



OPERATION & SERVICE MANUAL

LCAM 5/15

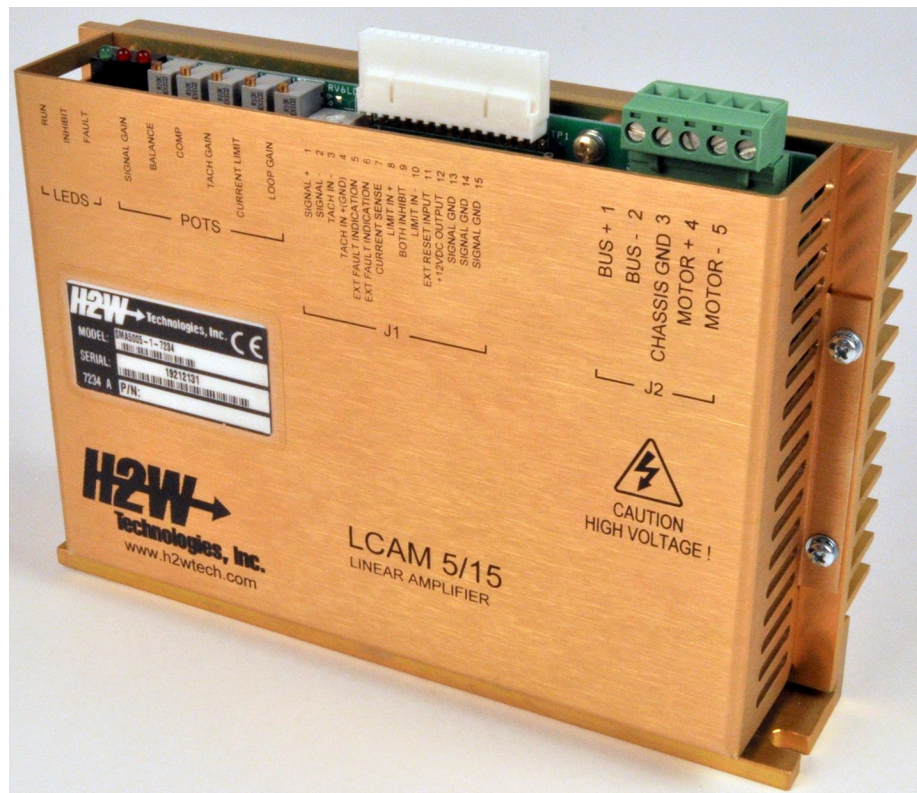


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INTRODUCTION

The H2W Technologies LCAM 5/15 H bridge linear servo amplifier provides the optimum solution for applications which require high current loop bandwidth, low radiated electrical noise and low crossover distortion. This amplifier is constructed using surface mount technology and incorporates the latest in heat transfer technology which makes it one of the most powerful amplifiers for a given form factor.

Typical applications are brushed DC permanent magnet motors and voice coil motors.

The LCAM 5/15 is configurable and can operate in the following modes:

1. Velocity mode for motors with tachometer feedback.
2. Current mode for torque mode operation.

A basic velocity mode servo loop for a brush type motor is shown in figure A. An external controller commands a given velocity (RPM). The velocity loop summing amplifier compares this command with the actual motor velocity, supplied by a DC tachometer on the motor shaft, and produces an error voltage proportional to the difference between the actual and commanded velocity.

The velocity error is used to command motor current in the inner servo-loop. The current loop summing amplifier compares the command current (velocity error) with the actual current in the motor and produces an error voltage proportional to the difference between the actual and commanded current.

Finally, the current error signal is used to produce an output to drive the motor.

The velocity loop may be bypassed, and an external current command fed directly to the current loop. In this case, the external command signal controls the torque of the motor, rather than the velocity. This is known as current-mode operation.

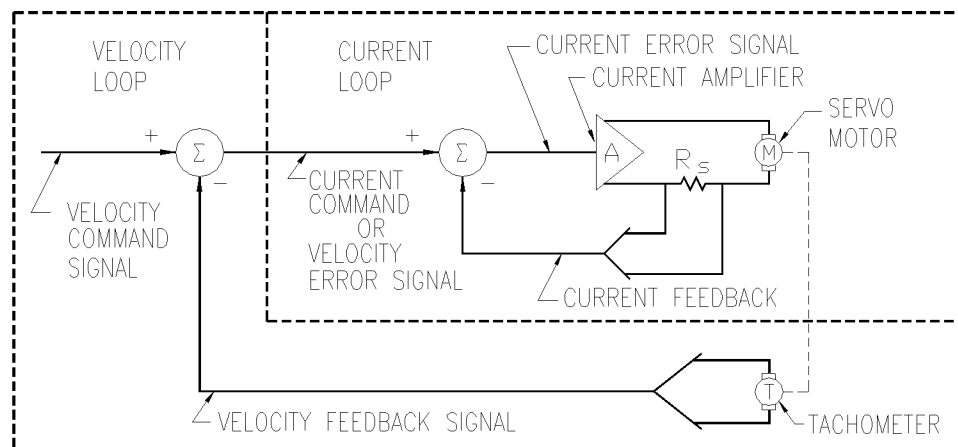


Figure A - Velocity mode servo loop for a brush type motor

FEATURES

- Ergonomic Design Easy access to connections, adjustments and test points.
- SMT construction Provides ultra compact size, cost competitive package and high reliability.
- Bandwidth All servo amplifiers have a nominal 10 kHz current loop bandwidth which varies with the motor inductance.
- Linear output stage Provides high bandwidth, low noise and zero crossover distortion.
- Multimode operation Velocity mode (tachometer feedback) and Current mode (torque) .
- Operating Voltage Operating input voltage range: 24-75 VDC for standard LCAM 5/15 module.
- Basic versions Velocity and current modes.
- Fault protection Short from output to output, short from output to ground, amplifier RMS over current, and amplifier over temperature.
- Status indicator LEDs indicate status on the LCAM 5/15.
- Dedicated inputs Command signals, +/- limits, inhibit, reset, and fault.
- Dedicated outputs Fault out and motor current monitor.
- Current limit Peak motor current is adjustable.
- External fault reset An input is provided to reset the amplifier in the event of a fault.
- CE compliant All servo amplifiers are CE marked.

APPLICATION NOTE

POWER DISSIPATION CONSIDERATIONS AND CALCULATIONS WHEN USING LINEAR DC SERVO AMPLIFIERS:

When selecting a linear amplifier, the following ratings of the amplifier should be known in order to properly size the amplifier to your system requirements:

1– The total wattage, peak current, and voltage rating of all the semiconductors installed on the heat sink of the output power stage of the amplifier.

Output transistor ratings for the LCAM 5/15 series are:

Voltage: 250 Volts

Peak current: 60 A; Continuous current: 30 A (Normally shipped with 12-20A limit)

Total wattage @25 deg C.:1200 Watts

The LCAM 5/15 series amplifier is a module style amplifier requiring an external unregulated single polarity DC power supply. H2W Technologies offers various unregulated power supplies for the LCAM 5/15 series amplifiers.

The LCAM 5/15series amplifier is also available in multi-axis configurations. That is, there are two basic baseplate assemblies namely 2-axis and 4-axis baseplate assemblies that have built-in AC to DC power supplies (un-regulated) and cooling fans. The 2-axis baseplate assembly contains one AC to DC power supply, one fan, and up to two LCAM 5/15 amplifier modules. The 4-axis baseplate assembly contains one AC to DC power supply, two fan, and up to four LCAM 5/15 amplifier modules. For multi-axis applications, it is always recommended to use three phases power transformers for minimizing ripple voltage during high current demand scenarios where all axis motors are running at full load simultaneously. H2W Technologies offers various isolated three phases power transformers.

2– Typical continuous internal rating of the amplifiers running at normal room conditions is:
LCAM 5/15 series; 250 Watts continuous

For most applications, the above heat sinking is adequate. However, if you have a usage mode where the heat sink temperature becomes excessive, please contact H2W Technologies and we can furnish a larger heat sink with greater air flow for your application.

Use the following relationships to calculate amplifier dissipation :

1) **$P_d = I_m \times V_b$ (watts)**

Where: P_d = Total watts delivered from bus

I_m = Motor current

V_b = Bus voltage

2) **$P_m = I_m \times V_m$ (watts)**

Where: P_m = Total power (watts) dissipated in motor

V_m = Motor voltage

3) **$P_a = I_m \times V_b - I_m \times V_m$**

Where: P_a = Total watts dissipated at amplifier

From the above relationship, it can be surmised that the worst case dissipation occurs when the amplifier has to deliver a high continuous current at a low motor speed, i.e., less motor BEMF and more current. For some applications, a power resistor can be added in series with the motor thus shifting some of the power dissipation from the amplifier to the resistor.

TECHNICAL SPECIFICATIONS

Output

- LCAM 5/15: 15A peak, 5A continuous, (forced air cooling required)
Note: Large motor and Small motor versions have different velocity loop compensation.

Input

- LCAM 5/15: 24-75VDC
- Integral forced air fan cooling (multi-axis LCAM 5/15 only)
- Analog command signals: differential & single ended, adjustable gain
- Reset: LCAM 5/15: pull up/pull down, active high only
- Inhibit: Same as Reset
- +/- Limits: Same as Reset

Output Connections

- Motor : MTR + & MTR-
- Fault out: LCAM 5/15: Optically isolated can sink up to 50 mA, active high only

Bandwidth

- 10 kHz maximum and varies with motor inductance

Status Indicator

- LCAM 5/15: Green Run LED, Red Inhibit LED, Red Fault LED

Mechanical

- LCAM 5/15 module: Height: 7.13", Width: 2.23", Depth: 5.69"
- LCAM 5/15 2-Axis: Height: 10.75", Width: 9.75", Depth: 6.93"
- LCAM 5/15 4-Axis: Height: 10.75", Width: 14.90", Depth: 6.93"

Environmental

- Operating temperature 0 to 55°C
- Storage temperature -40 to 80°C
- Humidity 5 – 95% relative (non-condensing)

STARTUP AND CALIBRATION

This section contains the procedure required for initial start up and amplifier calibration. The LCAM 5/15 series amplifier can be configured to run in velocity mode (x.x) and current mode (y.y).

Required Equipment: Oscilloscope, voltmeter & battery box. The battery box serves as a step input voltage command, applying and removing a flashlight battery can also be used for this function.

Refer to the technical specifications page and the drawings in the appendix for the information needed to supply the correct power and to wire the model you are starting up. An isolation transformer is needed for the multi-axis LCAM 5/15. An isolated power supply (unregulated is OK) providing the necessary voltage is required for the LCAM 5/15 module. H2W can provide appropriate transformers and power supplies. Consult an H2W applications engineer or sales person for assistance.

A. Initial Start Up:

When applying power to start up your amplifier system for the first time, we recommend you follow this procedure. If you have already gone through this procedure you can skip to the appropriate calibration procedure.

1. Check for any loose or damaged components.
2. Check that all connections are tight.
3. Be sure that the motor mechanism is clear of obstructions. If the mechanism has limited motion, e.g: a lead-screw, set the mechanism to mid-position.
4. Disconnect the signal and auxiliary inputs.
5. Be sure the Loop-Gain pot(s) are fully CCW (RV6 for LCAM 5/15). This will prevent the motor from running away in velocity mode when power is applied.
6. Check for the correct AC voltage before connecting to LCAM 5/15 multi-axis amplifier. The DC Bus (amplifier supply-voltage) will be 1.4 times greater than the AC value. If the voltage is correct, remove power and connect AC source to amplifier inputs. For the LCAM 5/15 module amplifier, check for the correct DC voltage before connecting to the amplifier power input.
7. Work on only one amplifier axis at a time for LCAM 5/15 multi-axis amplifiers.

B. Calibration of the Velocity Mode Amplifier (LCAM 5/15 Series):

The amplifier, in this configuration, receives an analog, bi-polar input command which is proportional to the motor velocity. The amplifier receives velocity feedback from a tachometer which is usually mounted to the rear of the motor. The following pots will be set during calibration: (Note: RV6 is a single turn pot and RV1-RV5 are 10-turn pots.)

Pots	Name of Pot	Notes
RV1	Signal Gain, SIG	Sets the input voltage to velocity ratio for signal input.
RV4	Tach Gain, TACH	Sets the DC tachometer gain.
RV6	Loop Gain, LOOP GAIN	Used to shut off uncalibrated amplifiers. When the loop gain is fully CCW, no current is delivered to the motor.
RV2	Balance, BAL	Used to null any offset in system.
RV3	Compensation, COMP	Used in conjunction with tach. gain to set the system bandwidth.
RV5	Current Limit, I LIMIT	Sets the maximum motor current. Shipped set CCW (min. current).

PROCEDURE:

1. Apply main power and fan power. Visually confirm a green LED. Depending on the configuration of the Inhibit, Reset and +/-Limits, it may be necessary to make appropriate connections to those terminals before the amplifier will be enabled and energize the motor.
2. Slowly turn the Loop Gain (RV6) CW fully. Motor should be stopped or turning slowly. If the motor starts running away, remove the power, reverse the tach leads, and retest.
3. Set Balance (RV2) for zero motor rotation.
4. Install a micro-shunt at J3 connector (across J3-1 to J3-2).
Note: For single-ended signal input amplifier, a micro-shunt is permanently installed at J3 connector. On the other hand, the micro-shunt should be removed for differential input amplifier after the calibration process.
5. Connect oscilloscope to J1-7 (MTR I) and battery box to J1-1 (J1-4 is common for both). The voltage on J1-7 is a function of motor current: $1V = 2.0A$. While applying a step input voltage, adjust Current Limit (RV5) for desired peak current.
The purpose of the following procedure is to set the system bandwidth to obtain a critically-damped response or a one hook overshoot response with the maximum possible Tach. Gain. There are many possible settings of Tach. Gain and Compensation which will yield the desired waveform: The optimum setting will occur when Tach Gain is as CW as possible and Compensation is as CCW as possible. However, the servo loop may become unstable (the motor oscillates or hunts) with a very low (near CCW) setting of Compensation. In this case, stability is the limiting factor: At no time should the servo-loop be allowed to be unstable. Amplifiers are normally shipped with the Tach. Gain (RV4) set at 100%. This is a good place to start. If you are unsure of where the Tach. Gain is set, turn the Tach Gain (RV4) fully CW (up to 10 turns).
6. Connect oscilloscope to J1-3 (TACH IN) and J1-4 is common. Set battery box for a DC signal output to obtain approximately 400RPM. The RPM may be set by measuring the tach voltage at J1-3, e.g., 2.8VDC for a 7V/KRPM tach is 400RPM.

7. Pulse the input and compare the waveform with figure B.

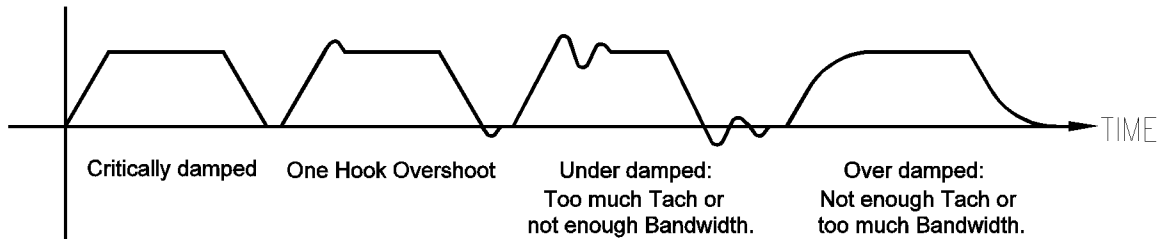


Figure B - Critically damped, One Hook Overshoot, Under and Over damped

8. Adjust the Compensation pot (RV3) CCW until the waveform is critically damped or one hook overshoot. Then proceed to step 10.
9. If the desired waveform cannot be obtained by adjusting the Compensation pot, back off the Tach Gain pot (CCW) a few turns and repeat step 8.
10. Do not adjust the Tach Gain or Compensation for the rest of the calibration procedure.
11. With battery box still connected at J1-1 and J1-4 for single-ended input (or if your system uses the Differential input, move battery box to J1-1 and J1-2, and remove micro-shunt at J3 connector), set battery box for a known DC voltage. Adjust the Signal Gain pot (RV1) to obtain the desired motor velocity.
12. If the motor is rotating in the wrong direction for a given input polarity, remove the power and reverse both the motor leads and the tach leads.
13. Remove the battery box, and repeat step 3.
14. Calibration complete. Reconnect signal wires.

C. Calibration of the Current Mode Amplifier (LCAM 5/15 Series):

The amplifier in this configuration, receives an analog, bi-polar input command which is proportional to the required motor current (motor torque). The following potentiometers (pots) will be set during calibration: (Note: RV6 is a single turn pot and RV1-RV5 are 10-turn pots.)

Pots	Name of Pot	Notes
RV1	Signal Gain, SIG	Sets the input voltage to velocity ratio for signal input.
RV4	Tach Gain, TACH	Sets the DC tachometer gain.
RV6	Loop Gain, LOOP GAIN	Used to shut off uncalibrated amplifiers. When the loop gain is fully CCW, no current is delivered to the motor.
RV2	Balance, BAL	Used to null any offset in system.
RV3	Compensation, COMP	Used in conjunction with tach. gain to set the system bandwidth.
RV5	Current Limit, I LIMIT	Sets the maximum motor current. Shipped set CCW (min. current).

PROCEDURE:

1. Apply main power and fan power. Visually confirm a green LED. Depending on the configuration of the Inhibit, Reset and +/-Limits, it may be necessary to make appropriate connections to those terminals before the amplifier will be enabled and energize the motor.
2. Slowly turn the Loop Gain (RV6) pot CW fully. The Motor should be stopped or turning slowly. Set the Balance (RV2) for 0V at J1-7 (MTR I).
3. Install a micro-shunt at J3 connector (across J3-1 to J3-2).
Note: For single-ended signal input amplifier, a micro-shunt is permanently installed at J3 connector. On the other hand, the micro-shunt should be removed for differential input amplifier after the calibration process.
4. Connect an oscilloscope to J1-7 (MTR I) and a battery box to J1-1 (J1-4 is common for both). The voltage on J1-7 is a function of motor current: $1V = 2.0A$. While applying a step input voltage, adjust the Current Limit (RV5) for the desired peak current. If the desired peak current cannot be achieved with the Current Limit pot full CW, increase the input Signal Gain (RV1) by turning in the CW direction.
5. With the battery box still connected at J1-1 and J1-4 for single-ended input (or if your system uses the Differential input, move battery box to J1-1 and J1-2, and remove micro-shunt at J3 connector), set the battery box for a known DC voltage. Apply \pm input signal pulses and adjust the Signal Gain pot (RV1) to obtain the desired current gain of the amplifier.
6. If the motor is rotating in the wrong direction for a given input polarity, remove the power and reverse the motor leads.
7. Remove the battery box, and repeat step 2.
8. Calibration complete. Reconnect signal wires.

D. Calibration Setup Record (LCAM 5/15 Series):

It is good practice to keep a record of all the pot settings. Doing so will facilitate calibration on future units and repair on this unit. Although not a substitute for the calibration procedure, it will at least get you "in the ballpark." Remove the power and allow all capacitors to discharge before taking measurements. Note: The balance pot should not be measured in this fashion, set per step 3 in the calibration procedure.

Pot/Dip-Switches	AMP1	AMP2	AMP3	AMP4
Signal Gain pot wiper TP2 to common (ohms):				
Tach Gain pot wiper TP3 to common (ohms):				
Compensation pot wiper TP4 to common (ohms):				
Current Limit pot wiper TP5 to common (ohms):				

Note: Tach voltage is measured at J1-3. Common for all measurements is at J1-4.

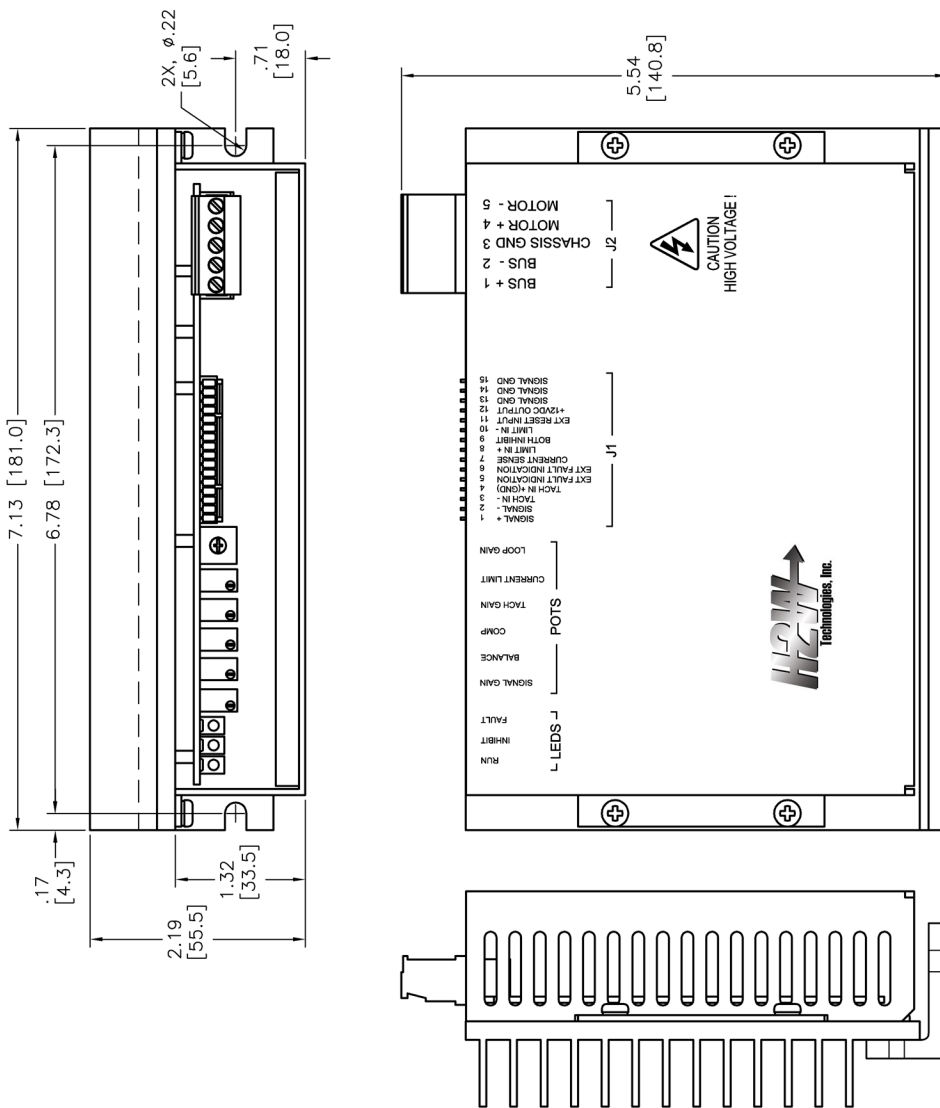
Date data taken: / /

Serial number S/N: _____

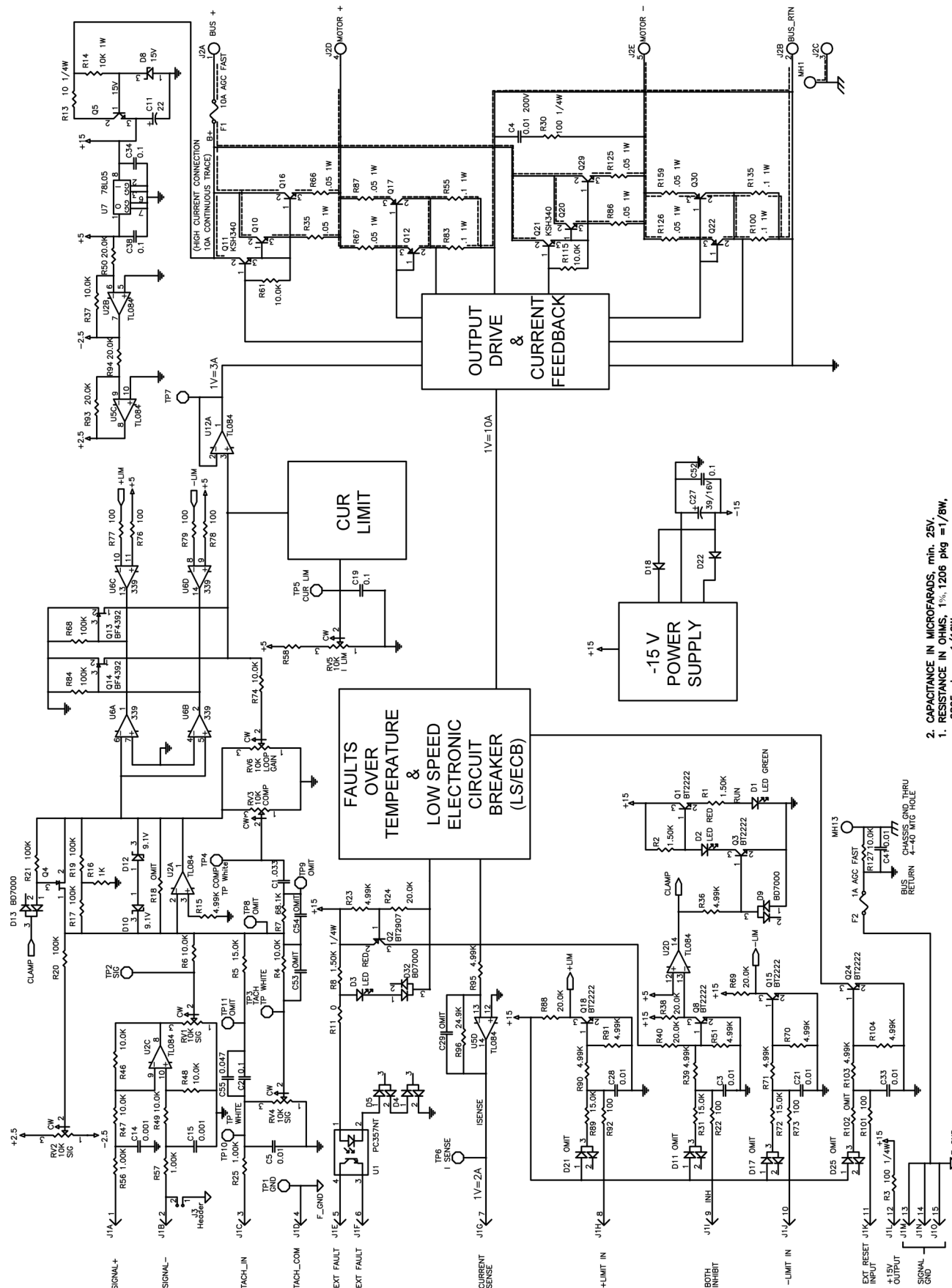
Model number: LCAM 5/15 _____

Note any changes to components or any special features in the space below:

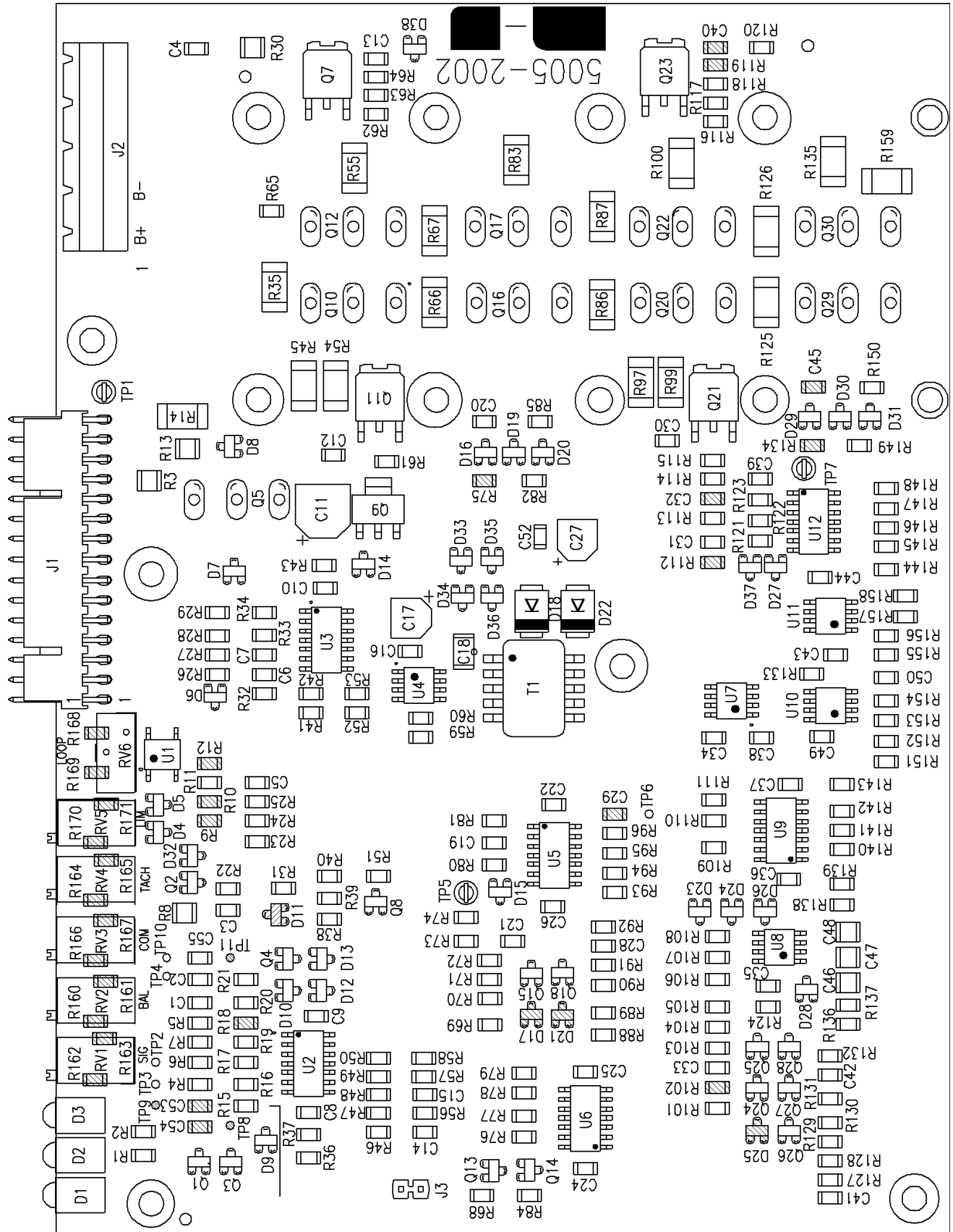
APPENDIX



Specifications and Features	
DC Bus Input Voltage	24 - 75 VDC max.
Peak Output Current	15 A @ 25°C Ambient (with forced air cooling)
Continuous Output Current	5.0 A @ 25°C Ambient (with forced air cooling)
Input Command Signal Gain	Adjustable
Low Speed Electronic Circuit Breaker (LS/ECB)	Latches when current exceeds ± 5 A to 2 seconds
Amplifier Over Temperature	Amplifier faults and is inhibited if the heat sink temperature reaches 75°C
Green Run LED	Amplifier enabled, normal operating condition
Red Inhibit LED	Amplifier disabled, non-latched condition (External Inhibited)
Red Fault LED	Amplifier over temperature or LS/ECB (Latched Condition)
Operating Temperature	0°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	5% to 95% non-condensing
Mating Connectors	
Motor and DC Input Connect- or (J2)	Phoenix P/N: 17 92 78 6
Signal Connector (J1)	Molex P/N: 22-12-2154-7478
Fuse Table	
DC Input BUS Fuse (F1)	10 A FAST, Bussman P/N: BK-AGC-10
Ground Fuse (F2)	1 A FAST, Bussman P/N: BK-AGC-1

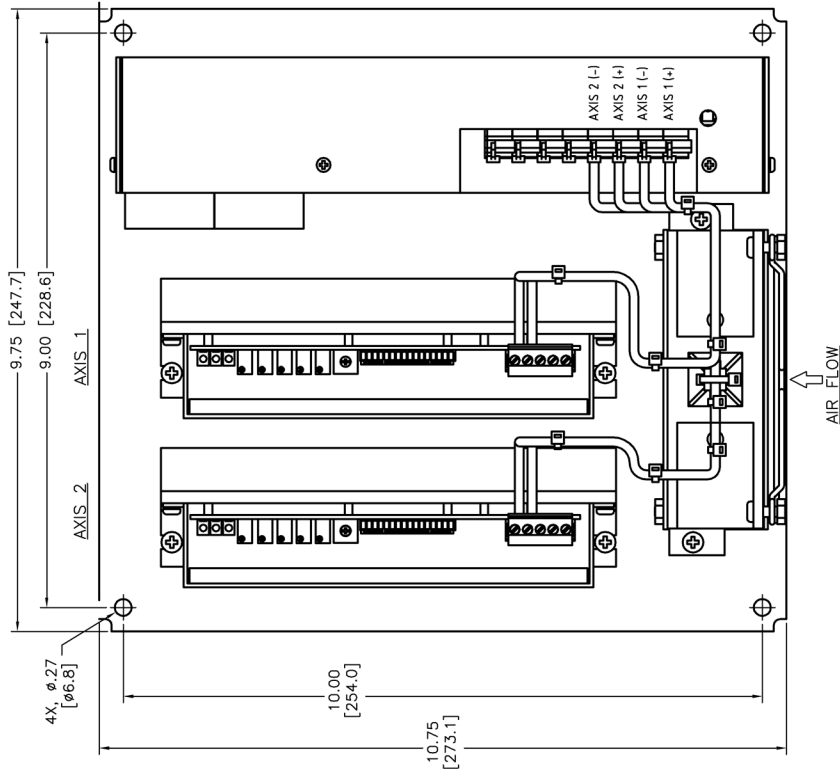
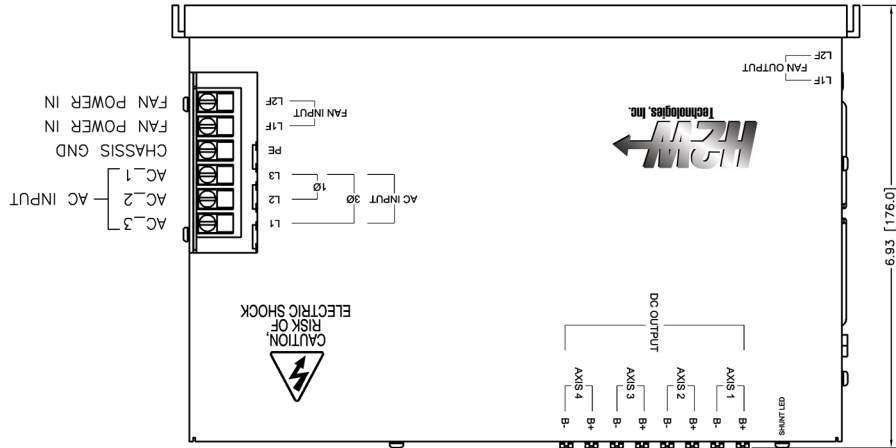


2. CAPACITANCE IN MICROFARADS, min. 25V.
 1. RESISTANCE IN OHMS, 1%, 1206 pkg = 1/8W,
 0805 pkg = 1/10W.
 NOTES: UNLESS OTHERWISE SPECIFIED.



LCAM 5/15 CIRCUIT BOARD ASSEMBLY

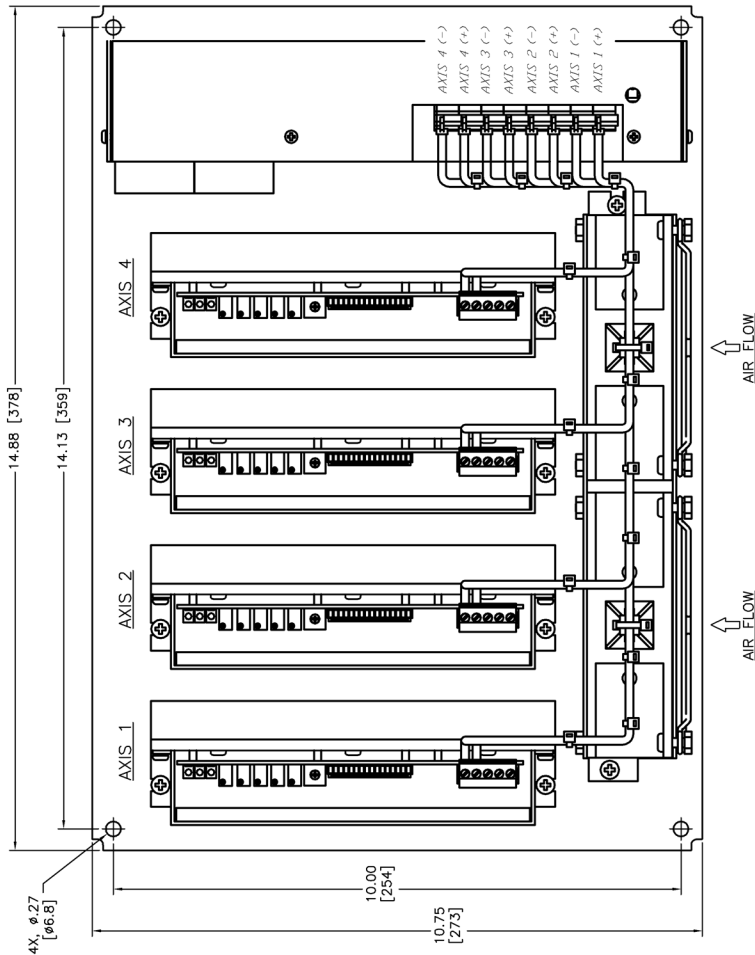
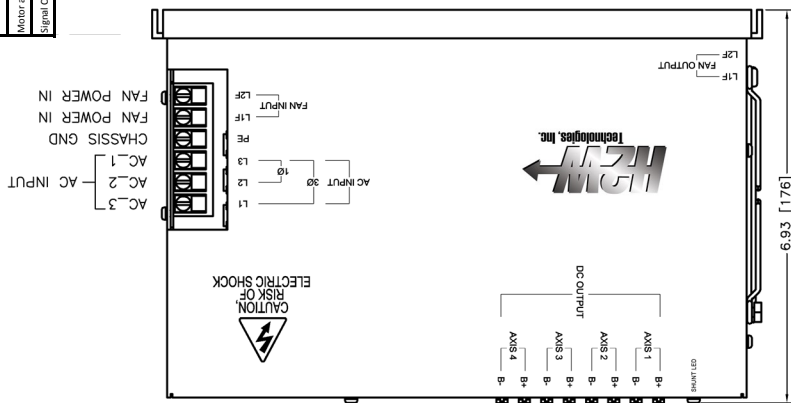
Specifications and Features	
AC Input Voltage	17-53 VAC, Single or Three Phase
Fan Input Voltage	110-130 VAC, Single Phase, 50/60 Hz
Derived DC Bus Voltage	Unregulated 70 VDC max. @ 50 VAC Input
Continuous Output Current	5.0 A @ 25°C Ambient (with forced air cooling) per amplifier
Amplifier Modules	LCAM 5/15 (QTY=4)
Wiring Connectors	
Motor and DC Input Connector	Phoenix P/N: 17-92-78-6
Signal Connector	Molex P/N: 22-12-2154-7478



- NOTE:
1. AC POWER INPUT IS APPLIED TO AC_1/AC_2 (SINGLE PHASE), OR AC_1/AC_2/AC_3 (THREE PHASES) OF POWER INPUT CONNECTOR. FAN POWER IS SINGLE PHASE ONLY.
 2. RECOMMEND WIRING TO BE 100% COPPER. USE SHIELDED CABLE (0.326 MM²) OR 24AWG (0.205 MM²).
 3. USE CRIMPING TOOL MOLEX ORDER NO. 11-01-0185 (CR26262).
 4. USE SHIELDED CABLE FOR COMMAND SIGNAL.
 5. RECOMMEND MOTOR OUTPUTS WIRING, 16AWG (1.31 MM²) OR LARGER, 105°C RATED PVC OR BETTER.
 6. RECOMMEND POWER INPUTS WIRING, 16AWG (1.31 MM²) OR LARGER, 105°C RATED PVC OR BETTER.
 7. NEVER GROUND THE OUTPUTS OF THE AMPLIFIERS.
 8. MINIMUM 8 INCHES OF SPACE AT BOTH ENDS AND TOP OF THE AMPLIFIERS TO ENSURE PROPER VENTILATION FOR THE UNIT.
 9. ALLOW 8 INCHES MIN. HEIGHT CLEARANCE.

LCAM 5/15-2A-2

Specifications and Features	
AC Input Voltage	17 - 55 VAC, Single or Three Phase
Fan Input Voltage	110 - 130 VAC, Single Phase, 50/60 Hz
Derived DC Bus Voltage	Unregulated 70 VDC max. @ 50 VAC Input
Continuous Output Current	5.0 A @ 25°C Ambient (with forced air cooling) per amplifier
Amplifier Modules	LCAM 5/15 (QTY4)
Mounting Connectors	
Motor and DC Input Connector	Phoenix P/N: 17-32-786
Signal Connector	Molex P/N: 22-12-2154-7878



- NOTE:
1. AC POWER INPUT IS APPLIED TO AC_1/AC_2 (SINGLE PHASE) OR AC_1/AC_2/AC_3 (THREE PHASES) AND THE POWER SUPPLY IS CONNECTED TO THE DC BUS.
 2. RECOMMEND SIGNAL WIRING TO MOLEX SOCKET CONNECTOR: 22AWG (0.326 MM²) OR 24AWG (0.205 MM²). USE CRIMPING TOOL MOLEX ORDER NO. 11-01-0185 (CR2262C).
 3. USE SHIELDED CABLE FOR COMMAND SIGNAL.
 4. RECOMMEND MOTOR OUTPUTS WIRING: 16AWG (1.31 MM²) OR LARGER, 105°C RATED PVC OR BETTER.
 5. RECOMMEND POWER INPUTS WIRING: 16AWG (1.31 MM²) OR LARGER, 105°C RATED PVC OR BETTER.
 6. MAINTAIN A MINIMUM OF 2" OF SPACE AROUND THE OUTPUTS OF THE AMPLIFIERS.
 7. PROPER VENTILATION FOR THE UNIT.
 8. ALLOW 8 INCHES MIN. HEIGHT CLEARANCE.

LCAM 5/15-4A-4



26470 Ruether Avenue #102, Santa Clarita, California 91350, USA.
Telephone: (661) 251-2081 | Fax: (61) 251-2067
www.h2wtech.com e-mail: info@h2wtech.com