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# BSA-Series
## Brushless Servo Amplifier

Instruction Manual

Electro-Craft®
MOTION CONTROL

Rockwell Automation/Electro-Craft
6950 Washington Avenue South
Eden Prairie, MN 55344

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- identify a hazard
- avoid the hazard
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CHAPTER 1:

# Introduction




FIGURE 1.1 **F-Series & H-Series Brushless Motors, and BSA-30, or BSA-15 Drive & LD-Series Motor**

## Introduction to the BSA-Series

The BSA-Series is a high performance square-wave current brushless servo drive employing a modular package suited to single or multi-axis applications. Using conventional analog velocity control (with an encoder based analog tachometer), potentiometer adjustments, and non-isolated 120 VAC input, the BSA-Series is a lower power, lower cost alternative to the Electro-Craft BRU-200 digital brushless servo drive. The BSA-Series powers the standard Electro-Craft S-Series, F-Series, and LD-Series permanent magnet synchronous motors along with other brushless motors that have conventional commutation and encoder feedback. A picture of standard BSA-Series components is shown in Figure 1.1.

For single axis positioning applications, the Electro-Craft PRO-Series controller card kits mount inside the BSA-Series drive modules. This eliminates the need for a separate controller package.



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## How to Use This Manual

This manual describes the Electro-Craft BSA-Series brushless servo drives along with standard Electro-Craft motors recommended for use with the BSA-Series. The manual is intended for use by qualified engineers or technicians directly involved in the installation, operation, and field level maintenance of the drives and motors.



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CHAPTER 2:

# Installation

## Mounting The Drive Modules

The BSA-Series drive modules are designed for simple installation on a flat surface such as the back wall or plate of an enclosure. The environment in the enclosure must be clean and free of oil mist, coolant mist, conductive particles, and corrosive chemicals. For industrial applications, a NEMA 12 or equivalent enclosure is recommended. The enclosure must be properly sized (and ventilated or cooled if required) to insure that the BSA-Series maximum ambient temperature is not exceeded. The BSA-Series drives must be mounted vertically to take advantage of natural convection cooling.

Drawing 9106-0029 shows the BSA-Series drive module dimensions including space requirements around the module for cable clearance and air flow. In some installations that limit air flow it may be necessary to provide a fan to increase air flow over the drive module. Note that the mounting hole pattern for the BSA-Series drives is the same as for the Electro-Craft BRU-200 brushless servo drives.

## Power Wiring



**WARNING:** Danger of electrical shock or burn. Only qualified individuals should work on this equipment. Dangerous voltages may exist after power is removed. Disconnect all power before working on equipment.



**CAUTION:** Do not connect the BSA-Series drives to a 230 VAC RMS 50/60 Hz Single Phase AC input. Maximum nominal input AC voltage is 120 VAC RMS 50/60 Hz Single Phase.

Drawing 9106-0031 shows the required power wiring for a typical installation. The phasing of the three phase drive module outputs R, S, and T must conform to the motor R, S, and T leads for proper operation. Earth ground must be connected as shown to insure a safe and proper installation. Wiring of the transformer, line fuses, and wire gauge sizes is also covered in this drawing.

## Motor Mounting and Wiring

Motor mounting dimensions for LD-Series, S-Series, and F-Series are located in the Reference Drawings starting on page 9-1.

Some motor mounting considerations are as follows:

1. Do not run motor unmounted. Attach all motor cables after motor is mounted.
2. Mount motor with connectors pointing downward and use cable drip-loops to keep liquids flowing away from connectors.



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3. Consider motor case temperature if necessary to safeguard operator and maintenance staff. Maximum case temperature is about 212°F (100°C) for a motor used at continuous rating at 104°F (40°C) ambient.

Motor and encoder connections are shown on pages 2-3 and 2-4.

## External Shunt Mounting and Wiring (Optional)

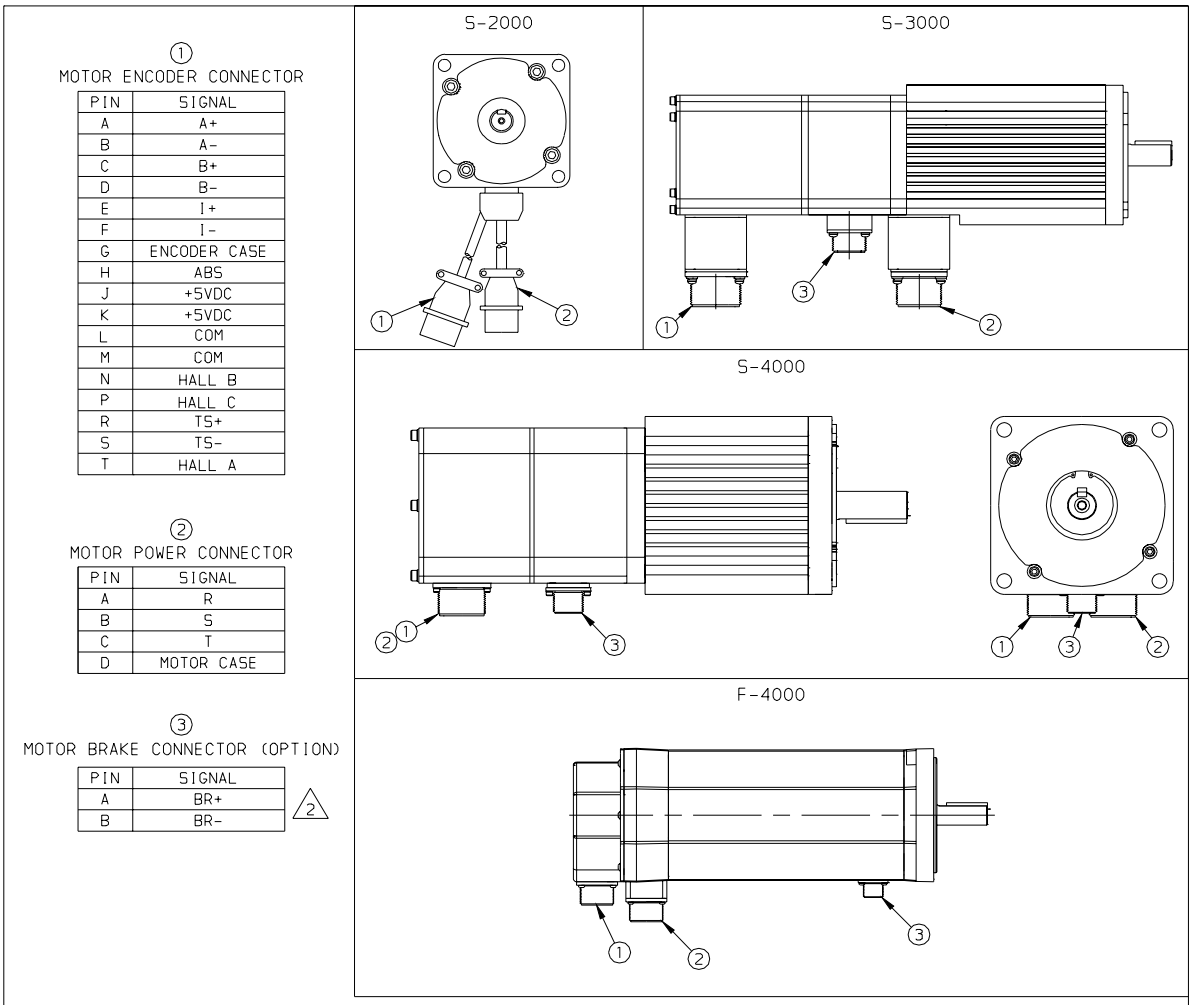


**CAUTION:** Do not substitute the BRU-200 External Shunt resistor that is the same physical size, but a different resistance value.

The external shunt mounts to a flat surface just like the BSA-Series drive module. The same mounting restrictions apply to the external shunt as to the BSA-Series. Drawing 9106-0027 shows the external shunt resistor dimensions and connection diagram.



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① MOTOR ENCODER CONNECTOR

| PIN | SIGNAL |
|---|---|
| A | A+ |
| B | A- |
| C | B+ |
| D | B- |
| E | I+ |
| F | I- |
| G | ENCODER CASE |
| H | ABS |
| J | +5VDC |
| K | +5VDC |
| L | COM |
| M | COM |
| N | HALL B |
| P | HALL C |
| R | TS+ |
| S | TS- |
| T | HALL A |

② MOTOR POWER CONNECTOR

| PIN | SIGNAL |
|---|---|
| A | R |
| B | S |
| C | T |
| D | MOTOR CASE |

③ MOTOR BRAKE CONNECTOR (OPTION)

| PIN | SIGNAL |
|---|---|
| A | BR+ |
| B | BR- |

△2

CONNECTOR PART NUMBERS

| ITEM | MOTOR CONNECTORS | MOTOR MATING CONNECTORS △1 | |
|---|---|---|---|
| | MS TYPE | MS TYPE | RELIANCE PART NO. |
| ① ENCODER CONNECTOR | | | |
| S-3000,S-4000,F-4000 | MS3102R20-29P | MS3106F20-29S | 9101-0329 |
| S-2000 | MS3101R20-29P | MS3106F20-29S | 9101-0329 |
| ② POWER CONNECTOR | | | |
| S-3000 | MS3102R18-4P | MS3106F18-4S | 9101-0325 |
| S-4000,F-4000 | MS3102R20-4P | MS3106F20-4S | 9101-0326 |
| S-2000 | MS3101F18-4P | MS3106F18-4S | 9101-0325 |
| ③ BRAKE CONNECTOR S-3000,S-4000,F-4000 | MS3102R12S-3P | MS3106F12S-3S | 9101-0330 |

NOTES:

△1 MS3106F TYPE MOTOR MATING CONNECTORS ARE AVAILABLE FROM RELIANCE MOTION CONTROL BY ORDERING THE RELIANCE PART NUMBER LISTED. THESE CONNECTORS ARE STRAIGHT CABLE EXIT TYPE, AND HAVE A CABLE CLAMP TYPE CONNECTOR BACK SHELL.

△2 BRAKE: SEE MOTOR MODEL NUMBER DEFINTITION IN REPLACEMENT PARTS SECTION TO DETERMINE BRAKE VOLTAGE. THE DC BRAKE VOLTAGE MAY BE APPLIED EITHER POLARITY. (THE BRAKE POWER SUPPLY IS NOT AVAILABLE FROM THE DRIVE. BRAKE POWER MUST BE PROVIDED BY THE USER.)

3. SHAFT ROTATION: THE MOTOR SHAFT ROTATES CW AS VIEWED FROM THE SHAFT END WHEN A POSITIVE VOLTAGE IS APPLIED AT DRIVE MODULE CONNECTOR P1, PIN 8 (VCS+) WITH RESPECT TO PIN 21 (VCS-).

4. FOR FURTHER MOTOR DETAIL, ENGINEERING SPECIFICATION DRAWINGS ARE AVAILABLE UPON REQUEST.

**FIGURE 2.1 S&F-Series Motor and Encoder Connections**



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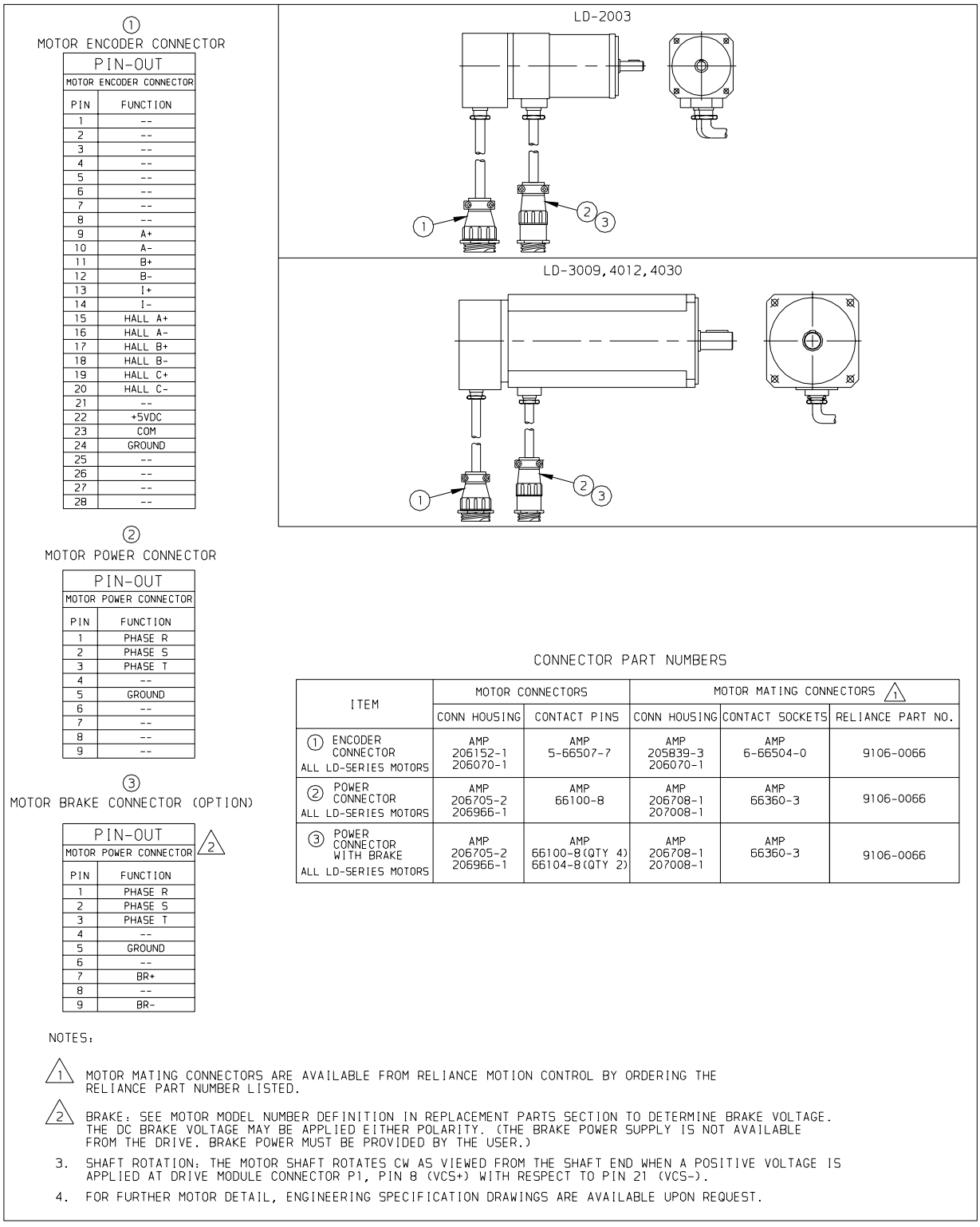



**FIGURE 2.2 LD-Series Motor and Encoder Connections**



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CHAPTER 3:

# Interface Circuitry

## Drive Module Interface Connectors

Figure below shows the three logic interface connectors and the pin signal names.

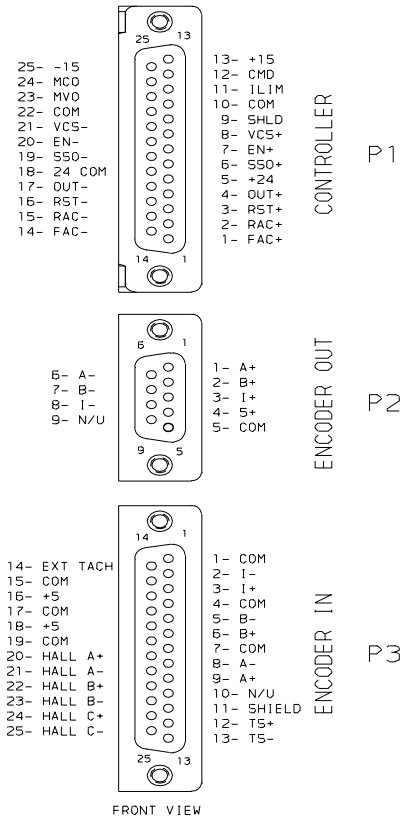



FIGURE 3.1 **BSA-Series Logic Connectors and Signal Names**

## Drive Module Interface Signal Specifications

Refer to drawing 9106-0030 for simplified schematic of interface circuitry for the BSA-Series.

TABLE 3.1 **P1 Connections**

| Pin Connection | Signal | Signal Type | Specification |
|---|---|---|---|
| P1-1<br>P1-14 | FAC+<br>FAC- | Input | Forward Amplifier Clamp: Connecting these pins together allows motion in the forward direction (CW motor rotation facing shaft end of motor). |
| P1-2<br>P1-15 | RAC+<br>RAC- | Input | Reverse Amplifier Clamp: Connecting these pins together allows motion in the reverse direction (CCW motor rotation facing shaft end of motor). |
| P1-3<br>P1-16 | RST+<br>RST- | Input | Reset: Momentarily connecting and then disconnecting these pins resets any drive module fault indications. |



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TABLE 3.1 **P1 Connections** (continued)

| Pin Connection | Signal | Signal Type | Specification |
|---|---|---|---|
| P1-4<br>P1-17 | OUT+<br>OUT- | Output | Normally, “open” relay contacts that close when the drive is enabled. The relay opens when the drive is inhibited. Maximum, 0.3 Amp contact rating at 24 VDC. |
| P1-5<br>P1-18 | +24 VDC<br>-24 VDC | Output | Available 24 VDC supply for external use. Maximum, 1.0 Amp output.<br>Common return for +24 VDC supply. Common internal to BSA and not connected to chassis. Connection to chassis common if desired. |
| P1-6<br>P1-19 | SSO+<br>SSO- | Output | Normally, “open” relay that closes when drive is ready. The relay opens if there is a drive fault. Maximum 0.3 Amp contact rating at 24 VDC. |
| P1-7<br>P1-20 | Enable+<br>Enable- | Input | Connecting these two pins together enables the drive; disconnecting them inhibits the drive. |
| P1-8<br>P1-21 | VCS+<br>VCS- | Input | Velocity command signal: ± 10 VDC input command signal range with 22 K ohms impedance. Absolute max input signal range is ± 12 VDC. Positive volts from VCS+ to VCS- results in CW motor rotation facing shaft end of motor. |
| P1-9 | Shield | Shield | Connected to chassis common internal to drive. |
| P1-10<br>P1-22 | Common | Common | Common returns for logic supplies. Connected to chassis common internal to drive. |
| P1-24 | MCO | Output | Motor current output: ± 10 VDC equal to zero to peak current of drive module. Does not include effect of current foldback. |
| P1-12 | CMD Monitor | Output | VCS monitor: signal representing the command input signal after the VCS scaling potentiometer. |
| P1-23 | MVO | Output | Motor velocity output: Signal from encoder tachometer representing motor speed. |
| P1-11 | External Current Limit | Input | If the I Limit pot is set fully CW and a 100k ohm resistor connected from this pin to common, the available current will be reduced by about 50%. A 32.2k ohm resistor will reduce the available current by about 25%. The exact amount of reduction is a function of the internal current limit for the motor being used. |
| P1-13<br>P1-25 | +15 VDC<br>-15 VDC | Output | NOT FOR EXTERNAL USE |

TABLE 3.2 **P2 Connections**

| Pin Connection | Signal | Signal Type | Specification |
|---|---|---|---|
| P2 | Encoder Out | Output | A+, A-, B+, I+, and I- encoder signals from the motor are unbuffered for use by the position controller. Signal A+ leads and signal B+ for CW motor rotation (facing shaft end of motor). (+5 VDC and common for the motor encoder can be supplied externally as an option with some jumper configurations). |

TABLE 3.3 **P3 Connections**

| Pin Connection | Signal | Signal Type | Specification |
|---|---|---|---|
| P3 | Encoder In | Input | Power supply and signal connections for motor encoder and thermostat. |



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CHAPTER 4:

# Start-Up and Adjustments

## Initial Start-Up Procedure



**WARNING:** Danger of electrical shock or burn. Only qualified individuals should work on this equipment. Disconnect all power before working on equipment. Dangerous voltages may exist after power is removed.

1. Measure voltage between BSA-Series terminals marked L1 & L2 to insure incoming power is off. Observe that LOGIC P/S LED is off.
2. Disconnect the wires connected to terminals marked L1 & L2. Arrange these wires to safe position for testing of incoming voltage.
3. Turn incoming power on and measure line voltage to insure that it is in the proper voltage range (see specifications on page 7-1).
4. If incoming voltage is the correct voltage then turn power off and reconnect the wires to terminals L1 & L2.
5. With incoming power still off, disconnect motor leads from BSA-Series terminals R, S, and T. Verify with an ohmmeter that the resistance between BSA-Series terminals R to GND, S to GND, and T to GND is 100K ohms minimum.
6. Verify that the BSA-Series has the correct potentiometer and jumper settings. The cover of the BSA-Series drive must be removeddrawing (refer to drawing 9106-0011). Drawing on page 4-3 shows potentiometer, fuse, test point locations, and jumper locations. Recommended set-up for the BSA-15, BSA-30, and the BSA-30X and the standard Electro-Craft motors is shown pages 4-4, 4-5, and 4-6 respectively. Connect all interface cables to the BSA-Series.
7. Apply incoming power with the drive inhibited and observe the LEDs. The LOGIC P/S LED should be on while the other LEDs should be off.
8. Connect a DC voltmeter between the MVO test point and common. Observe that the voltage goes negative when the motor is rotated CW and positive when the motor is turned CCW as viewed from the motor drive end.
9. Remove incoming power and observe that all BSA-Series LEDs turn off within one second.
10. Disconnect the motor(s) from the mechanical load(s) when initially checking out the system. If this is not possible, then take adequate precautions in the event of a fault.
11. Connect the motor R, S, and T to the BSA-Series. Be sure to connect R, S, and T of motor to R, S, and T of the drive. Also, connect a ground wire from the motor case to BSA-Series terminal GND. With the drive inhibited, reapply incoming power and observe proper power up diagnostics as indicated by module LEDs.
12. Set a low current limit (25% is a typical value while fully CCW is zero) using the I Limit potentiometer. Apply a small positive voltage (about 0.5 VDC) to the VCS inputs of the drive. Enable the drive and observe CW rotation of the motor shaft as viewed facing



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the motor drive end. If motor does not turn CW, check that motor power wires and encoder wires are connected to the drive properly (Motor and Encoder Connection drawings on pages 2-3 and 2-4).

13. After system installation is verified, return the current to a value to suit the application. Approximate settings are as follows:

| Number Turns CW | Percent Peak Current (Approximate) |
|---|---|
| 5 | 20% |
| 7 | 33% |
| 10 | 53% |
| 12 | 73% |
| 15 | 100% |

The average current limit is always 50% of the peak current limit.

## Adjustments

The BSA-Series brushless drives use conventional jumpers and potentiometers to configure the drive to specific motor and load combinations. The wide input voltage range of 108-132 VAC rms is accommodated automatically and the dissipative shunt regulator automatically tracks the internal DC bus.

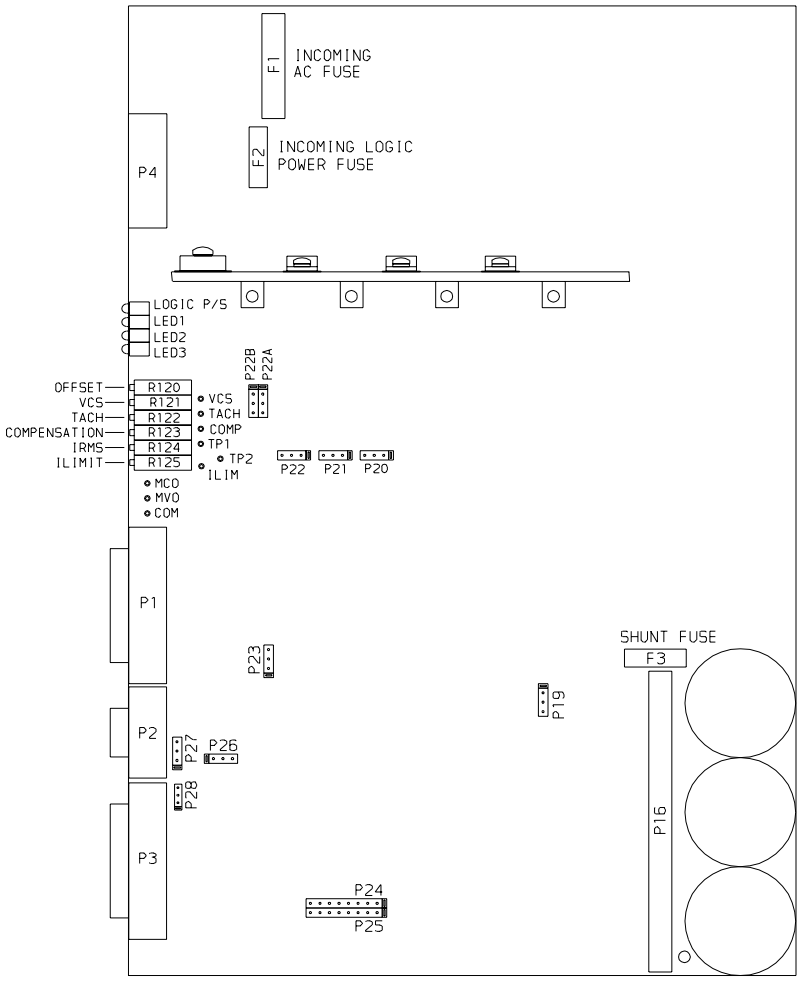
The BSA-Series has several jumpers, potentiometers, and test points that are shown in the drawing on page 4-4. Factory installed locations for the jumpers are indicated.

Standard drive / motor / load combinations are configured on pages 4-4, 4-5, and 4-6 showing recommended jumper and potentiometer settings. The resistance of the potentiometers is easily measured with the pot test points (refer to Potentiometer, Fuse, Test Point, and Jumper Locations on page 4-4, 4-5, and 4-6).

Final adjustment or fine tuning of the potentiometers may be required depending on the application performance requirements. BSA-Series Set-Up on page 4-7 shows typical tachometer responses (MVO test point) for various adjustments.



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REFER TO SECTION 1X FOR FUSE REPLACEMENT PART NUMBERS.
REFER TO SECTION VII FOR LED INDICATIONS.

| DESIGNATOR | POSITION | SELECTS |
|---|---|---|
| P19 | *PINS 1-2 | CURRENT COMMAND FROM INTERNAL SOURCE |
| | PINS 2-3 | CURRENT COMMAND FROM EXTERNAL SOURCE |
| P20 | PINS 1-2 | EXTERNAL TACH |
| | *PINS 2-3 | INTERNAL ENCODER TACH |
| P21 | *PINS 1-2 | DAMPING COMPENSATION OUT |
| | PINS 2-3 | DAMPING COMPENSATION IN |
| P22 | *PINS 1-2 | VELOCITY MODE |
| | PINS 2-3 | TORQUE MODE |
| P22A/22B | PINS 1/1 | TORQUE MODE COMPENSATION SETTING |
| | PINS 2/2 | OPTIONAL COMPENSATION SETTING |
| | *PINS 3/3 | STANDARD COMPENSATION SETTING |
| P23 | PINS 1-2 | DISABLE MOTOR THERMOSTAT |
| | *PINS 2-3 | ENABLE MOTOR THERMOSTAT |
| P24/25 | *PINS 3/3 | PULSE TACH CLOCK |
| P26 | PINS 1-2 | DIFFERENTIAL COMMUTATION FEEDBACK |
| | *PINS 2-3 | SINGLE ENDED COMMUTATION FEEDBACK |
| P27 | *PINS 1-2 | INTERNAL +5VDC ENCODER POWER |
| | PINS 2-3 | EXTERNAL +5VDC ENCODER POWER |
| P28 | *PINS 1-2 | INTERNAL +5VDC ENCODER POWER |
| | PINS 2-3 | EXTERNAL +5VDC ENCODER POWER |

* DENOTES FACTORY SETTING.
BANDED END OF SYMBOL IS PIN 1 END.

| DESIGNATOR | FUNCTION (ALL POTS 15 TURN TYPE) |
|---|---|
| R120 (OFFSET) | USED TO ADJUST OFFSET SO THAT A ZERO VELOCITY COMMAND RESULTS IN ZERO MOTOR RPM (ZERO OFFSET IS MIDRANGE ON POT) |
| R121 (VCS) | USED TO SCALE VELOCITY COMMAND (FULLY CCW RESULTS IN NO VELOCITY COMMAND) |
| R122 (TACH) | USED TO SCALE TACH AND ADJUST TACH RESPONSE IN COMBINATION WITH COMPENSATION POT (FULLY CCW IS MINIMUM TACH SIGNAL) |
| R123 (COMPENSATION) | USED TO ADJUST TACH RESPONSE (FULLY CCW IS MINIMUM GAIN) |
| R124 (IRMS) | USED TO ADJUST THE FOLDBACK LEVEL FROM APPROXIMATELY ZERO TO A MAXIMUM OF 5 AMPS. |
| R125 (ILIMIT) | FULLY CW IS PEAK CURRENT OF DRIVE. AVERAGE CURRENT LIMIT IS ALWAYS 50% OF PEAK CURRENT LIMIT SET BY ILIMIT POT. |

RECOMMENDED POT SETTINGS FOR STANDARD MOTORS AND TYPICAL LOADS ARE SHOWN IN FIGURES 5-2, 5-3, AND 5-4.

| TEST POINT DESIGNATOR | AC POWER STATUS | FUNCTION |
|---|---|---|
| VCS | OFF | MEASURE RESISTANCE OF POT TO COMMON TEST POINT |
| TACH | OFF | |
| COMPENSATION | OFF | |
| TP1 | OFF | MEASURE RESISTANCE OF |
| TP2 | OFF | IRMS POT BETWEEN TP1 & TP2 |
| I LIMIT | OFF | MEASURE RESISTANCE BETWEEN ILIM TEST POINT AND COMMON |
| MCO | ON | MONITOR MOTOR CURRENT |
| MVO | ON | MONITOR MOTOR TACH |
| COMMON | ON | TEST POINT COMMON |

**FIGURE 4.1** **Potentiometer, Fuse, Test Point, and Jumper Locations**



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| BSA-15 | | | | | | | | | | LOAD/MOTOR INERTIA RATIO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR TYPE | MAX. SPEED RPM | PEAK TORQUE lb-in (Nm) | CONT. TORQUE lb-in (Nm) | MVO OUTPUT MAX SPEED VOLTS | JUMPERS P22A P22B | JUMPERS P24 P25 | JUMPERS P23 | JUMPERS P26 | POT | $\frac{J_L}{J_m}$ = 1-2 △5 RESISTANCE | $\frac{J_L}{J_m}$ = 1-2 △1 TURNS | $\frac{J_L}{J_m}$ = 10 △5 RESISTANCE | $\frac{J_L}{J_m}$ = 10 △1 TURNS |
| LD-2003 | 4500 | 9 (1.02) | 3 (0.34) | 6.0 | 3/3 | 2/2 | 1/2 | 1/2 | VCS | 11.74K | 10 1/2 | 11.74K | 10 1/2 |
| | | | | | | | | | TACH | 6.4K | 7 | 6.4K | 7 |
| | | | | | | | | | COMP | 682 | 11 1/2 | 377 | 12 1/2 |
| | | | | | | | | | △2 IRMS | 99.5K | FULLY CW | 99.5K | FULLY CW |
| | | | | | | | | | ILIM | 4.69K | 5 | 4.69K | 5 |
| S-2005 | 6000 | 16 (1.8) | 4.75 (.53) | 4.0 | 2/2 | 1/1 | 2/3 | 2/3 | VCS | 7.35K | 7 1/2 | 7.35K | 7 1/2 |
| | | | | | | | | | TACH | 6.8K | 6 1/4 | 6.8K | 6 1/4 |
| | | | | | | | | | COMP | 300 | 14 1/2 | 125 | 15 1/8 |
| | | | | | | | | | △2 IRMS | 33K | 5 1/4 | 33K | 5 1/4 |
| | | | | | | | | | ILIM | 5.0K | 15 | 5.0K | 15 |
| S-3007 | 3500 | 27 (3.05) | 6.65 (.75) | 5.5 | 3/3 | 2/2 | 2/3 | 2/3 | VCS | 8.25K | 8 1/2 | 8.25K | 8 1/2 |
| | | | | | | | | | TACH | 5.7K | 5 1/4 | 5.7K | 5 1/4 |
| | | | | | | | | | COMP | 500 | 14 | 170 | 15 |
| | | | | | | | | | △2 IRMS | 33K | 5 1/4 | 33K | 5 1/4 |
| | | | | | | | | | ILIM | 6.9K | 9 1/2 | 6.8K | 9 1/2 |

NOTES:
△1 TURN FULLY CCW, THEN SET FOR NUMBER OF TURNS SHOWN.
△2 RESISTANCE READING IS TAKEN BETWEEN TP1 & TP2.
3. IF THE MOTOR IS OPERATED WITH LITTLE OR NO LOAD, REDUCE THE COMPENSATION SETTING BY 2.5 TURNS CCW FROM THE 1-2 LOAD/MOTOR RATIO SETTING.
4. P1 MUST BE REMOVED FOR RESISTANCE MEASUREMENTS.
△5 RESISTANCE READINGS ARE MEASURED AT TEST POINTS AFTER SETTING THE NUMBER OF TURNS SHOWN.

**FIGURE 4.2 BSA-15/Motor Matrix**



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| BSA-30 | | | | | | | | | | LOAD/MOTOR INERTIA RATIO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR TYPE | MAX. SPEED RPM | PEAK TORQUE lb-in (Nm) | CONT. TORQUE lb-in (Nm) | MVO OUTPUT MAX SPEED VOLTS | JUMPERS P22A P22B | JUMPERS P24 P25 | JUMPERS P23 | JUMPERS P26 | POT | $\frac{JL}{Jm}$ = 1-2 | | $\frac{JL}{Jm}$ = 10 | |
| | | | | | | | | | | 5 RESISTANCE | 1 TURNS | 5 RESISTANCE | 1 TURNS |
| LD-3009 | 4500 | 27 (3.05) | 8 (0.9) | 6.0 | 3/3 | 2/2 | 1/2 | 1/2 | VCS | 14.9K | FULLY CW | 14.9K | FULLY CW |
| | | | | | | | | | TACH | 10.6K | 10 | 10.6K | 10 |
| | | | | | | | | | COMP | 682 | 12 1/2 | 83 | 14 |
| | | | | | | | | | 2 IRMS | 95.9K | FULLY CW | 95.9K | FULLY CW |
| | | | | | | | | | ILIM | 4.4K | 5 1/2 | 4.4K | 5 1/2 |
| S-3016 | 3500 | 60 (6.78) | 19 (2.15) | 5.0 | 3/3 | 2/2 | 2/3 | 2/3 | VCS | 13.9K | 13 | 13.9K | 13 |
| | | | | | | | | | TACH | 10.5K | 10 | 10.5K | 10 |
| | | | | | | | | | COMP | 800 | 13 | 375 | 14 1/4 |
| | | | | | | | | | 2 IRMS | 57.5K | 8 1/2 | 57.5K | 8 1/2 |
| | | | | | | | | | ILIM | 6.3K | 11 1/4 | 6.3K | 11 1/4 |
| LD-4012 | 4500 | 35 (3.9) | 12 (1.35) | 6.0 | 3/3 | 2/2 | 1/2 | 1/2 | VCS | 13.9K | 13 | 13.9K | 13 |
| | | | | | | | | | TACH | 9.68K | 7 1/2 | 9.68K | 7 1/2 |
| | | | | | | | | | COMP | 830 | 12 1/2 | 348 | 13 1/2 |
| | | | | | | | | | 2 IRMS | 95.9K | FULLY CW | 95.9K | FULLY CW |
| | | | | | | | | | ILIM | 5.67K | 7 1/2 | 5.67K | 7 1/2 |
| S-4030 | 2000 | 100 (11.3) | 28.5 (3.22) | 5.5 | 3/3 | 3/3 | 2/3 | 2/3 | VCS | 14.0K | 13 1/4 | 14.0K | 13 1/4 |
| | | | | | | | | | TACH | 9.75K | 9 1/4 | 9.75K | 9 1/4 |
| | | | | | | | | | COMP | 1385 | 11 1/4 | 400 | 14 |
| | | | | | | | | | 2 IRMS | 57K | 8 3/4 | 57K | 8 3/4 |
| | | | | | | | | | ILIM | 6.4K | 12 | 6.4K | 12 |
| F-4030 | 2000 | 100 (11.3) | 29 (3.3) | 5.5 | 2/2 | 3/3 | 2/3 | 2/3 | VCS | 11.7K | 11 | 11.7K | 11 |
| | | | | | | | | | TACH | 7.7K | 7 1/4 | 7.7K | 7 1/4 |
| | | | | | | | | | COMP | 250 | 14 1/2 | 75 | 13 3/4 |
| | | | | | | | | | 2 IRMS | 95.9K | FULLY CW | 95.9K | FULLY CW |
| | | | | | | | | | ILIM | 6.5K | 11 1/2 | 6.5K | 11 1/2 |

NOTES:
1. TURN FULLY CCW, THEN SET FOR NUMBER OF TURNS SHOWN.
2. RESISTANCE READING IS TAKEN BETWEEN TP1 & TP2.
3. IF THE MOTOR IS OPERATED WITH LITTLE OR NO LOAD, REDUCE THE COMPENSATION SETTING BY 2.5 TURNS CCW FROM THE 1-2 LOAD/MOTOR RATIO SETTING.
4. P1 MUST BE REMOVED FOR RESISTANCE MEASUREMENTS.
5. RESISTANCE READINGS ARE MEASURED AT TEST POINTS AFTER SETTING THE NUMBER OF TURNS SHOWN.

**FIGURE 4.3 BSA-30/Motor Matrix**



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| BSA-30X | | | | | | | | | | LOAD/MOTOR INERTIA RATIO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR TYPE | MAX. SPEED RPM | PEAK TORQUE lb-in (Nm) | CONT. TORQUE lb-in (Nm) | MVO OUTPUT MAX SPEED VOLTS | JUMPERS | | | | | $\frac{J_L}{J_m}$ = 1-2 | | $\frac{J_L}{J_m}$ = 10 | |
| | | | | | P22A P22B | P24 P25 | P23 | P26 | POT | ⚠5 RESISTANCE | ⚠1 TURNS | ⚠5 RESISTANCE | ⚠1 TURNS |
| S-4030-M | 4000 | 60 (6.78) | 28.5 (3.22) | 5.5 | 3/3 | 2/2 | 2/3 | 2/3 | VCS | 14.0K | 13 1/4 | 14.0K | 13 1/4 |
| | | | | | | | | | TACH | 9.75K | 9 1/4 | 9.75K | 9 1/4 |
| | | | | | | | | | COMP | 1385 | 11 1/4 | 400 | 14 |
| | | | | | | | | | ⚠2 IRMS | 75K | 11 1/2 | 75K | 11 1/2 |
| | | | | | | | | | ILIM | 6.4K | 12 | 6.4K | 12 |
| LD-4030 | 3000 | 78 (8.8) | 34 (3.8) | 8.0 | 3/3 | 3/3 | 1/2 | 1/2 | VCS | 14.64K | 13 1/2 | 14.64K | 13 1/2 |
| | | | | | | | | | TACH | 7.05K | 6 1/2 | 7.05K | 6 1/2 |
| | | | | | | | | | COMP | 845 | 11 | 252 | 13 |
| | | | | | | | | | ⚠2 IRMS | 92.2K | FULLY CW | 92.2K | FULLY CW |
| | | | | | | | | | ILIM | 6.5K | 10 | 6.5K | 10 |
| S-4050 | 2000 | 120 (13.5) | 57 (6.44) | 5.5 | 3/3 | 3/3 | 2/3 | 2/3 | VCS | 15.0K | 14 1/2 | 15.0K | 14 1/2 |
| | | | | | | | | | TACH | 10.3K | 10 | 10.3K | 10 |
| | | | | | | | | | COMP | 890 | 12 3/4 | 445 | 14 |
| | | | | | | | | | ⚠2 IRMS | 70.0K | 10 1/2 | 70.0K | 10 1/2 |
| | | | | | | | | | ILIM | 5.0K | FULLY CW | 5.0K | FULLY CW |
| F-4050 | 2000 | 135 (15.3) | 58 (6.5) | 5.5 | 3/3 | 3/3 | 2/3 | 2/3 | VCS | 15.0K | 14 1/2 | 15.0K | 14 1/2 |
| | | | | | | | | | TACH | 10.3K | 10 | 10.3K | 10 |
| | | | | | | | | | COMP | 335 | 14 1/4 | 125 | 14 3/4 |
| | | | | | | | | | ⚠2 IRMS | 60.0K | 9 1/4 | 60.0K | 9 1/4 |
| | | | | | | | | | ILIM | 5.6K | 14 | 5.6K | 14 |
| S-4075 | 1500 | 175 (19.7) | 85.5 (9.66) | 4.0 | 3/3 | 3/3 | 2/3 | 2/3 | VCS | 12.0K | 11 1/4 | 12.0K | 11 1/4 |
| | | | | | | | | | TACH | 10.0K | 9 3/4 | 10.0K | 9 3/4 |
| | | | | | | | | | COMP | 900 | 12 3/4 | 225 | 14 1/2 |
| | | | | | | | | | ⚠2 IRMS | 70.0K | 10 1/2 | 70.0K | 10 1/2 |
| | | | | | | | | | ILIM | 5.0K | FULLY CW | 5.0K | FULLY CW |
| F-4075 | 1500 | 170 (19.2) | 78 (8.8) | 4.0 | 3/3 | 3/3 | 2/3 | 2/3 | VCS | 12.0K | 11 1/4 | 12.0K | 11 1/4 |
| | | | | | | | | | TACH | 10.0K | 9 3/4 | 10.0K | 9 3/4 |
| | | | | | | | | | COMP | 220 | 14 1/2 | 125 | 14 3/4 |
| | | | | | | | | | ⚠2 IRMS | 75K | 11 1/2 | 75K | 11 1/2 |
| | | | | | | | | | ILIM | 6.0K | 13 | 6.0K | 13 |

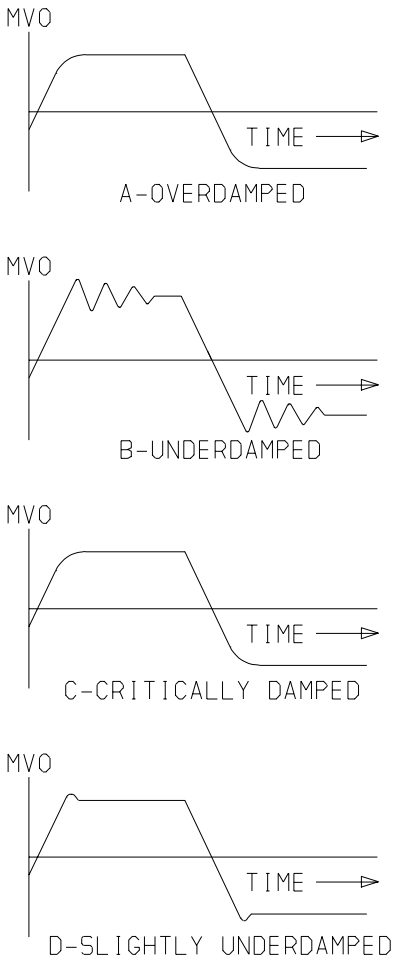
NOTES:
⚠1 TURN FULLY CCW, THEN SET FOR NUMBER OF TURNS SHOWN.
⚠2 RESISTANCE READING IS TAKEN BETWEEN TP1 & TP2.
3. IF THE MOTOR IS OPERATED WITH LITTLE OR NO LOAD, REDUCE THE COMPENSATION SETTING BY 2.5 TURNS CCW FROM THE 1-2 LOAD/MOTOR RATIO SETTING.
4. P1 MUST BE REMOVED FOR RESISTANCE MEASUREMENTS.
⚠5 RESISTANCE READINGS ARE MEASURED AT TEST POINTS AFTER SETTING THE NUMBER OF TURNS SHOWN.

**FIGURE 4.4** **BSA-30X/Motor Matrix**



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| | |
|---|---|
| AMPLIFIER MODEL_____ MACHINE NAME _____ DATE _____<br>MOTOR MODEL _____ AXIS NAME _____ | |
| VCS POT ____ OHMS ___ TURNS CW | COMPENSATION JUMPER STD___ OPT___ TORQUE MODE ___ |
| TACH POT ____ OHMS ___ TURNS CW | MODE JUMPER VELOCITY _____ TORQUE _____ |
| COMP POT ____ OHMS ___ TURNS CW | DAMPING JUMPER IN _____ OUT _____ |
| IRMS POT ____ OHMS ___ TURNS CW | TACH JUMPER INT _____ EXT _____ |
| ILIMIT POT ____ OHMS ___ TURNS CW | ENCODER JUMPER _____ LINE ENCODER |




TACH RESPONSE-FINE TUNING PROCEDURE

1) Initially configure recommended set-up as in figures 5-2, 5-3, or 5-4.

2) The normal ideal response should be like the slightly underdamped example shown.

3) Some fine-tuning of the TACH pot and COMPENSATION pot may be required. Higher gain or faster response is CW with both pots.

4) After the final pot settings for TACH and COMPENSATION are determined, the VCS pot should be set to scale the velocity command to the required actual motor speed.

**FIGURE 4.5 BSA-Series Set-Up**



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CHAPTER 5:

# Troubleshooting & Maintenance

## Introduction

The BSA-Series drive has been designed to provide troubleshooting aids that help isolate any problems to the incoming power, drive, motor and encoder, position controller, cables, and mechanical system. If a BSA-Series drive is found to have a failure, then the drive should be replaced. All jumper and potentiometer settings should be duplicated on the replacement unit to maintain the same performance.

Maintenance for the BSA-Series is unnecessary. The BSA-Series has no fans so the primary consideration is to insure that the BSA-Series is operated in a properly sized and ventilated NEMA-12 (or equivalent) enclosure with proper fusing.

## BSA-Series LEDs

TABLE 5.1 **LED Diagnostics**

| LED Label | LED Color | Description |
|---|---|---|
| LOGIC P/S | Green | Off = No incoming AC or if AC is present, then drive has internal power supply failure. |
| 1, 2, 3 | Red | Off = No Fault |
| 1 | Red | On = Motor Over Temperature |
| 2 | Red | On = Over Current (output short-circuit) |
| 3 | Red | On = Bus Over Voltage |
| 1, 2 | Red | On = AC Line Loss |
| 2, 3 | Red | On = Drive Over Temperature |
| 1, 3 | Red | On = Logic Supply Fault |



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CHAPTER 6:

# Optional Accessories

## PRO-Series Controller Kit Installation Instructions

The Electro-Craft PRO-Series position controller kits are available to integrate into the BSA-Series drive packages. In this cost effective configuration, the PRO-Series controller card shares the BSA-Series power supplies, package, and encoder.

Drawing 9106-0011 provides installation instructions for mounting the PRO-Series controller card in the BSA-Series drive. Additional details may be found in the specific PRO-Series manual.

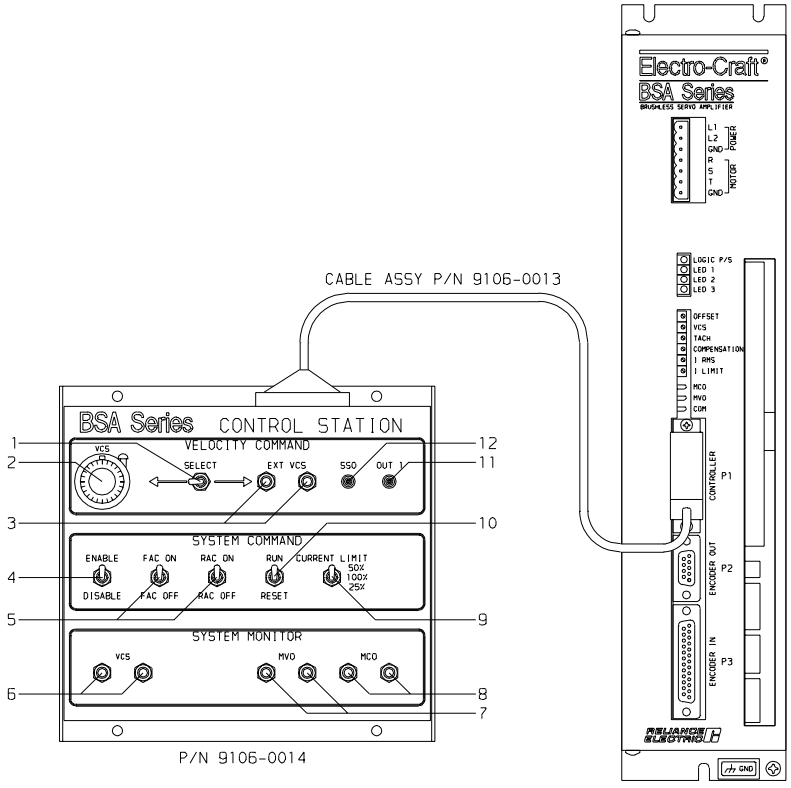



FIGURE 6.1 **BSA-Series Control Station**

## BSA-Series Control Station

A BSA-Series control station and cable (refer to above figure) is available to operate the BSA-Series drive during a test or set-up mode.

1. The SELECT switch selects the VCS potentiometer or an external VCS input as the velocity command.
2. The VCS potentiometer supplies a ± 10 VDC command. Mid-position (dial reading is 5.0) is zero volts.
3. The EXT VCS points are used to connect an external VCS signal (when the VCS dial is not being used and the select switch is in the EXT VCS position).



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4. The ENABLE / DISABLE switch is used to ENABLE or DISABLE drive power to the motor.
5. The FAC and RAC switches are used to hold motor torque and prevent motion in the specific direction.
6. The VCS test points are used to monitor the VCS signal.
7. The MVO test points are used to monitor the Motor Velocity Output (the tachometer signal).
8. The MCO test points are used to monitor the Motor Current Output (the current command signal).
9. The Current Limit switch sets the current limit to 25%, 50%, or 100% of the internal current limit setting.
10. The RUN / RESET switch is used to reset the BSA-Series drive by momentarily setting to RESET and then to RUN.
11. The OUT LED is on when the drive is enabled.
12. The SSO LED is on if the drive is ready to run; it is off if there is a drive fault.




**Note:** The black test points are connected to the drive common.



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CHAPTER 7:

# Specifications

## BSA-15, BSA-30, BSA-30X Specifications

| Model | BSA-15 | BSA-30 | BSA-30X | Units |
|---|---|---|---|---|
| Continuous Drive Current[1] | 5 | 10 | 15 | Amperes |
| Peak Drive Current[1] | 15 | 30 | 30 | Amperes |
| Input Voltage | 108-132 VAC RMS single phase<br>Internal DC bus 152-187 VDC<br>(170 VDC with 120 VAC Input) | | | |
| Shunt Power[2]<br>Continuous<br>Peak | <br>50<br>1,000 | | | Watts |
| Ambient Temperature<br>Operating<br>Storage | <br>32°-122°F (0°-50°C)<br>-40°-158°F (-40°-70°C) | | | |
| Relative Humidity | 5% to 90% non-condensing | | | |
| Weight | 11.8 lbs<br>(5.4 kg) | 11.8 lbs<br>(5.4 kg) | 17.2 lbs<br>(7.8 kg) | |
| VCS Input Impedance | 22 K ohms | | | |

[1] peak value of sine wave per phase

[2] There is an optional external shunt resistor available that provides 200 W continuous and 1 kW peak shunt power. See drawing 9106- 0027 in the Reference Drawings section for additional detail.

[3] See drawing 9106-0029 in the Reference Drawings section for physical dimensions of the BSA-Series drives.

In the United States, the National Electrical Code (NEC), specifies that fuses must be selected based on the motor full load amperage (FLA), which is not to be confused with the drive input current. The largest fuse allowed under any circumstances is four times the motor FLA. Therefore the largest fuse permissible for use with the BSA is four times the motor rated continuous current (converted to an RMS value). The BSA has been evaluated and listed by Underwriters Laboratories Inc. with fuses sized as four times the continuous output current of the Amplifier (FLA), according to UL 508C.

In almost all cases, fuses selected to match the Amplifier input current rating will meet the NEC requirements and provide the full Amplifier capabilities. Dual element, time delay (slow acting) fuses should be used to avoid nuisance trips during the inrush current of power initialization. The fuse sizes listed are recommended values, but local regulations must be determined and followed.

The BSA utilizes solid state motor short circuit protection rated as follows:

**Short Circuit Current Rating with no Fuse Restrictions:**

Suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical Amperes, 120 volts maximum.

**Short Circuit Current Rating with Fuse Restrictions:**

Suitable for use on a circuit capable of delivering not more than 200,000 RMS symmetrical Amperes, 120 volts maximum, when protected by high interrupting capacity, current limiting fuses (Class CC, G, J, L, R, and T).



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## Motor/BSA-Series System Specifications

The System specification for the BSA-Series drives with the standard Electro-Craft motors are shown below:

| MOTOR MODEL | LD-2003 | S-2005 | S-3007 | LD-3009 | LD-4012 | S-3016 | S-4030 | F-4030 | S-4030 -M | LD-4030 | F-4050 | S-4050 | F-4075 | S-4075 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BSA SERIES MODEL | BSA-15 | | | BSA-30 | | | | | BSA-30X | | | | | |
| Stall Torque [1] (lb-in) | 3.0 | 4.75 | 6.65 | 8.0 | 12.0 | 19.0 | 28.5 | 29.0 | 28.5 | 34.0 | 58.0 | 57.0 | 78.0 | 85.5 |
| Stall Torque [1] (Nm) | 0.34 | 0.53 | 0.75 | 0.9 | 1.35 | 2.15 | 3.22 | 3.3 | 3.22 | 3.8 | 6.5 | 6.44 | 8.8 | 9.66 |
| [2] Speed (rpm) | 4500 | 6000 | 3500 | 4500 | 4500 | 3500 | 2000 | 2000 | 4000 | 3000 | 2000 | 2000 | 1500 | 1500 |
| Jm ($lb\text{-}in\text{-}sec^2 \times 10^{-3}$) | 0.097 | 0.13 | 0.27 | 0.57 | 0.77 | 0.72 | 2.2 | 9.0 | 2.2 | 2.1 | 19.0 | 4.1 | 29.0 | 6.0 |
| Jm ($kg\text{-}m^2 \times 10^{-3}$) | 0.011 | 0.015 | 0.03 | 0.064 | 0.087 | 0.08 | 0.25 | 1.0 | 0.25 | 0.24 | 2.1 | 0.46 | 3.2 | 0.68 |
| Kt [3] (lb-in/A) | 1.3 | 1.3 | 2.7 | 1.8 | 1.7 | 2.7 | 4.8 | 5.3 | 2.4 | 3.4 | 5.3 | 4.8 | 7.1 | 7.2 |
| Kt [3] (Nm/A) | 0.15 | 0.14 | 0.31 | 0.20 | 0.19 | 0.31 | 0.54 | 0.6 | 0.27 | 0.38 | 0.6 | 0.54 | 0.8 | 0.81 |
| [4] Ke (V/krpm) | 16 | 16 | 34 | 21 | 20 | 34 | 60 | 66 | 30 | 41 | 66 | 60 | 89 | 90 |
| [5] R (ohms) | 4.4 | 2.6 | 6.6 | 1.7 | 0.9 | 1.3 | 2.0 | 2.24 | 0.5 | 0.6 | 0.89 | 0.8 | 0.98 | 0.9 |
| [5] L (mH) | 3.5 | 4.1 | 12.0 | 3.0 | 2.6 | 3.4 | 9.0 | 6.8 | 1.9 | 2.2 | 3.3 | 3.3 | 3.4 | 5.4 |
| Friction (lb-in) | 0.1 | 0.25 | 0.12 | 0.12 | 0.16 | 0.25 | 0.30 | 0.33 | 0.30 | 0.5 | 0.65 | 0.60 | 0.76 | 1.2 |
| Friction (Nm) | 0.011 | .028 | 0.014 | 0.013 | 0.018 | 0.028 | 0.034 | 0.04 | 0.034 | 0.056 | 0.07 | 0.068 | 0.08 | 0.14 |
| Damping (lb-in/krpm) | 0.03 | 0.12 | 0.09 | 0.06 | 0.07 | 0.12 | 0.30 | 0.5 | 0.30 | 0.12 | 0.94 | 0.40 | 1.3 | 0.60 |
| Damping (Nm/krpm) | 0.003 | 0.014 | 0.01 | 0.007 | 0.008 | 0.014 | 0.034 | 0.06 | 0.034 | 0.014 | 0.1 | 0.045 | 0.15 | 0.068 |
| Thermal Resistance [6] (°C/Watt) | 2.2 | 1.45 | 1.2 | 1.6 | 1.1 | 0.89 | 0.79 | 0.63 | 0.79 | 0.70 | 0.48 | 0.57 | 0.4 | 0.48 |
| Standard Encoder Line Count | 2000 | 1000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |

1. Stall torque with square wave currents is 5% less than with sine wave currents for sine wave motors (motor is mounted to a 12" x 12" x 1/2" Aluminum plate).
2. Maximum continuous operating speed.
3. Peak amps of per phase square wave (square wave Kt is about 10% higher than sine wave Kt for a sine wave motor).
4. Peak volts of line to line sine wave.
5. Phase to phase.
6. Motor is mounted to a 12"x12"x1/2" Aluminum plate.



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CHAPTER 8:

# Replacement Parts

## Drive Modules

| Part Number | Description |
|---|---|
| 9106-0081 | BSA-15 Drive Module |
| 9106-0082 | BSA-30 Drive Module |
| 9106-0083 | BSA-30X Drive Module |
| 9106-0033 | Kit, Fuse, F1, F2, F3<br>(F1 Bussmann ABC-15 or Littelfuse 314015)<br>(F3 Littelfuse 225004)<br>(F2 Littelfuse 225006) |
| 9106-0077 | Connector Kit, Logic and Power |

## Accessories

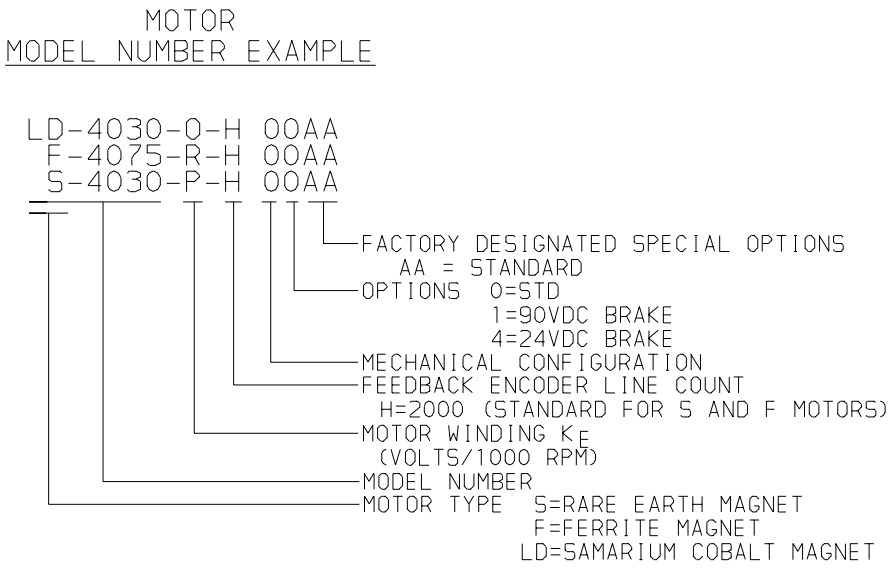
| Part Number | Description |
|---|---|
| 9106-0014 | BSA-Series Control Station |
| 9106-0013 | BSA-Series Control Station Cable |
| 9106-0026 | BSA-Series External Shunt Resistor Kit |
| 0020-5097 | 3.0 KVA Single Phase Isolation Transformer |



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## Motors

Motor model numbers are explained below.




**Motor Model Numbers**

## PRO-Series Kits

| Part Number | Description |
|---|---|
| 9097-1111 | PRO-100 Kit |
| 9097-1112 | PRO-200 Kit |
| 9097-1113 | PRO-300 Kit |
| 9097-1114 | PRO-400 Kit |
| 9097-1115 | PRO-150 Kit |
| 9097-1116 | PRO-450 Kit |

## Cables

| Part Number | Description |
|---|---|
| 9106-0034-XXXBSA | Feedback Cable Terminated for P3 |
| 9106-0035-XXXBSA | S-Series or F-Series Feedback Cable |
| 9101-1080-XXXBSA | S-2000 / S-3000 Power Cable |
| 9101-1081-XXXBSA | S-4000 / F-4000 Power Cable |
| 9106-0064-XXXBSA | LD-Series Power Cable |
| 9106-0065-XXXBSA | LD-Series Feedback Cable |

Standard cable lengths are 10, 25, 50, and 75 feet. Last three digits denote length of cable in feet. For example, a ten foot power cable is 9101-1080-010.



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## Motor Connectors

| Part Number | Description |
|---|---|
| 9101-0325 | Motor Power Connector Kit, S-2000, S-3000 Motors (MS3106F18-4S Connector) |
| 9101-0326 | Motor Power Connector Kit, S-4000, F-4000 Motors (MS3106F20-4S Connector) |
| 9101-0329 | Encoder Connector Kit, S-Series, F-Series Motors (MS3106F20-29S Connector) |
| 9101-0330 | Brake Connector Kit, S-Series, F-Series Motors (MS3106F12S-3S Connector) |
| 9106-0066 | Motor Power and Feedback Connector Kit, LD-Series Motors |

## Motor Shaft Seal Kits

| | |
|---|---|
| 0041-5056 | Shaft Seal Kit, S-2000 Motor (22 mm O. Dia. x 12 mm I. Dia. x 7 mm wide) |
| 0041-5057 | Shaft Seal Kit, S-3000 Motor (28 mm O. Dia. x 15 mm I. Dia. x 7 mm wide) |
| 0041-5058 | Shaft Seal Kit, S-4000 Motor (47 mm O. Dia. x 20 mm I. Dia. x 7 mm wide) |
| 0041-5060 | Shaft Seal Kit, F-4000 Motor (1,437 mm O. Dia. x .875 mm I. Dia. x .25 mm wide) |



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CHAPTER 9:

# Reference Drawings

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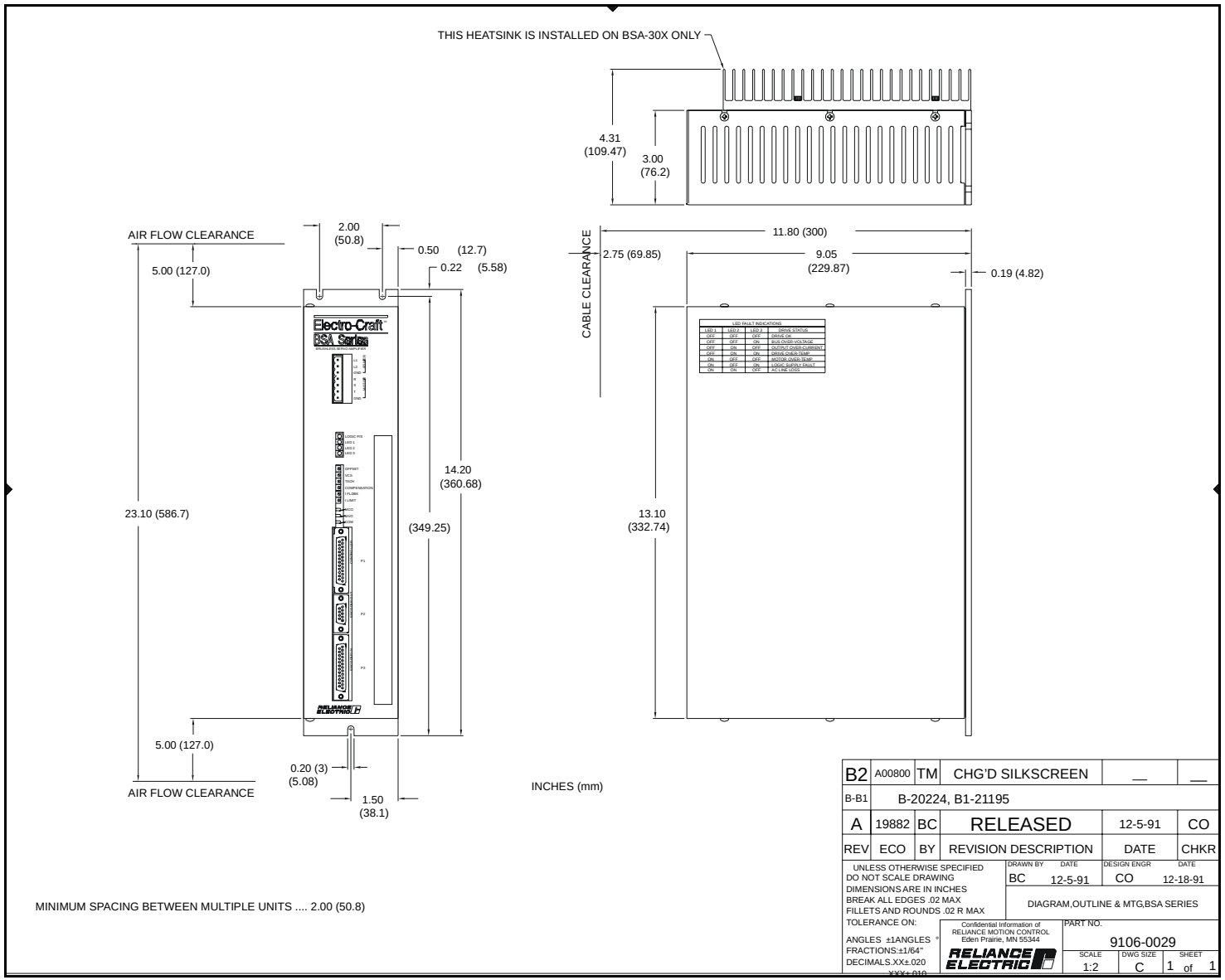



**FIGURE 9.1** **BSA-Series Outline/Mounting**

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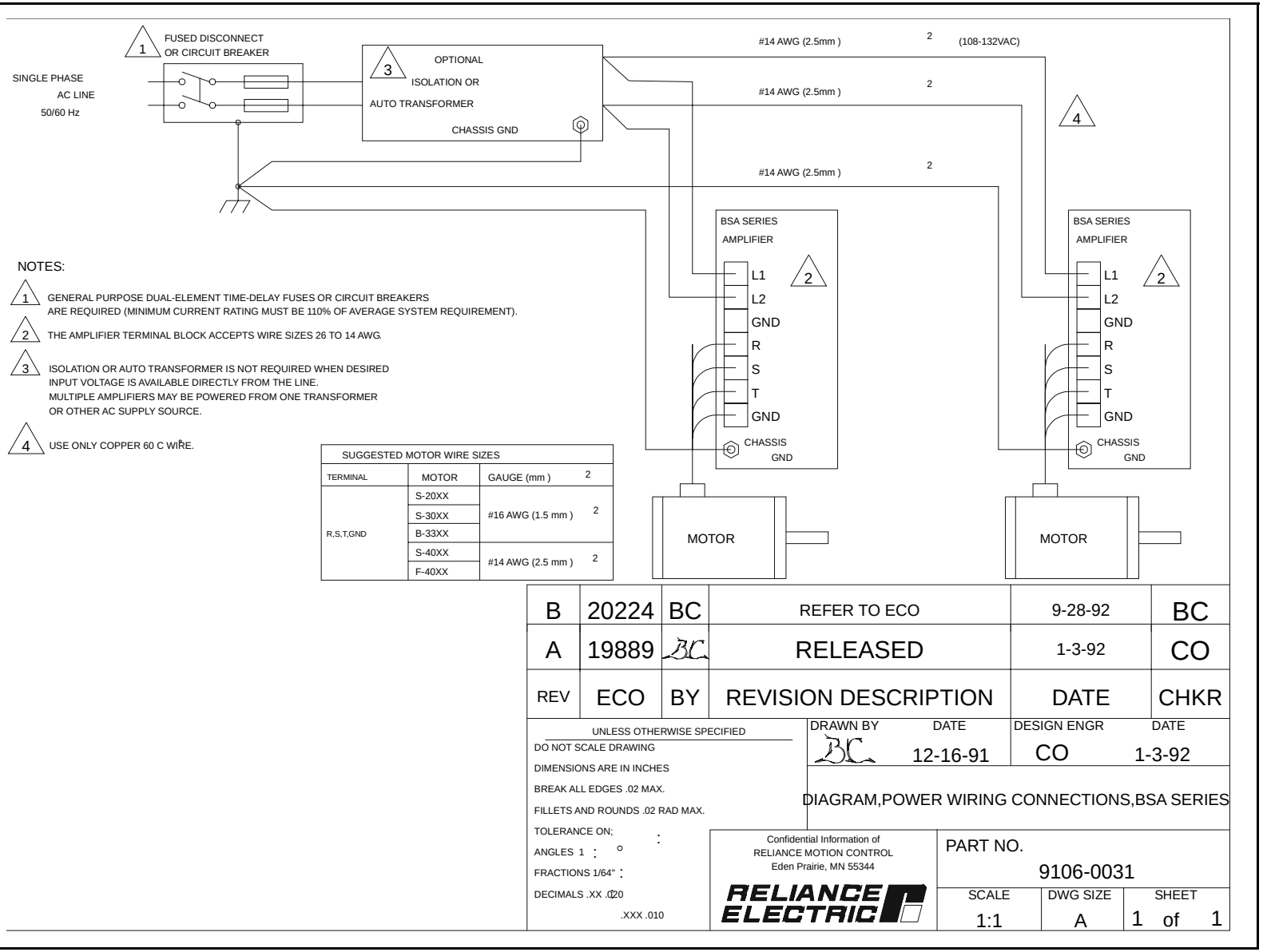



**FIGURE 9.2** **BSA-Series Power Wiring**





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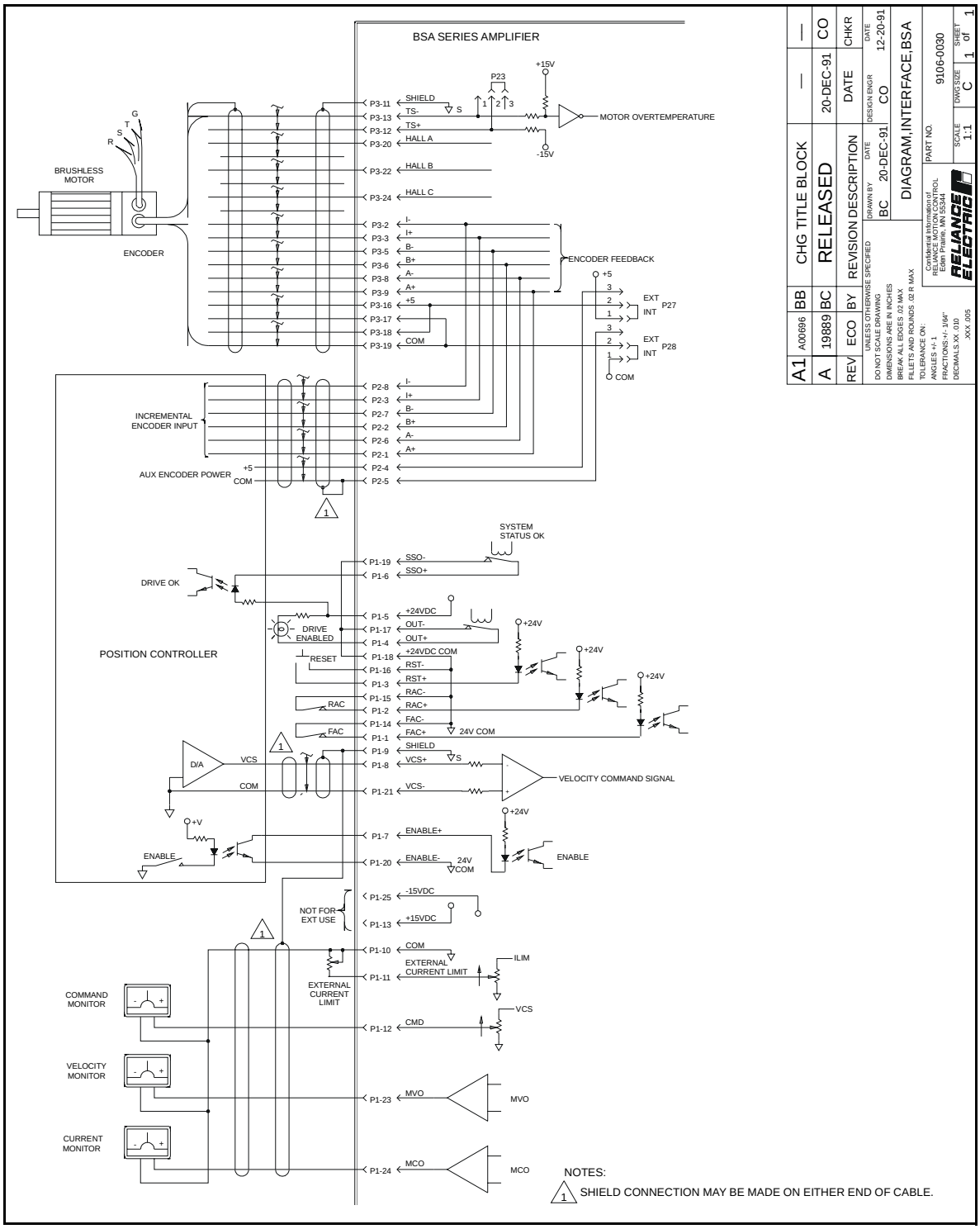
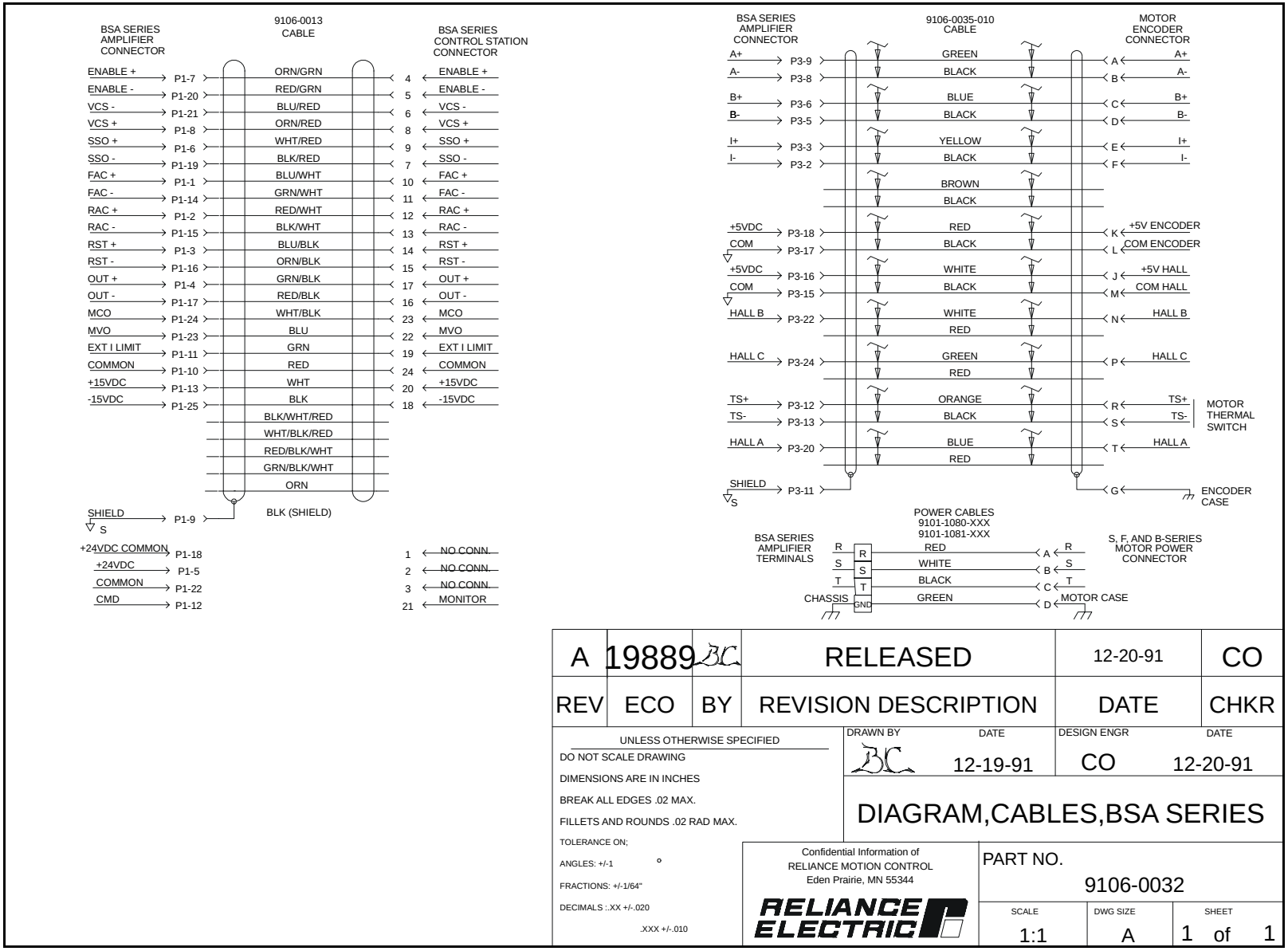



FIGURE 9.3 **BSA-Series, Interface Logic**



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| REV | ECO | BY | REVISION DESCRIPTION | DATE | CHKR |
|---|---|---|---|---|---|
| A | 19889 | BC | RELEASED | 12-20-91 | CO |

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX.
FILLETS AND ROUNDS .02 RAD MAX.
TOLERANCE ON;
ANGLES: +/-1 °
FRACTIONS: +/-1/64"
DECIMALS :.XX +/-.020
.XXX +/-.010

DRAWN BY BC DATE 12-19-91
DESIGN ENGR CO DATE 12-20-91

DIAGRAM,CABLES,BSA SERIES

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RELIANCE MOTION CONTROL
Eden Prairie, MN 55344

RELIANCE ELECTRIC

PART NO. 9106-0032

| SCALE | DWG SIZE | SHEET |
|---|---|---|
| 1:1 | A | 1 of 1 |

**FIGURE 9.4** **Cables, BSA-Series**





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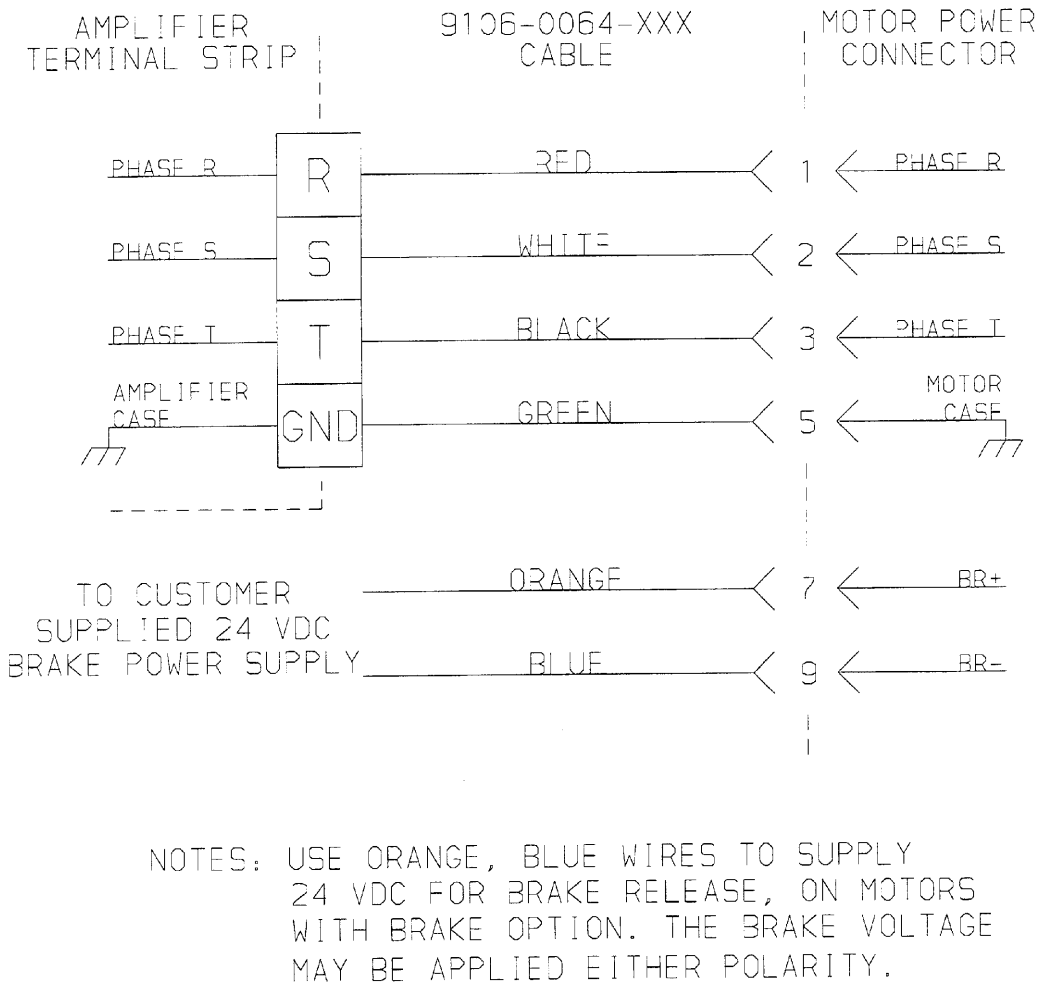
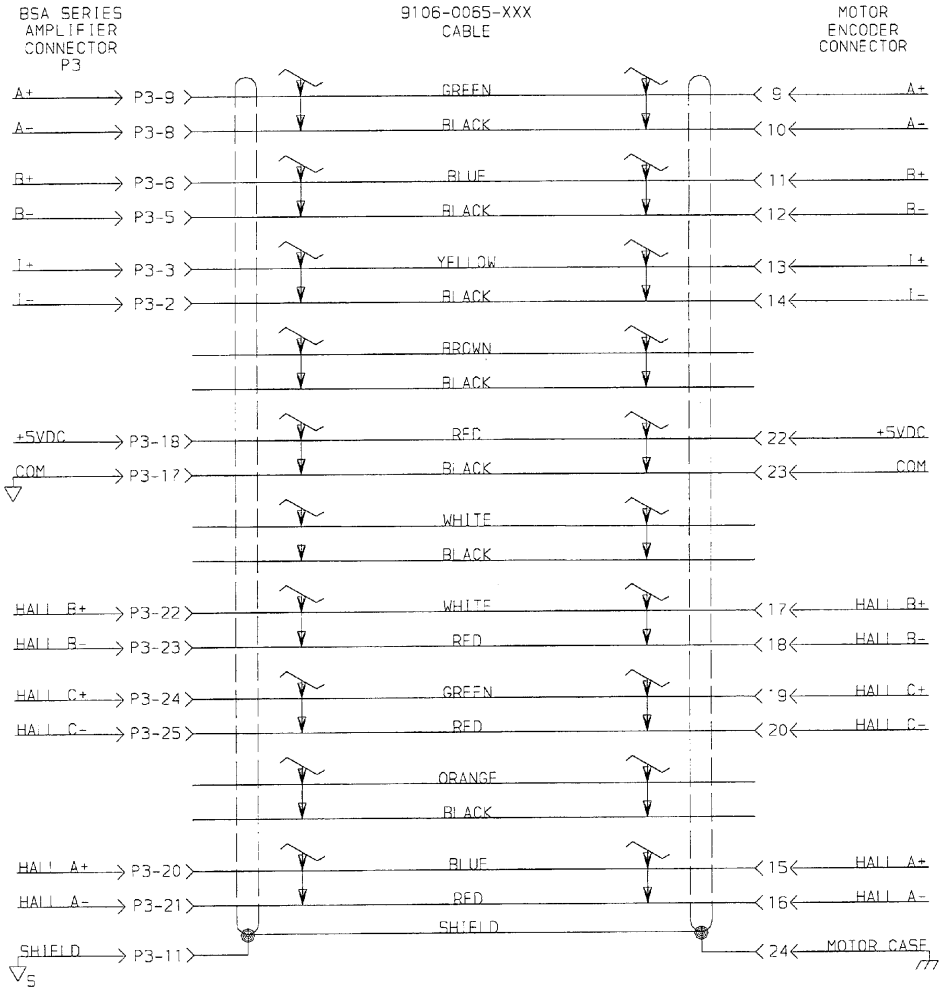



**FIGURE 9.5** **Cables, LD-Series, Power**



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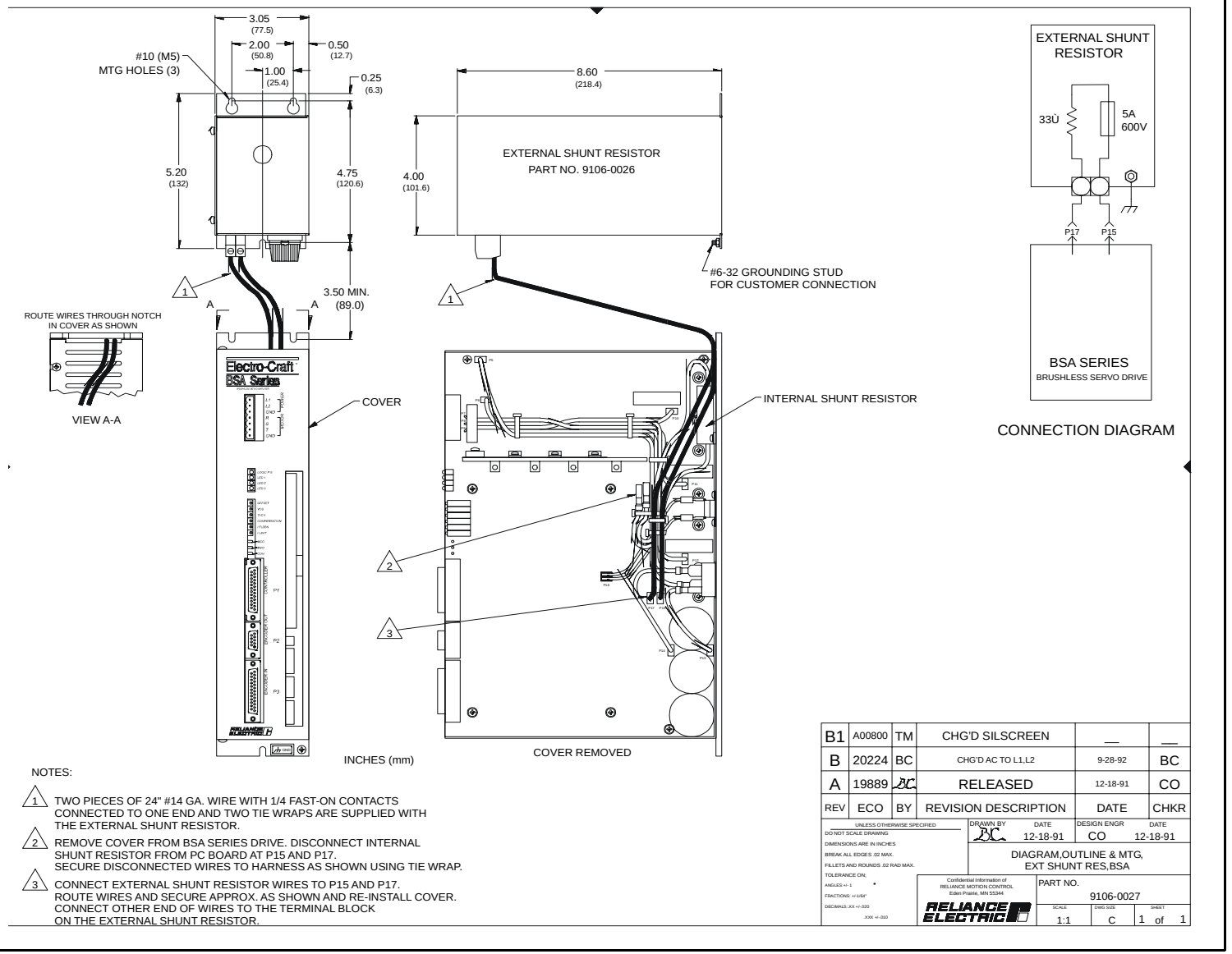



NOTE:
THIS CABLE PROVIDES CONNECTIONS FOR DIFFERENTIAL LINE DRIVER COMMUTATION SIGNALS (HALL A+,A-,B+,B-,C+,C-). THIS CABLE DOES NOT PROVICE CONNECTION FOR MOTOR THERMOSTAT SIGNALS (TS+,TS-). SET THE BSA AMPLIFIER JUMPERS TO THE CORRECT POSITION FOR THESE FEATURES, AS DESCRIBED IN THE BSA INSTRUCTION MANUAL.

**FIGURE 9.6** **Cables, LD-Series, Encoder**



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NOTES:

1. TWO PIECES OF 24" #14 GA. WIRE WITH 1/4 FAST-ON CONTACTS CONNECTED TO ONE END AND TWO TIE WRAPS ARE SUPPLIED WITH THE EXTERNAL SHUNT RESISTOR.
2. REMOVE COVER FROM BSA SERIES DRIVE. DISCONNECT INTERNAL SHUNT RESISTOR FROM PC BOARD AT P15 AND P17. SECURE DISCONNECTED WIRES TO HARNESS AS SHOWN USING TIE WRAP.
3. CONNECT EXTERNAL SHUNT RESISTOR WIRES TO P15 AND P17. ROUTE WIRES AND SECURE APPROX. AS SHOWN AND RE-INSTALL COVER. CONNECT OTHER END OF WIRES TO THE TERMINAL BLOCK ON THE EXTERNAL SHUNT RESISTOR.

| REV | ECO | BY | REVISION DESCRIPTION | DATE | CHKR |
|---|---|---|---|---|---|
| B1 | A00800 | TM | CHG'D SILSCREEN | __ | __ |
| B | 20224 | BC | CHG'D AC TO L1,L2 | 9-28-92 | BC |
| A | 19889 | BC | RELEASED | 12-18-91 | CO |

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX.
FILLETS AND ROUNDS .02 RAD MAX.
TOLERANCE ON:
ANGLES +/- 1 °
FRACTIONS +/-1/64"
DECIMALS: XX +/-.020
.XXX +/-.010

DRAWN BY: BC DATE: 12-18-91
DESIGN ENGR: CO DATE: 12-18-91

DIAGRAM,OUTLINE & MTG,
EXT SHUNT RES,BSA

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Eden Prairie, MN 55344

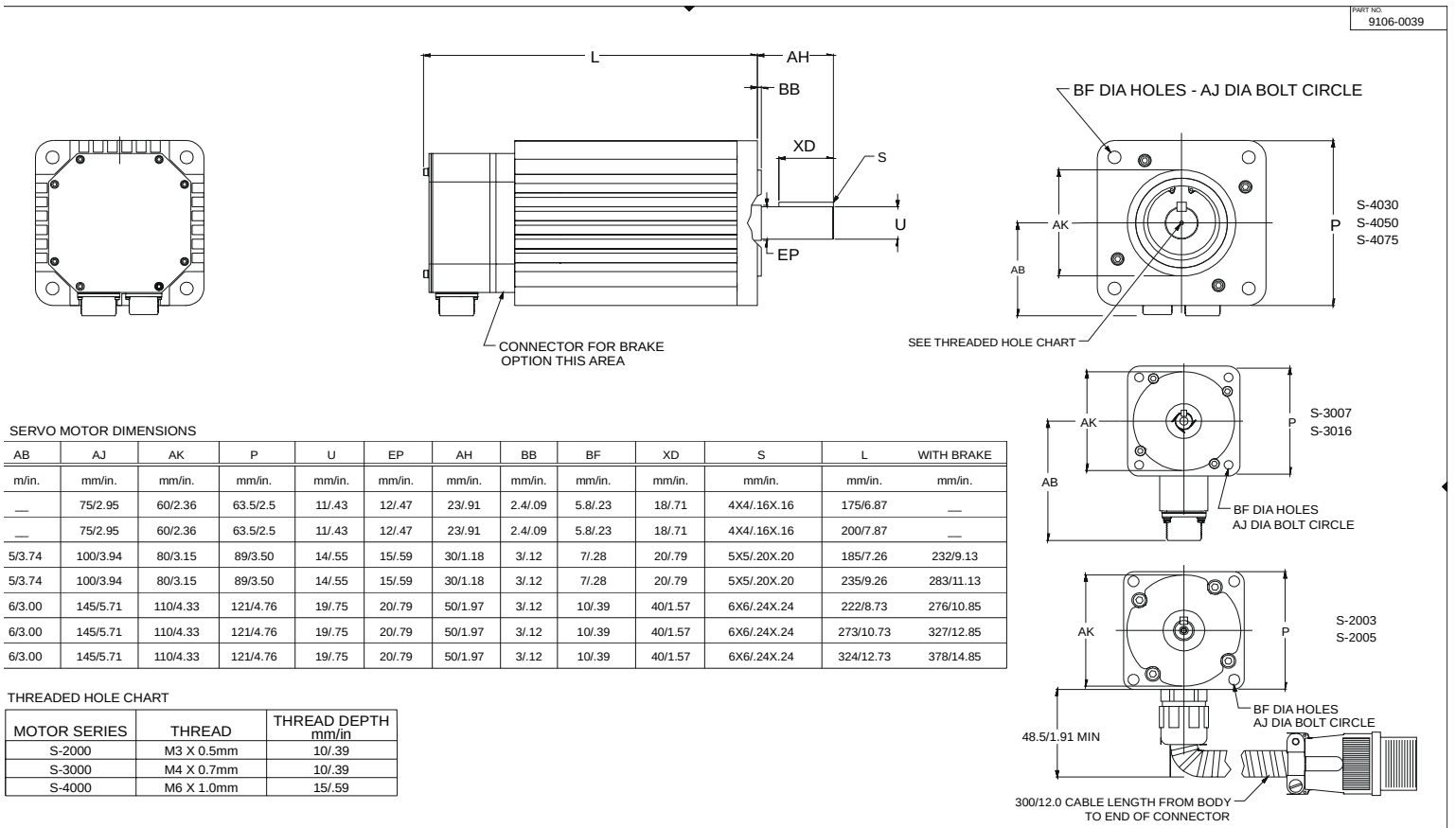
RELIANCE ELECTRIC

PART NO. 9106-0027

SCALE: 1:1 | DWG SIZE: C | SHEET: 1 of 1

**FIGURE 9.7 BSA-Series External Shunt**

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SERVO MOTOR DIMENSIONS

| AB | AJ | AK | P | U | EP | AH | BB | BF | XD | S | L | WITH BRAKE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| m/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. |
| __ | 75/2.95 | 60/2.36 | 63.5/2.5 | 11/.43 | 12/.47 | 23/.91 | 2.4/.09 | 5.8/.23 | 18/.71 | 4X4/.16X.16 | 175/6.87 | __ |
| __ | 75/2.95 | 60/2.36 | 63.5/2.5 | 11/.43 | 12/.47 | 23/.91 | 2.4/.09 | 5.8/.23 | 18/.71 | 4X4/.16X.16 | 200/7.87 | __ |
| 5/3.74 | 100/3.94 | 80/3.15 | 89/3.50 | 14/.55 | 15/.59 | 30/1.18 | 3/.12 | 7/.28 | 20/.79 | 5X5/.20X.20 | 185/7.26 | 232/9.13 |
| 5/3.74 | 100/3.94 | 80/3.15 | 89/3.50 | 14/.55 | 15/.59 | 30/1.18 | 3/.12 | 7/.28 | 20/.79 | 5X5/.20X.20 | 235/9.26 | 283/11.13 |
| 6/3.00 | 145/5.71 | 110/4.33 | 121/4.76 | 19/.75 | 20/.79 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 222/8.73 | 276/10.85 |
| 6/3.00 | 145/5.71 | 110/4.33 | 121/4.76 | 19/.75 | 20/.79 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 273/10.73 | 327/12.85 |
| 6/3.00 | 145/5.71 | 110/4.33 | 121/4.76 | 19/.75 | 20/.79 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 324/12.73 | 378/14.85 |

THREADED HOLE CHART

| MOTOR SERIES | THREAD | THREAD DEPTH mm/in |
|---|---|---|
| S-2000 | M3 X 0.5mm | 10/.39 |
| S-3000 | M4 X 0.7mm | 10/.39 |
| S-4000 | M6 X 1.0mm | 15/.59 |

MOTOR ARE MANUFACTURED TO MILLIMETERS DIMENSIONS SHOWN. INCH DIMENSIONS SHOWN ARE APPROXIMATE CONVERSIONS FROM MILLIMETERS.

FOR FURTHER MOTOR DETAIL, ENGINEERING SPECIFICATION DRAWINGS ARE AVAILABLE UPON REQUEST.

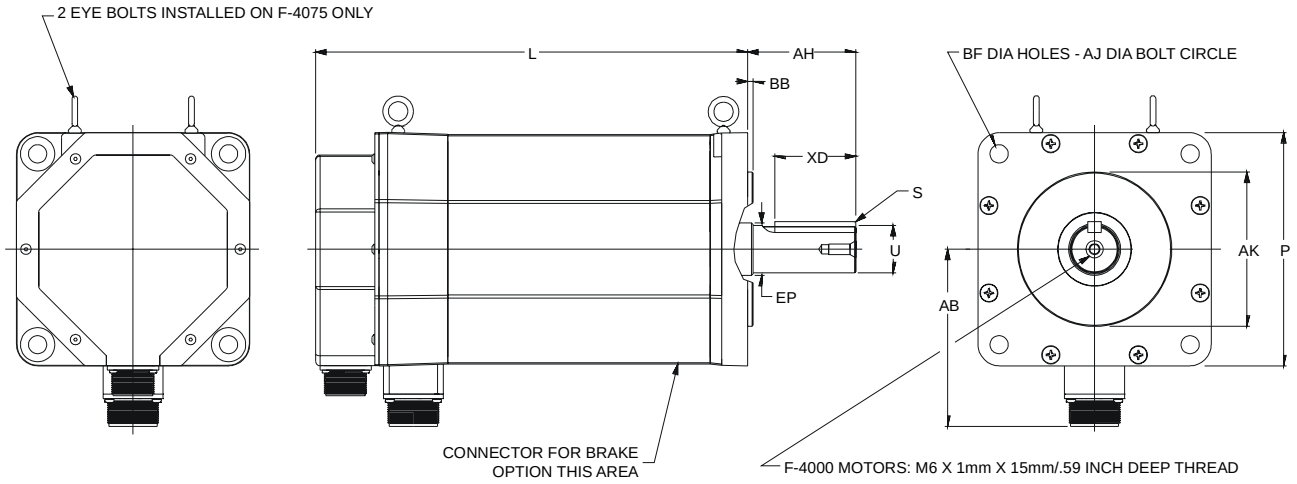
**FIGURE 9.8** **Outline and Mounting, S-Series Motors**



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F-Series Motor Dimensions

| MODEL | AB | AJ | AK | P | U | EP | AH | BB | BF | XD | S | L | with brake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm/in. (1) | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. (1) | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. | mm/in. |
| F4030 | 102/4.02 | 145/5.71 | 110/4.33 | 127/5.00 | 19/.75 | 22.2/.875 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 194/7.64 | 257/10.12 |
| F4050 | 102/4.02 | 145/5.71 | 110/4.33 | 127/5.00 | 19/.75 | 22.2/.875 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 272/10.71 | 335/13.19 |
| F4075 | 102/4.02 | 145/5.71 | 110/4.33 | 127/5.00 | 19/.75 | 22.2/.875 | 50/1.97 | 3/.12 | 10/.39 | 40/1.57 | 6X6/.24X.24 | 350/13.78 | 413/16.26 |




NOTES:

1. MOTORS ARE MANUFACTURED TO MILLIMETER DIMENSIONS SHOWN. INCH DIMENSIONS SHOWN ARE APPROXIMATE CONVERSIONS FROM MILLIMETERS. (EXCEPTION: DIMENSION EP IS MANUFACTURED IN INCHES)
2. FOR FURTHER MOTOR DETAIL, ENGINEERING SPECIFICATION DRAWINGS ARE AVAILABLE UPON REQUEST.

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX.
FILLETS AND ROUNDS .02 RAD MAX.
TOLERANCE ON;
FRACTIONS: +/- 1/64"
DECIMALS: .XX +/- .010
.XXX +/- .005
ANGLES: +/- 1 °

MATERIAL: N/A

DRAWN BY: SJ — DATE: 02-JAN-92
CHECKED BY — DATE
DESIGN ENGR — DATE
USED ON: N/A
FINISH: N/A

| REV | ECO | BY | REVISION DESCRIPTION | DATE | CHKR |
|---|---|---|---|---|---|
| A | 19901 | BC | RELEASED | — | — |

DIAGRAM,
OUTLINE & MOUNTING,
F-SERIES MOTORS

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RELIANCE ELECTRIC
Reliance Motion Control, Inc./Eden Prairie, MN 55344

DRAWING NO. 9106-0040

SCALE: N/A — DWG SIZE: C — SHEET of 1 1

**FIGURE 9.9 Outline and Mounting, F-Series Motors**



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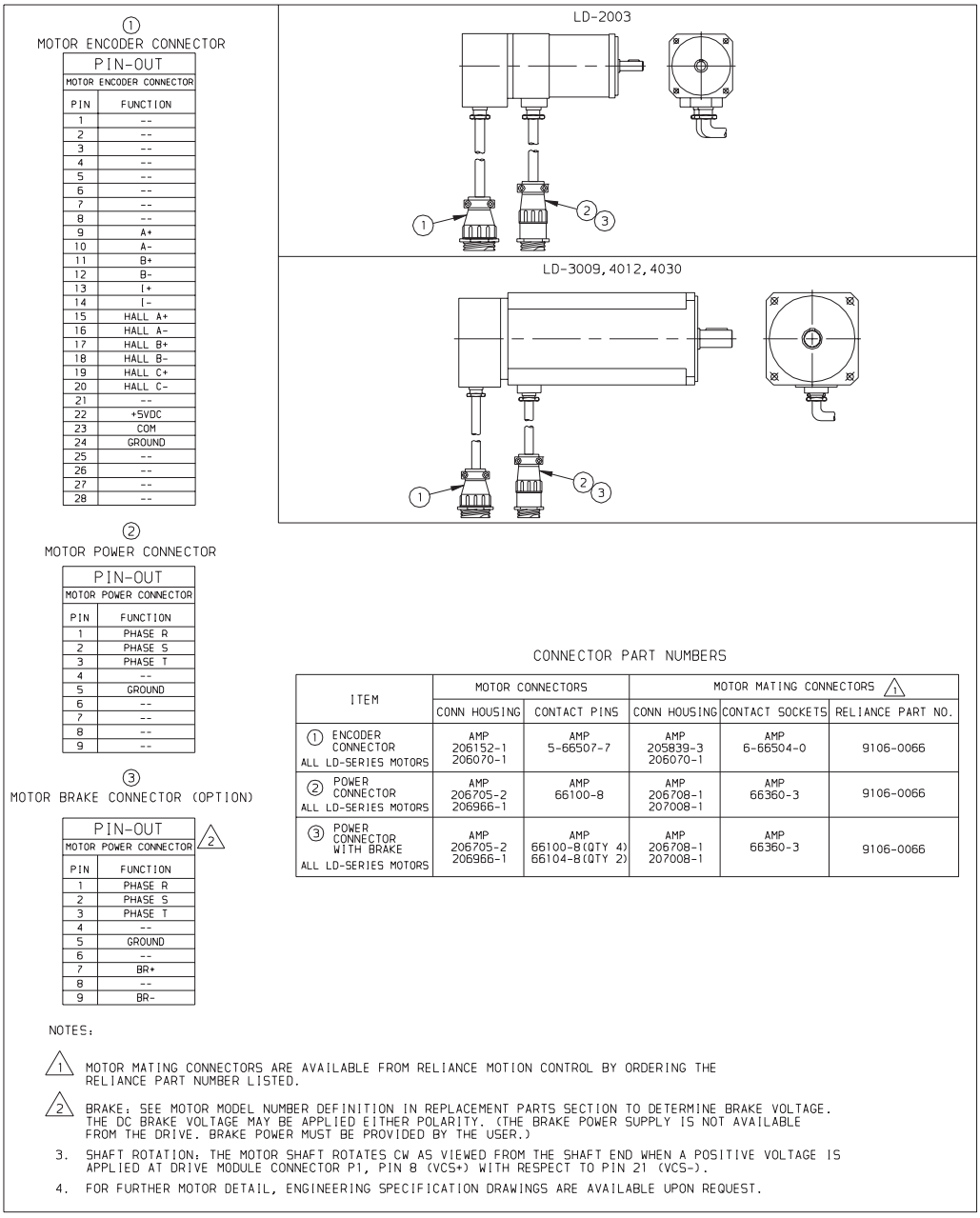
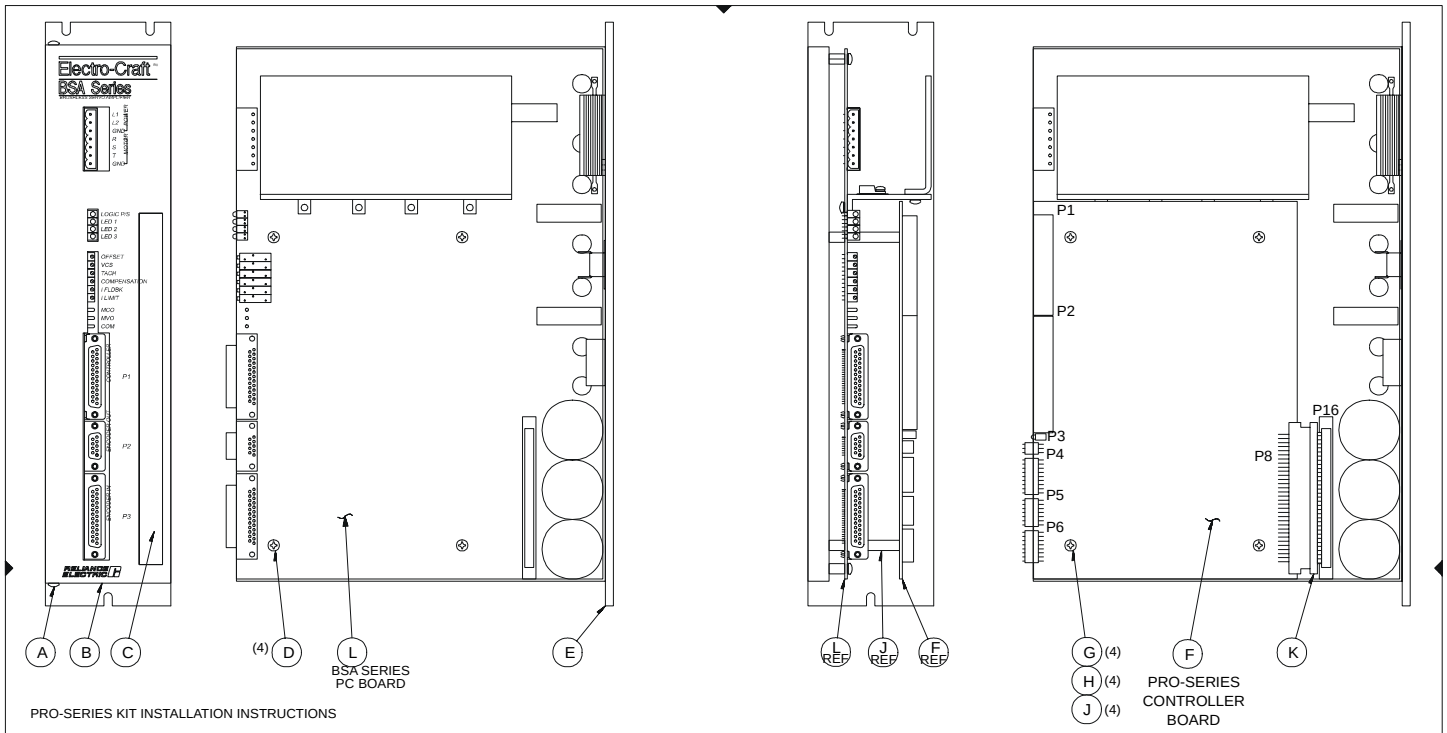



**FIGURE 9.10** **Outline and Mounting, LD-Series Motors**



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PRO-SERIES KIT INSTALLATION INSTRUCTIONS

1. LOOSEN COVER MOUNTING SCREWS (A) AND REMOVE COVER (B) FROM CHASSIS (E).

2. REMOVE FILLER PANEL (C) FROM COVER (B).

3. REMOVE AND DISCARD MOUNTING SCREWS (D) FROM BSA SERIES PC BOARD.

4. INSTALL PRO-SERIES CONTROLLER BOARD (F) ONTO BSA SERIES PC BOARD (L) USING SPACERS (J) , SCREWS (G) AND WASHERS (H).

5. INSTALL ONE END OF RIBBON CABLE (K) INTO CONNECTOR P8 OF PRO-SERIES CONTROLLER CARD. PLUG OTHER END OF RIBBON CABLE INTO CONNECTOR P16 OF BSA SERIES PC BOARD.

6. RE-INSTALL COVER ONTO CHASSIS AND TIGHTEN MOUNTING SCREWS.

NOTES:

1. MATING CONNECTORS ARE PROVIDED WITH PRO-SERIES KIT FOR CUSTOMER CONNECTIONS TO P1, P2, P3, & P5.

| REV | ECO | BY | REVISION DESCRIPTION | DATE | CHKR |
|---|---|---|---|---|---|
| B1 | A00800 | TM | CHG'D SILKSCREEN | — | — |
| B | 20224 | BC | CHG'D AC TO L1,L2 | 9-28-92 | BC |
| A1 | A00519 | BC | UPDATED TITLE BLOCK | 3-2-92 | BC |
| A | 19752 | BC | RELEASED | 8-19-91 | SC |

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DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX.
FILLETS AND ROUNDS .02 RAD MAX.
TOLERANCE ON:
ANGLES 1° ±
FRACTIONS ±1/64"
DECIMALS .XX .020 ±
.XXX .010 ±

DRAWN BY BC DATE 8-19-91
DESIGN ENGR SC DATE 8-19-91

DIAGRAM,INSTALLATION,PRO KIT/BSA

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Eden Prairie, MN 55344

RELIANCE ELECTRIC

PART NO. 9106-0011

SCALE 1:1 | DWG SIZE C | SHEET 1 of 1

**FIGURE 9.11 Installation, PRO-Series Kit**

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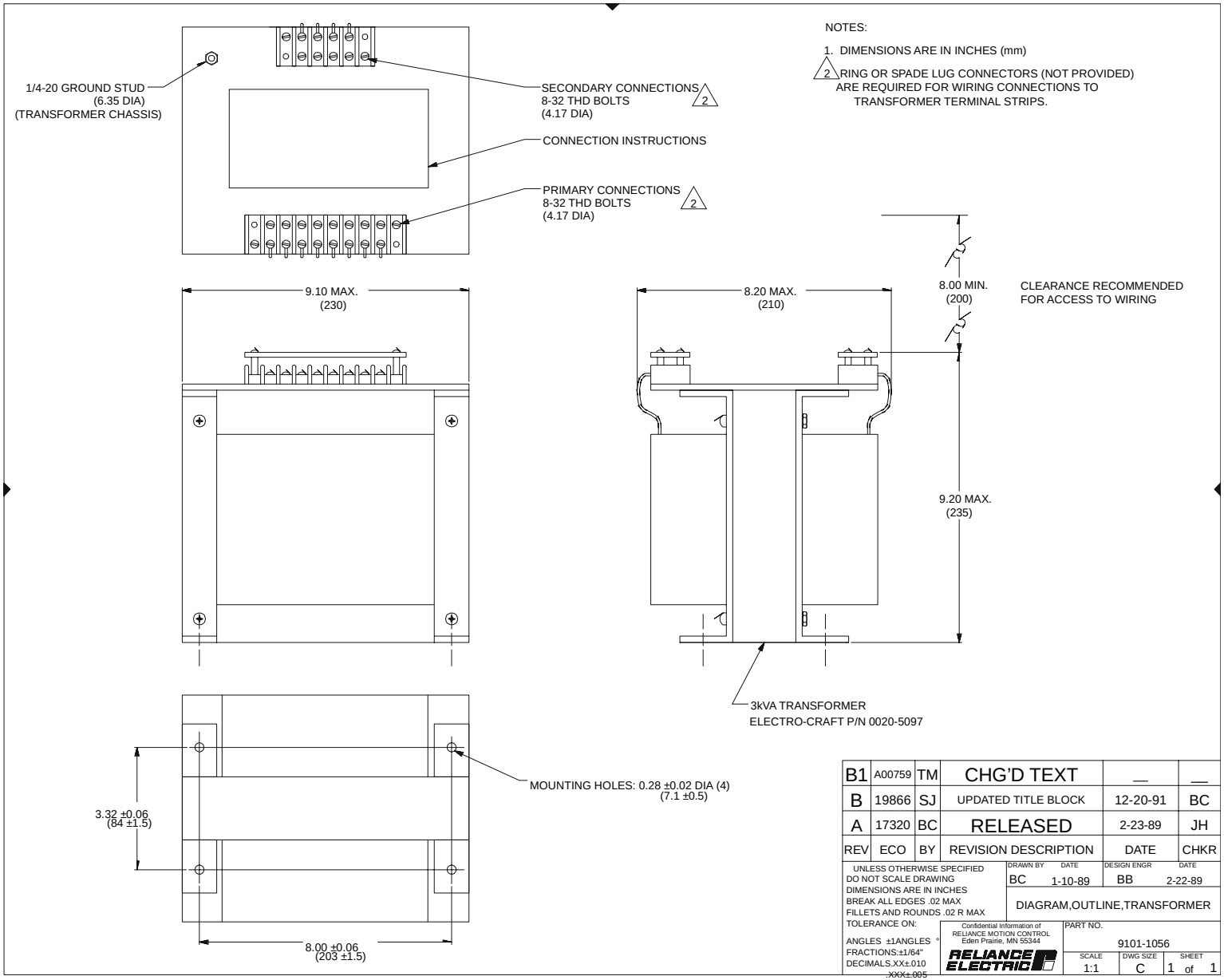



**FIGURE 9.12** **Outline, Transformer**





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**Rockwell Automation/Electro-Craft**

Technical Communications Department
6950 Washington Avenue South
Eden Prairie, MN 55344
Fax: 612-942-3636

## DOCUMENTATION IMPROVEMENT FORM

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**Page Number:** _____

**Comments:** Please give page numbers and specific paragraphs that the change will affect. Include markups from the document or attach additional pages if necessary.

_____

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What improvements will this suggestion provide? _____

_____

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Originator:_____ City: _____ State: _____ Zip: _____

Company: _____ Phone: _____

Address: _____ Date: _____

**Thank you for your comments.**



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The following information summarizes the Electro-Craft “Returned Goods and Field Service Policy,” which is available upon request from Rockwell Automation.

## Defective Equipment

If you are unable to correct a problem, and the product is defective, you may return the unit to your Electro-Craft distributor for repair or replacement.

There are no field serviceable parts in the drive, other than fuses and jumpers. If the drive fails, the unit should be returned to the factory repair or replacement. To save unnecessary work and repair charges, please verify that the drive unit is defective before returning it for repair.

The Electro-Craft BSA-Series drives are warranted against defects in material and assembly. Limitations to warranty coverage are detailed in “Returned Goods and Field Service Policy.” Products that have been modified by the customer, physically mishandled, or otherwise abused through incorrect wiring, inappropriate settings, and so on, are exempt from the warranty plan.

## Return Procedure

To ensure accurate processing and prompt return of any Electro-Craft product, the following procedure must be followed:

1. Call your Electro-Craft distributor to obtain a Return Material Authorization (RMA) number. Do *not* return the drive or any other equipment without a valid RMA number. Returns lacking a valid RMA number will *not* be accepted and will be returned to the sender.
2. Pack the drive in the original shipping carton. Electro-Craft is not responsible or liable for damage resulting from improper packaging or shipment.
3. Include a detailed description of the problem and any relevant information.

Repaired units are shipped via UPS Ground delivery. If another method of shipping is desired, please indicate this when requesting the RMA number and include this information with the returned unit.



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Electro-Craft product support is available over the phone. When you call, you should be at your computer and have the hardware and software manuals at hand. Be prepared to give the following information:

- The version numbers of the hardware and software products.
- The type of hardware that you are using.
- The fault indicators and the exact wording of any messages that appears on your screen.
- How you tried to solve the problem.

## Distributor & Representative Network

Electro-Craft has a wide network of distributors that are trained to support our products. If you encounter problems, call the distributor or representative where you purchased the product before contacting the factory.

## Applications Engineers and Field Service

In the United States you can reach the Electro-Craft factory based support staff by phone between 7:30 AM and 5:00 PM (CST) Monday through Friday at 1-800-328-3983. The applications engineers can assist you with programming difficulties as well as ideas for how to approach your automation task. Should your problem require on-site assistance, field service is available.

The applications engineers can also be reached via fax at 1-612-942-3756. The fax machine is open 24 hours 7 days a week. Faxes will be answered during regular business hours only.

In Europe, support can be obtained through Electro-Craft Limited. The support staff may be reached by telephone between 8:30 and 17:30 local time, Monday through Friday at [44] 1270-580142, or via fax at [44] 1270-580141.

## Bulletin Board Service (BBS)

If you have a modem, you can reach the Electro-Craft BBS 24 hours a day, 7 days a week at 1-612-942-3618. The following services are available through the BBS:

- Example application programs.
- Technical bulletins.
- Leave messages and files for the application engineers.
- Help with your application.



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