

FEATURES

- 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, I²T 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

- Internal solderless header configures amplifier for plug and play operation

| MODEL | POWER | I-CONT (A) | I-PEAK (A) |
|--------|-----------|------------|------------|
| 7225X1 | 24~180VDC | 10 | 25 |



FEATURES

The 7xx5X1 model is a PWM servo-amplifier 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 synthesizes the current command for the W winding.

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, 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.



MODEL 7225X1

LINE-ISOLATED AC BRUSHLESS SERVO AMPLIFIER WITH +/-10V ANALOG U-V INPUTS

TECHNICAL SPECIFICATIONS

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

| | | |
|--|--|--|
| MODEL | | 7225X1 |
| OUTPUT POWER | | |
| Peak power | | 25 A @ 170 VDC |
| Peak time | | 2.4 sec at peak power independent of polarity reversal |
| Continuous power | | 10 A @ 180 VDC |
| OUTPUT VOLTAGE | | |
| On-resistance (Ro, ohms) | | 0.2 |
| Max PWM Peak Output Voltage | | $\pm V_{out} = (VDC) \times (0.97) - (Ro) \times (Io)$ |
| INPUT POWER | | |
| DC voltage | | 22~186 VDC |
| Input current @ continuous output rating | | 10 A |
| LOAD INDUCTANCE | | |
| Minimum inductance | | 400 μH. |
| Maximum inductance | | No maximum. Bandwidth varies with inductance, +HV, and header parts. |
| BANDWIDTH Small signal | | |
| | | -3dB @ 3 kHz 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 0 V output |
| REFERENCE INPUT | | |
| | | Differential, 94 kΩ max. to 47 kΩ min. between inputs, ±20 V maximum |
| POTENTIOMETERS | | |
| R14 U Ref Fine Gain | Default = Center | CW increases gain of U output phase current. |
| R26 V Ref Fine Gain | Default = Center | CW increases gain of V output phase current. |
| R49 U phase current Zero | | Adjusts U output current to zero with U and V inputs = 0 V. |
| R41 V phase current Zero | | Adjusts V output current to zero with U and V inputs = 0 V. |
| INTERNAL JUMPER | | |
| JP1 /Enable input active polarity | Pos. 1-2 (default) Pos. 2-3 | Gnd enables amplifier, open or +5 V inhibits. Gnd inhibits, open or +5 V enables |
| LOGIC INPUTS | | |
| /Enable | 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. |
| /Motemp | Motor temp sensor. | HI (open) = Motor HOT, amp channel shuts down. Non-latching. LO (gnd) = Motor OK, amp channel will operate. |
| /Reset | Default = Open Input resistance Logic threshold voltage Input voltage range | GND resets latching fault condition, ground for self-reset every 1 s. 10kΩ to +5V, R-C filters on inputs 2.5V (Schmitt trigger inputs with hysteresis, 74HC14) 0V to +32VDC |
| LOGIC OUTPUTS | | |
| /Normal | | LO (current sinking) when channel is Enabled AND OK Amp OK = (NOT Short) AND (NOT Over, Undervoltage, or Basetemp) AND (MotorTemp OK) +5V (no load). Output is N-channel MOSFET drain terminal with 10kΩ pull-up resistor to +5V On resistance Ro = 5Ω. Max sink current of 250 mA. max off-voltage = 50VDC |
| /CurrLimit | HI output voltage LO output voltage | HI when amplifier is not current limiting; LO when current is limit is active. +5V (No load). Output is LM339 open collector with 10kΩ pullup resistor to +5V Max sink current of 15 mA, max off voltage = 32VDC |
| AmpOK | HI output voltage LO output voltage | 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 Green | Amplifier OK AND Amp Enabled |
| Fault | Solid Red | Amplifier NOT OK (Over voltage, /Motemp not connected or open) |
| Latching Fault | Blinking Red | Heatplate overtemp or short circuit (output-output, output-ground, output-+HV or internal) |
| MONITOR OUTPUTS | | |
| Current Monitor U | | Motor winding current in U phase: ±10 V @ ±25 A or 2.5 A/V (2.2 kΩ, 4.7 nF R-C filter) |
| Current Monitor V | | Motor winding current in V phase: ±10 V @ ±25 A or 2.5 A/V (2.2 kΩ, 4.7 nF R-C filter) |

PROTECTIVE FEATURES

| | |
|---|---|
| <ul style="list-style-type: none"> Short circuit Overtemperature Under voltage Over voltage Current-limiting | <p>Latches unit OFF (Power off/on, or ground at /Reset input resets)</p> <p>Latches unit OFF at 70°C on heatplate (Power off/on, or ground at /Reset input resets)</p> <p><i>Wire /Reset input to ground for automatic reset after latching fault</i></p> <p>Shutdown at DC buss < 22 VDC</p> <p>Shutdown at DC buss > 195 VDC</p> <p>(Amplifier operation resumes when internal DC buss is NOT Under voltage or NOT Over voltage)</p> <p>Continuous current and I²T limit set by header components</p> <p>Current is reduced to continuous setting when I²T limit is reached.</p> <p> I_u , I_v are hardware limited to 26A, whereas I_w = -(I_u + I_v) at all times</p> <p>Maximum I²T setting (H13 = H14 = 0 ohms) will activate latching fault after 25Arms for 2.5s</p> <p>Minimum I²T setting (H13 = H14 = Open) will activate latching fault after 25Arms for 80mS</p> <p>Limiting action reduces transconductance so relative amplitude of U,V,W currents is maintained for no loss of phase</p> <p>/CurrLimit output indicates when current limiting is active.</p> <p>Amplifier will shutdown (latching fault) if I_w > 29A at any time.</p> |
|---|---|

AMPLIFIER DISSIPATION

| | |
|--|------|
| Watts maximum at Vref = 0, amplifier enabled | 7 W |
| Watts @ continuous current | 60 W |

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 |

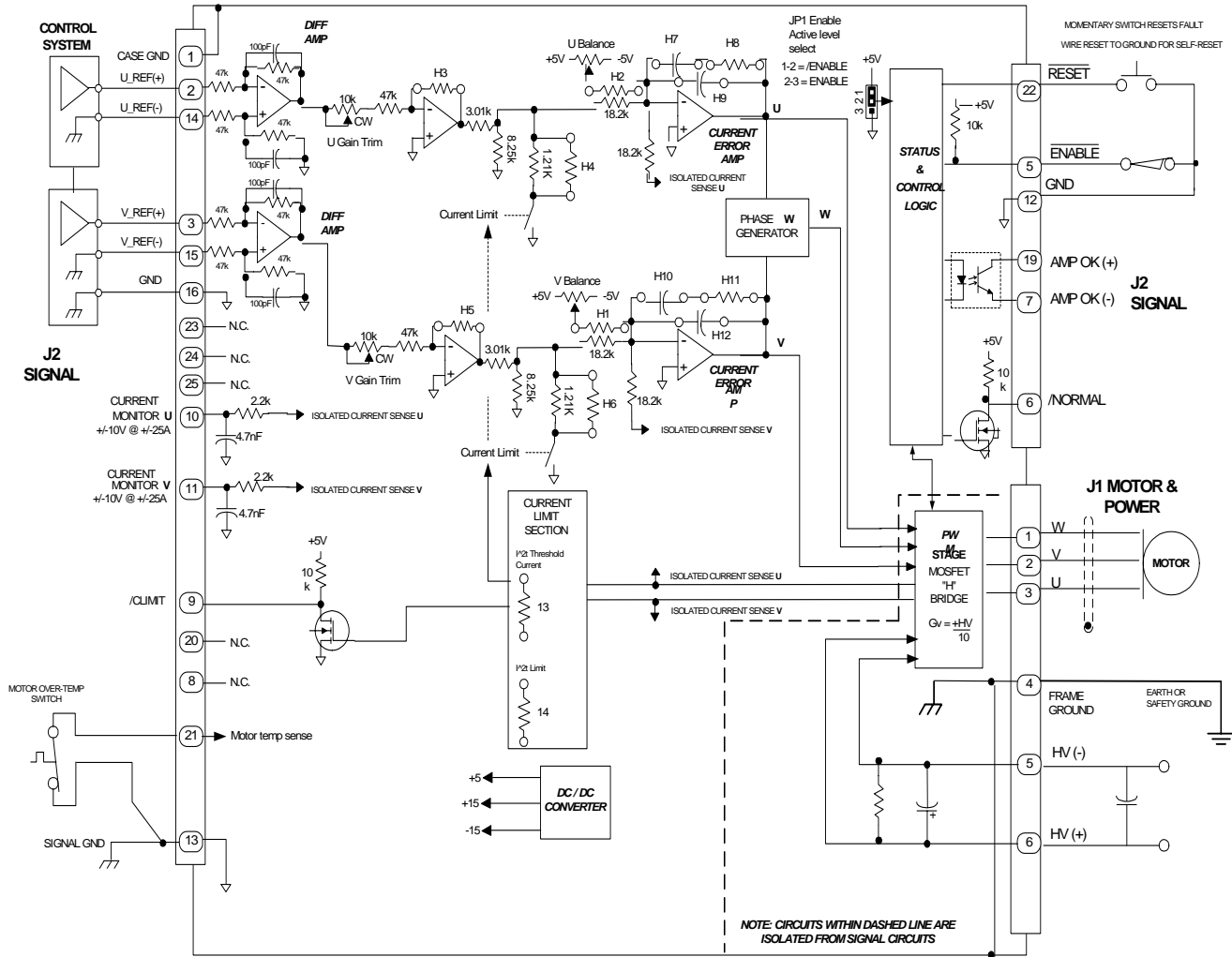
MECHANICAL

| | |
|--------|---|
| Size | 7.35 x 4.4 x 1.40 in. without optional heatsink |
| Weight | 1.48 lb. (0.67 kg) |

CONNECTORS

| | | |
|----|---------------------------|--|
| J1 | Power & Motor connections | 6-position Euro connector |
| J2 | Signal connections | 25-position female Sub-D type. #4-40 standoffs for cable shell lock screws |

FUNCTIONAL DIAGRAM



CONNECTORS

J1 POWER AND MOTOR WINDING CONNECTIONS

Connector type: Euro style terminal block.

| PIN | SIGNAL | FUNCTION |
|-----|-------------|---|
| 1 | Motor W | Amplifier output to "W" winding of motor |
| 2 | Motor V | Amplifier output to "V" winding of motor |
| 3 | Motor U | Amplifier output to "U" winding of motor |
| 4 | Chassis Gnd | Chassis safety ground. Also for cable shield of motor cable. |
| 5 | HV(-) | DC Power Gnd/Return (<i>Note: HV is isolated from 0V signal ground</i>) |
| 6 | HV(+) | DC Power Input |

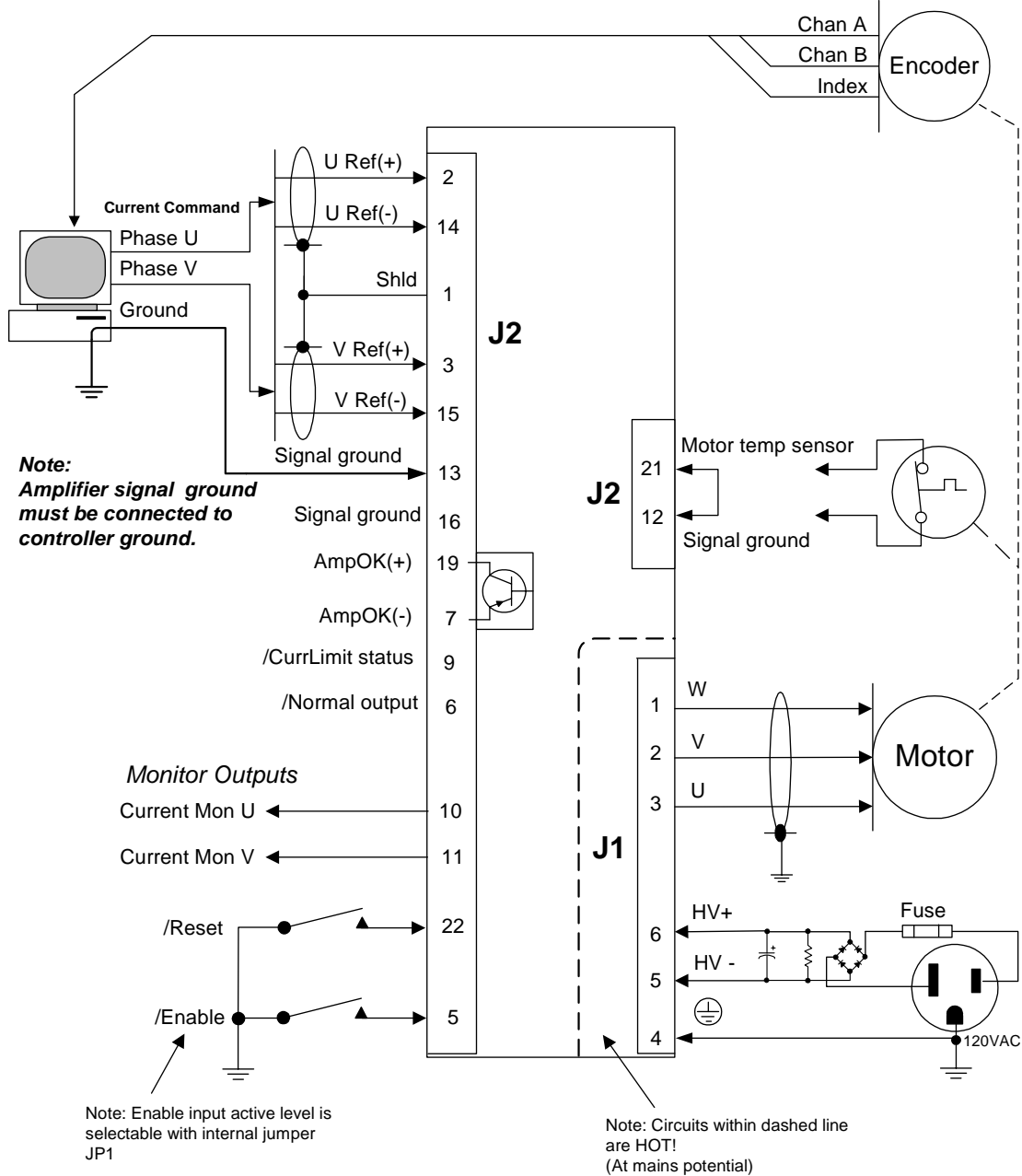
J2 SIGNAL CONNECTIONS

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

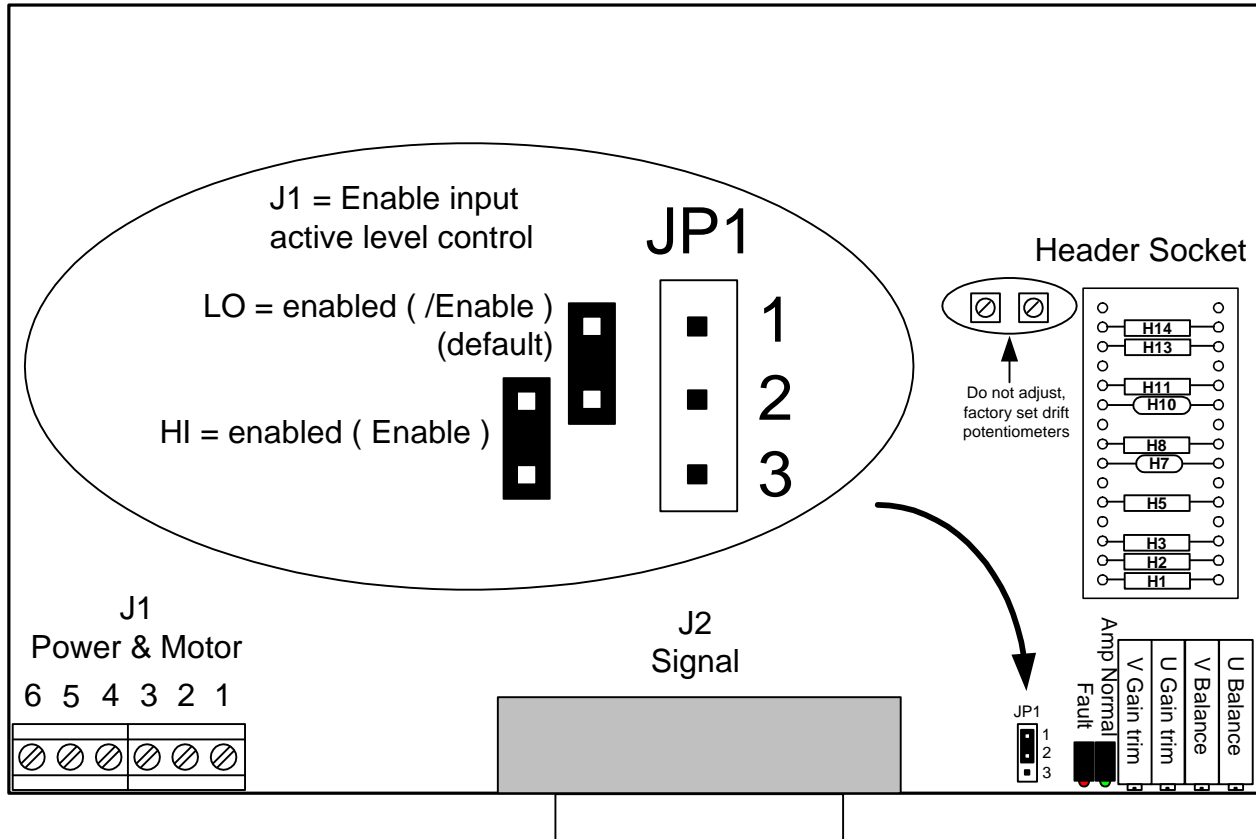
| PIN | SIGNAL | FUNCTION | PIN | SIGNAL | FUNCTION |
|-----|-------------------|---|-----|-------------------|---|
| 1 | Safety GND (Case) | Chassis ground. Use to ground cable shield. Not connected to internal signal ground (J3-12, 13,16). | | | |
| 2 | U Ref (+) | Positive terminal of differential +/-10V analog command input | 14 | U Ref (-) | Negative terminal of differential +/-10V analog command input |
| 3 | V 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 | /Enable input | Amplifier enable | 17 | N.C. | |
| 6 | /Normal output | Mosfet output amp status | 18 | N.C. | |
| 7 | Amp OK (-) output | Opto-isolator emitter (NPN) | 19 | Amp OK (+) output | Opto-isolator collector (NPN) |
| 8 | N.C. | | 20 | N.C. | |
| 9 | /CLIMIT | Current limit status | 21 | Motemp | (Note 1) |
| 10 | Current Monitor U | +/-10V @ +/-25 A | 22 | /Reset input | |
| 11 | Current Monitor V | +/-10V @ +/-25 A | 23 | N.C. | (Note 2) |
| 12 | 0V. | Signal ground. | 24 | N.C. | (Note 2) |
| 13 | 0V. | Signal ground must be connected to the controller. | 25 | N.C. | (Note 2) |

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

TYPICAL AMPLIFIER CONNECTIONS



PC BOARD LAYOUT



HEADER SOCKET COMPONENTS

| Part | Value | Remarks |
|------|-----------|---|
| H15 | N/a | No function |
| H14 | 86.6kΩ | I ² T Current Limit select |
| H13 | 0Ω<short> | I ² T Threshold Current select |
| H12 | <out> | Ch. V Current Error Amp hi-frequency roll off |
| H11 | 30.1kΩ | Ch. V Current Error Amp proportional gain |
| H10 | 100nF | Ch. V Current Error Amp integrator |
| H9 | <out> | Ch. U Current Error Amp hi-frequency roll off |
| H8 | 30.1kΩ | Ch. U Current Error Amp proportional gain |
| H7 | 100nF | Ch. V Current Error Amp integrator |
| H6 | <out> | Ch. V Continuous Current Limit |
| H5 | 75kΩ | Ch. V Transconductance |
| H4 | <out> | Ch. U Continuous Current Limit |
| H3 | 75kΩ | Ch. U Transconductance |
| H2 | 1.5MΩ | Ch. U Balance Range select |
| H1 | 1.5MΩ | Ch. V Balance Range select |

HEADER SOCKET COMPONENT SELECTION

LOAD INDUCTANCE

| L (mH) | H8, H11 @ 80V | H8, H11 @ 160V | H7, H10 |
|----------|---------------|----------------|-------------|
| 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 & H12 not installed. Values in **bold and italic** are factory installed.

CURRENT LIMITS

A micro controller uses an I²T algorithm to monitor to protect against overload conditions. The I²T overload protection for each channel operates independent of the other. The algorithm detects when the current in any phase exceeds the continuous current limit level set by the header component H13. The I²T algorithm tracks the energy of the overload (A² sec) and when the I²T limit is reached, the output current is limited to a level set by H4 and H6. The following tables or equations can be used to select header component values to obtain the desired over-current protection setting.

| Cont. Current (A) | H4 & H6 (Ohm) | H13 (Ohm) |
|-------------------|--------------------|-----------------------|
| 10 | <out> | 0 Ohms (short) |
| 8 | 2.5k | 16k |
| 6 | 825 | 49k |
| 4 | 383 | 150k |
| 2 | 150 | <out> |

| I ² T Limit (A ² sec) | H14 (Ohm) |
|---|------------------|
| 1250 | 0 (short) |
| 800 | 16k |
| 450 | 49k |
| 200 | 150k |
| 50 | <out> |

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

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

Example: The I²T 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 I²T set point is set via header resistor H14. Using a 0 Ohm value for H14 gives an I²T set point of 1250 A²*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 I²T protection will activate (current is forced to continuous limit as set by H4,H6 after a time T = 1250 A²*S/(25²-10²) = 2.4 seconds.

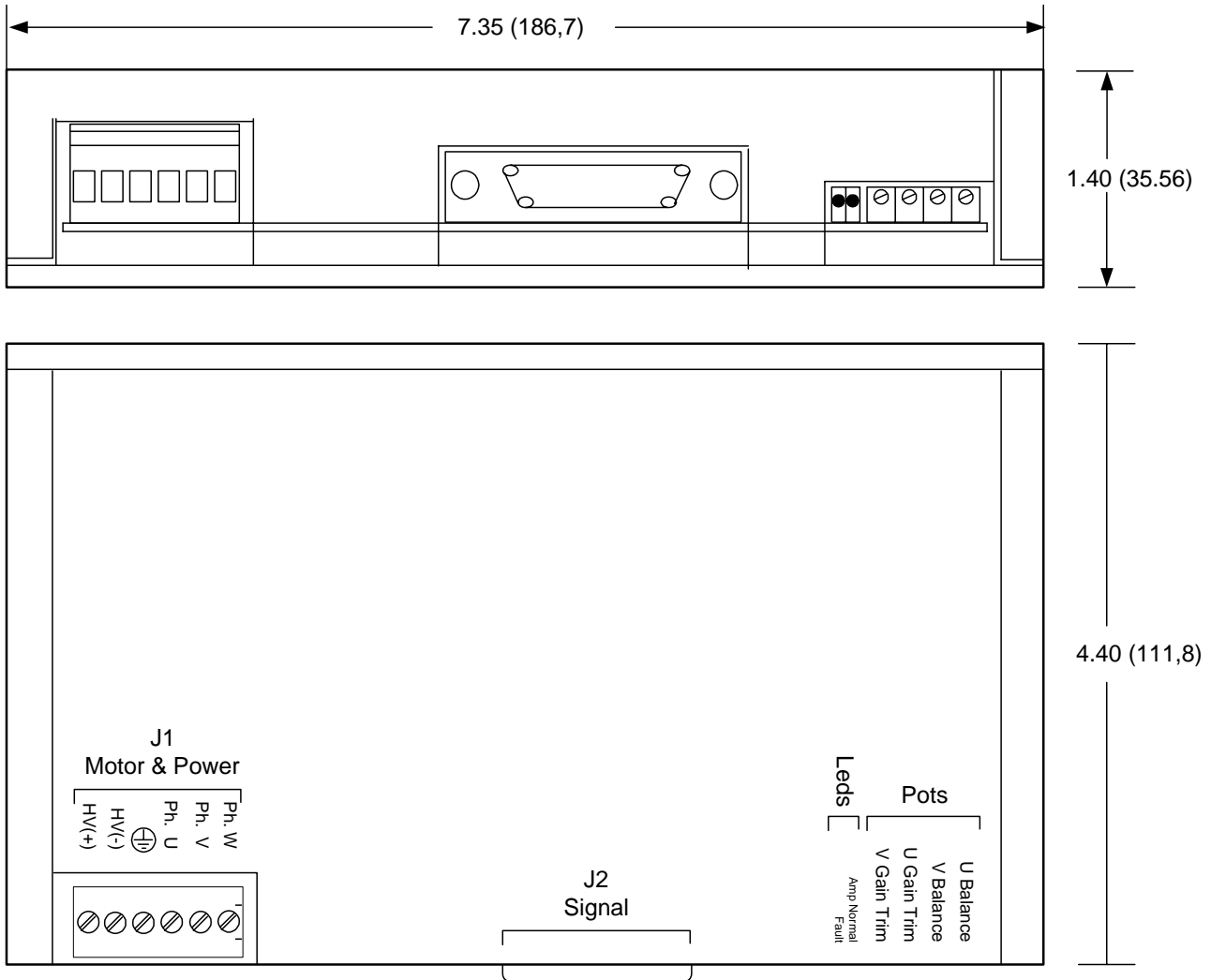
BALANCE RANGE AND TRANSCONDUCTANCE SETTINGS

Header components H1 & H2 control the offset range. Default value is 1.5Mohm 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 & H5. The chart below gives some common settings.

| Gain (A/V) | H3 & H5 |
|------------|--------------|
| 2.5 | 102k |
| 2.0 | 75.0k |
| 1.5 | 59k |
| 1 | 29.4k |
| 0.5 | 14.3k |

DIMENSIONS

Note: Dimensions in inches (mm.)



NOTES