MODEL 7225X2
DUAL LINE-ISOLATED AC BRUSHLESS SERVO AMPLIFIER WITH +/-10V ANALOG U-V INPUTS

FEATURES

- **Two independent amplifiers in one package drive two 3-phase AC brushless motors with sinusoidal commutation**
- **Compatible with controllers that output +/-10V analog torque commands for U & V phases**
- **Reduced offset drift**
- ***FAULT PROTECTIONS***
  Short-circuits
  output to output
  output to HV (+)
  output to HV (-)
  Over / under voltage
  Over temperature
  Self-reset or latch-off
- ***No Transformer Required!***
  Operates from power supplies that rectify the line directly with full optical isolation between signal and power stages.
- **CURRENT LIMITING**
  User selectable, I^2T Limit with, indicator signal for control system
- ***Greater than 3 kHz Bandwidth***

WORKS WITH POPULAR CONTROLLERS

- ***Technology 80*** **5651A**
- ***PMD*** **MC1231A Chipset**
- ***Delta Tau*** **PMAC**
- ***MEI*** **DPS Series**
- ***Galil*** **DMC-1700**

THE OEM ADVANTAGE

- **Single package simplifies equipment construction**

MODEL	POWER	I-CONT (A)	I-PEAK (A)
7225X2	24~180VDC	10	25

Above specifications apply to each of two channels

FEATURES

The 7225X2 model is a dual (two-motor) PWM servoamplifier for AC Brushless servomotors that are commutated externally by digital control systems that output two +/-10V signals that represent the current command to the motor U and V windings. The amplifier then synthesizes the current command for the W winding.

Dual-axis construction simplifies equipment design, lowers per-axis cost over single package per axis designs.

Control cards take feedback from an encoder on the motor and use various techniques to determine the rotor position. When this has been done, the controller is able to output two signals that correspond to the current in the U and V windings to produce torque in the motor. The amplifier synthesizes the W winding current from UV signals that are 120 electrical degrees apart.

Amplifier adjustments with this system consist of inductance compensation, current limit, transconductance, and offset. Thereafter, the controller does all of the velocity and/or position control of the motor.

Internal solderless sockets let the user 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 inductance's to maximize bandwidth with different motors.

The /Enable input active logic-level is jumper-selectable to ground or +5V to interface with all types of control cards.

MOSFET output stage deliver four-quadrant power for bi-directional acceleration and deceleration of motors.

All models are protected against output short circuits (output to output, output to ground, and output to HV) and heatplate overtemperature. With the /Reset input open the amplifier will latch off until powered-down or the /Reset input is toggled. The amplifier will reset itself automatically from faults if the /Reset input is wired to GND.

TECHNICAL SPECIFICATIONS

Test conditions: 25°C. ambient, Load = 400uH in series with 1Ω, +HV = 180V.

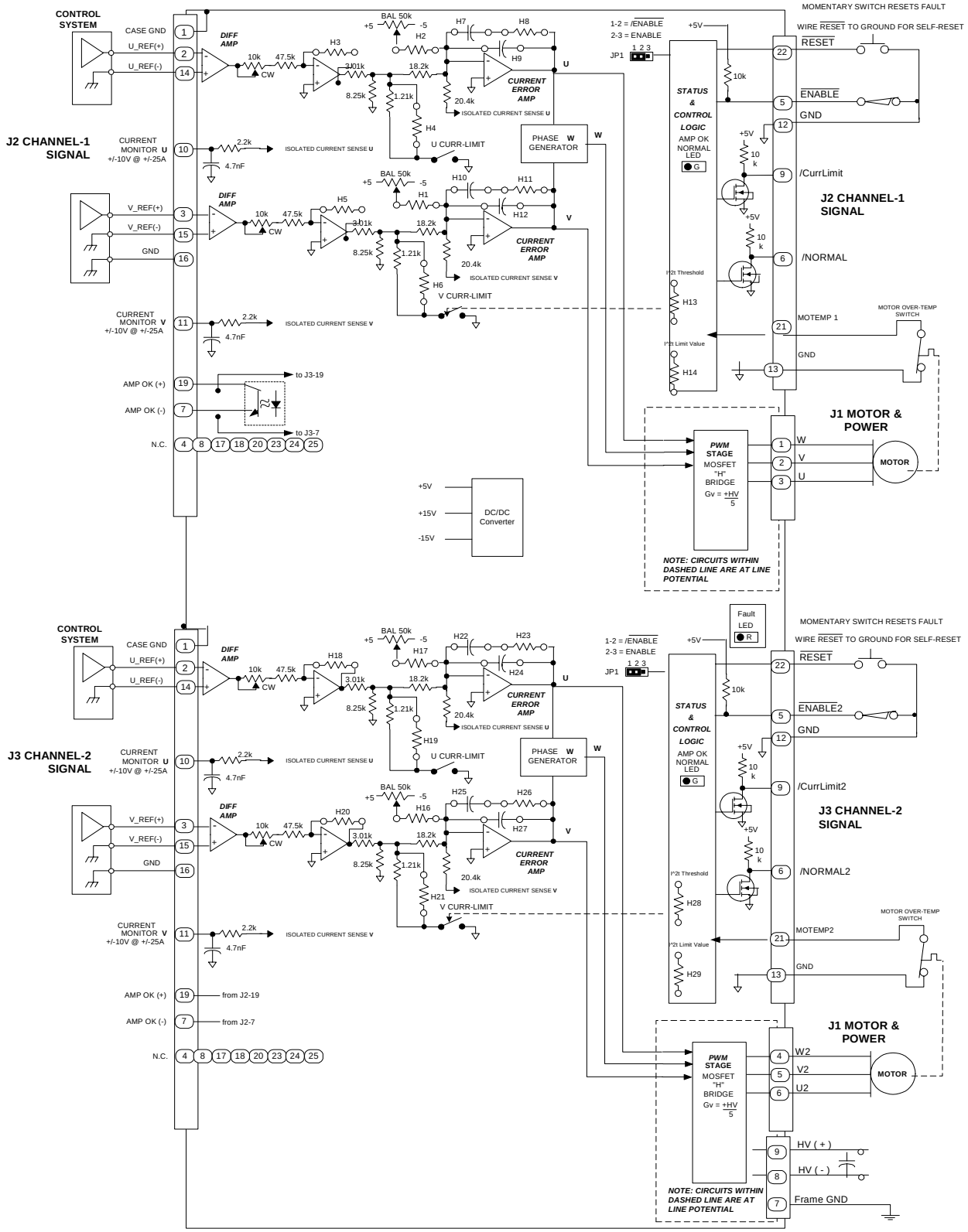
MODEL			7225X2
OUTPUT POWER (per channel)			
	Peak power		25 A @ 170VDC
	Peak time		1 sec at peak power independent of polarity reversal
	Continuous power		10 A @ 180VDC
OUTPUT VOLTAGE			
	On-resistance (Ro, ohms)		0.2
	Max PWM Peak Output Voltage		±Vout = (VDC)×(0.97) - (Ro)×(Io)
INPUT POWER			
	DC voltage		22~186VDC
	Input current @ continuous output rating		20 A
LOAD INDUCTANCE			
	Minimum inductance		400 µH.
	Maximum inductance	No maximum. Bandwidth varies with inductance, HV, and header parts.	
BANDWIDTH	Small signal	-3dB @ 3kHz with minimum load at nominal supply voltage. Varies with load inductance and header values	
PWM OUTPUTS			
	PWM frequency		25 kHz
	Modulation		Carrier-cancellation, 50% duty cycle at 0V output
REFERENCE INPUT			Differential, 94kΩ max. to 47kΩ min. between inputs, ±20V maximum
POTENTIOMETERS	Ch 1 R37 U Ref fine gain		Default = Center CW increased U gain.
	Ch 1 R48 V Ref fine gain		Default = Center CW increased V gain.
	Ch 1 R71 U Phase current zero		Adjusts U output current to zero with U and V inputs = 0V.
	Ch 1 R63 V Phase current zero		Adjusts V output current to zero with U and V inputs = 0V.
	Ch 2 R75 U Ref Fine Gain		Default = Center CW increased U gain.
	Ch 2 R86 V Ref Fine Gain		Default = Center CW increased V gain..
	Ch 2 R103 U Phase current zero		Adjusts U output current to zero with U and V inputs = 0V.
	Ch 2 R96 V Phase current zero		Adjusts V output current to zero with U and V inputs = 0V.
INTERNAL JUMPER			
	JP1	/Enable input active polarity. JP1 Position 1-2 (default): Gnd enables amplifier, open or +5V inhibits. 2-3: open enables	
LOGIC INPUTS			
	/Enable1, /Enable2	Default = GND active	GND enables channel open or >2.5V inhibits with JP1 on 1-2. If JP1 on 2-3 then GND inhibits Response time is 1 ms from enable active to amplifier output ON.
	/Motemp1, /Motemp2	Motor temp sensor.	HI (open) = Motor HOT, amp channel shuts down. Non-latching. LO (gnd) = Motor OK, amp channel will operate.
	/Reset	Default = Open	GND resets latching fault condition, ground for self-reset every 50 ms.
		Input resistance	10kΩ to +5V, R-C filters on inputs
		Logic threshold voltage	2.5V (Schmitt trigger inputs with hysteresis, 74HC14)
		Input voltage range	0V to +32VDC
LOGIC OUTPUTS			
	/Normal1, /Normal2		LO (current sinking) when channel is Enabled AND OK Amp OK = (NOT Short) AND (NOT Over, Undervoltage, or Basetemp) AND (MotorTemp OK)
	HI output voltage		+5V (no load). Output is N-channel MOSFET drain terminal with10kΩ pull-up resistor to +5V
	LO output voltage		On resistance Ro = 5Ω. Max sink current of 250 mA. max off-voltage = 50VDC
	/CurrLimit1, /CurrLimit2		HI when amplifier is not current limiting; LO when current is limit is active.
	HI output voltage		+5V (No load). Output is LM339 open collector with 10kΩ pullup resistor to +5V
	LO output voltage		Max sink current of 15 mA, max off voltage = 32VDC
	AmpOK		Opto-isolated signal: opto-transistor output stage of optocoupler Transistor is ON when Amp is OK (see above) One output is connected to pins 7 & 19 of both J1 & J3
STATUS LEDS			
	Amp OK	Blinking Green	Power OK, no faults amp will run when enabled.
	Normal	Solid GreenGreen	Amplifier OK AND Enabled
	Fault	Solid Red	Amplifier NOT OK (Over/Under voltage, /Motmep not connected or open.)
	Latching Fault	Blinking Red.	Heatplate overtemp or short circuit.

CURRENT MONITOR OUTPUTS

Chan 1 Current Monitor U: Motor winding current in U phase: ±10V @ ±25 A or 2.5 A/V (2.2kΩ, 4.7nF R-C filter)
Chan 1 Current Monitor V: Motor winding current in V phase: ±10V @ ±25 A or 2.5 A/V (2.2kΩ, 4.7nF R-C filter)
Chan 2 Current Monitor U: Motor winding current in U phase: ±10V @ ±25 A or 2.5 A/V (2.2kΩ, 4.7nF R-C filter)
Chan 2 Current Monitor V: Motor winding current in V phase: ±10V @ ±25 A or 2.5 A/V (2.2kΩ, 4.7nF R-C filter)

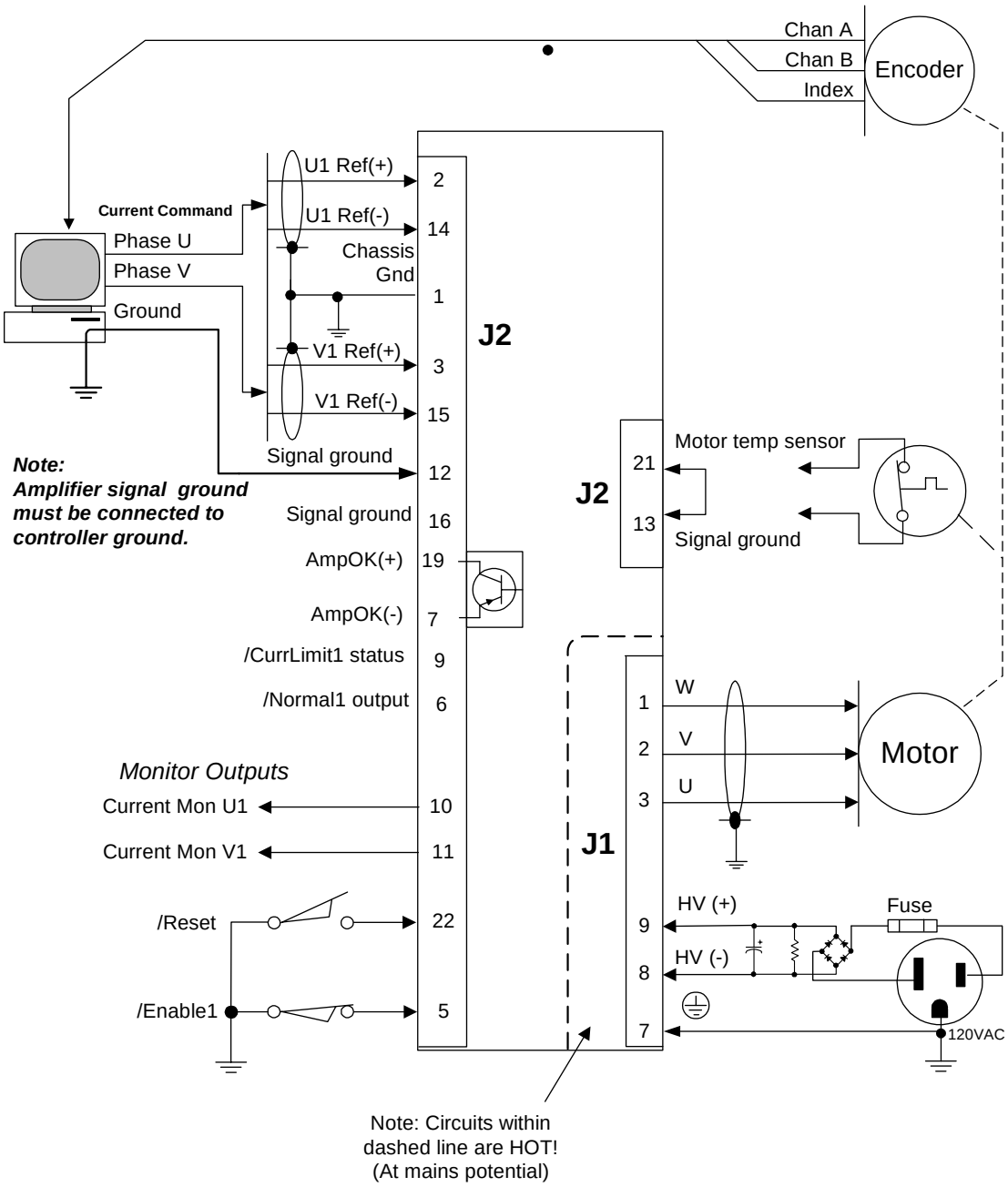
PROTECTIVE FEATURES		
	Short circuit (output to output, output to ground)	Latches channel OFF (Power off/on, or ground at /Reset input resets)
	Overtemperature	Latches channel OFF at 70°C on heatplate (Power off/on, or ground at /Reset input resets) *Wire /Reset input to ground for automatic reset after latching fault*
	Undervoltage	Shutdown at DC buss < 22VDC
	Overvoltage	Shutdown at DC buss > 195VDC (Amplifier operation resumes when internal DC buss is NOT Undervoltage or NOT Overvoltage)
	Current-limiting	Continuous current and I^2T limit set by header components Current is reduced to continuous setting when I^2T limit is reached. $\|I_U\|$, $\|I_V\|$ are hardware limited to 26A, whereas $\|I_W\| = -(I_U + I_V)$ at all times Maximum I^2T setting (H13 & H28 = H14 & H29 = 0 ohms) will activate latching fault after 25Arms for 2.5s Minimum I^2T setting (H13 & H28 = H14 & H28 = Open) will activate latching fault after 25Arms for 80mS Limiting action reduces transconductance so relative amplitude of U,V,W currents is maintained for no loss of phase /CurrLimit output indicates when current limiting is active. Amplifier will shutdown (latching fault)if $\|I_W\|$ > 29A at any time.
AMPLIFIER DISSIPATION		
	Watts minimum	11W Vref=0 and both channels enabled.
	Watts @ continuous current	120W at maximum continuous output current, both channels
THERMAL REQUIREMENTS		
	Storage temperature range	-30°C to +85°C
	Operating temperature range	0° to 70°C baseplate temperature
	Thermal resistance (heatplate to ambient):	No heatsink or fan: 2.7 deg. C/W; With heatsink, no fan: 1.6 deg. C/W No heatsink with fan: 1 deg. C/W; With heatsink and fan: 0.4 deg. C/W
MECHANICAL		
	Size	9.90 x 4.97 x 1.81 in. without optional heatsink
	Weight	2.32 Lbs (1.10 kg)
CONNECTORS		
	J1: Power & motor	9-position Euro connector for Chan-1 and Chan-2 motor outputs, HV inputs, and chassis Gnd
	J2: Chan-1 Signal connections	25-position female Sub-D type. #4-40 standoffs for cable shell lock screws
	J3: Chan-2 Signal connections	25-position female Sub-D type. #4-40 standoffs for cable shell lock screws

FUNCTIONAL DIAGRAM

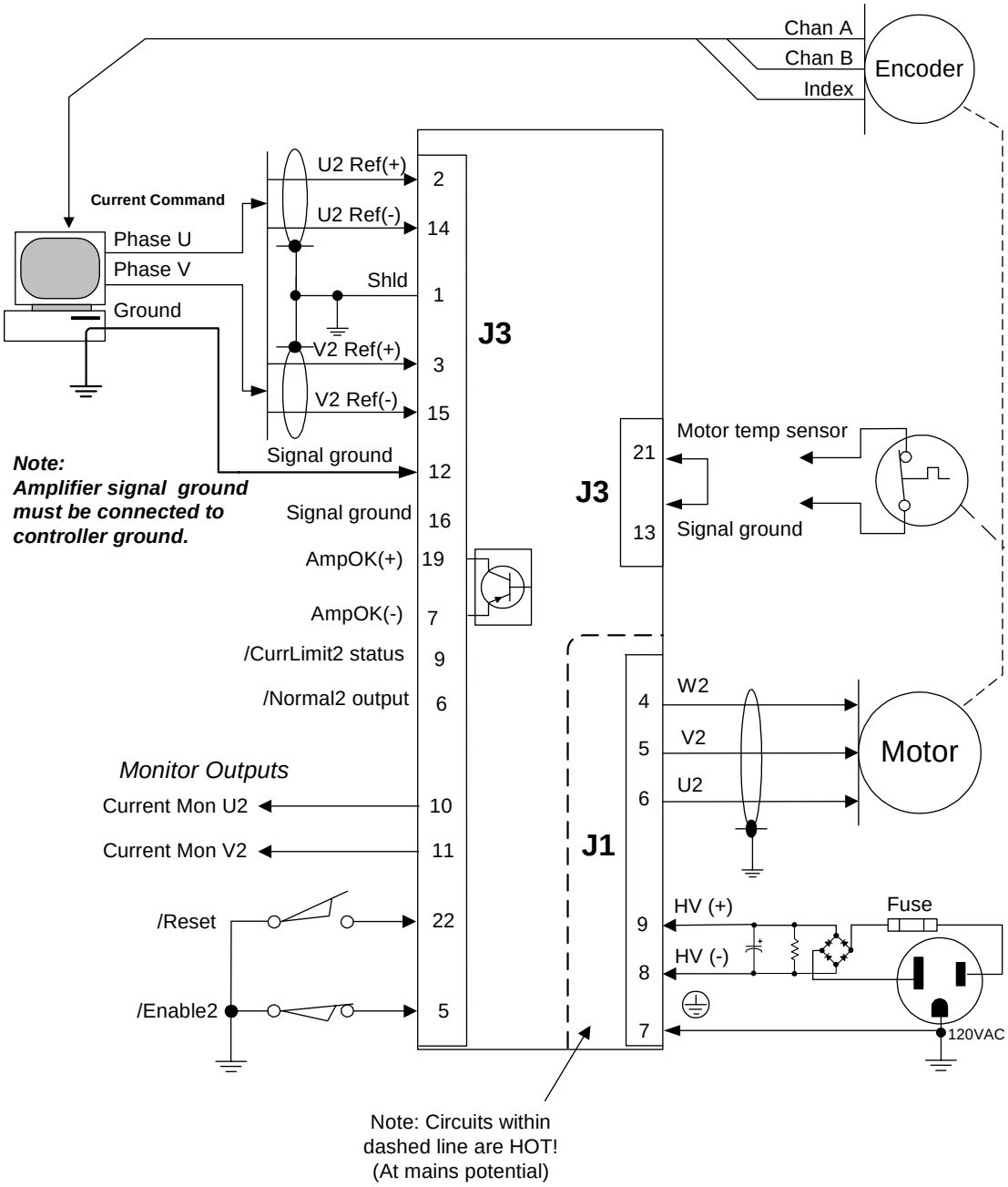


TYPICAL AMPLIFIER CONNECTIONS

Channel 1 Connections



Channel 2 Connections



CONNECTORS

J1 POWER AND MOTOR WINDING CONNECTIONS (BOTH CHANNELS)

Connector type: Barrier-block, Screw-terminal connections. #6-32 locking screws with cable clamps.

PIN	SIGNAL	FUNCTION
1	Ch. 1 Motor W	Channel-1 Amplifier output to “W” winding of motor
2	Ch. 1 Motor V	Channel-1 Amplifier output to “V” winding of motor
3	Ch. 1 Motor U	Channel-1 Amplifier output to “U” winding of motor
4	Ch. 2 Motor W	Channel-2 Amplifier output to “W” winding of motor
5	Ch. 2 Motor V	Channel-2 Amplifier output to “V” winding of motor
6	Ch. 2 Motor U	Channel-2 Amplifier output to “U” winding of motor
7	Chassis Gnd	Chassis safety ground. Also for cable shield of motor cable.
8	HV(-) Input	DC Power Gnd/Return
9	HV(+) Input	DC Power Input

J2 CHANNEL-1 SIGNAL CONNECTIONS

Connector type: Female Sub-D, 25-position, #4-40 locking standoffs

PIN	SIGNAL	FUNCTION	PIN	SIGNAL	FUNCTION
1	Safety GND (Case)	Chassis ground. Use to ground cable shield. Not connected to internal signal ground (J2-11).			
2	U1 Ref (+)	Positive terminal of differential +/-10V analog command input	14	U Ref (-)	Negative terminal of differential +/-10V analog command input
3	V1 Ref (+)	Positive terminal of differential +/-10V analog command input	15	V Ref (-)	Negative terminal of differential +/-10V analog command input
4	N.C.		16	0V.	Signal ground.
5	/Enable1 input	Amplifier enable	17	N.C.	
6	/Normal1 output	Mosfet output amp status	18	N.C.	
7	AmpOK (-) Output	Opto-isolator emitter	19	AmpOK (+) Output	Opto-isolator collector
8	N.C.		20	N.C.	
9	/CLIMIT1	Current limit status	21	Motemp Input	
10	Current Monitor U1	+/-10V @ +/-25 A	22	/Reset input	
11	Current Monitor V1	+/-10V @ +/-25 A	23	N.C.	
12	0V	Signal Gnd	24	N.C.	
13	0V	Signal ground ***must be connected to the controller***	25	N.C.	

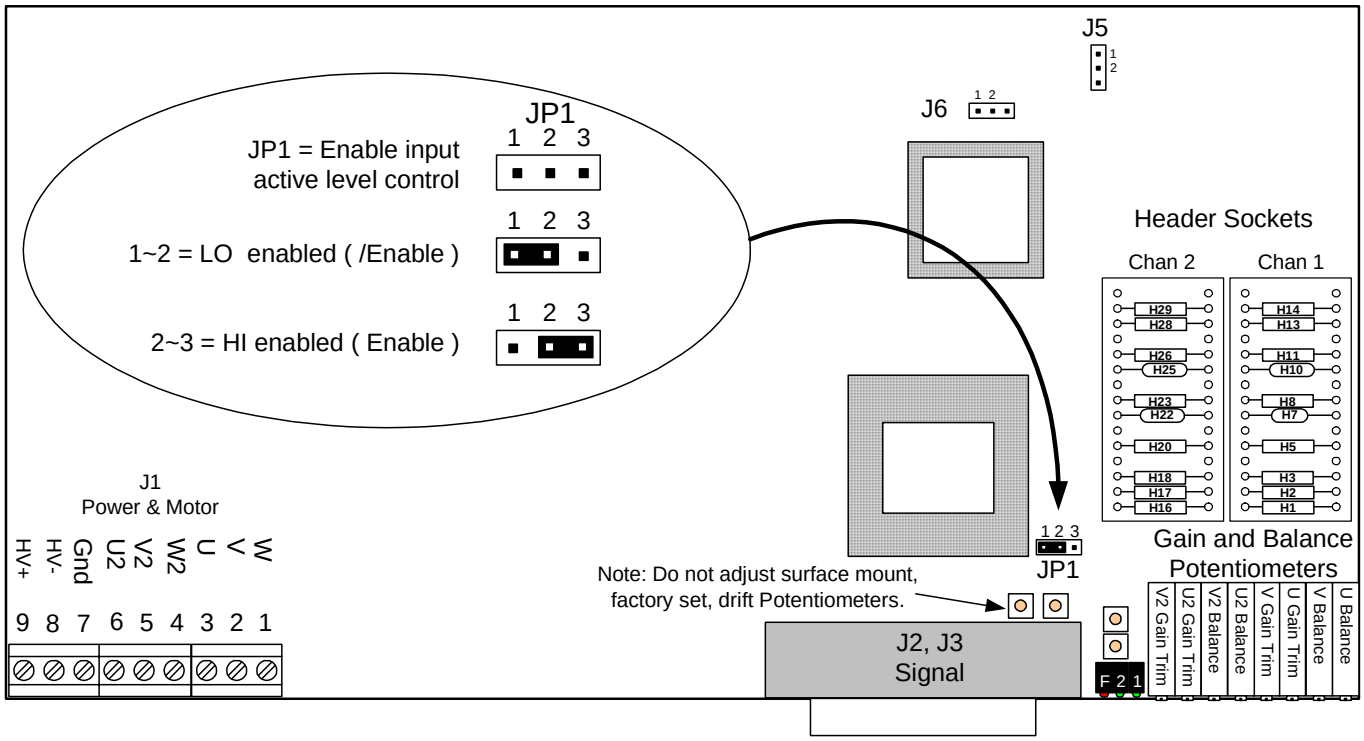
J3 CHANNEL-2 SIGNAL CONNECTIONS

Connector type: Female Sub-D, 25-position, #4-40 locking standoffs

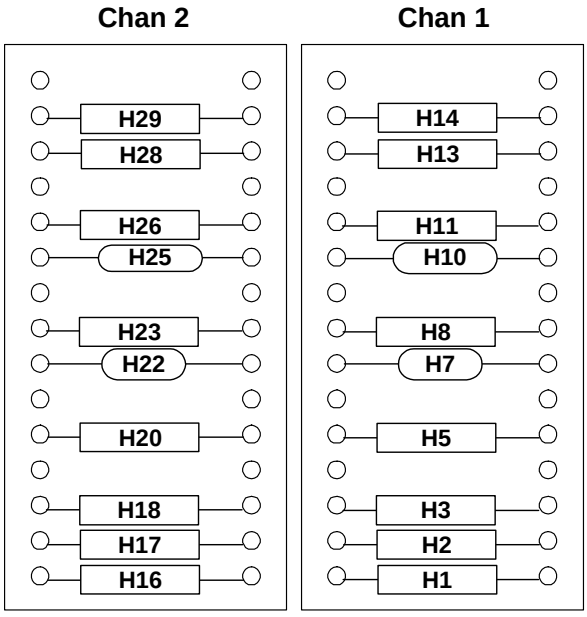
PIN	SIGNAL	FUNCTION	PIN	SIGNAL	FUNCTION
1	Safety GND (Case)	Chassis ground. Use to ground cable shield. Not connected to internal signal ground (J2-11).			
2	U2 Ref (+)	Positive terminal of differential +/-10V analog command input	14	U Ref (-)	Negative terminal of differential +/-10V analog command input
3	V2 Ref (+)	Positive terminal of differential +/-10V analog command input	15	V Ref (-)	Negative terminal of differential +/-10V analog command input
4	N.C.		16	0V.	Signal ground.
5	/Enable2 input	Amplifier enable	17	N.C.	
6	/Normal2 output	Mosfet output amp status	18	N.C.	
7	AmpOK (-) Output	Opto-isolator emitter	19	AmpOK (+) Output	Opto-isolator collector
8	N.C.		20	N.C.	
9	/CLIMIT2	Current limit status	21	Motemp Input	
10	Current Monitor U2	+/-10V @ +/-25 A	22	/Reset input	
11	Current Monitor V2	+/-10V @ +/-25 A	23	N.C.	
12	0V	Signal Gnd	24	N.C.	
13	0V	Signal Gnd	25	N.C.	

1. The motor temperature sensor input is supported on 7225X1. J2-21 and J3-21 must be grounded for amplifier to operate (motor temp sensor should be a normally-closed switch that opens when motor is too hot

PC BOARD LAYOUT



HEADER SOCKETS DETAIL



I^2T LIMIT VALUE
I^2T THRESHOLD
V INDUCTANCE COMP HI FREQUENCY CAPACITOR
V INDUCTANCE COMP RESISTOR
V INDUCTANCE COMP CAPACITOR
U INDUCTANCE COMP HI FREQUENCY CAPACITOR
U INDUCTANCE COMP RESISTOR
U INDUCTANCE COMP CAPACITOR
V CONTINUOUS CURRENT LIMIT SET
V TRANSCONDUCTANCE
U CONTINUOUS CURRENT LIMIT SET
U TRANSCONDUCTANCE
V BALANCE
U BALANCE

HEADER SOCKET COMPONENT SELECTION

LOAD INDUCTANCE

L (mH)	H8, 11, 23, 26 @ 80V	H8, 11, 23, 26 @ 160V	H7,10, 22, 25
0.4	16.5k	11k	33nF
1	***32.4k***	***18.2k***	***33nF***
3	86.6k	42.4k	33nF
10	249k	124k	33nF
30	750k	392k	33nF

Note: Table values apply with components H9, 12, 24, 27 not installed. Values in ***bold and italic*** are factory installed.

CURRENT LIMITS

A micro controller uses an I^2T algorithm to monitor to protect against overload conditions. The I^2T overload protection for each channel operates independent of the other. The algorithm detects when the current is any phase exceeds the continuous current limit level set by the header component H13 &28. The I^2T algorithm tracks the energy of the overload (A^2 sec) and when the I^2T limit is reached, the output current is limited to a level set by H4, 6, 19, & 21. The following tables or equations can be used to select header component values to obtain the desired over-current protection setting.

Cont. Current (A)	H 4, 6, 19, 21 (Ohm)	H 13, 28 (Ohm)
10	***<out>***	***0 Ohms (short)***
8	2.5k	16k
6	825	49k
4	383	150k
2	150	<out>

I^2T Limit (A^2sec)	H 14, 29 (Ohm)
1250	***0 (short)***
800	16k
450	49k
200	150k
50	<out>

$$\text{H13 \& H28} = 47.5\text{k ohms} * \frac{(10 - I_{cont})}{(I_{cont} - 2)}$$

$$\text{H14 \& H 29} = 47.5\text{k ohms} * \frac{\left(6.25 - \sqrt{\frac{I^2T_{limit}}{32}}\right)}{\left(\sqrt{\frac{I^2T_{limit}}{32}} - 1.25\right)}$$

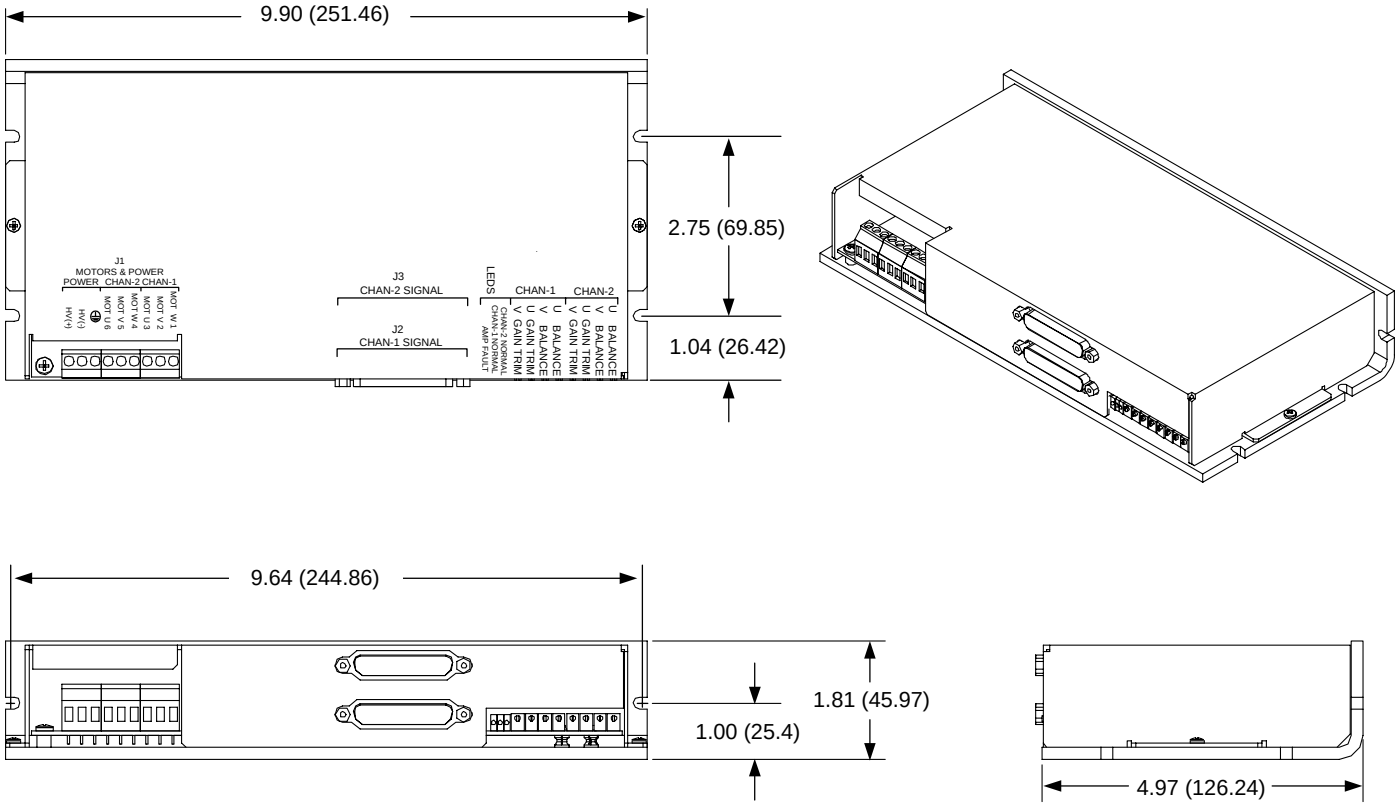
Example: The I^2T set point applies only to the energy delivered to the load over and above the continuous rating of the load. The amplifier's microchip is informed of the continuous current rating of the load via header resistor H13. The I^2T set point is set via header resistor H14. Using a 0 Ohm value for H14 gives an I^2T set point of 1250 A^2*S. If a 0 ohm value is also used for H13, the continuous current setting is set to 10A. This means for a 25 Arms current on either phase U,V, or W, the I^2*T protection will activate (current is forced to continuous limit as set by H4,H6 after a time T = 1250 A^2*S/(25^2-10^2) = 2.4 seconds.

BALANCE RANGE AND TRANSCONDUCTANCE SETTINGS

Header components H1,2,16, & 17 control the offset range. Default value is 665k ohm that gives a range of +/-350mA. The ratio between output current, and the reference voltage at the input is the *transconductance* of the amplifier. It is measured in Amps/Volt, and is controlled by components H3, 5, 18, & 20 The chart below gives some common settings.

Gain (A/V)	H 3, 5, 18, 20
2.5	95.3k
2.0	***75k***
1.5	54.9k
1	36.5k
0.5	17.8k

DIMENSIONS



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