HEADER PARTS!!

OPERATING MODES

These amplifiers operate as either open-loop current sources, or feedback devices using analog tachometers.
As open-loop current sources, the ±10V at the reference inputs produce *current* in the load, typically a motor. The motor acts as a transducer, and converts current into *torque*, the twisting force at the motor shaft. This is called *torque mode*. It is used most frequently in systems that have controllers taking feedback from an encoder on the motor shaft. The computer calculates both position and velocity from the encoder signal, processes them in a digital filter, and outputs a signal to the motor causing it to accelerate or decelerate.
As a feedback amplifier, a signal is generated by an analog brush tachometer mounted on the motor. This is a generator that produces an analog signal that has a polarity and amplitude proportional to the motor speed. The amplifier subtracts the tach signal from the reference signal, and amplifies the *difference* between them. This is called *velocity mode*, because the amplifier changes the motor current (torque) so that the motor *velocity* is proportional to the reference signal.

TORQUE MODE OPERATION

Torque mode is the default configuration. For input voltages of ±10V, the amplifier will output its peak rated current.
In torque mode, motor current is held constant, and motor speed, or velocity changes as the load changes.
In torque mode the gain of the servo preamplifier is simply 0.6 and scales the ±10V from the reference signal down to the ±6V that drives the PWM stage.
The servo preamplifier integrator function is disabled, and the low gain is constant over a wide range of frequencies. Thus we sometimes call this *flat-gain* mode.

VELOCITY MODE OPERATION

The difference between the reference and tachometer signals is amplified and used to change the torque on the motor. Ideally, the difference between the command and feedback signals would be zero, so in velocity mode operation the servo preamplifier must have much higher gain than when in torque mode.
In addition, the gain must change over a range of frequencies. For "stiffness" that corrects for steady-state changes, the amplifier uses an integrator. For fast response the loop gain of the servo preamplifier must be tailored to the characteristics of the motor and tachometer. To control oscillations from the tachometer, the gain of the preamplifier must roll-off, or decrease at higher frequencies.
In velocity mode, motor speed is held constant, while motor current changes in response to changes in the load.

THE PARTS OF THE AMPLIFIER

DIFFERENTIAL AMPLIFIER

The reference signal (the command signal from the control system) is sensed by a differential amplifier. This acts like a voltmeter with two probes, measuring a voltage between two points. Current flowing in the amplifier power wiring causes voltage drops in the wires resistance. This in turn can produce a voltage at the amplifier ground that is different than the control system ground. If this voltage is added to the output of the control system, it can produce oscillation, or inconsistent operation. To eliminate this effect, you should always use *both* reference inputs.
Connect the Ref(+) input to the output of the controller card, and the Ref(-) input to ground *at the control card*. Now, the differential amplifier will measure the control signal at the control card and will reject any noise that exists between amplifier and control system grounds.

THE SERVO PREAMPLIFIER

This section processes the reference signal and any feedback signals, and generates an internal *current reference* signal that controls the PWM stage to produce output currents. It is here that the reference signal and tachometer signals are compared, and the difference signal produced and amplified.
Three components on the header control the behavior of the servo preamp. The chart below lists the default torque-mode and starting-point values for velocity mode operation:

Part	Torque	Velocity
CH9	out	220pF
RH10	60.4k	680k
CH11	short	4.7nF

CH9 controls the high-frequency roll-off.
RH10 controls the *loop gain*, and thus the step-response of the amplifier.
CH11 (along with RH7) forms the integrator that gives the stiffness at a standstill, or speed regulation while running.

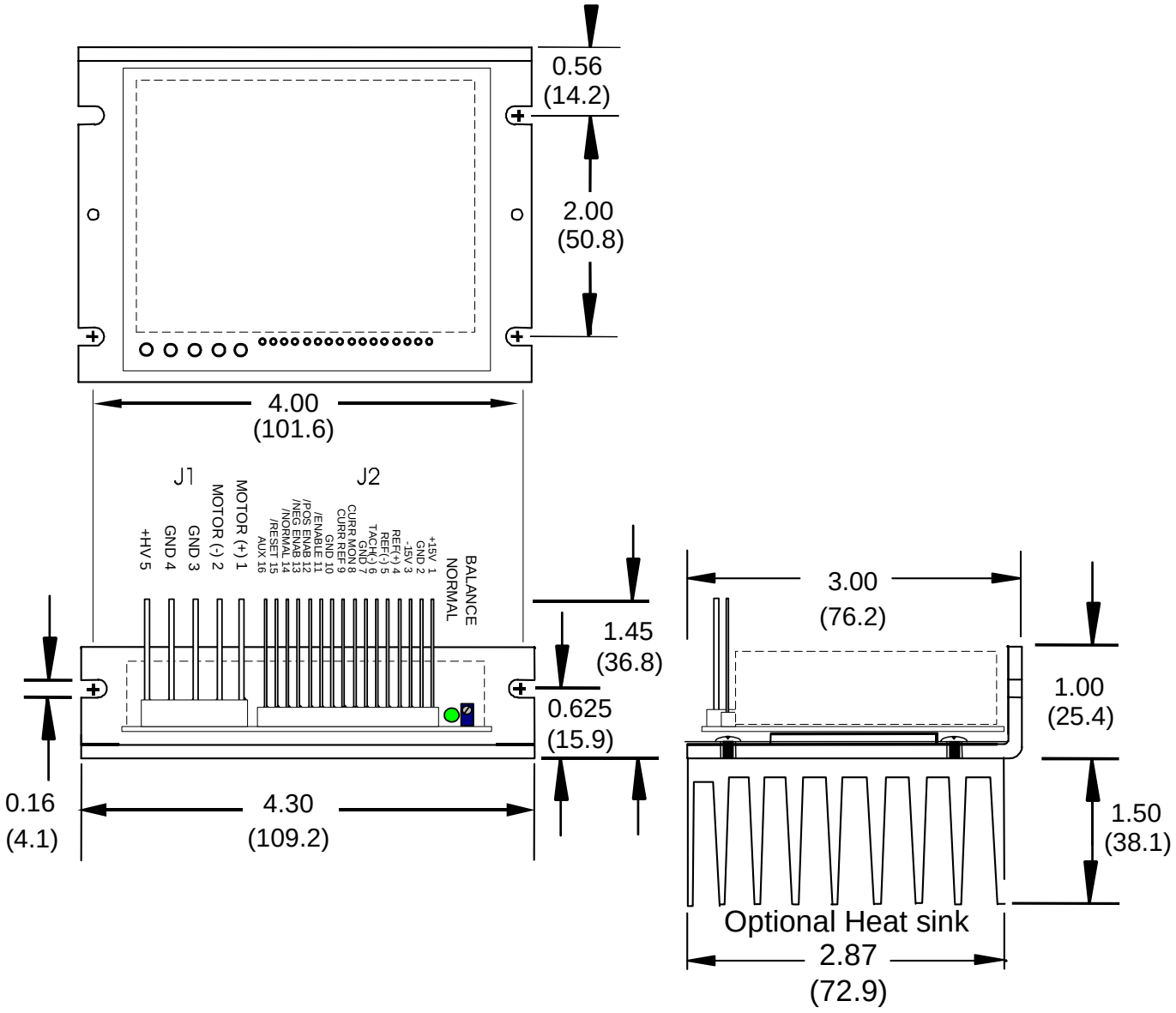
CURRENT LIMITING

This stage takes the output of the servo preamplifier, and processes it before sending it to the PWM stage. The amplitude of the signal is first clamped to produce peak current limiting. This signal then goes to the continuous current-limit circuit where these functions are produced. Finally, the current-limited signal is outputted to the PWM stage as the *current-reference* signal. This signal is quite useful in that the current limit action can be seen here and measured without connecting a motor, thus protecting it from overload during initial setup.

PWM STAGE

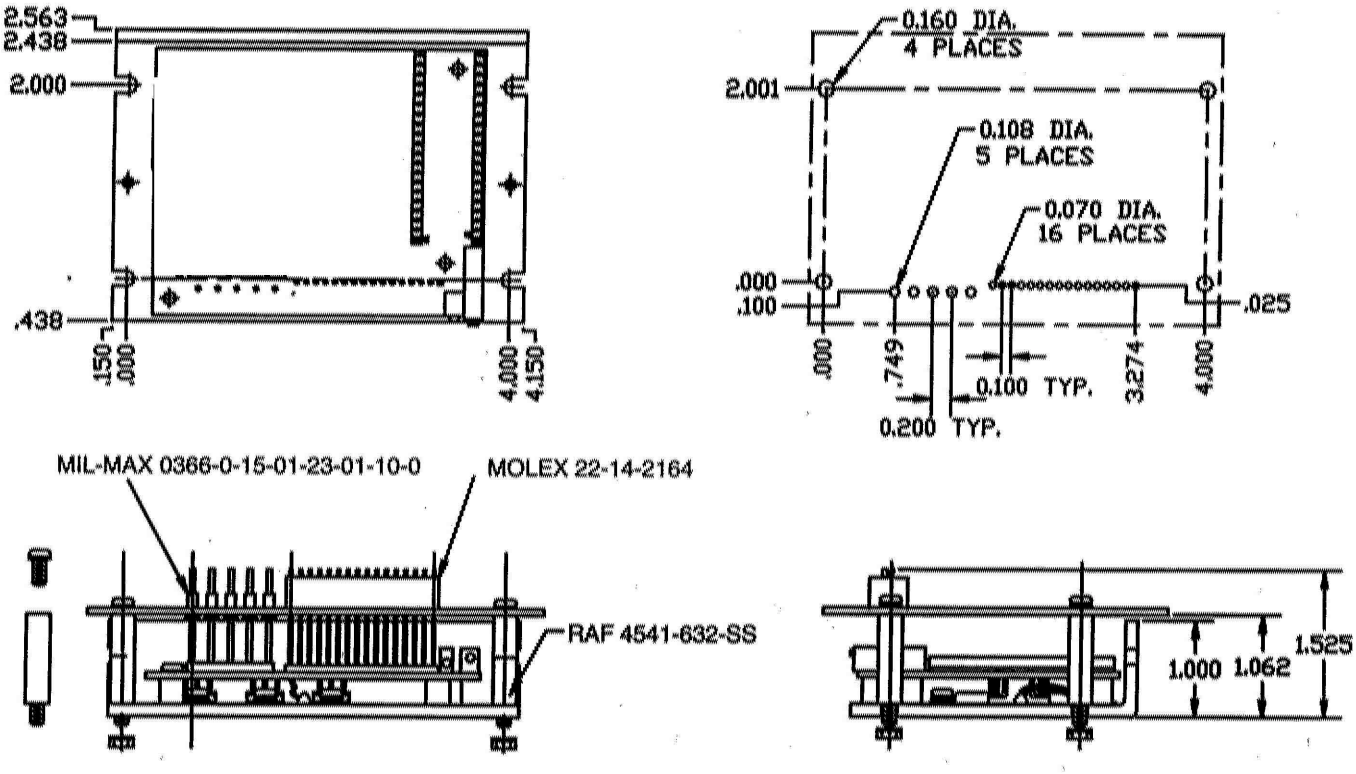
The voltage at the output of the current limit stage is called the *current reference*. This signal becomes the *demand* signal that controls the PWM stage. Here the current demand is converted into a current in the motor. This current can be measured at the current monitor, which shows the *response* of the motor to the current demand signal. By operating as a current source, the PWM stage is able to achieve faster response from the motor than if was acting only as a variable voltage.
The *current error amplifier* compares the current reference with the current monitor, and adjusts the output voltage such that the demanded current flows in the motor. The gain of this amplifier is controlled by RH15, CH16, and CH17, which are used to *compensate* the amplifier for the motors' inductance.

BASEPLATE OUTLINE DIMENSIONS



Dimensions in inches (mm.)

TYPICAL PCB ADAPTER OUTLINE DIMENSIONS



OTHER DC BRUSH SERVO AMPLIFIERS

400 Family Six models operating from 24-225VDC, 5-15A continuous, 10-30A peak.
Fully featured with adjustment potentiometers, voltage feedback with IR compensation.

Model 403 For torque-mode only applications at low cost. +18 to +55VDC operation, 5A continuous, 10A peak

ORDERING GUIDE

Model 4122P	20A peak, 10A continuous, +22 to +90VDC brush motor amplifier
Model 4212P	12A peak, 6A continuous, +22 to 125VDC brush motor amplifier

Note: For heatsink option. Add "H" to part number. For example: 4122PH would be a model 4122P with heatsink.
For 50% modulation option. Add "Z" to part number. For example: 4122zP.
For the PWM /DIR option Add "D" to the part number. For example: 4122PD.

ReB, 02/22/2001