MODELS 4122, 4212 AND VARIANTS
"P" VERSIONS FOR PC BOARD MOUNTING

FEATURES

- ***Mounts on customers printed circuit boards.***
- **Uses output filter option for reduced PWM noise to adjacent circuits**

APPLICATIONS

- **OEM drive systems**

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
4122ZP	+24~90VDC, 10/20A, 50% modulation
4212ZP	+24~90VDC, 6/12A, 50% modulation

FEATURES

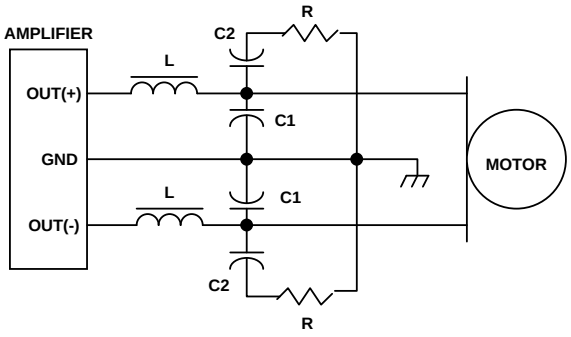
These versions of the 4122/4212 models and their variants use extended pins that interface with printed circuit board mounted connectors for direct mounting of the amplifier to customers pc boards.

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.

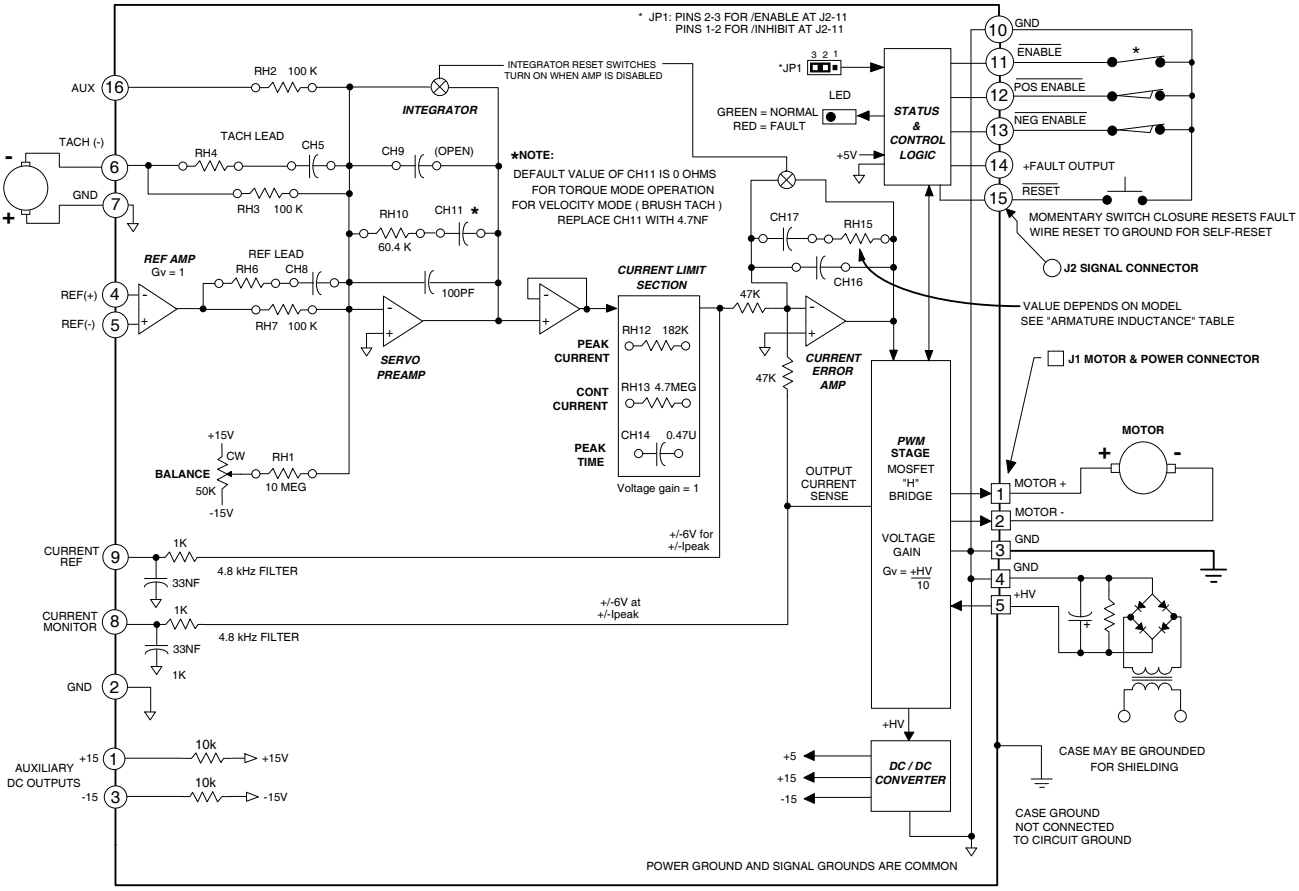
The output filter card option uses the same connectors as the popular 300 series models (303, 306, 306A and variants) for easy upgrading to the 4xx2 models.

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.

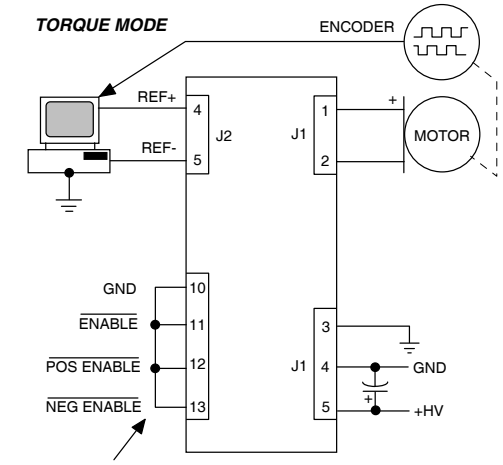
FILTER DIAGRAM



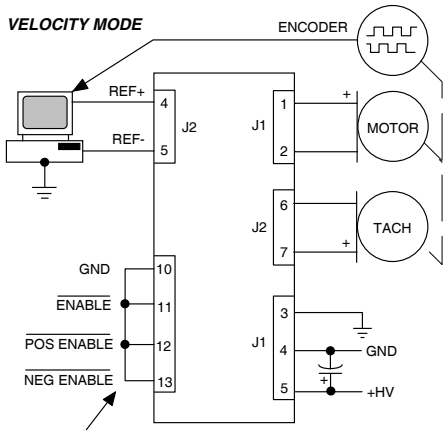
FUNCTIONAL DIAGRAM



TYPICAL CONNECTIONS



Note: JP1 on pins 2-3 (default)



Note: JP1 on pins 2-3 (default)

Notes

1. All amplifier grounds are common (J1-3, J1-4, J2-2, J2-7, and J2-10)
   Amplifier grounds are isolated from case & heatplate..
2. Jumper JP1 default position is on pins 2-3 for ground active /Enable input (J2-11)
   For /Inhibit function at J2-11 (+5V enables), move JP1 to pins 1-2
3. For best noise immunity, use twisted shielded pair cable for reference and tachometer inputs.
   Twist motor and power cables and shield to reduce radiated electrical noise from pwm outputs.

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

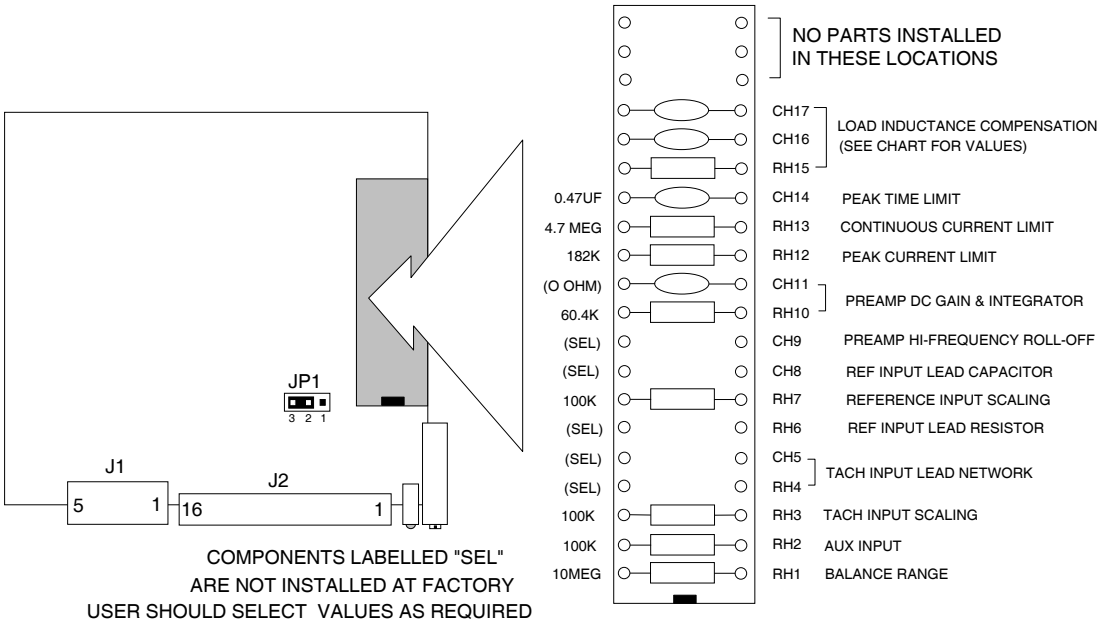
Dual color, red/green.

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 4122, >20V and <129V for model 4212
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



ARMATURE INDUCTANCE

Model	4122			4212		
Load (mH)	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 (4122) and 125V (4122). At lower supply voltages RH15 may be increased and CH17 decreased.

PEAK CURRENT LIMIT (AMP)

4122	4212	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)

4122	4212	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

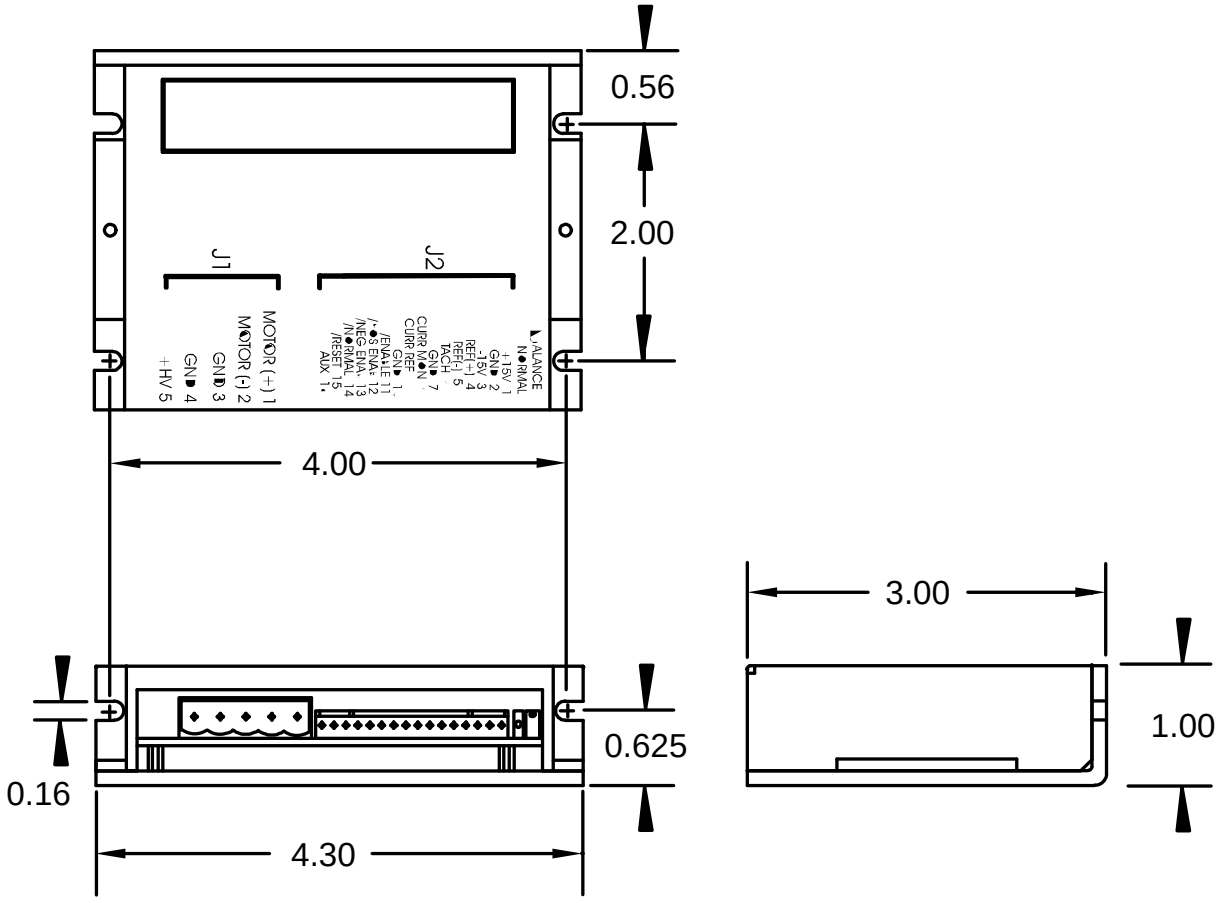
This stage takes the output of the servo preamplifier, and processes it before sending it to the PWM stage. The amplitude of the signal is first clamped to produce peak current limiting. This signal then goes to the continuous current-limit circuit where these functions are produced. Finally, the current-limited 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.
1)

OUTLINE DIMENSIONS

Dimensions in inches (mm.)



ORDERING GUIDE

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

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