MODEL ACE500-XXX-XXXX

User's Manual

Digital Velocity/Torque/Position Mode Servo Drive

This manual covers the use and maintenance of the model ACE500 series Torque, Velocity and Position mode brushless motor control product family.

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Installation and Operation

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Purpose of Documentation: This documentation describes…

- Installation and operation of the ACE500 drive.

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1 ACE500 Controller

1.1 Overview

This manual describes the installation and operation of the ACE500 series of digital high voltage servo-amplifiers manufactured by ElectroCraft MI, Inc.

This document applies to serial numbers ending with xxxx 0109 and beyond.

The ACE500 amplifier is:

- Configurable operation modes: Torque, Velocity, and Position.
- Selectable BLAC (sine wave, flux vector) or BLDC (Six step, trapezoidal) commutation.
- 4 Quadrant performance.
- Phase output, PWM controlled output.
- Full digital control of all loops
- Variable servo rate from up to 10 kHz.
- Loop tuning via serial interface (No potentiometers!).
- Drive setup & status information available serially via RS232 link.
- 90 – 254 VAC input power supply range.
- Output current of 7.5 Amp continuous, 15 Amp peak.
- Compact package size.
- **ElectroCraft CompletePower™ Plus** graphical windows interface for Setup, Configuration and Tuning.

Software

For further documentation support of software and its usage, refer to the **ElectroCraft CompletePower™ Plus** software user's manual.

Parameters and Variables

For further documentation support of parameters, variables, commands and graphing refer to the ElectroCraft Parameter Guide.

2 ACE500 Introduction

2.1 Amplifier

The ACE500 is a fully digital servo amplifier that uses DSP technology to provide a powerful feature set that is fully configurable by means of a RS232 serial port. The ACE500 servo drive is configurable as a Torque, Velocity, or Position mode servo amplifier. The ACE500 is designed to operate a single 3 phase Brushed or Brushless DC or AC, permanent magnet motor. The motor may have either a WYE or Delta wound stator. The ACE500 provides commutation using Hall sensors or encoder feedback.

The ACE500 Torque, Velocity or Position modes accept +/- 10 volt DC analog or digital PWM.

2.2 Theory of Operation

The ACE500 operates as a "mode configurable" digital servo amplifier. This product is typically applied as a component within an end use industrial application. Within industry, application requirements for servo amplifiers vary widely. For example, one application may require an amplifier with an analog input reference for speed. Another application may require an amplifier that offers torque control and Hall sensor commutation only. For this reason the ACE500 offers a choice of many different servo-operating modes. This flexibility is made possible because all of the control functions within the ACE500 are implemented in software. The ACE500 physical I/O and closed loop functionality are selected using the **ElectroCraft CompletePower™ Plus** software setup utility. See Section 7, Introduction to the **ElectroCraft CompletePower™ Plus** software, and the **ElectroCraft CompletePower™ Plus** software User Manual for additional information on using this software.

The internal firmware architecture of the ACE500 is modular. ACE500 software is built as a series of components (or modules) that are linked together to form an ACE500 servo-operating mode. ACE500 software components are stored in ROM memory as a run time library. These components exist as Reference input modules, Feedback modules, PI (D) control modules, commutation modules and firmware extension modules.

3 Product Safety Precautions

READ THIS ENTIRE SECTION BEFORE ATTEMPTING TO USE THE ACE SERVO DRIVE! GIVE SPECIAL ATTENTION TO ALL BOLD PRINT ITEMS.

WARNING!

THIS PRODUCT USES HIGH VOLTAGE ELECTRIC POWER AND POSES A SHOCK HAZARD TO THE USER.

To operate your control successfully, these minimum safety precautions MUST be followed to insure proper performance without injury to the operator and damage to motor or control. **FAILURE TO OBSERVE THESE SAFETY PRECAUTIONS COULD RESULT IN SERIOUS BODILY INJURY, INCLUDING DEATH IN EXTREME CASES.**

3.1 Operation

1. Do not touch any of the output connector pins from connectors P1, P2, or P3 when power has been applied. The voltages at these connector pins are dangerous and can produce an electric shock. Bare wires from adjacent connector pins must never be allowed to touch one another.

2. The ground stud, must be connected to an external earth ground. Follow wiring procedures carefully. Know and understand which connectors are NOT electrically isolated from the AC/DC voltages within the drive.

3. Always operate the control within the prescribed voltage limits. Any attempt to operate outside these bounds may result in damage to the unit.

4. Read ElectroCraft's Life Support Policy in section 3.5 for application limitations.

5. Follow precautionary guidelines in this manual with regard to proper installation of an external shunt resistor. See Section 14 of this manual.

6. Do not operate the control in an explosive area or near explosive or flammable materials.

7. Do not use the control in environments where it is likely to be exposed to strong and/or frequent static discharge.

8. Conduct trial operations on the servo drive alone with the motor shaft disconnected from the machine to avoid any unexpected accidents. Motor shaft should be uncoupled and free to rotate without coming in contact with user or any stationary object during set up and preliminary operation.

9. Under no circumstances should a phase output from the control be connected to anything other than a passive inductive/resistive motor load. Short circuit protection for the drive is limited to momentary conditions only! Repetitive short circuits on any of the output pins for P3 will likely cause permanent damage to the ACE500.

10. Never touch any moving parts while the motor is running. Failure to observe this warning may result in injury.

11. Excessive speed and current can destroy some motors and possibly injure the user. Check the motor manufacturer's specifications to ensure that the maximum current and voltage for your control model, does not exceed their limitations.

12. External methods are advisable to limit both the top speed and travel motion of the motor and its load. Whenever the ACE500 drive is disabled for any reason, the motor is placed into a free/spinning coast mode.

13. When using the servomotor for a vertical axis, install safety devices to prevent work pieces from moving due to occurrences of over travel. Failure to do this may cause injury to work pieces or person.

14. Provide an appropriate stopping device on the machine side to ensure safety. A holding brake for a servomotor with brake is not a stopping device for ensuring safely. Failure to observe this warning may result in injury.

15. Do not parallel multiple motors off the same control.

16. Do not make any extreme adjustments or settings changes of parameters. Failure to observe this caution may result in injury due to instable operation.

17. Do not turn the control on or off frequently unless necessary. Failure to observe this caution may cause internal parts to deteriorate.

18. Avoid plugging connector P1 into the control while live power is applied to the connecting cables. Ignoring this precaution will cause electrical arcing at the connector pins, which can cause permanent connector damage.

19. Do not remove the connectors on ports J2, J3, P1, P2, or P3 from the control while the motor is operating.

20. Do not remove the cover if one has been supplied. Each model has dangerous voltages on the circuit boards and may store a high voltage charge for several minutes after being disconnected.

21. Do not damage, press, exert excessive force or place heavy objects on the cables. Failure to observe this warning may result in electric stock, stopping operation of the product, or burning.

22. Do not service or modify this product. Only authorized personnel must perform disassembly or repair of the drive. Failure to observe warning may result in injury or damage to product.

23. To avoid a shock hazard always wait at least 5 minutes <u>after</u> disconnecting power from P1 before physically touching any internal circuits or external terminals. Residual voltage may cause electric shock. If necessary, use a functioning voltmeter to be certain that all high voltage capacitors inside the ACE500 are fully discharged before physically touching internal circuits or external terminals.

3.2 Storage and Transportation

1. Do not store or install the product in the following place
    a. Locations subject to temperature outside of the range specified.
    b. Locations subject to humidity outside the range specified.
    c. Locations subject to condensation as the result of extreme changes in temperature.
    d. Locations subject to corrosive or flammable gases and liquids.
    e. Locations subject to dust, salts, or iron contaminants.
    f. Locations subject to exposure to water, oil, or chemicals.
    g. Locations subject to shock or vibration.

    Failure to observe this caution may result in fire, electric shock, damage to the product.

2. Do not hold the product by the cables or motor shaft while transporting it. Failure to observe this caution may result in injury or malfunction.
3. Store the ACE500 drive when not in use, in temperatures between -20 to +85 degrees C.

3.3 Installation

1. Take appropriate and sufficient countermeasures when installing systems in the following locations.
    a. Locations subject to static electricity or other forms of noise.
    b. Locations subject to strong electromagnetic fields and magnetic fields.
    c. Locations subject to possible exposure to radioactivity.
    d. Locations close to power supplies including power lines.

    Failure to observe this caution may result in damage to the product.

2. Keep any external shunt resistor away from flammable materials. Read Section 14 carefully for more shunt installation details.

3. Never use this product in an environment subject to liquids, corrosive chemicals or gases, or combustibles, or where foreign materials are allowed to fall onto or collect inside the drive Failure to observe this caution may result in electric shock or fire.

4. Do not place heavy objects on the product. Failure to observe this warning may result in stopping operation of the product.

5. Do not cover or prevent air from escaping or entering through the vents with obstruction or foreign object. Failure to observe this caution may cause internal elements to deteriorate resulting in malfunction or fire.

6. Provide the specified clearance between the drive and the control panel or with other devices. Provide sufficient space around the drive for cooling by natural convection or provide cooling fans to prevent excessive heat, see section 5.3 for details. Failure to observe this caution may result in fire or malfunction.

3.4 Wiring

1. Verify **ALL** wiring **BEFORE** applying power to the control and motor. Motor may spin or oscillate uncontrollably if improperly wired. Drive may be damage or improper wiring may prevent drive from operation.

2. The threaded ground stud **MUST** always be mechanically and electrically connected to an appropriate external earth ground.

3. Connect the ground terminal to the electrical codes (ground resistance should be less than 10 ohms. Improper grounding may result in electric shock or fire.

4. Do not connect three-phase or any supply power to the U, V, and W terminals. Failure to observe this caution may result in injury or fire.

5. Securely connect the power supply terminals and motor output terminals. Failure to observe this caution may result in fire.

6. Do not bundle or run power and signal lines together in the same duct. Keep power and signal lines separated by at least 30cm.

7. Use twisted-pair shielded wires or multi-core twisted pair shielded wires for signal and encoder feedback lines.

8. Always use the specified power supply voltage. An incorrect voltage may result in burning. Be particularly careful where the power supply is unstable. An incorrect power supply may result in damage to the product.

9. Install external breakers or other safety devices against short-circuiting in external wiring. Failure to observe this caution may result in fire or damage to the control.

3.5 Life Support Policy

READ THIS ENTIRE SECTION BEFORE ATTEMPTING TO USE THE ACE500 SERVO DRIVE! GIVE SPECIAL ATTENTION TO ALL BOLD PRINT ITEMS.

ElectroCraft's products are not authorized for use as critical components in life support devices or systems without the express written approval from ElectroCraft MI, Incorporated.

1. Life support devices or systems, are devices or systems which are intended for surgical implant into the body, or support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the User's Manual and in the labeling, can be reasonable expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

4 Checking Product on Delivery

When your package arrives, inspect the shipping box and the unit carefully, and save ALL packing materials. Compare the packing slip against all items included in the shipping box. Any shortages or other inspection problems should be reported to ElectroCraft immediately.

The following procedure is used to check products upon delivery. Check the following items when your ACE500 is delivered.

- Verify that the model number marked on the nameplate of the drive(s) is the correct model ordered.
- Check the overall appearance. Check for damage or scratches that may have occurred during shipping.

If any damage, or if the unit is the wrong type, contact your ElectroCraft sales representative immediately.

Your ACE500 has arrived carefully packaged from ElectroCraft MI, in an antistatic bag. As you unseal this bag, inspect the contents carefully. There should not be any loose or damaged parts inside.

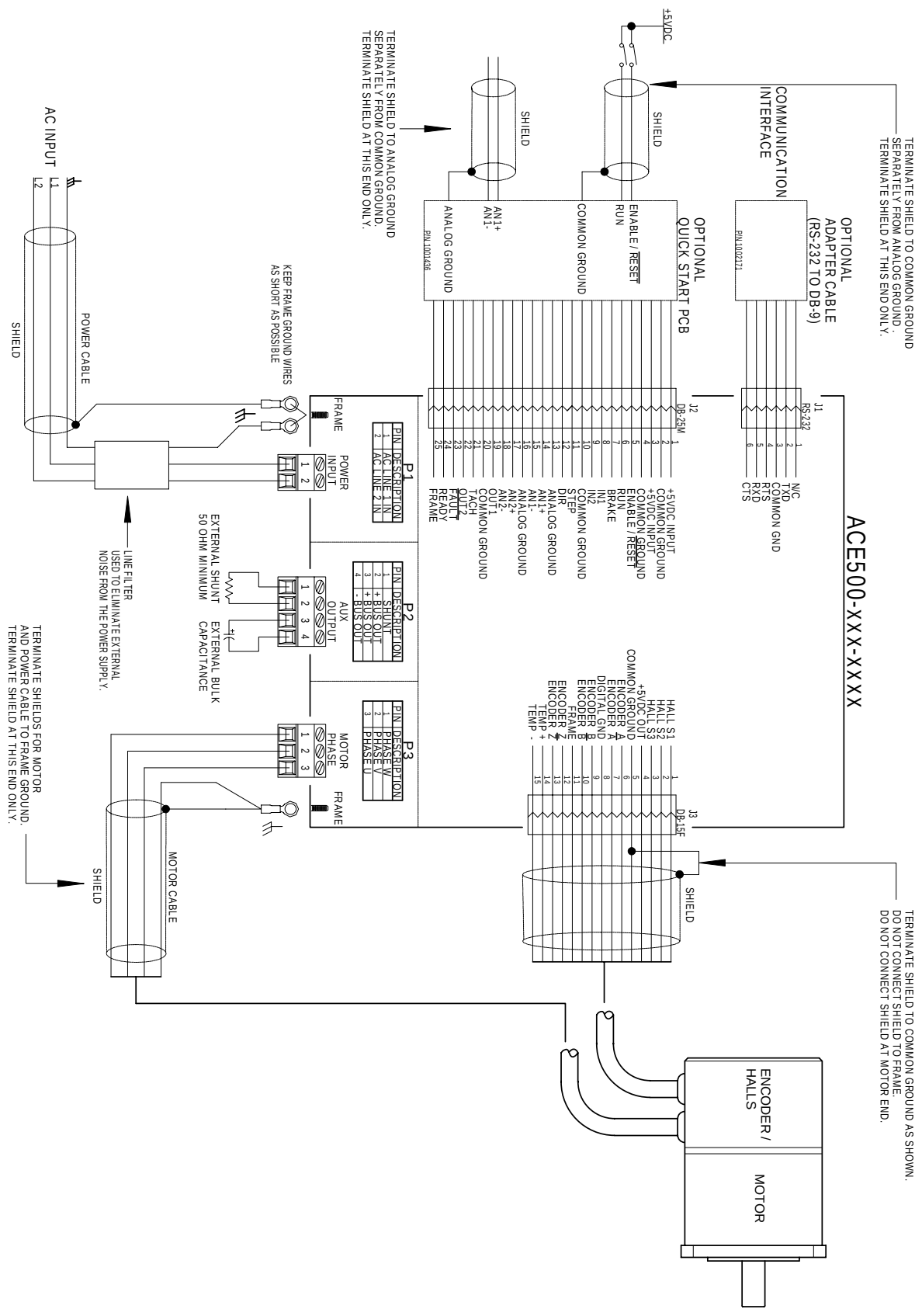
Never attempt to operate or power-up the drive if there is any visible external damage or if it sounds as though there are loose materials inside the chassis. While unpacking, if you discover any loose or damaged parts, notify ElectroCraft within two working days.

ElectroCraft recommends that all packing materials be saved in the event that the ACE500 needs to be shipped back. Always place the ACE500 in the same antistatic bag used in the original shipment. Abundant anti-static filler material should always be placed around the ACE500 so that it cannot shift inside the box. Extreme care should be exercised when placing packing material around all external connectors to prevent mechanical stress damage.

All material to be returned to ElectroCraft must have a Return Material Authorization (RMA) tracking number assigned before shipment. This may be obtained by contacting the ElectroCraft Service Dept. Any product returned without this number will be rejected by ElectroCraft.

Always insure your shipment for the proper replacement value of its contents. ElectroCraft will not assume responsibility for any returned goods that have been damaged outside of our factory because of improper packaging or handling. All goods shipped to ElectroCraft must be shipped FREIGHT PREPAID.

5 Recommended Cabling and Installation



6 ACE500 Installation and Setup

READ ENTIRE USER MANUAL FIRST BEFORE ATTEMPTING TO USE THIS PRODUCT.

If you require further assistance then provided within this manual, please email, call, or fax:

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This chapter presents installation procedures and instructions on how to setup your ACE500 drive.

WARNING!

HIGH VOLTAGE MAY BE PRESENT AT THE P2 CONNECTOR.

If the user adds supplemental external capacitance via terminal P2, provisions should be made by the user to rapidly bleed this high voltage energy down to safe levels whenever the user's power source is disconnected from the system. Bleeder resistors are frequently used for this purpose. It will be necessary for the user to size this discharge method appropriately. The objective is to reduce the motor rail voltage down to safe levels (generally below +40 Volts DC) within an acceptable time period after the user's external power source is turned off or disconnected.

6.1 Mounting the ACE500

Use this preferred hardware type, see table below, for mounting your ACE500 drive. Mount your ACE500 in the following manner.

Base Mounted	Four M4/ No. 8 screws. Include spring (locking) washer with plain washer.	Customer supplied
Rack Mounted	Two M4/ No. 8 screws. Include spring (locking) washer with plain washer	Customer supplied

Weight: 0.86Kg (1.9lb)
Size: 6.9" (175mm) x 5.2" (132mm) x 1.95" (50mm) without heatsink.

6.2 Environmental Conditions in the Control Panel

- Storage Temperature: -20-85 degree C
- Humidity: 5-95%RH, Non-condensing
- Operating Temperature range: 0-50 degree C
- Vibration: Install a vibration isolator beneath the drive to avoid subjecting it to vibration.

6.3 Installation in the Control Panel

Base Mount

Install the ACE500 parallel to the wall so that the front (containing connectors) faces preferably left or right.

When installing the ACE500, provide at least 10 mm (0.39 in) between units or control panel and at least 50 mm (1.97 in) above and below each drive. Install cooling fans above or below the drive to maintain a constant temperature inside the control panel and to prevent an excess temperature rise around the drive.

Rack Mount

Install the ACE500 vertical to the wall so that the front (containing connectors) faces outward.

When installing the ACE500 side by side, provide at least 10 mm (0.39 in) between units or control panel and at least 50 mm (1.97 in) above and below each drive. Install cooling fans above or below the drive to maintain a constant temperature inside the control panel and to prevent an excess temperature rise around the drive.

6.4 Simplified ACE500 Internal Block Diagram

This following diagram is provided to familiarize the user with the internal architecture of the ACE500. An internal digital signal processor (DSP) is used to read I/O signals, motor feedback signals and to process serial communication messages. ROM memory inside the ACE500 is used to store a library of modular software components. RAM memory is used for data logging and graphical tuning of the ACE500. The serial EEPROM provides nonvolatile memory for retention of user-configured parameters and operating mode. EEPROM memory is also used to extend the program functionality of the ACE500.

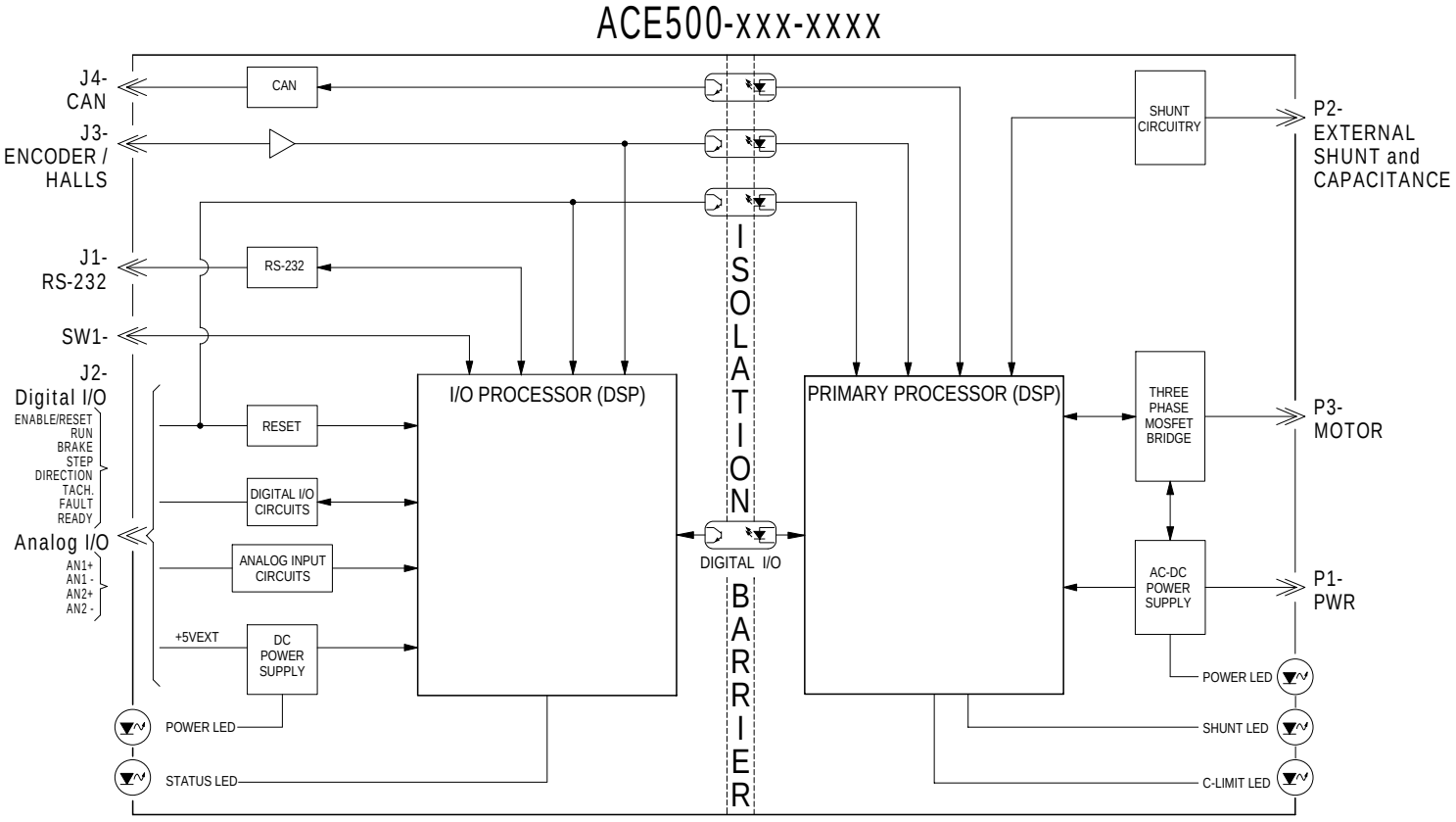


Figure 1: ACE500 Block Diagram

6.5 ACE500 Connector Description

Drive specific I/O operates independent of the user selected operating mode. Dive specific I/O signals have fixed functionality. These signals are used to interface the ACE500 to an outside control system. They provide "hand shaking" signals for enabling, disabling, and monitoring the status of the ACE500. For visual reference to the ACE500 connectors, see Figure 2 below.

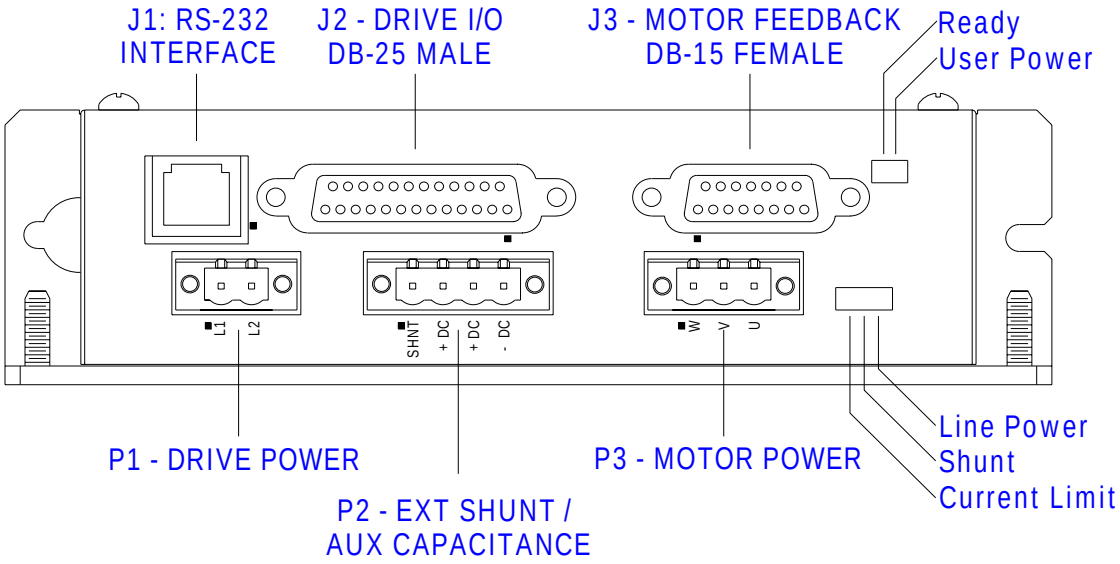


Figure 2: ACE500 Connector Layout

6.5.1 J1 Connector: RS-232 Communications Port, RJ-11 (6-pin)

Pin #	I/O	Description
1	N/C	No Connect.
2	TX	RS232 TXD Output, RS232 signal level.
3	GND	Common
4	RTS	RS232 RTS Output, RS232 signal level.
5	RX	RS 232 RXD Input, RS232 signal level.
6	CTS	RS 232 CTS Input, RS232 signal level.

6.5.2 J2 Connector: User I/O Control, DB-25 plug with metal shell

Pin #	I/O	Description
1	Input	+ 5 volts DC Power. User supplied regulated +5VDC power. 250 mA.
2	Input	Common Return
3	Input	+ 5 volts DC Power. User supplied regulated +5VDC power. 250 mA
4	Input	Common Return
5	Input	Enable/Reset Control Signal Input; TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. Positive true logic. Forces a master hardware reset for entire drive on a falling edge. Drive recovers beginning after rising edge. Drive remains disabled while a logic "0" is applied to this input. When Enabled (logic "1" applied), the active inrush current limit relay will close after a 3 second delay. After this delay, the drive will be allowed to enter Run Mode as commanded by the Run Command Signal Input on pin 6.
6	Input	Run Command Signal Input; TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. Positive true logic. A logic "1" state will allow motor commutation once some level of current is commanded. A logic "0" state places motor into a coast state.
7	Input	Dynamic Brake Command Signal Input; TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. Positive true logic. A logic "1" state will suspend motor commutation and current delivery from drive. It shorts all three motor phases together to cause the motor's BEMF to generate a dynamic braking torque within the motor.
8	Input	General Purpose Digital Input; TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. This input function is application specific. *Or* I2C Clock Input. 0V - +5V input signals
9	Input	General Purpose Digital Input; TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. This input function is application specific. *Or* I2C Data Input. 0V - +5V input signals
10	Input	Common Return
11	Input	Step or PWM Input; 0 to +5 VDC logic signal. TTL compatible. 10K ohm internal pull down. Used in step and direction mode. Used with direction input.
12	Input	Direction Input; Zero to +5 Volt logic signal. TTL compatible. +5.5 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm internal pull down. Selects relative direction of "Step" command.
13	Input	Analog Common.
14	Input	AN1+ Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
15	Input	AN1- Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
16	Input	Common Return
17	Input	AN2+ Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor

		torque. Input is protected to ±24 Volt maximum.
18	Input	AN2- Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
19	Output	General Purpose Digital Output. TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. This output function is application specific.
20	Input	Common Return
21	Output	Tachometer Signal Output. 250 Ohm output impedance. Zero to +5 Volt logic signal.
22	Output	General Purpose Digital Output. TTL compatible. +24 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm input impedance. This output function is application specific.
23	Output	Fault Signal Output. 250 Ohm output impedance. Zero to +5 Volt logic signal. Negative true output signal. Logic "1" state indicates drive is NOT in a Fault mode.
24	Output	Ready Output; 0 to +5 VDC logic signal. Logic 0 when drive is in "Standby" or "Reset". Logic 1 when drive is in "Run" mode and ready to deliver current.
25	-	Frame Ground (OPTIONAL). Factory option to connect to servo drive frame. Its configuration for this purpose may violate certain safety agency requirements. Consult ElectroCraft.
26	-	J1 Connector Frame. Connector shell is connected to servo frame ground.

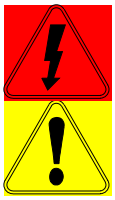
6.5.3 J3 Connector: Motor Feedback, DB-15 Receptacle w/ metal shell

Pin #	I/O	Description
1	Input	Hall signal Input S1.
2	Input	Hall Signal Input S2.
3	Input	Hall Signal Input S3.
4	Output	+5 Volt DC Hall/Encoder supply voltage.
5	Output	Common
6	Input	A Encoder Signal Input.
7	Input	!A Encoder Signal Input.
8	Output	Common
9	Input	B Encoder Signal Input.
10	Input	!B Encoder Signal Input.
11	-	Factory Optional Servo Frame Ground. Normally this pin is not connected.
12	Input	Z Encoder Signal Input.
13	Input	!Z Encoder Signal Input.
14	Input	PTC/thermal switch contact for motor temp sensing.
15	Input	PTC/thermal switch contact for motor temp sensing.
Case	-	J2 Connector Frame. Connector shell is connected to servo frame ground.

6.5.4 J4 Connector: Dual CAN Communications Ports, RJ-45 Receptacle

Pin #	I/O	Description
1	In/Out	CAN HI. CAN Bus Communication
2	In/Out	CAN LOW. CAN Bus Communication
3	In	Common Return
4	-	NO CONNECT
5	-	NO CONNECT
6	In	CAN SHIELD
7	In	CAN GROUND
8	In	+ 5 V

Note: These are optional connectors that are wired in parallel: The same pin out for both connectors.



WARNING!

THIS PRODUCT USES AN INTERNAL OR EXTERNAL SHUNT RESISTOR, PRECAUTIONS MUST BE FOLLOWED TO PREVENT A POSSIBLE FIRE HAZARD.

The connectors P1 and P2, shown below have **High Voltage** power applied to several of the associated pins. Use extreme care when making wire connections to them. All external electrical power should be OFF whenever wiring to these connectors to avoid a shock hazard. Refer to the Product Safety Precaution, section 3.

The use of shunt resistor, either internal or external, requires careful placement to avoid a possible fire hazard. See section 14 of this manual for further precautionary details

For information pertaining to mating connectors, refer to section 12.

6.5.5 P1 Connector: AC/DC Power Input, plug

Pin #	I/O	Description
1	AC Input	90 to 254 VAC, 50/60 Hz, 1 Phase AC or ±120 to 360 Volts DC
2	AC Input	90 to 254 VAC, 50/60 Hz, 1 Phase AC or ±120 to 360 Volts DC

6.5.6 P2 Connector: External Shunt Resistor or External Supplemental capacitance, plug.

Pin #	I/O	Description
1	Output	Shunt Resistor. Connection for external user supplied shunt resistor. The other side of the external shunt resistor connects to terminal 2 or 3.
2	Output	+Bus Motor Rail. High Voltage DC positive rail for motor power. This terminal is used for connecting external supplemental capacitance and/or an external user supplied shunt resistor. Peak voltage is at this terminal.
3	Output	+Bus Motor Rail. High Voltage DC positive rail for motor power. This terminal is used for connecting external supplemental capacitance and/or an external user supplied shunt resistor. Peak voltage is at this terminal.
4	Output	- Bus Motor Rail. High Voltage DC negative rail for motor power. This terminal is used for connecting external supplemental capacitance supplied by user.

6.5.7 P3 Connector: Motor Phase Output, plug.

Pin #	I/O	Description
1	Output	Motor Phase 1: Peak voltage out of this terminal is dependent upon the incoming crest voltage on connector P1. Peak amperage is model dependant.
2	Output	Motor Phase 1: Peak voltage out of this terminal is dependent upon the incoming crest voltage on connector P1. Peak amperage is model dependant.
3	Output	Motor Phase 1: Peak voltage out of this terminal is dependent upon the incoming crest voltage on connector P1. Peak amperage is model dependant.

7. ACE500 Status LED's

7.1. User Ready "Status" LED (Yellow)

FLASH CODE	DESCRIPTION	POSSIBLE CAUSE	RESULT	RECOVERY METHOD
ON Steady	ACE500 is in RUN mode.	User commanded RUN mode via user interface or RS232 port.	Commanded power delivered to motor	NA
OFF	Processor is in reset or programming state.	Enable line low. CTS line on RS232 port is high.	Drive inoperable	Set enable line low and CTS line high.
16 Rapid flashes	Line side processor inoperable.	Line side processor not programmed, programmed incorrectly, or hardware problem.	Drive inoperable.	Flash new program into line side processor.
1	Drive is in Standby mode	The drive will not deliver current to the motor.	Motor phases not connected to drive.	Command RUN mode via RUN line.
2	Phase short.	Phase shorted or low impedance.	Drive placed in standby.	Correct short and toggle the RUN line.
3	1.8 Volt Fault.	Hardware or line power problem.	The drive is placed in standby mode.	Correct power problem and toggle the RUN line.
4	5 Volt Fault or 15 Volt Fault.	Hardware or line power problem.	The drive is placed in standby mode.	Correct power problem and toggle the RUN line.
5	PM or MT	Power module damaged or motor temp. high.	The drive is placed in standby mode and faults.	Correct over temperature and toggle the RUN line.
6	B+ Low.	Hardware or line power problem.	The drive is placed in standby mode.	Correct power problem and toggle the RUN line.
7	B+ High	Hardware or line power problem, or too much regeneration, due to aggressive deceleration.	The drive is placed in standby mode.	Correct problem and toggle the RUN line.
8	Shunt Fault	Shunt is on continuously longer than 5 seconds.	The drive is placed in standby mode.	Toggle the run line. If repeated faulting occurs, consider selecting a larger shunt.
9	Power Module Fault		The drive is placed in standby mode.	Toggle the RUN line.
10	Memory Fault	Either line side processor program checksum fault or new version installed on line side processor.	The drive is placed in standby mode.	Either follow instructions for installing new firmware or reprogram processor and then toggle the RUN line.
11	Locked Rotor Fault	Delivered current exceeded locked rotor current for a period exceeding selected safe limit without a new Hall state.	The drive is placed in standby mode.	Change locked rotor parameters or free motor and toggle RUN line.
12	Line Side Communications Fault	Hardware problem or software timing problem causing loss of communication detected by line side.	The drive is placed in standby mode.	Toggle RUN line or toggle Enable line, then RUN.
13	SELV 5 Volt Fault.	Incorrect user supplied 5 Volt supply.	The drive is placed in standby mode.	Correct user supply and toggle RUN line.
14	SELV side Communications Fault	Hardware problem or software timing problem causing loss of communication detected by SELV side.	The drive is placed in standby mode.	Toggle RUN line or toggle Enable line, then RUN.
15	Over Speed Fault	Motor rpm> VL.LV	The drive is placed in standby mode.	Toggle RUN line or toggle Enable line, then RUN.

Note: To toggle the run command, set the Run/! Standby signal logic '0' state for 100mS, then back to a logic '1'

7.2. User Power LED (Green)

LED	Description	Possible Cause	Result	Recovery Method
ON	+5 VDC Power Indicator	On if user power is on	Required to Run	N/A
OFF	+5 VDC Power Indicator	No user supplied +5 volts	Drive will not Run	Apply +5volts

7.3. Line Side Power LED (Green)

LED	Description	Possible Cause	Result	Recovery Method
ON	+5 VDC Power Indicator	Logic power is on	Required to Run	N/A
OFF	+5 VDC Power Indicator	Logic power is not on	Drive will not Run	Check AC power

7.4. Line Side Current Limit LED (Red)

LED	Description	Possible Cause	Result	Recovery Method
ON	Steady State	Drive in Reset		Toggle the DRIVE ENABLE signal
ON	During Power Up	Soft Charge (Relay Opened)		Allow 5 second power-up delay to allow internal capacitors to charge.
OFF		N/A	Soft Charge Complete (Relay Closed)	N/A
DIM	Flickering – Drive current limit	Current is sensed to be more than the calibrated drive capacity		N/A

7.5. Line Side Shunt Status LED (Yellow)

LED	Description	Possible Cause	Result	Recovery Method
ON		B+ Rail is high, above the Shunt turn on limit of 390V	The shunt resistor is turned on	
OFF		B+ Rail is below the shunt turn off limit of 375V	The shunt resistor is turned off	

8. Introduction to ElectroCraft CompletePower™ Plus Software

ElectroCraft CompletePower™ Plus is a Windows-based program used for setup, configuration, system diagnostics and motion control management. **ElectroCraft CompletePower™ Plus** will lead the user through a step-by-step Wizard to create the correct parameter configuration and information required for the user to run a particular motor with a particular drive. The result will be an "Application" containing all of the configuration information required to run the motor with the drive.

This section is described within the software user manual: **ElectroCraft CompletePower™ Plus** software users manual. Please refer to the software user's manual for full documentation support to properly configure and operate your drive.

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9 Recommended Minimum Hookup

Apply DC voltage to the Quick Start I/O interface:

a. J1 pin 1/2: +5VDC.
b. J1 pin 9/10: Common return

For additional information pertaining to the optional Quick Start I/O Board, refer to document: Quick Start User Guide.doc(x) located at the ElectroCraft web site.

9.1 Quick-Start I/O Test Interface Setup Diagram

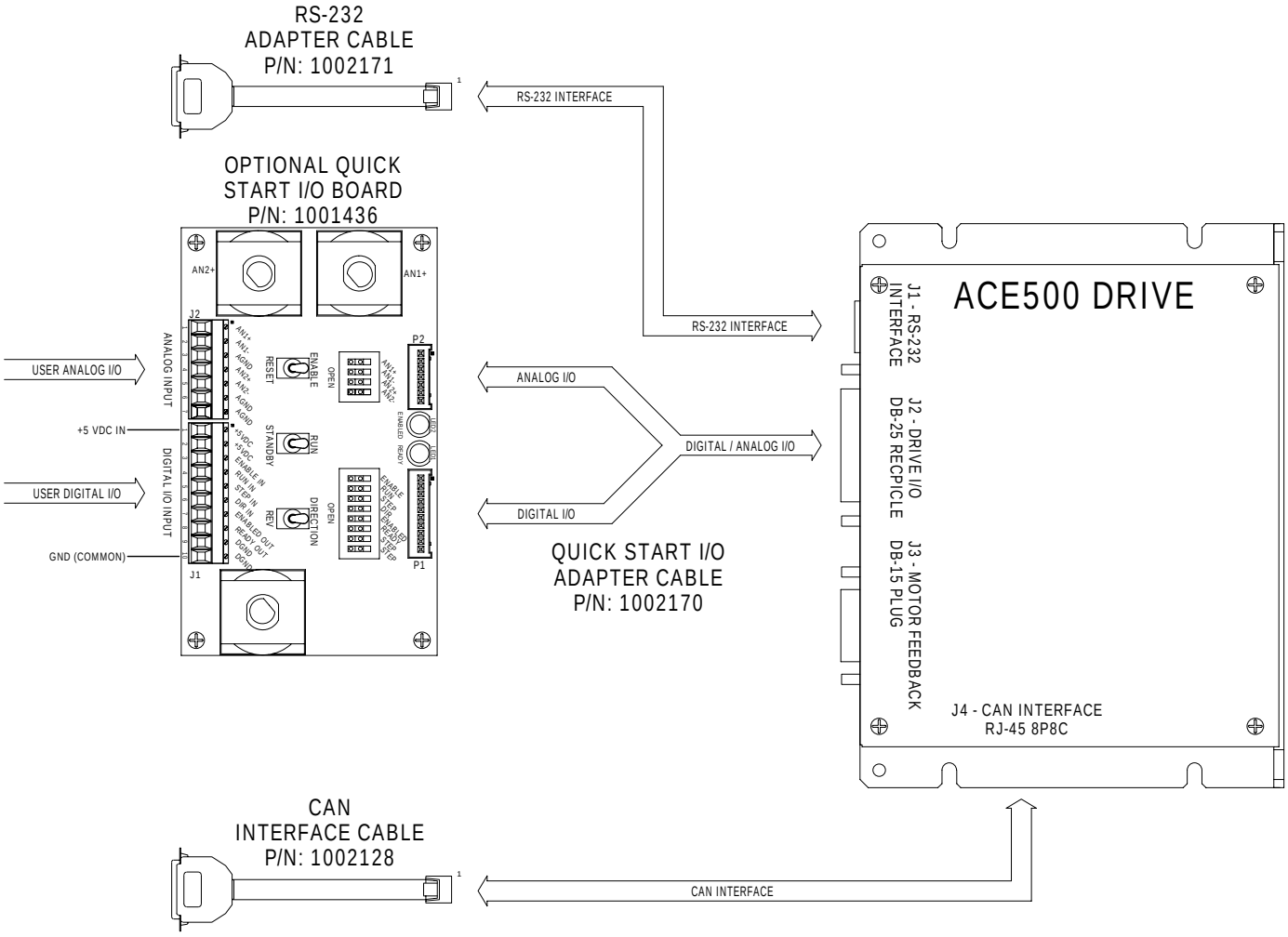

Figure 3: Optional Drive Setup

9.2 Wiring Diagrams for Optional User Interfaces

For mating connectors, see section 11. For additional accessories refer to appendix A.

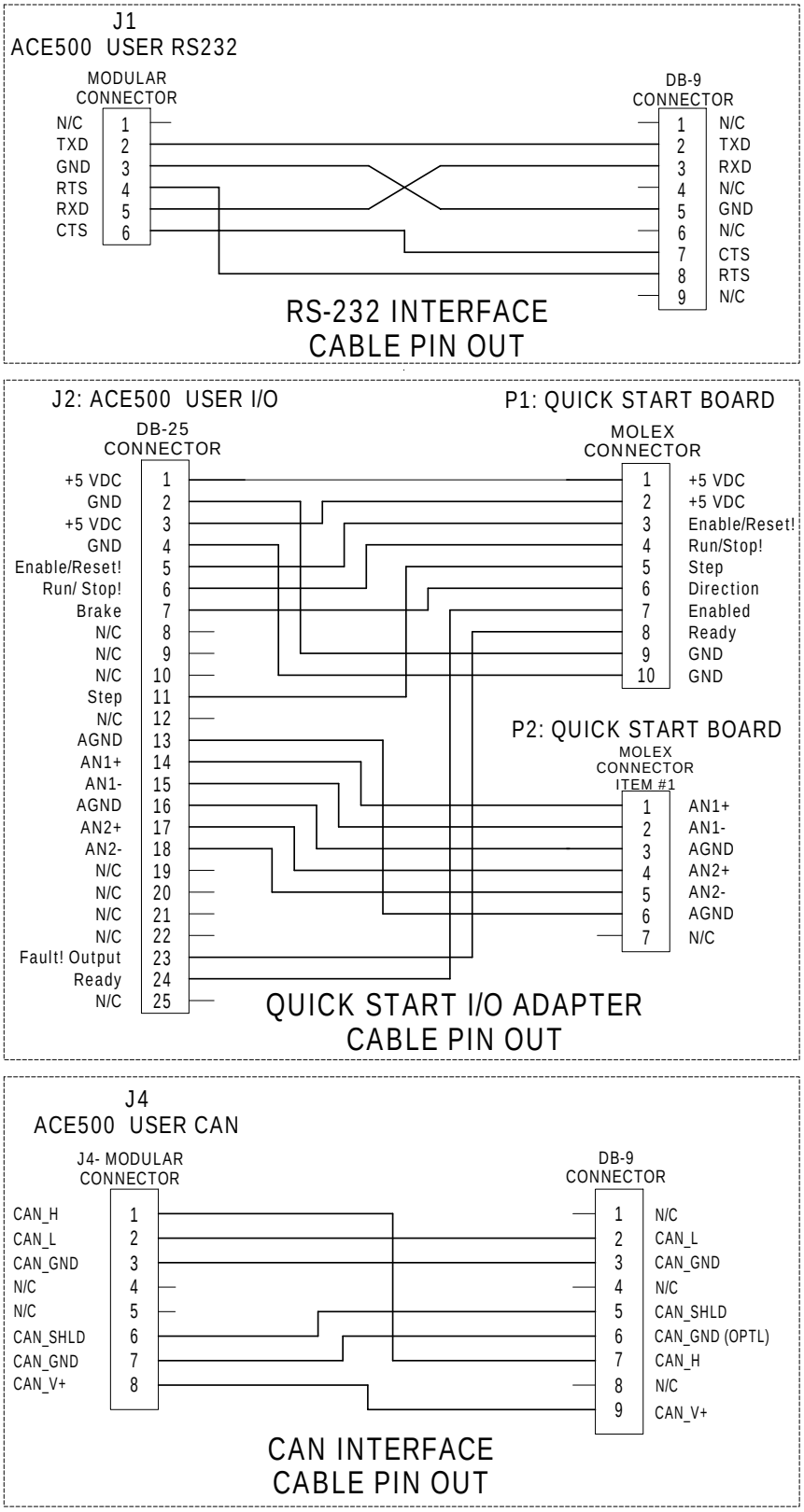

Figure 4: Optional Drive Setup wiring diagrams

10 First Time Operation

10.1 Phasing the Motor

ElectroCraft has determined the correct motor phasing for all ElectroCraft motors. If your drive was ordered with an ElectroCraft motor specified, the correct parameter set for the mating ElectroCraft motor was loaded into your drive at the factory prior to shipment.

Alternate ElectroCraft motor parameters can be selected from the motor selection file on the software disk supplied with your drive, or you can contact ElectroCraft for these files.

In addition, ElectroCraft has established the correct motor phasing relationships for many other popular US and foreign motor manufacturers. A listing of these additional motor manufacturers may be obtained from ElectroCraft upon request.

10.2 Using ElectroCraft CompletePower™ Plus

To establish the correct motor phasing for a new or unknown motor ElectroCraft has provided a Windows based setup utility. Please refer to the **ElectroCraft CompletePower™ Plus** software user manual to setup your drive and analyze the performance of the drive as well as the motor.

Getting Started

To make use of this feature proceed as follows:

1. Install **ElectroCraft CompletePower™ Plus** software onto user PC.
2. Connect all motor phase and feedback wires to the drive.
3. Place drive into standby
4. Connect power and establish communications
5. Load a starting parameter set (Use default supplied in drive, user saved parameter set, or contact ElectroCraft for assistance)
6. The motor should now be properly phased for the ACE500. You can now proceed with drive loop tuning.

10.3 ACE500 Electrical Ratings

Ratings at Temperatures = 0…50°C, (unless otherwise noted)

Parameter	Conditions	Value	Units
Supply			
Supply voltage	Nominal operating (single phase)	90 to 254	VAC
Supply current, surge	Inrush pulse duration <=100mS		A
Supply current, idle	No load condition.		mA
Supply current, operating			A
Over Voltage protection	Internal peak supply limited.		VAC
Reversed polarity withstand	Continuous; supply current externally limited to:		A
+5VDC User Supplied - regulation	Encoder Inputs, Hall Inputs and Digital I/O	4.75 to 5.25	V
+5VDC User Supplied - current required	Encoder Inputs, Hall Inputs and Digital I/O	250 minimum	mA
P3-Motor Outputs			
Output current, continuous	No additional heatsink	7.5	Arms
Output current, peak (rms)		15 (10.6)	A
Short circuit withstand	Phase-to-phase, phase-to-ground, phase to-supply threshold.	+/-	Amp
Short circuit protection delay		3 to 4	uS
On state voltage drop	Phase current = +/-5Amp	2.5	V
Off-state leakage current	Phase Voltage = +/-48V.	250	uA
PWM frequency	Programmable, PWMPER	15 to 30	kHz
J2-Digital I/O Maximum Ratings			
Input voltage	All inputs (opto-isolated); referenced to +COM	0 to 5.5	V
Input current	All inputs (opto-isolated); referenced to +COM	5.0 to 6.0	mA
Output voltage	All outputs	5 to 5.5	V
Output current	All outputs	40 to 50	mA
J2-Digital Inputs			
On state voltage threshold	Referenced to +com	1.0 to 2.0	V
Off state voltage threshold	Referenced to +com	0.6 to 1.5	V
On state current	Input = -5V	20	uA
J2-Digital Outputs			
On state current	Referenced to +com	7.8 to 9.0	mA
On state voltage drop	On state current = 15 mA	0.40 to 0.46	V
J2-Analog Inputs			
Input voltage Common-mode	Referenced to AGND	-10 to +10	V
Input voltage differential	Nominal operating	0 to 10	V
Input impedance	Differential	15.4 to 15.6	K Ohm
Input impedance	Common mode, referenced to AGND	15.4 to 15.6	K Ohm
Analog ground current	Maximum AGND to GND	0 to 50	mA

ACE500 Electrical Ratings, continued

Ratings at Temperatures = 0…50°C, (unless otherwise noted)

Parameter	Conditions	Value	Units
J3-Encoder Inputs			
Input voltage, Max.	Common-mode, referenced to GND	-25 to +25	V
Input voltage, Max.	Differential peak A to A , B to B , Z to Z	-30 to +30	V
Input voltage, differential	RS422 receiver, A to A , B to B , Z to Z operating.	-5 to +5	V
J3-Halls			
Input voltage range	Transient peak	-0.3 to +5.3	V
Low level voltage	Operating	0 to 1.8	V
Low level input current	Internal 1 K pull up to +5V	4 to 5	mA
Input hysteresis		0.2 to 0.5	V
Other			
Thermal resistance	Case to ambient		°C/W
Frame isolation voltage withstand	GND to Frame.	4000	VAC / Minute
Operating temperature	powered	0 to +50	°C
Storage temperature	Not powered	-20 to +85	°C
Humidity	Non-condensing	5 to 95	%RH
Weight		1.9 / 0.86	Lb./Kg

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11 ACE500 Dimensional Drawing

Units: mm [in]

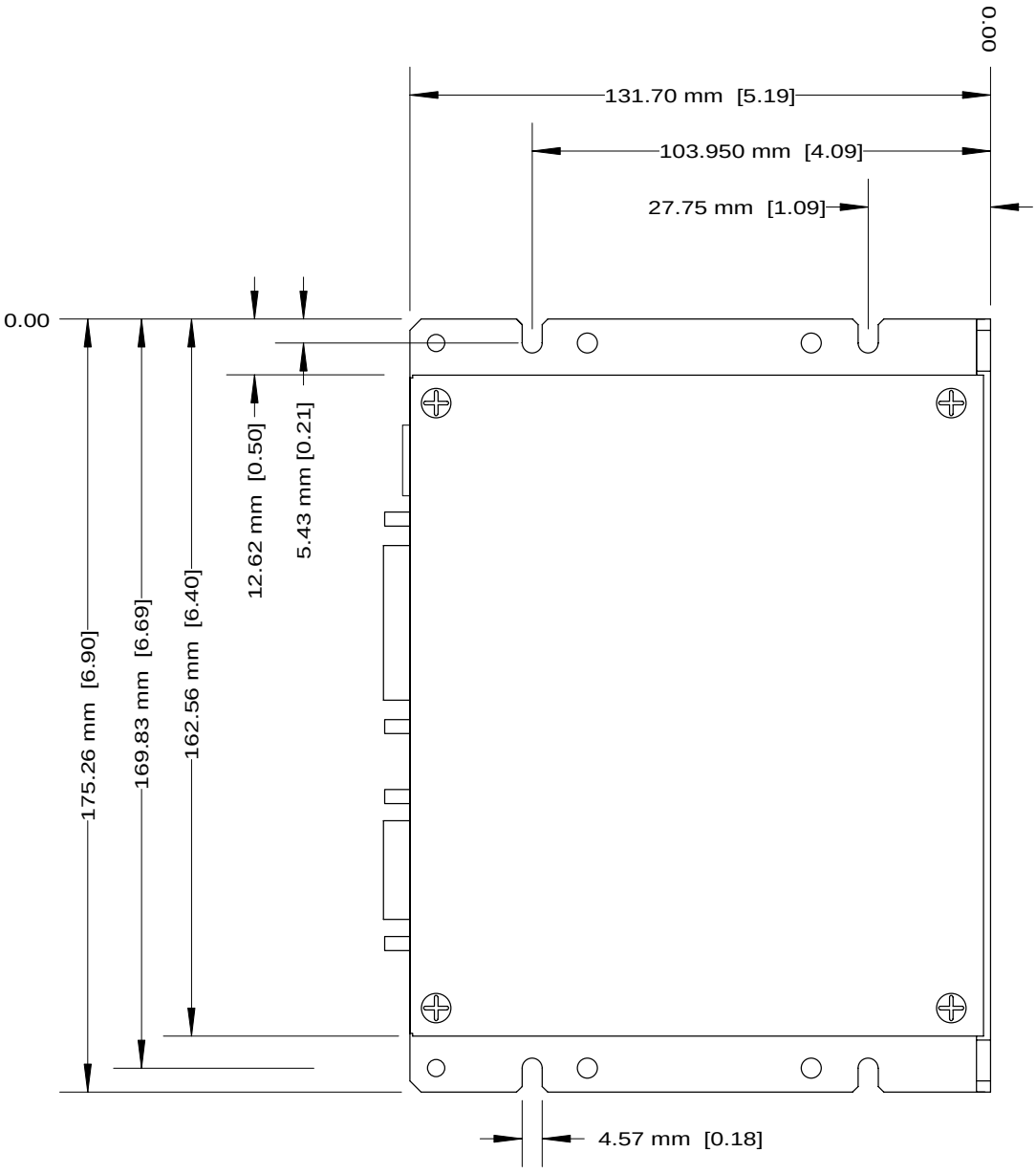
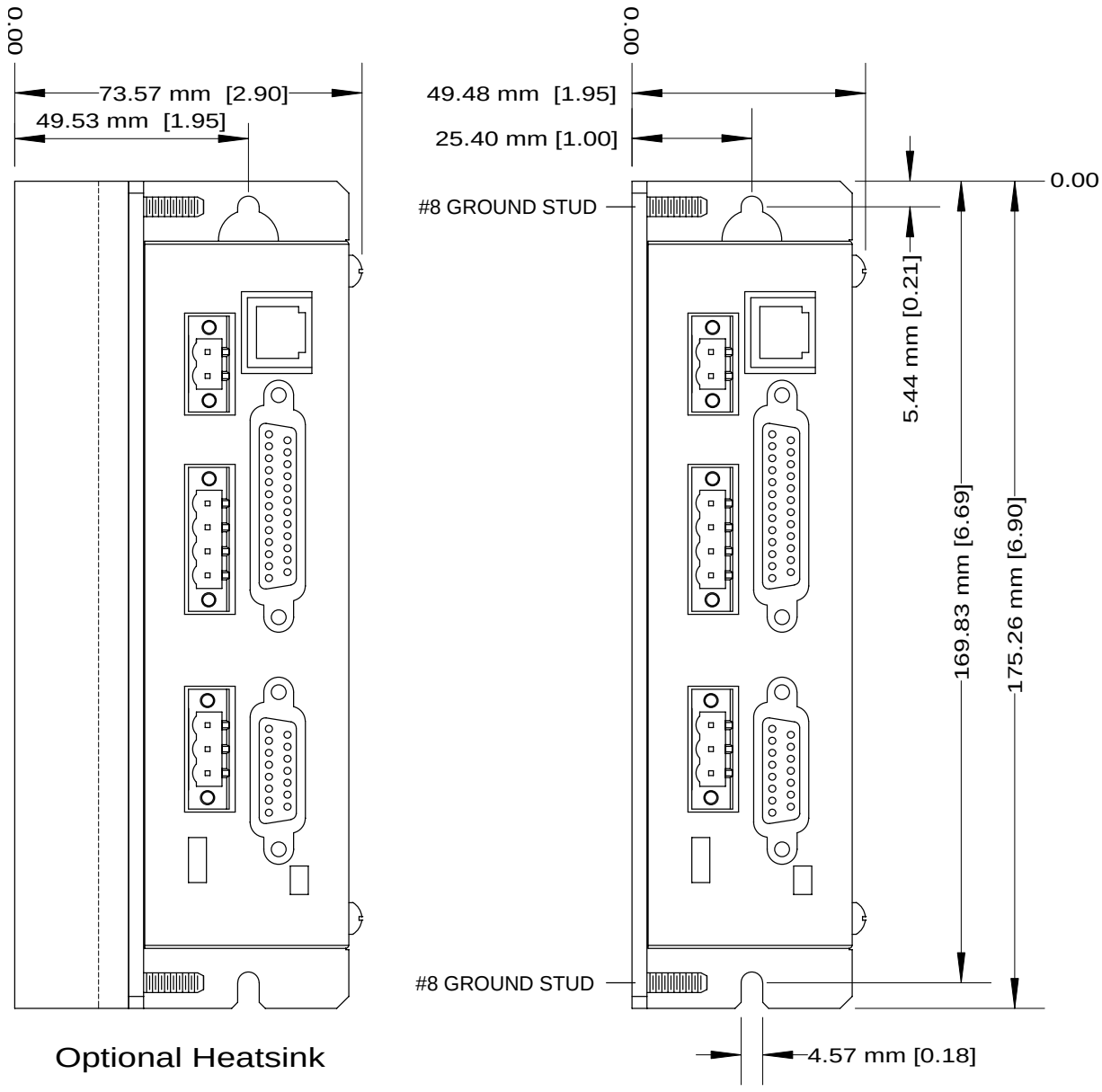


Figure 5: ACE500 Package Outline – Side View

ACE500 Dimensional Drawing, continued

Units: mm [in]



Note: For Optional heatsink please contact the Sales department.

Figure 6: ACE500 Package Outline – Front View

12 List of Mating Connectors

Ref.	Connector name	Manufacturer	P/N
P1	PWR	PHOENIX CONTACT	MST BT 2,5/2-STF-5, 08
P2	EXTERNAL SHUNT / AUX CAPACITORS	PHOENIX CONTACT	MST BT 2,5/4-STF-5, 08
P3	MOTOR POWER	PHOENIX CONTACT	MST BT 2,5/3-STF-5, 08
J1	RS-232	TYCO	5-641337-3
J2	DIGITAL & ANALOG I/O	AMP / TYCO	5-747908-2
J3	MOTOR FEEDBACK	AMP / TYCO	5-747913-2

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13 ACE500 Interface Circuitry

13.1 J1: RS232 Communications Interface

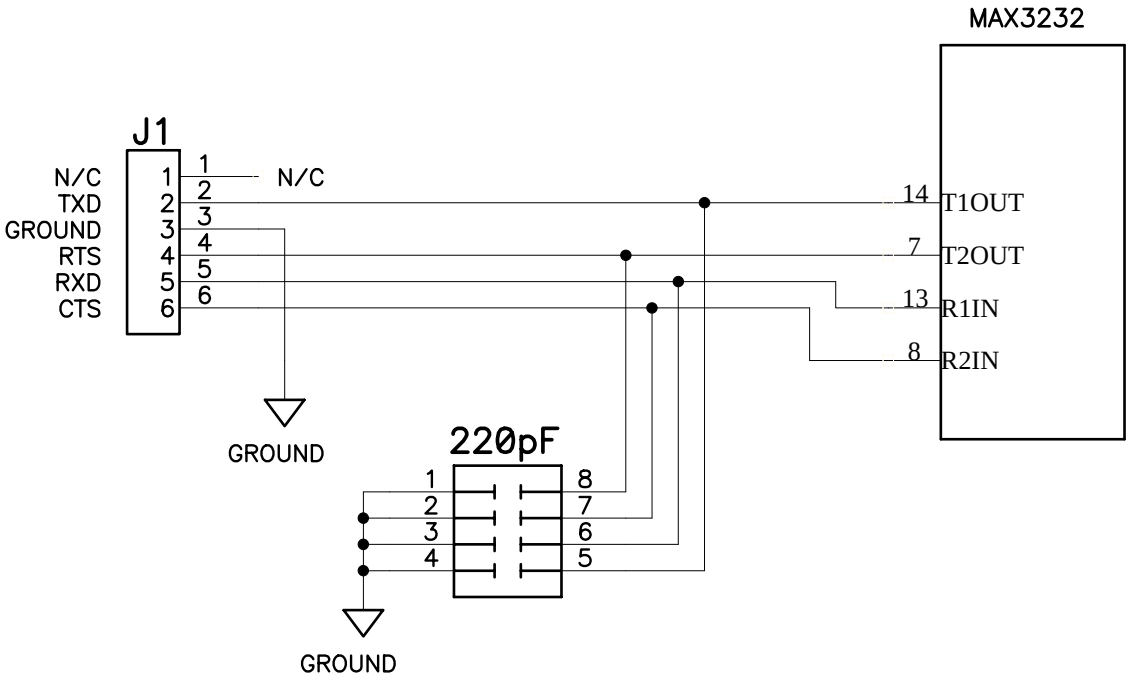


Figure 7: RS232 Communications Interface Circuitry

13.2 J2: Digital and Analog I/O

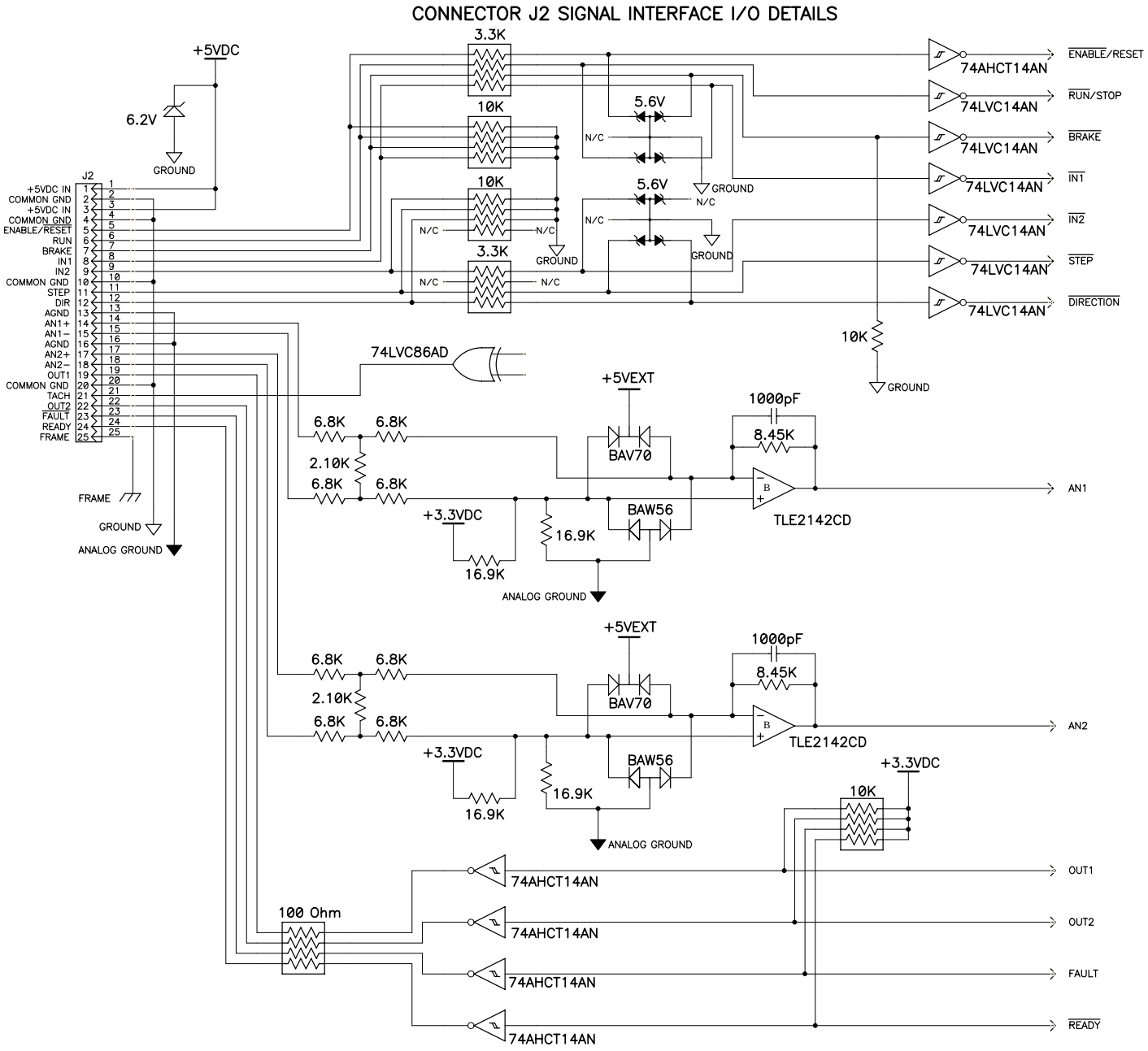


Figure 8: I/O Interface Circuitry

13.3 J3: Motor Interface

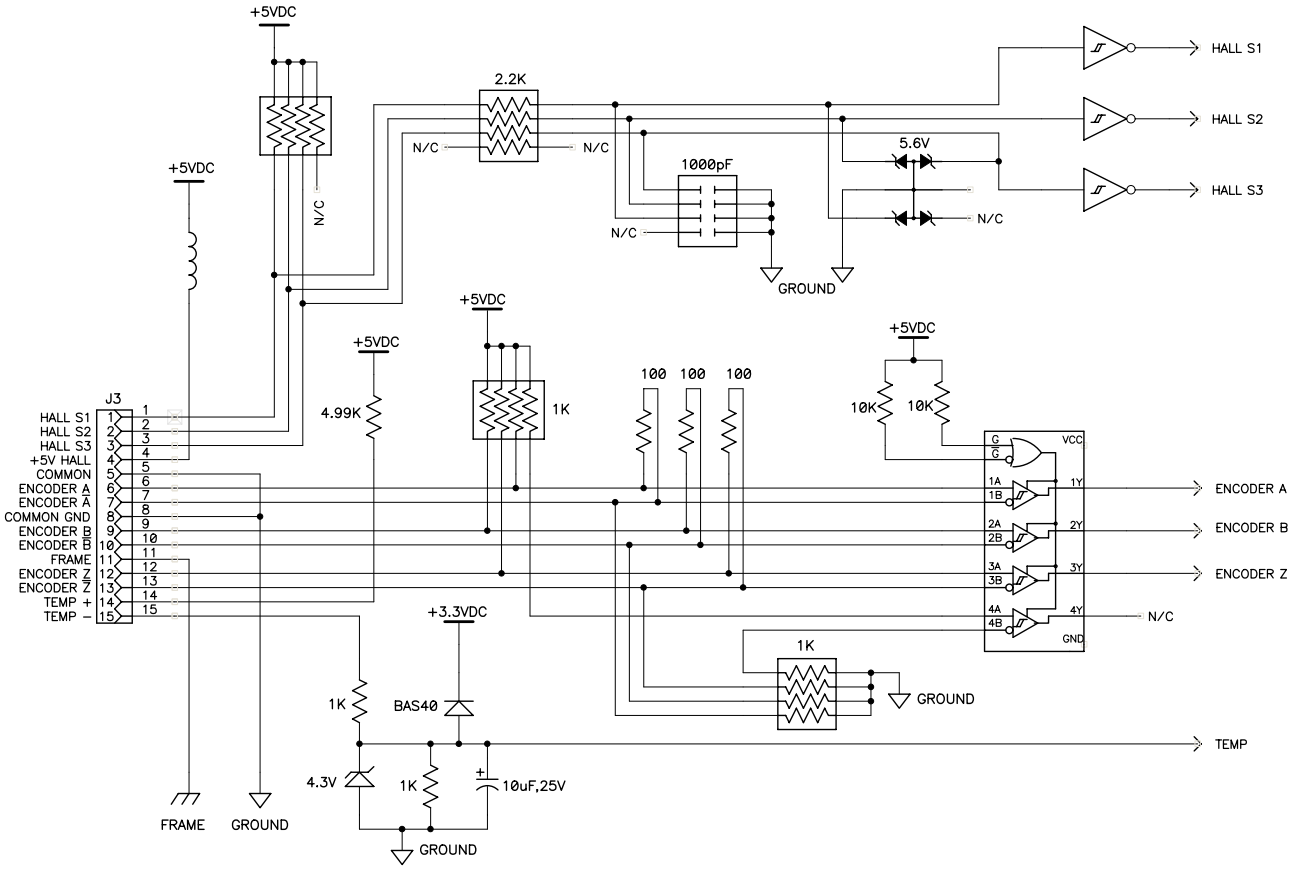


Figure 9: Motor Interface Circuitry

14 External Shunt P2 Connector

14.1 Use and Selection of the External Shunt

CAUTION!

WHEN THIS PRODUCT USES AN EXTERNAL SHUNT RESISTOR PRECAUTIONS MUST BE FOLLOWED TO PREVENT A POSSIBLE FIRE HAZARD.

Never mount the external shunt resistor where it can make contact with flammable materials, flammable liquid and/or flammable chemicals. If the ACE500 contains an optional shunt resistor mounted internal to the chassis, it too must be kept away from flammable materials, flammable liquid and/or flammable chemicals. Never use the ACE500, either with or without a shunt resistor of any type, in an explosive atmosphere. Never place the shunt resistor in the proximity of flammable materials that could melt or drop upon the shunt resistor body or the ACE drive.

THIS PRODUCT USES HIGH VOLTAGE ELECTRIC POWER AND POSES A SHOCK HAZARD TO THE USER.

Shunt resistor(s) function using high voltage electric power. Avoid physical contact with them whenever the ACE500 has power applied. Shunt resistor(s) can also become extremely hot. Follow the precautions stated below, and in conjunction with the manufactures precautions, to help prevent a fire hazard. The electrical terminals of shunt resistors are also a shock hazard. High voltage electricity is present on these terminals whenever the ACE500 has power applied. A safety cover or shield is recommended to avoid a shock hazard.

In most applications when heavy dynamic braking and/or regenerative braking are involved, the ACE500 will require an external shunt resistor.

ElectroCraft recommends using Isotek model ULH/ULV300N50 shunt: ElecrtoCraft part number 1001502:

- 300 watt / 50 ohm external shunt module.
- Non inductive windings, to isolate noise transients.
- Operating temperature range of -55 to 200°C.
- UL listed thermal protection (resettable fuse) set to 226°C.
- Dielectric strength of 1000v minimum.
- Wire lead length of 1000mm long.

See Isotek website page for additional information.

The minimum permissible resistance value for the external shunt resistor(s) is 50 Ohms. If a lower resistance is required, consult ElectroCraft.

The external shunt resistor will connect to **connector P2** and must be wired across **terminals (1 and 2)**. Please refer to section 6.5.6 for connector wiring.

- DO NOT CONNECT the shunt resistor to connector P2 terminals 2 or 3 and terminal 4.
- DO NOT SHORT P2 terminals 1, 2, 3 or 4 to frame ground.
- DO NOT USE a shunt resistor with a value less than 50 ohms. The resistor(s) should be rated for high momentary overloads.

It is important that the external shunt resistor be adequately sized to be reliable. It is also essential that this shunt resistor be located where it cannot cause a fire should it ever overheat. ElectroCraft recommends that the shunt resistor be placed in a well ventilated location and be kept away from flammable materials.

The shunt operates in conjunction with a transistor switch that places it across the motor high voltage rail. Should the transistor ever fail in the ON condition the resistor would remain powered continuously. This could result in the shunt resistor becoming very hot. A user-supplied heat shield may be required to limit a possible fire hazard.

The selected wattage rating for the shunt resistor is application dependent. Usually a heavy-duty wire wound resistor will work best. However, not all wire wound resistors are suitable for shunt service. ElectroCraft has found the Ohmite type 250 series works reliably in many shunt applications.

If the user is supplying their own shunt resistor contact ElectroCraft for further application advice. Ask for Field Application Bulletin #101-0195.

14.2 Dimensional Drawing Optional External Shunt

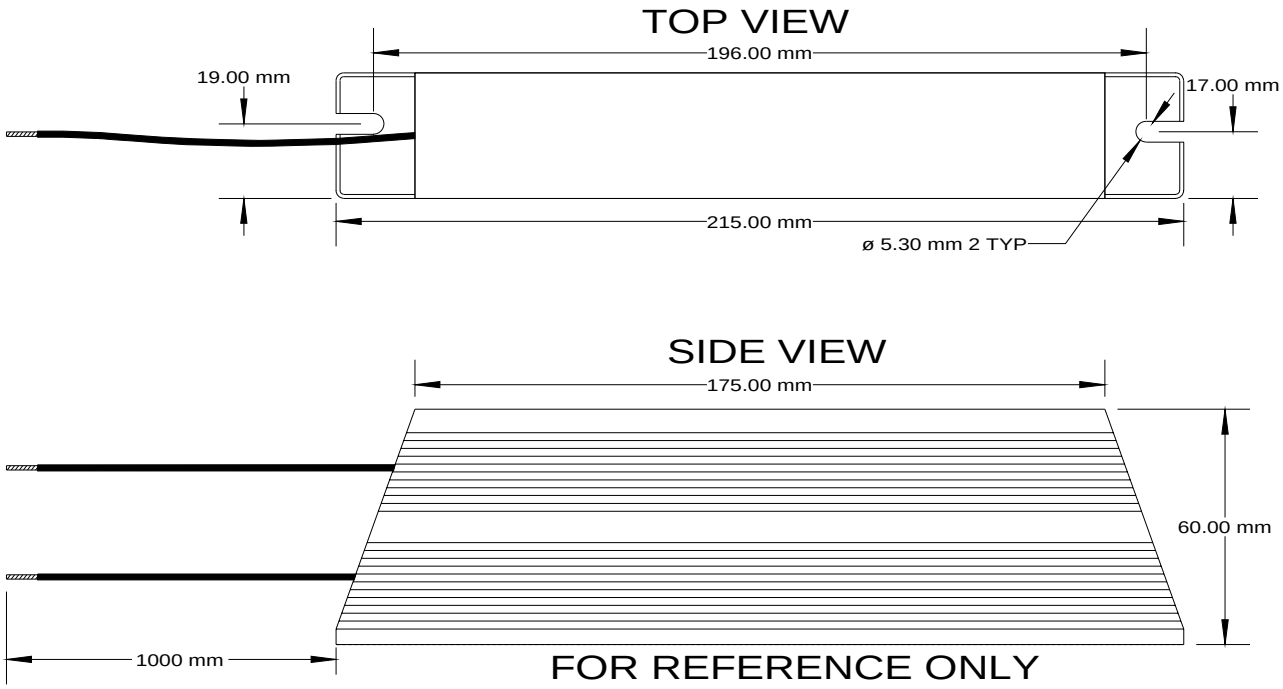
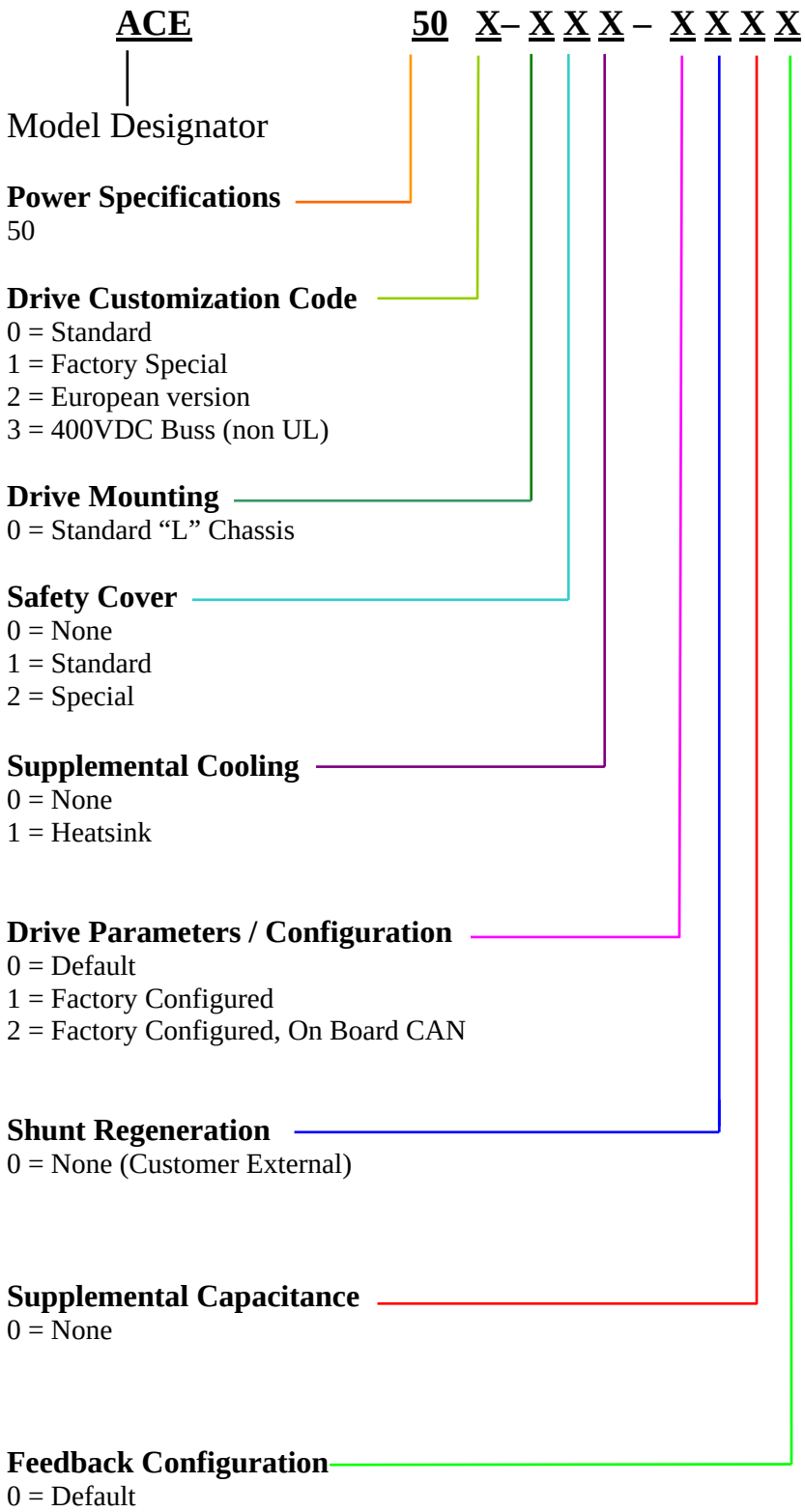


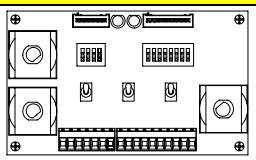
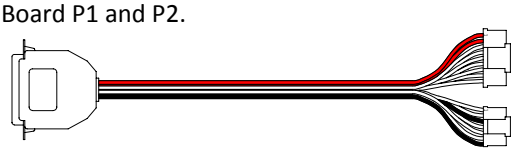
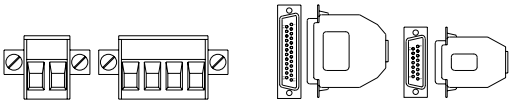
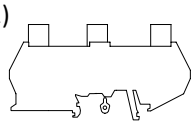
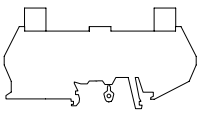
Figure 10: Isotek model ULV300 vertical mount

Note: Please visit the Isotek web site for current dimensional specifications.

15 Model Identification



16 Appendix A - Optional Accessories

Name	Size mm (inch)	Description	Part No.	
Quick-Start I/O Test Board	108 x 65 x 36mm (4.25 x 2.5 x 1.4") (W x H x D)	Test Board 	1001436	1002995 (Set)
RS232 Interface Cable (Interface cable for PC)	178mm (7")	D-sub 9 pin Plug to ACE500 J1 modular 6P6C. 	1002171	
Quick Start to ACE500 Adapter Cable	330mm (13")	D-sub 25 pin Plug ACE500 J2 to Quick Start Test Board P1 and P2. 	1002170	
CAN Interface cable (Interface cable for PC)	178mm (7")	D-sub 9 pin Plug to ACE500 J4 modular 8P8C. 	1002128	
ACE500 Connector Kit	n/a	Mating connectors for P1, P2, P3, J2, and J3. 	1002106	
ACE Series External Shunt.	215 x 60 x 175mm (8.46 x 2.36 x 6.89")	300 Watt (50 ohm) external shunt 	1001502	
Dual Encoder Assembly (Din Rail Mount)	46 x 90 x 48mm (1.8 x 3.6 x 1.9) (W x H x D)	Used when two encoder signals are supplied to the drive. (splits signals; 2 too 1) 	2000658	
R/D Converter Assembly (Din Rail Mount)	46 x 90 x 48mm (1.8 x 3.6 x 1.9) (W x H x D)	Used to create encoder or hall signals when a reslover is used. 	2000659	