

BJR/BJP
Installation Manual

Manual M95102
July 1996

BJR/BJP Installation Manual

Manual M95102
Kollmorgen Motion Technologies Group
201 Rock Road
Radford, VA 24141

July 1996

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Dangerous voltages, currents, temperatures, and energy levels exist in this product and in the associated servo motor(s). Extreme caution should be exercised in the application of this equipment. Only qualified individuals should attempt to install, set-up, and operate this equipment. Ensure that the motor, amplifier, and the end-user assembly are all properly grounded and current limited per NEC requirements.

European Community (EC) Declaration of Conformity

We, Kollmorgen Corporation Industrial Drives Division, 201 Rock Road, Radford, Virginia USA; declare under sole responsibility that this equipment is exclusively designed for incorporation in another machine. The operation of this equipment is submitted to the conformity of the machine in which it is incorporated, following the provisions of the EC Electro-Magnetic Compatibility (EMC) directive 89/392/EEC.

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CHAPTER 1

SYSTEM DESCRIPTION

INTRODUCTION

This chapter presents an overview of the BJR/BJP: functions, features, and options.

PRODUCT DESCRIPTION

The BJx is a family of positioners, positioner/amplifiers, and smart amplifiers. Together, these products represent some of the smallest, most cost-effective intelligent motion controllers available. The BJx line includes three products:

- BJR** The BJR is a programmable positioner/amplifier for brush and brushless motors which operates from 40 VDC and below.
- BJRL** The BJRL is a programmable positioner/amplifier for brush and brushless motors which operates from 115 AC.
- BJP** The BJP is a positioner that can be used with any servo amplifier, such as the KXA from Kollmorgen PMI.

This manual deals with installation of the BJR and BJP. Installation of the BJRL is discussed in manual M96-106. The programming of all three products is discussed in the BJx *User's Manual*, M96105.

All members of the BJx line execute the BJx language, which has set standards for motion control with its simple BASIC-like command structure and sophisticated decision-making capability. The BJx line provides the servo performance you have come to expect from Kollmorgen. By incorporating a high-performance microprocessor, Kollmorgen has designed these products without compromising on either positioner software or servo performance. This single microprocessor closes all servo loops, resulting in a truly integrated positioning system. The BJx line has the features and performance you need in your next positioning application.

FEATURES

The BJR and BJP offer a wide feature set to accommodate real world positioning requirements:

- **LOW COST**

These products are affordable, even with their wide variety of advanced features.

- **INTEGRATED PACKAGE**

The BJR is easy to install because the servo amplifier and the positioner are integrated into one package.

- SIMPLE PROGRAMMING LANGUAGE

The BJx language uses simple BASIC-like commands such as RUN, GOTO (for branching), and GOSUB/RETURN (for subroutines). Advanced IF/ELIF/ELSE/ENDIF statements result in programs that are easier to read. In addition, you can comment every line in your program.

- ADVANCED MOTION CONTROL MOVES

The simple language does not prevent you from solving complex problems. The BJx language supports separate acceleration and deceleration rates, as well as multiple S-curve acceleration profiles. Profiles can be changed in response to real-time events.

- MASTER/SLAVE - ELECTRONIC GEARBOX

The electronic gearbox is used to link two motors together so that the velocity of the slave is proportional to the velocity of the master. The ratio can be from 32767:1 to 1:32767. Also, the "index-on-gearing" feature permits real-time phase adjustments.

- MASTER/ SLAVE - PROFILE REGULATION

With profile regulation you can control the slave's motion profile according to an external master motor or frequency. Profile regulation modifies the velocity and acceleration of the slave axis without affecting the final position of the move. You can use profile regulation to implement "feed rate override."

- MOTION GATING

The BJx language supports precalculation of moves to begin after a transition on the GATE input. This provides rapid and repeatable motion initiation.

- REGISTRATION

All BJx products have the ability to capture the current position within 40 microseconds after a real-time event, resulting in accurate registration sequences.

- MATHEMATICS

Algebraic math is provided for commands such as:

$$X1 = 2 \times (X2 + X3)$$

The BJx language has 100 program labels, 750 user-definable variables, and 50 user-definable switches. It also has 15 mathematical/logical operations and over 100 system variables.

- USER UNITS

Quantities such as position, velocity, and acceleration are automatically scaled into user-defined units. This allows you to program in convenient units, such as feet, inches, RPM, or degrees.

- SUPERIOR SERVO LOOP CONTROL

All BJx products offer smooth, high-resolution motion control and a 32-bit position word. Long-term speed stability is 0.01%.

- SELF-TUNING

BJx products are self-tuning. You do not need to be a servo expert to set up a system quickly. Just specify the desired bandwidth and let the BJx do the rest.

- DIGITAL SERVO LOOPS

Both the position and velocity loops are totally digital. The digital loops provide features not available in standard velocity drives, such as self-tuning, zero velocity offset, and digitally-adjustable servo tuning parameters.

- FEED-FORWARD GAIN

Digital feed-forward gain reduces following error for more reliable position control at speed.

- DIAGNOSTICS

The BJx language offers a complete set of error diagnostics, including English error messages. It remembers 20 errors even through power loss. In addition, you can write your own error handler so you can shut down your process smoothly. Trace and single-step modes are available for debugging. Also included is complete fault monitoring, including travel limit switches and software position limits, as well as hardware safety circuits and checksums for safer and more reliable operation.

- DIGITAL I/O

All BJx products have up to 20 optically isolated I/O sections. These I/O sections operate on 5 VDC, 12 VDC, or 24 VDC. Inputs and outputs can be connected as sourcing or sinking.

- ANALOG I/O

BJx products provide three 10-bit, single-ended, 0-10 VDC analog inputs. Analog power is provided to simplify connection to potentiometers. Also provided is one 8-bit ± 10 VDC analog output for meters.

- SERIAL COMMUNICATIONS

Serial communications provide a powerful link to other popular factory automation devices, such as PLCs, process control computers, and smart terminals. All units support both RS-232 for terminals and PCs and RS-422/RS-485 for multidrop communications. With multidrop you can place up to 32 axes on one serial line. These units can autobaud from 300 baud to 19.2k baud, simplifying installation.

- MOTION LINK

Kollmorgen also offers MOTION LINK, a powerful, menu-driven communications package for your IBM-PC (c) compatible computer. With this package, programs and variables can be retrieved from or saved to a disk drive. Also, on-screen help and a full screen editor are built into MOTION LINK.

- MENU-DRIVEN SOFTWARE

The BJx programming language allows you to write operator-friendly, menu-driven software. By incorporating a Kollmorgen Hand Held Terminal

(HHT-02) or other serial communications device, the operator can be prompted for specific process data.

- MONITOR MODE

The BJx language provides interactive communications and permits all system variables and parameters to be examined and modified at any time--even during program execution or while the motor is running.

PART NUMBER DESCRIPTION

A model number is printed on a tag on the front of your BJR/BJP. The model number identifies how the equipment is configured. Each component is described in Figure 1.1. Verify that the model numbers represent the equipment desired for your application.

Current Loop (BJR only)

The BJR has analog current loops which are tuned with one capacitor (CL in J3) and one resistor (RL in J4). The values of these components vary depending on the motor and amplifier models. Failure to install the correct values can result in damage to the motor and amplifier. See Chapter 2 for more information.



CAUTION

FOR THE BJR:

Failure to install the proper compensation components in RL/CL can cause damage to the BJR, the motor, or both.

BJR/BJP Model Number

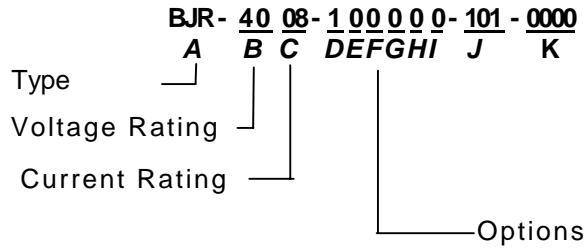


Figure 1.1 BJR/BJP Model Number Scheme

Table 1.1 BJR/BJP Model Number Scheme Description

LEGEND		DEFINITION
A	BJR BJP	Type Programmable Amplifier/Positioner Programmable Positioner
B	40	Voltage Rating 40 VDC
C	04 08	Continuous Current Rating (BJR Only) 4 Amps/Phase 8 Amps/Phase
D	0 1	Master/Slave Configuration No Master/Slave (Standard) Master/Slave
E	0 1	Extended Memory and I/O Standard I/O & Standard Memory Extended I/O & Extended Memory
F	0 1	Power Supply (BJP Only) 20 - 40 VDC Input 115/230 VAC Input
GH	00	Standard
I	1 0	Cover Option Cover No Cover
J		Firmware Version (Assigned by Kollmorgen, not normally specified when ordering)
K		User Program (This is reserved for systems that are programmed by Kollmorgen. This is not normally specified when ordering.)

SPS(R) Model Number
SILVERLINE Power Supply with Optional Regen

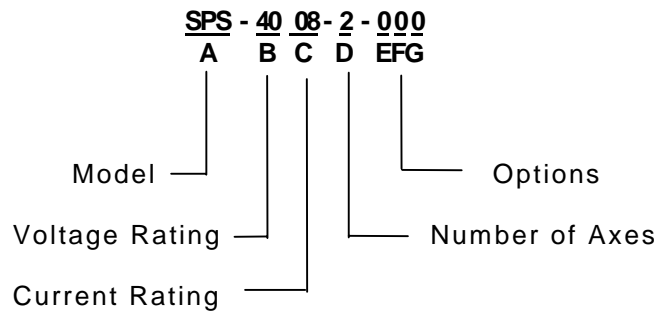


Figure 1.2 SPS(R) Model Number Scheme

Table 1.2 SPS(R) Model Number Scheme Description

LEGEND	DEFINITIONS
A SPS SPSR	Type Power Supply without Regen Power Supply with Regen
B 40	Voltage Rating 40 VDC
C 08	Current Rating 8 Amps DC
D 0-4	Number of Amplifiers that can be mounted to the SPS(R)
EFG 000	Standard

SPECIFICATIONS AND RATINGS

Table 1.3 Specifications

BJR-40XX		
DESCRIPTION	BJR-4004	BJR-4008
Main DC Bus		
Minimum	20 VDC	20 VDC
Maximum	40 VDC	40 VDC
Output Current (DC) (40°C AMB)		
Continuous (RMS)	4 AMPS	8 AMPS
Peak (2.0 sec) (RMS)	8 AMPS	16 AMPS
Output VA (@ 40 VDC Bus)		
Continuous (45°C AMB)	160 VA	320 VA
Peak (2.0 sec) (RMS)	320 VA	640 VA
PWM Switching Frequency	18 kHz	18 kHz

Table 1.3 Specifications (Cont.)

SPS(R) - 4008	
DESCRIPTION	RATING
Main AC Line Input Voltage (short term 2-3) (short terms 1-2 & 3-4)	207-264 104-132
Phase	1
Frequency	57-63 Hz
Current Cont. (DC)	8 AMPS
Peak (2.0 sec)	16 AMPS
Peak (50.0 msec)	24 AMPS
Main DC Bus Output Voltage (Nominal 115/230 VAC Input/Full Load)	30 VDC
Shunt Regulator Current (PK)	16 AMPS
Regen Power Dissipation (Cont.)	25 WATTS
Regen Power Dissipation (PK)	250 WATTS
Internal Heat Dissipation	25 WATTS
Regen Trip voltage	41-43 VDC

Table 1.4 Environmental Specifications

Operating Temperature*	0°C to 40°C
Storage Temperature	-20°C to 70°C
Humidity (Non-Condensing)	10% to 90%

*For operation ambients above 40°C, consult the Applications Engineer at your ICP Regional Office

Table 1.5 Mechanical Specifications

MODEL NUMBER	WIDTH		HEIGHT		DEPTH*	
	MM	IN.	MM	IN.	MM	IN.
BJR 40XX	66	2.6	204	8	92	4
BJP	66	2.6	204	8	92	4
SPS(R)-4008-0	150	5.9	241	9.5	108	4.25
SPS(R)-4008-1	213	8.4	241	9.5	108	4.25
SPS(R)-4008-2	297	11.7	241	9.5	108	4.25
SPS(R)-4008-3	381	15.0	241	9.5	108	4.25
SPS(R)-4008-4	463	18.3	241	9.5	108	4.25

*Serial connectors (J14, J15) add approximately (12 mm) 0.5" to the depth.

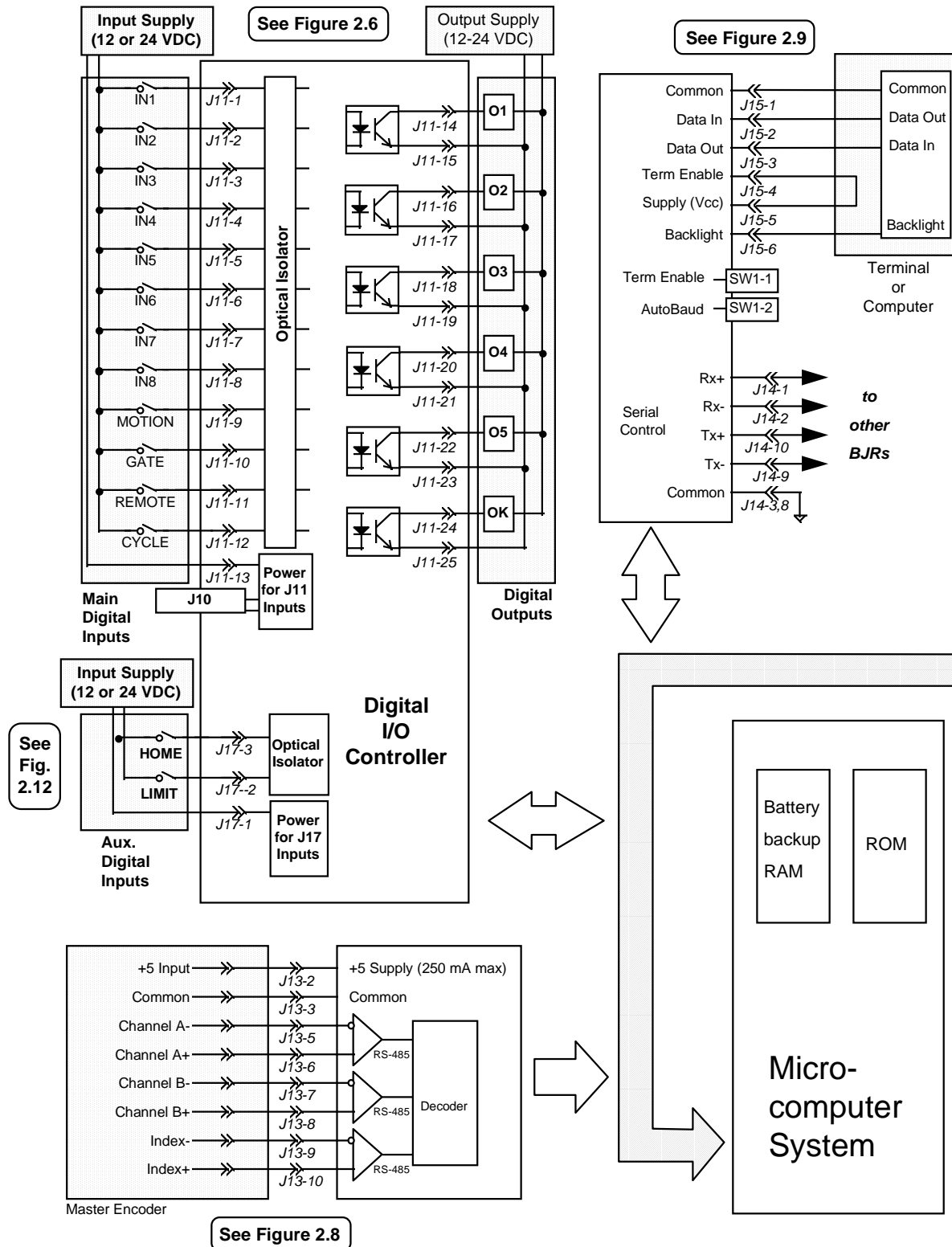
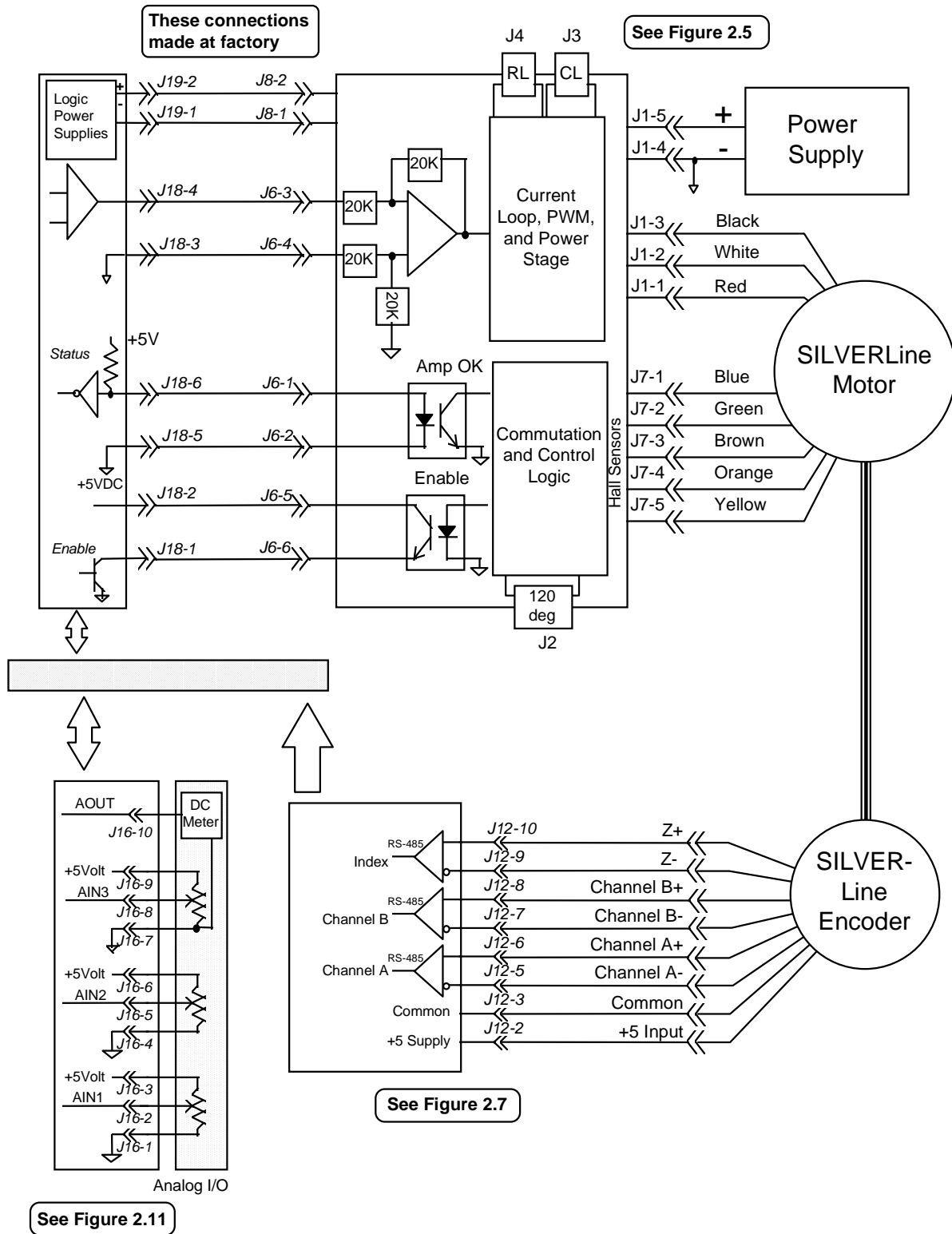


Figure 1.3 BJR/BJP System Wiring Diagram



CHAPTER 2

MOUNTING AND WIRING

INTRODUCTION

This chapter provides safety information, unpacking and inspection, installation requirements, mounting procedures, and wiring for installing the BJR/BJP and the SPS(R). Read the entire chapter carefully because most installation problems are caused by incorrect wiring or poor wiring practices.

SAFETY INFORMATION

This section will alert you to possible safety hazards associated with this equipment and the precautions you can take to reduce the risk of personal injury and damage to the equipment.

Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.



The safety-alert symbols are illustrated above. When you see these symbols in this manual, be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices included with the alert symbols.

WARNING refers to personal safety and alerts you to potential danger or harm. Failure to follow warning notices could result in personal injury or death.

CAUTION directs attention to general precautions which, if not followed, could result in personal injury and/or equipment damage.

NOTE highlights information critical to your understanding or use of these products.

UNPACKING AND INSPECTION



Electronic components in this amplifier are static sensitive. Use proper procedures when handling component boards.

Upon receipt of the equipment, closely inspect components to ensure that no damage has occurred in shipment. If damage is detected, notify the carrier immediately.

Carefully remove packing material and remove the equipment from the shipping container. Do not dispose of shipping materials until the packing list has been checked. Parts contained within the shipment but not physically attached to the equipment should be verified against the packing list. If any parts are missing notify Kollmorgen at once.

INSTALLATION REQUIREMENTS

Proper installation and field wiring are of prime importance when considering the application of servo amplifiers. Many problems will be avoided if equipment installation is done properly. Users should familiarize themselves with and follow installation and wiring instructions in addition to all applicable codes, laws, and standards. Pay special attention to the following topics when installing Kollmorgen equipment.

Environmental Considerations

The environment in which this equipment is placed can dramatically affect its operation. Kollmorgen recommends that the BJP/BJR and SPS(R) be operated and stored under the following conditions:

- Operating Temperature: 0°C to 40°C
- Storage Temperature: -20°C to 70°C
- Humidity: 10% to 90%
(Non-Condensing)

Ventilation

The SPS(R) and BJR should be mounted vertically to allow maximum ventilation of the components. This configuration allows the heat generated by the components to vent through the top and draft in cooler air through the bottom. The top and bottom of the components are vented to allow this drafting to occur. Check ventilation paths to ensure they are not constricted by accumulation of contaminants.

MOUNTING

The BJR, BJP, and SPS(R) should be mounted in a cabinet or other suitable enclosure to protect them from physical and environmental damage.

Mounting the SPS(R)

The SPS(R) power supply module may be mounted on either side of the BJR. However, when the optional side covers are used, a 20 mm (0.8 inch) space is required between units.

The SPS(R) power supply and mounting bracket must be mounted so the BJR units are vertical. A 25 mm (1 inch) clearance must be maintained on all four sides of the SPS(R). Refer to the SPS(R) Outline Drawing in Appendix B for more information (Figure B.1).

Mounting BJR/BJP units on SPS(R)s

SPS(R)s include mounting holes for up to four BJRs. The number of BJR units that can be mounted is specified when you order your units.

Mounting BJRs without an SPS(R)

The BJR must be mounted vertically. (The BJP can be mounted in any orientation.) These units are convection cooled and require 6 mm (.25 inch) clearance on both sides, as well as at least 25 mm (1 inch) above and below. See the BJR/BJP Outline drawings in Appendix B for more information (Figures B.2, B.3, and B.4).

WIRING

The customer is responsible for providing proper circuit breaker or fuse protection. The customer is responsible for providing proper wire gauge and insulation rating for all wiring, including motor, AC line, and DC bus. The customer is responsible for making sure that all system wiring and electrical protection comply with all applicable national and local electric codes.

When wiring your system, observe the following guidelines:

1. Twist all AC leads to minimize electromagnetic emissions (noise).
2. Avoid running signal leads in close proximity to power leads, motor stator leads, or other sources of electromagnetic noise. Run signal leads in separate conduit from power leads. Shields are recommended for signal leads.
3. Minimize lead lengths.
4. Provide adequate strain relief for all cables and wires.

Wiring the Ground with an SPS(R)

To prevent shock hazard and to ensure proper operation of the system, the bus- and the motor must be grounded. The BJR/BJP is not isolated from bus-, so grounding bus- will ground the BJR/BJP.



WARNING

Ground bus- and motor PROPERLY! Failure to provide proper grounding can result in a shock hazard.

Providing the DC Bus

The BJR/BJP is configured at the factory for operation from a 40 volt DC (max) bus. Regulated supplies may provide up to the maximum voltage, providing that regulation is within 2% overall line and load conditions. Nominal voltage from unregulated supplies must be limited to 75% of the maximal DC voltage to allow for line and load regulation. For example,

the maximum allowed nominal voltage for a 40 volt BJR/BJP from an unregulated supply is 30 volts DC.



CAUTION

Nominal voltages supplied from unregulated DC supplies must be less than 75% of the BJR/BJP rated voltage to allow for line and load variation.

Providing DC Bus Using an SPS(R)

Refer to Figure 2.1 on page 24. The SPS(R) is configured in the field for operation from either a 115 volt or a 230 volt AC line. The SPS(R) and BJR/BJP must both have the same voltage rating. For example, an SPS-4008-2 and a BJR-4008-110001 are both rated for 40 volts. Operating an SPS(R) or a BJR/BJP with incorrect voltage can damage the units.

Note that all SPS(R)s are unregulated supplies and provide a nominal voltage of 75% of the rated voltage. This limits the actual supplied voltage to be no more than the rated voltage under reasonable line variation.

The SPS(R) provides field terminations for DC bus connections for up to 4 BJR/BJP units on a terminal strip. This strip is detailed in Figure 2.1. Each terminal has four internally connected "insertion points." The lower two are provided for customer connections; the upper two are reserved for the factory.

The SPS(R) provides wire tie receptacles above and below each BJR/BJP unit. These receptacles allow for proper strain relief of all cables and wires entering and exiting the BJR/BJP units.

SPS(R) Wire Preparation and Insertion

SPS(R) field terminations accept 16-28 AWG wire. Wire should be stripped 6mm (0.25"). Normally, wires need not be tinned or crimped with a wire ferrule. To insert wires, place a small screw driver fully into the opening just above the insertion point and rotate upward slightly. The metal clamp will open; insert wire and remove the screw driver. Take care that the termination is not clamping to insulation. Ensure that no bare wire is exposed outside the insertion point.

Gently pull the wire to ensure that it is fully inserted.

Wiring SPS(R) AC Line

Configure the SPS(R) for the appropriate voltage (115 or 230 volts AC) according to Figure 2.1. Use small jumpers prepared according to instructions in “SPS(R) Wire Preparation and Insertion” above. Four connections are provided for bus+ (two from each of terminals 5 and 6) and four are provided for bus- (two from each of terminals 7 and 8).

Motor Protection

If the amplifier is oversized (that is, it can provide continuous current that exceeds the motor's continuous current rating), you may want to add motor overload relays in series with the motor. Also, you can wire a contactor in series with the motor leads. ALWAYS BE CAREFUL TO WIRE THE MOTOR PROPERLY.

WIRING THE BJR/BJP

Refer to Figure 2.2 (page 26) for an overview on all BJR connectors. Refer to Figures 2.3 (page 27) and 2.4 (page 28) for an overview of BJP connectors. Connectors J1-J7 are on the power board (top PCB of BJR); connectors J10-J20 are on the control board. A description of each connector can be found in Table 2.5 on page 25.

Strain Relief

All cables that connect to the BJR/BJP must be properly strain relieved. Excessive strain causes damage to the PCB and may result in failure or unreliable operation. Ribbon cables must be properly strain relieved. Absent or inadequate strain relief of insulation displacement connector (IDC) systems causes unreliable interconnects.



Strain relieve all cables leading to the BJR/BJP. Excessive strain may cause damage to the PCB and may result in failure or in unreliable operation.

Wiring J1, Bus Power and Motor Leads (BJR only)

J1 is a 5-pin pluggable screw-terminal with connections on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J1. Refer to Figure 2.5 for wiring (page 29).

Wiring Bus Leads

Connect bus+ to J1-5; connect bus- to J1-4. The bus must be 20-40 volts DC.

Wiring Motor Leads for Kollmorgen BLDC Motors

Connect the three motor leads according to the color code shown on Figure 2.5. These connections are for Kollmorgen SILVERLINE and RBE motors.

Wiring Motor Leads for Other BLDC Motors

Contact your local ICP Regional Office (see Appendix C) for information on connecting BLDC motors from other manufacturers. Only certain combinations of motor and hall sensor wiring are correct. Incorrect combinations may either cause the motor to lock in one position or to rotate but provide very little torque.

Be aware that phasing depends also on the encoder; if phasing of the encoder or the motor is reversed, the motor will run away. The BJR provides the software switch ENCDIR, which allows you to reverse phasing without changing the wiring. After the system is wired, you can verify encoder phasing with the TUNE command (see Chapter 3 for more information on using TUNE for this purpose).



CAUTION

Motor may run away if motor or encoder leads are connected incorrectly.



WARNING

Failure to observe polarity of the DC bus can result in personal injury and damage to the SPS(R) and BJR.

**NOTE**

You can reverse encoder phasing by inverting the software switch ENCDIR. For SILVERLINE motors, ENCDIR is normally set to 1.

Wiring Motor Leads for Brush Motors

Remove Jumper J2. Connect motor leads to J1-1 and J1-2. For SERVOLINE Brush Motors from Kollmorgen PMI, connect motor lead A to J1-2, and motor lead B to J1-1. Note that phasing of non-SERVOLINE brush motors is often a matter of trial-and-error. After the system is wired, you can verify phasing with the TUNE command (see Chapter 3.)

Installing J2, 120° Commutation (BJR only)

J2 selects motor commutation type. For SILVERLINE motors, RBE motors, and most other BLDC motors, install J2. Most BLDC motors are commutated with 120° sensors. In this case, install J2. Some BLDC motors are commutated with 60° sensors. In this case, remove J2. For brush motors remove J2.

Installing C_L in J3 (BJR only)

**CAUTION**

Failure to install the correct value for C_L may result in damage to the amplifier or significant loss of performance.

J3 is a 2-pin cage clamp connector that accepts the current loop compensation (tuning) capacitors. The value of C_L depends on the amplifier model number, the applied voltage, and the motor line-to-line inductance (L). You can measure the value of L, check the data sheets, or contact your ICP Regional Office (see Appendix C) for assistance in determining this value.

Calculate the value of the capacitor according to Equation 2.1 or 2.2, depending on the model number of your unit:

BJR-4004

$$C_L = \frac{2}{V \times L}$$

Equation 2.1

BJR-4008

$$C_L = \frac{1}{V \times L}$$

Equation 2.2

where C_L is the value of the capacitor in μF
 V is the actual applied voltage (units)
 L is the line-to-line inductance (mH).

You can round these values to the nearest 20% so you can use a standard capacitor value. Use multilayer ceramic capacitors such as Panasonic ECU series. Do not use polarized capacitors such as electrolytic or tantalum capacitors.

**CAUTION**

Use multilayer ceramic capacitors for C_L . Do not use polarized capacitors. Failure to use the correct type of capacitor may lead to unpredictable performance or damage to the system.

Installing R_L in J4 (BJR only)

**CAUTION**

Failure to install the correct value for R_L may result in damage to the amplifier or significant loss of performance.

J4 is a 2-pin cage clamp connector that accepts the current loop compensation (tuning) resistor. The value of R_L depends on the amplifier model number, the applied voltage, and L, the motor line-to-line inductance. You can measure the value of L or contact your ICP Regional Office (see Appendix C) for assistance in determining this value.

Calculate the value of the resistor according to Equation 2.3 or 2.4, depending on the model number of your unit:

BJR-4004

$$R_L = 0.5 \times V \times L$$

Equation 2.3

BJR-4008 $R_L = V \times L$
Equation 2.4

where R_L is the value of the capacitor
in kOhm
V is the actual applied voltage
L is the line-to-line inductance
of your motor.

You can round these values to the nearest 20% so you can use a standard value. Use 1/8 or 1/4 Watt resistors.

Prepare the resistors by clipping the leads to 12mm (0.5") and bending the leads out so they are approximately 5mm (0.2") apart.

Installing J5, Current-Loop Mode Select (BJR only)

J5 sets the current loop mode of operation. It should always be installed across pins 1 and 2 (the current-loop or "C" mode as marked on the PCB). If the jumper is installed in the open-loop or "O" mode, the unit will not function properly.



Ensure that Jumper J5 is installed across pins 1 and 2, as marked by "C" on the PCB. Failure to install J5 properly may lead to unstable or unpredictable performance.

Wiring J6, Amplifier Status and Control (BJR only)

J6 is a 6-pin pluggable screw-terminal with connections on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J6. For the BJR, J6 connects control lines to J18 on the lower PCB. They are connected at the factory in reverse; that is, J6-1 to J18-6, J6-2 to J18-5, and so on. These connectors should remain connected at all times.

Wiring J7, Hall Sensors Input (BJR only)

J7 is a 5-pin pluggable screw-terminal with connections on 5mm (0.2") centers. Note that in

high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J7.

Connect the hall sensors from your motor according to Figure 2.5. Note that color codes are shown for Kollmorgen SILVERLINE motors. (RBE motors have the same color code.) Motors from other manufacturers can be used. Contact your ICP Regional Office (see Appendix C) for more information. If you are connecting a brush motor, leave J7 open; there is no need to jumper any sensor lines.

Wiring JB1, Bus Power Out (BJR only)

JB1 is a 2-pin pluggable screw-terminal with connections on 5mm (0.2") centers. It is wired to J19 at the factory. Pin 1 is ground; pin 2 is Bus.

Installing J10, 12/24 Volt DC Select

J10 selects the voltage level for all inputs accessed via J11. J11 inputs can be either 5-12 volts DC (J10 installed) or 18-24 volts DC (J10 removed). Note that all inputs must operate from the same voltage level.



CAUTION

Failure to install J10 correctly may result in damage to the unit or unreliable operation of J11 inputs.

Wiring J11, Main I/O

J11 is a DB-25S connector that provides access to the following digital inputs and outputs:

Table 2.1A J11 Digital Inputs

INPUTS		
Name	Pins	Function
I1-I8	1-8	General purpose inputs
MOTION	9	Enables motion
GATE	10	Gates precalculated motion
REMOTE	11	Allows unit to be enabled
CYCLE	12	Begins a program cycle
Source/ Sink	13	Source or sink for all J11 inputs.

Table 2.1B J11 Outputs

OUTPUTS		
Name	Pins	Function
O1-O6	14-23	General purpose outputs
OK	24, 25	Indicates unit is functioning properly

You must properly strain relieve all connections to the BJR/BJP. Kollmorgen recommends that you avoid molded cables for connecting to J11. These connectors produce excessive strain on the lower PCB. Instead, we recommend ribbon cable connections. A short ribbon cable can then interconnect the BJR/BJP to a breakout or field terminations. Kollmorgen provides the necessary ribbon cable and ribbon cable connectors in the BJ-C100 connector kit. Kollmorgen also provides a screw-terminal breakout for J11 as the BJ-BKO-25.

**CAUTION**

Strain relieve the cable connecting to J11. Avoid molded cables. They are difficult to strain relieve. Excessive strain will damage the PCB and will result in less reliable operation.

J11 Inputs

All J11 inputs are optically isolated from the power bus. The isolation is low-voltage (less than 36 volts) and is provided for noise elimination, not for high-voltage isolation. All J11 inputs have a nominal 25-microsecond propagation delay.

**WARNING**

Isolation for J11 inputs is Low Voltage (less than 36 volts). Attempting to use this barrier as high-voltage isolation will result in a shock hazard and will damage the unit.

All J11 inputs are bi-directional--they can source or sink current. However, all inputs must either source or sink. For switches that sink current, connect the I/O power supply source (+) to J11-13 and connect inputs too common to turn the input on. This configuration is shown in Figure 2.6 (page 30). For switches that source current, invert the power supply--connect the power supply common (-) to J11-13.

If you are using a regulated 24 volt DC supply for the BJR/BJP Main Bus (Connector J1), you may use the same supply as the I/O supply. However, the I/O Power supply must be limited to 24 volts DC. Failure to observe this limit may result in damage to the unit. You may not use the SPS(R) bus supply as the I/O supply.

**CAUTION**

I/O power supply must be limited to 24 volts DC. Using an I/O supply greater than 24 volts DC may result in damage to the unit. Do not use the SPS(R) Bus supply for an I/O supply.

J11 Outputs

All J11 outputs are optically isolated from the power bus. The isolation is low-voltage (less than 36 volts) and is provided for noise elimination, not for high-voltage isolation. J11 outputs can produce 75 mA continuously. These units are fused with Raychem PolySwitches ® RXE series. These fuses will protect the outputs from some overcurrent conditions. However, they will not protect the units from short-circuits. All J11 outputs drop approximately 2 volts when they are turned on. All J11 outputs have a nominal 25-microsecond propagation delay.

**CAUTION**

Drawing current in excess of 75 mA may damage the unit.



Isolation for J11 outputs is Low Voltage (less than 36 volts). Attempting to use this barrier as high-voltage isolation will result in a shock hazard and will damage the unit.

J11 outputs are bi-directional--they can source or sink current. For current sinking, connect the negative outputs (the odd pins J11-15 through J11-25) to I/O Power Supply Common (-) and connect the positive outputs (the even pins J11-14 through J11-24) to the loads. This configuration is shown in Figure 2.6 (page 30). For current sourcing, connect the positive outputs to I/O Power Supply Source (+) and connect the negative outputs to the loads. Unlike the inputs, note that output configuration for sink/source and for voltage level are all independent.

Wiring J12, Feedback Encoder

J12 is a 10-pin ribbon cable connector. It is wired according to the HEDL ® standard from Hewlett-Packard. Refer to Figure 2.7 (page 31). If you are using a standard SILVERLINE encoder or any encoder compatible with the HEDL standard, you may connect the encoder directly to the BJR/BJP with a ribbon cable. If you are not using a standard SILVERLINE encoder, or if the distance or environment is inappropriate for ribbon cable, you can connect J12 to the BJ-BKO-10, a 10-pin ribbon cable DIN-rail mounted breakout from Kollmorgen. The breakout provides screw-terminal connectors for conventional field wiring. If your environment requires discrete wires in place of ribbon cable, substitute appropriate connectors such as AMP 102387-1 shells and 87756-7 pins.

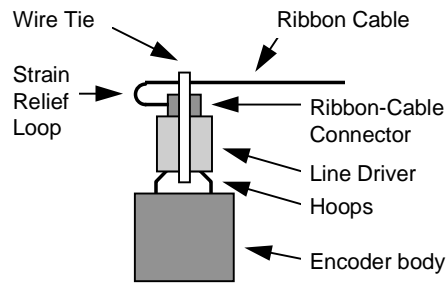
If your encoder does not provide differential line-driver outputs, the BJR/BJP provides resistor networks to center the complementary inputs (J12-5, J12-7, and J12-9). So, in systems with short interconnects and in low-noise environments, you can connect single-ended signals to the positive inputs (J12-6, J12-8, and J12-10). However, please note that Kollmorgen

recommends differential line drivers because of the superior noise rejection.

Always strain relieve the encoder cable. If the encoder cable is disconnected or cable connections are broken, the motor will run away. Strain relieve at the connectors and along the length of the cable if necessary. Be particularly thorough when providing strain relief in environments with significant vibration.

On SILVERLINE motors, strain relief for the encoder cable is provided with a wire tie which secures the ribbon cable connector and line driver to the encoder body. Use a 0.1" wide, 4.5" long wire tie such as Richo WIT-18R. This wire tie fits securely in notches of the standard SILVERLINE encoder ribbon-cable connector (Amp 746285-1). Two steel hoops are attached to the encoder body through which the wire tie is threaded. Note that the connector does not have an integral strain relief as the version with strain relief cannot be fastened reliably with a wire tie. Do not interchange the black encoder connector with blue connectors which are provided for the BJR/BJP.

As the connector does not provide strain relief for the cable, this function is also provided by the wire tie. Assemble as shown below: fold the ribbon cable across the back of the connector to form a small loop and install the wire tie securely, preferably with a wire-tie gun or similar device.



Side View: Application of Wire Tie to Secure and Strain Relieve Ribbon Cable

If the encoder cable is disconnected, the motor will run away!



WARNING

Vibration can loosen and disconnect this cable!

Secure the encoder cable to the Encoder using a wire tie. Use Amp 746285-1 connector.

Strain relieve the encoder cable at both ends.

Wiring J13, Master Encoder (optional)

J13 is a 10-pin ribbon cable connector. It is provided as an option that must be specified at the time of ordering. Like J12, J13 is wired according to the HEDL ® standard from Hewlett-Packard. Refer to Figure 2.8 (page 32). If you are using a standard SILVERLINE encoder or any encoder compatible with the HEDL standard as a master encoder, you may connect the encoder directly to the BJR/BJP with a single ribbon cable. If you are not using an actual encoder, or if you are using an encoder other than a standard SILVERLINE encoder, or if the distance or environment is inappropriate for ribbon cable, you can connect J13 to the BJ-BKO-10, a 10-pin ribbon-cable DIN-rail mounted breakout from Kollmorgen. The breakout provides screw-terminal connectors for conventional field wiring.

Stepper Motor Emulator

The BJR/BJP supports Stepper-Motor Emulation, a mode of operation where the unit generates position command from two standard stepper motor formats: UP/DOWN and COUNT/ DIRECTION. In this mode the motor will follow the position from the stepper controller. Adjust the gear ratio (through GEARI and GEARO) to set the correct number of steps per revolution. Refer to the BJx *User's* manual for more information. If you are using the BJR/BJP as a stepper motor emulator, connect the pulse train inputs as follows:

Command Mode	Channel A	Channel B
UP/DOWN	UP	DOWN
COUNT/DIRECTION	COUNT	DIRECTION
UP ONLY	UP	Not used

Note that you must select the command mode in software by using the variable MSTRMODE. Refer to the *User's* manual for more information on MSTRMODE.

Wiring J14, RS-485 Serial Connector

The BJR/BJP supports RS-232 and RS-485 communications. RS-485 can be used separately or in conjunction with RS-232. The most common way to use

RS-485 is to network multiple BJR/BJP units by interconnecting them through J14. Then use J15 from any one of the units as a “port” onto the network for RS-232 devices such as computers and terminals. From this port, the RS-232 device can communicate with all the BJR/BJP units.

J14 is a 10-pin ribbon cable connector. Refer to Figure 2.9 for pinouts (page 32). You can “daisy-chain” up to 32 BJR/BJP units with a single ribbon cable and one connector for each unit. If the distance or environment is inappropriate for ribbon cable, you can connect J14 to the BJ-BKO-10, a 10-pin ribbon cable DIN-rail mounted breakout from Kollmorgen. The breakout provides screw-terminal connectors for conventional field wiring.

In unusual circumstances you may need to add line terminators to your RS-485 serial line. This is usually required only for interconnected devices separated by large distances. Line terminators reduce ringing, a phenomenon where the normally square edges of digital communication are distorted so that they have excessive overshoot and ringing. This can cause communication errors and, in some cases, can damage the BJR/BJP.

Line terminators are 120-Ohm, 1/2W resistors that are connected across J14-1 and J14-2, and across J14-9 and J14-10. There should be, at most, one pair of terminators on each end of the RS-485 (four resistors total). To add line

terminators, install an extra ribbon cable connector on each end of the RS-485 bus; solder the terminating resistors to a header, such as Sullins PZC36DABN, and insert into these connectors.

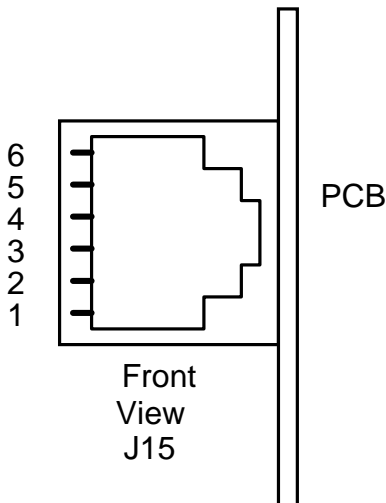
Wiring J15, RS-232 Serial Connector

J15 is a 6-pin RJ11 connector. Note that although J15 is similar to a telephone cable connector, it is not a modem connection; you cannot connect J15 directly to a telephone outlet. Normally, J15 is wired with common telephone cable. However, if the distance or environment is inappropriate for telephone cable, you can connect J15 to the BJ-BKO-6, a 6-pin RJ11 cable DIN-rail-mounted breakout from Kollmorgen. This breakout provides screw-terminal connectors for conventional field wiring.



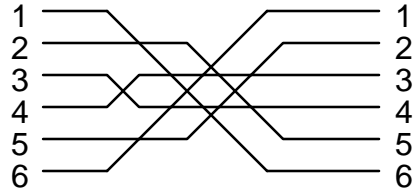
Do not connect J15 directly to a telephone outlet. Doing so may damage the BJR/BJP and telephone wiring.

Pinouts for Connector J15 are labeled on the BJR/BJP Control Card and are shown below:

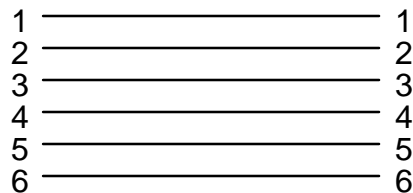


When connecting the J15 telephone cable, be aware that there are two types of cables: reversing and non-reversing. Please refer to the following figure. Telephone cables are normally

reversing: that is, pin 1 of one end is connected to pin 6 of the other. All BJR/BJP documentation assumes reversing cables.



Reversing Cable for J15 (Standard)



Non-Reversing Cable for J15

Wiring J15 to an IBM-PC

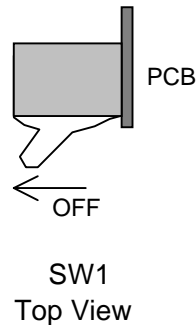
Connect the serial port of your IBM-PC to J15 as shown in Figure 2.9 (page 32). There are two IBM-PC standards for RS-232 ports: the 9-pin DSUB connector found on most newer PCs, and the 25-pin DSUB connector. Convert the RJ11 cable to the appropriate DSUB connector using a converter which is available in the BJ-C100 connector kit. Refer to Table 2.2 for interconnections. Note that transmit and receive are interchanged between the 9-pin and 25-pin standards.

Table 2.2 Interconnections for J15

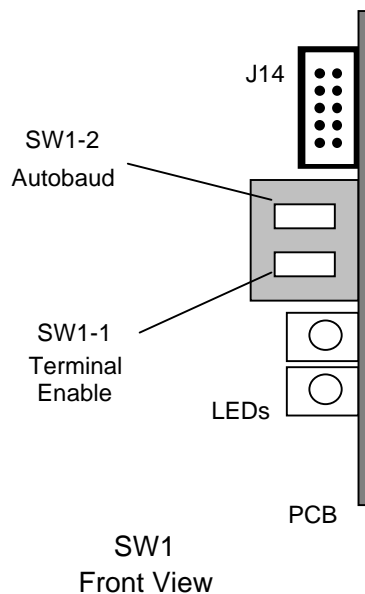
BJR/BJP Function	Pinout	IBM-PC Function	DB-9 IBM-PC	DB-25 IBM-PC
Common	J15-1	Common	Pin 5	Pin 7
Data In	J15-2	Data Out	Pin 3	Pin 2
Data Out	J15 -3	Data In	Pin 2	Pin 3
Enable	J15-4 to J15-5	N/A	N/A	N/A

Notice in Figure 2.9 that pins 4 and 5 of the RJ11 connection are connected inside the RJ11-to-DB converter. This automatically enables the serial port when the connector is inserted. The BJR/BJP serial port must be enabled before it will receive data. This control is required to support networking units. In networks, no more

than one BJR/BJP RS-232 terminal may be enabled on the network at a time. Therefore, the user is responsible for enabling the serial port before transmitting and, in RS-485-networked systems, ensuring that no more than one RS-232 port is enabled at one time. Kollmorgen recommends shorting the J15-4 and 5; however, the RS-232 port can be enabled and disabled manually using SW1-1. To turn SW1-1 off, move the handle away from the PCB.



SW1 has two switches SW1-1 (Terminal Enable) and SW1-2 (Autobaud). SW1-1 is nearest the LEDs; SW1-2 is next to J14. One way to remember is that SW1-1 is the closer of the two to J15 and enables and disables J15.



Wiring the HHT-02

Connect your HHT-02 as shown in Figure 2.10 (page 34). Note that this requires a reversing cable. An appropriate cable is provided in the BJ-C100 connector kit.

Earlier, the use of Terminal Enable (SW1-1) was discussed in relationship to multidrop systems. Another use of Terminal Enable is to prevent surges from the BJR/BJP backlight power supply. This supply is connected directly to the BJR/BJP logic supply, and surges will disrupt that supply and reset the BJR/BJP. This is a problem because most backlight supplies have large capacitors across the supply input so that they generate current surges upon connection. This is the case with the HHT-02. In fact, connecting an HHT-02 with backlight will reset the BJR/BJP and cause it to execute the power-up sequence. This can be corrected using the Terminal Enable.

The backlight supply powers up slowly, over about 100 msec after Terminal Enable is turned on. This prevents surges, allowing the BJR/BJP to continue operation through plug-in.

If your HHT-02 has a backlight and it will be plugged and unplugged during operation, Kollmorgen recommends that you build Terminal Enable into the connector by shorting J15-4 to J15-5. Otherwise, the operator must remember to disable the serial port through SW1-1 each time the HHT-02 is plugged in.



WARNING

Plugging an HHT-02 into J15 when the RS-232 port is enabled will reset the BJR/BJP and cause it to execute the power-up sequence. Disable the RS-232 port before connecting the HHT-02.

Wiring J16, Analog Inputs

J16 is a 10-pin ribbon cable connector. Refer to Figure 2.11 for pinouts (page 35). If the distance or environment is inappropriate for ribbon cable, you can connect J14 to a BJ-BKO-10, a 10-pin ribbon cable DIN-rail mounted breakout from Kollmorgen. The breakout provides screw-terminal connectors for conventional field wiring.

Note that the analog inputs are unidirectional--they are 0-10 volt inputs and are resolved to 10 bits and accurate to 8 bits. Also, internal resistor

scaling may introduce up to a 1% gain error. The input impedance is 20 kOhm. For potentiometers, J16 provides 3 connections to the BJR/BJP internal 5 volt supply. In this case, potentiometers should have a resistance of at least 500 ohms to limit current draw on this supply. Optionally, you can supply up to 10 VDC to obtain the full range of the analog inputs.

The analog output is a bi-directional, ±10 VDC output. This output is current limited with a 1 kOhm resistor.

Wiring J17, Auxiliary Inputs

J17 is a 3-pin pluggable screw-terminal that provides connections for HOME and LIMIT inputs. Refer to Figure 2.12 (page 36). Connections are on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J17.

Note that J17 inputs are similar to the inputs of the Main I/O connector, J11. Note that J17 is electrically isolated from J11, thus simplifying system wiring--HOME and LIMIT can be connected to a supply electrically isolated from other inputs. If you wish for J11 inputs and J17 inputs to share a supply, connect J11-13 and J17-1. Although J17 inputs are optically isolated from the power bus and from the I/O on J15, that isolation is low-voltage (less than 36 volts) and is provided for noise immunity, not for high-voltage isolation. HOME and LIMIT have a nominal 25-microsecond propagation delay.



Isolation for J17 inputs is low voltage (less than 36 volts). Attempting to use this barrier as high-voltage isolation will result in a shock hazard and may damage the unit.

Wiring J18 and J20, Amplifier Status and Control

J18 is a 6-pin pluggable screw-terminal that provides connections for amplifier command,

enable, and status. Connections are on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J18.

Factory Wiring of J18 and J20 (BJR only)

For the BJR, J18 is connected to J6 in reverse at the factory as shown in Table 2.3. Also, P20, a 2-pin shorting jumper should be placed in J20 in the position marked "STD" (standard).

Table 2.3 Factory connections for J18 connections (BJR only)

Connection	J18	J6
Amplifier Enable (-)	Pin 1	Pin 6
Amplifier Enable (+)	Pin 2	Pin 5
Analog Command (+)	Pin 3	Pin 4
Analog Command (-)	Pin 4	Pin 3
Amplifier Status (-)	Pin 5	Pin 2
Amplifier Status(+)	Pin 6	Pin 1

Customer Wiring J18 and J20 (BJP Only)

For the following discussion refer to Figures 2.13 and 2.14 on pages 37 and 38.

Wiring Amp Enable and J20

Amplifier Enable is connected to J18-1. This is an open-collector output that normally pulls to ground when the BJR/BJP commands the amplifier to enable. However, this signal can be inverted using J20, a 3-pin header. If the amplifier enables when Enable pulls low, install P20, a 2-pin shorting jumper in J20, in the position marked "STD" (standard). If the amplifier disables when Enable pulls low, install P20 in the position marked "INV" (inverted). If your Amplifier Enable is optically isolated, wire J18 according to Figure 2.14.

Wiring Analog Command

The Analog Command is a ±10 volt DC signal that commands torque or current. Wire according to Figure 2.13. Note that although Amplifier Enable and Status can be electrically isolated from the BJR/BJP, Analog Command cannot be isolated.

Wiring Amplifier Status

Amplifier Status is connected to J18-6. Wire according to Figure 2.13. This signal is normally

pulled low by a logic gate or an open collector transistor when the amplifier is enabled. However, you can invert its sense by setting the software variable "STATSEN" to 0 (see the *User's manual*). If your Amplifier Status signal is optically coupled, wire J18 according to Figure 2.13.

Wiring J19, Unregulated DC Supply

J19 is a 2-pin pluggable screw-terminal that provides DC power into the BJR/BJP. From this supply, the BJR/BJP control card derives all of its logic supplies. Connections are on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J19.

Factory Wiring of J19 (BJR only)

For the BJR, J19 is connected to JB1 on the top PCB at the factory as shown in Table 2.4.

Table 2.4 Factory Connections for J19 Connections (BJR only)

Connection	J19	JB1
DC Supply (-)	Pin 1	Pin 1
DC Supply (+)	Pin 2	Pin 2

Customer Wiring of J19 for DC Powered BJP (Standard)

Refer to Figure 2.14 on page 38. Connect DC power supply bus power to J19-1 (DC-) and J19-2 (DC+). The DC supply must be between 20 and 40 volts DC and must be capable of supplying up to 7 watts of power. The customer must ensure that voltages are limited to 40 volts, even in extreme conditions such as power line surges. Kollmorgen recommends the use of transient absorbers for this protection. The transient absorber clamp voltage should be below 40 volts. Do not rely on fuses for this protection.



CAUTION

If your DC power supply does not limit voltage to 40 volts DC, use a transient absorber to clamp voltages below 40 volts. Failure to limit voltage to 40 volts may result in damage to the BJP.

Customer Wiring of J19 for AC Powered BJP (Option)

If your BJP is specified to operate from AC Power, note that J19 is connected to J102 on the top PCB at the factory. J19-1 is connected to J102-1; J19-2 is connected to J102-2. Refer to Figure 2.15.

Installing J20, Amplifier Enable Polarity

J20 is a 3-pin header that selects the polarity of the amplifier enable signal. P20 is a 2-position shorting jumper that can be installed in two locations on J20: STD (Standard) and INV (Inverted.) P20 is installed in the STD position at the factory. See discussion of J18 above.

Wiring AC Line Power, J101 (BJP with AC Line Power Option Only)

J101 is a 4-pin pluggable screw-terminal that provides connections for AC line power. See Figure 2.15 on page 39. Connections are on 5mm (0.2") centers. Note that in high-vibration environments, it is often preferable to crimp a ferrule onto each connection of J101.

J101 will accept either 115 or 230 volts AC. AC inputs are connected into J101-1 and J101-4. If the input is 115 volts, short J101-1 to J101-2, and short J101-3 to J101-4. If the input is 230 volts, short J101-2 to J101-3. Shorting J101 incorrectly may lead to improper voltages being supplied to the BJP Control Card. This will be a shock hazard. The equipment may be damaged. The unit may not operate reliably.

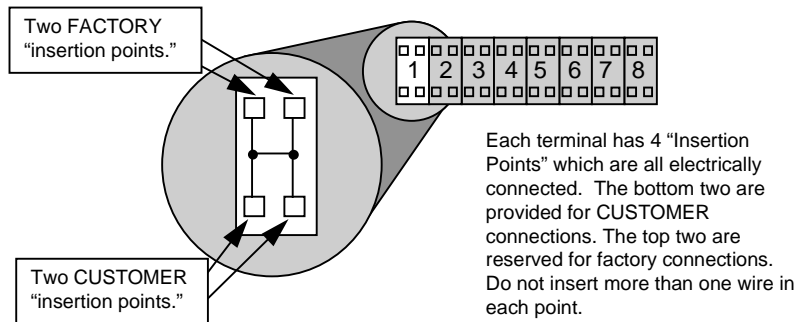
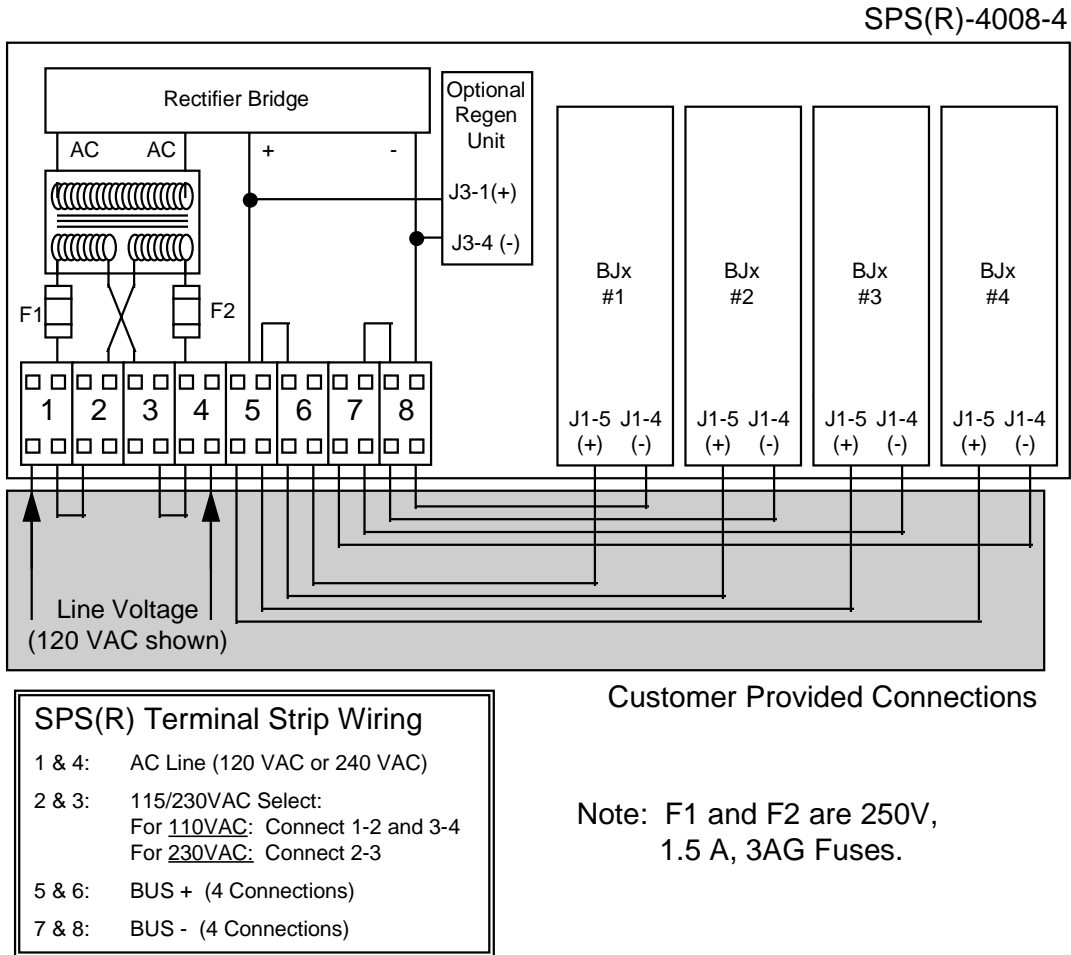
Shorting J101 incorrectly may lead to improper voltages being supplied to the BJP Control Card.



WARNING

THIS WILL BE A SHOCK HAZARD.

The equipment may be damaged. The unit may not operate reliably. Be certain to configure J101 properly for the voltage input you select.



**Figure 2.1 SPS(R)-4008-4
Field Wiring with Detail of Terminal Strip**

Table 2.5 BJR/BJP Connector Function

	Name	Location	Type	Description
J1	Power	Top PCB	5- Pin Screw Terminal	Connections for power bus and motor leads.
J2	120°	Top PCB	Jumper	120° select. Install for SILVERLINE BLDC motors and other 120° BLDC Motors. Remove for Brush and 60° BLDC Motors.
J3	CL	Top PCB	2-pin WAGO cage clamp	Install current loop compensation capacitor.
J4	RL	Top PCB	2-pin WAGO cage clamp	Install current loop compensation resistor.
J5	Current/ Voltage Mode	Top PCB	Two position jumper	Always install jumper across pins 1 and 2 (marked "C".)
J6	Amplifier Input	Top PCB	6-pin Screw Terminal	Amplifier control and status. This connector is wired to J18 at the factory.
J7	Hall Sensor	Top PCB	5-pin Screw Terminal	Connect to hall sensor cable from motor.
JB1	Bus Out	Top PCB	2-pin Screw Terminal	Bus power to BJR. This connector is wired to J19 at the factory.
J10	12/24 VDC Select	Bottom PCB	Jumper	Specifies power conditioning for inputs on Main I/O connector (J11). Install for 5-12 volt DC inputs. Remove for 24 volt DC inputs.
J11	Main I/O	Bottom PCB	DB-25S	Connections for most digital I/O.
J12	Feedback Encoder	Bottom PCB	10-pin Ribbon	Input for feedback encoder. Accepts SILVERLINE encoders directly.
J13	Master Encoder	Bottom PCB	10-pin Ribbon	(Optional) Input for master encoder. Accepts SILVERLINE encoders directly.
J14	RS-485 Serial	Bottom PCB	10-pin Ribbon	RS-485 bus for up to 32 BJR/BJP units or other RS-485 devices.
J15	RS-232 Serial	Bottom PCB	RJ-11	Standard serial input for IBM-PC, HHT-02 or most other serial devices.
J16	Analog I/O	Bottom PCB	10-pin Ribbon	3 10-bit 0-10 volt DC analog inputs; 1 8-bit ± 10 volt DC output.
J17	Auxiliary Inputs	Bottom PCB	3-pin Screw Terminal	Inputs for HOME and LIMIT.
J18	Amplifier Control/ Status	Bottom PCB	6-pin Screw Terminal	Amplifier control and status. This connector is wired to J6 at the factory.
J19	DC Power Input	Bottom PCB	2-pin Screw Terminal	20-40 VDC, 7 Watts. For BJR, this connector is wired to J8 at the factory.
J20	Enable Polarity	Bottom PCB	3-pin Header	Normally, install jumper P20 in "STD"; move P20 to "INV" to invert. For BJR, installed at factory as "STD."

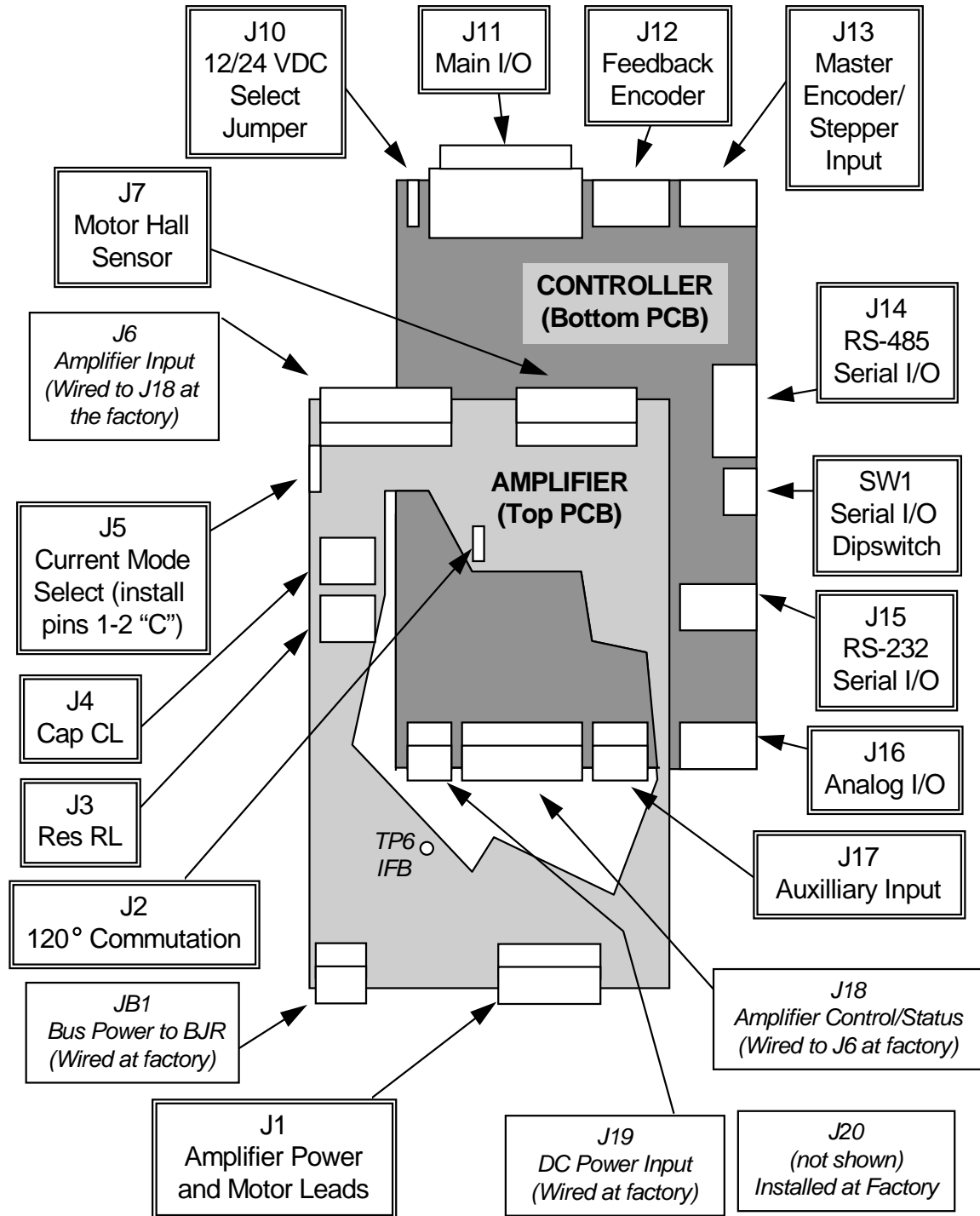


Figure 2.2 BJR Connector Layout

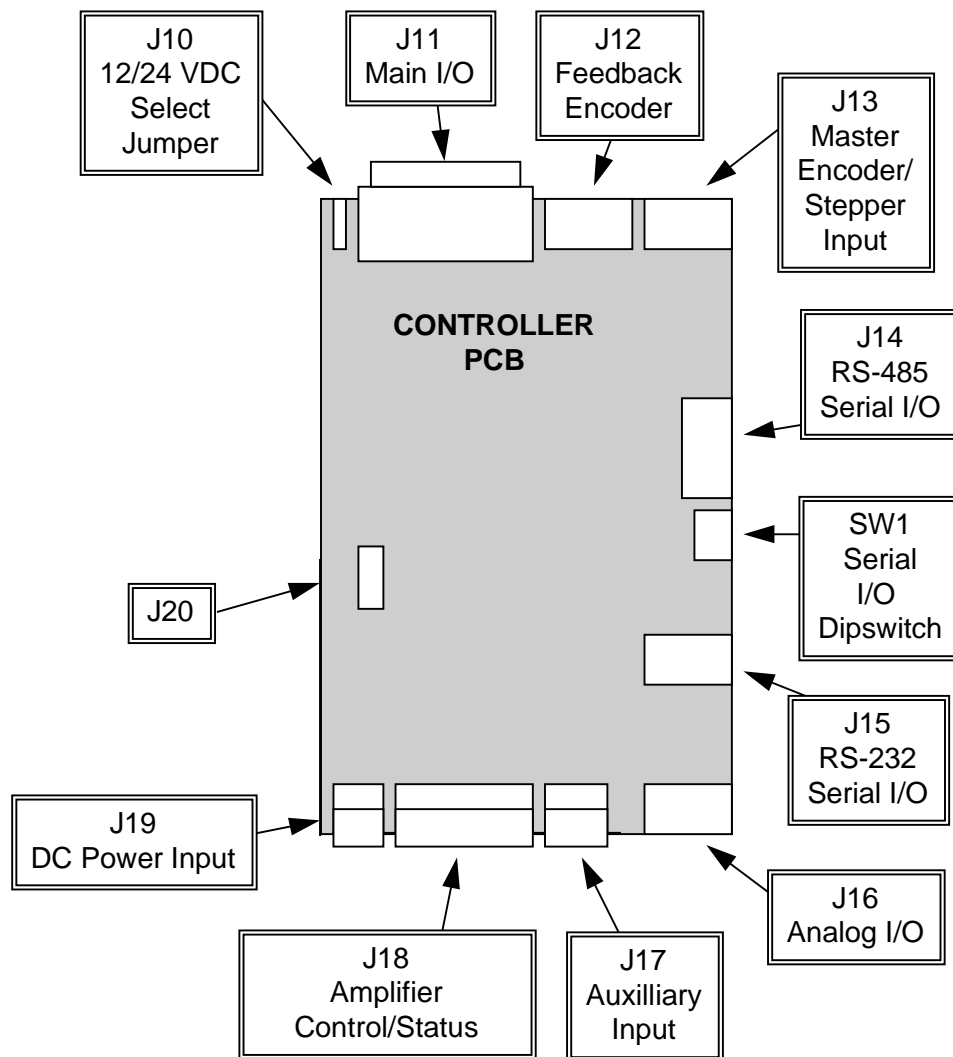


Figure 2.3
BJP Connector Layout

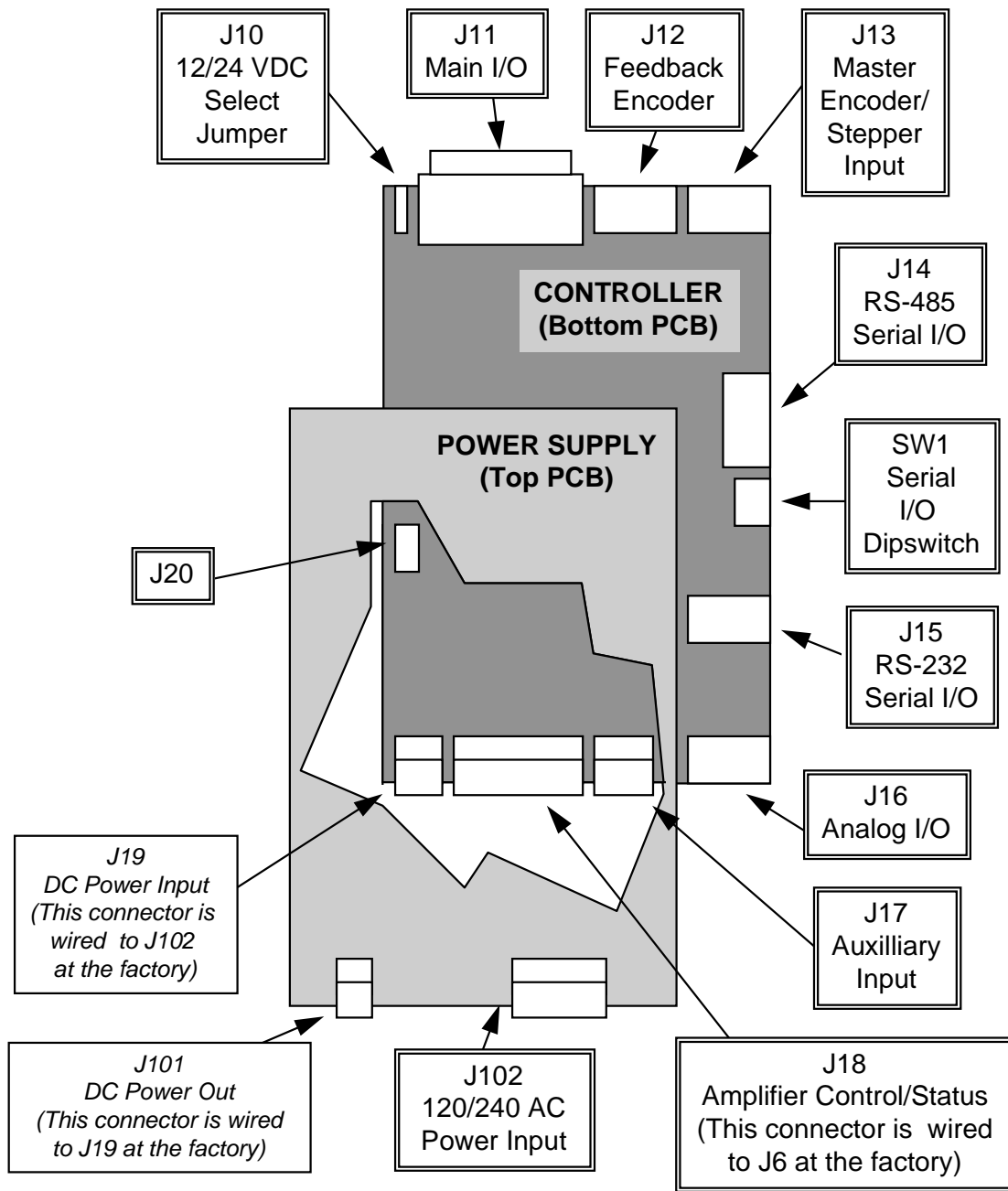
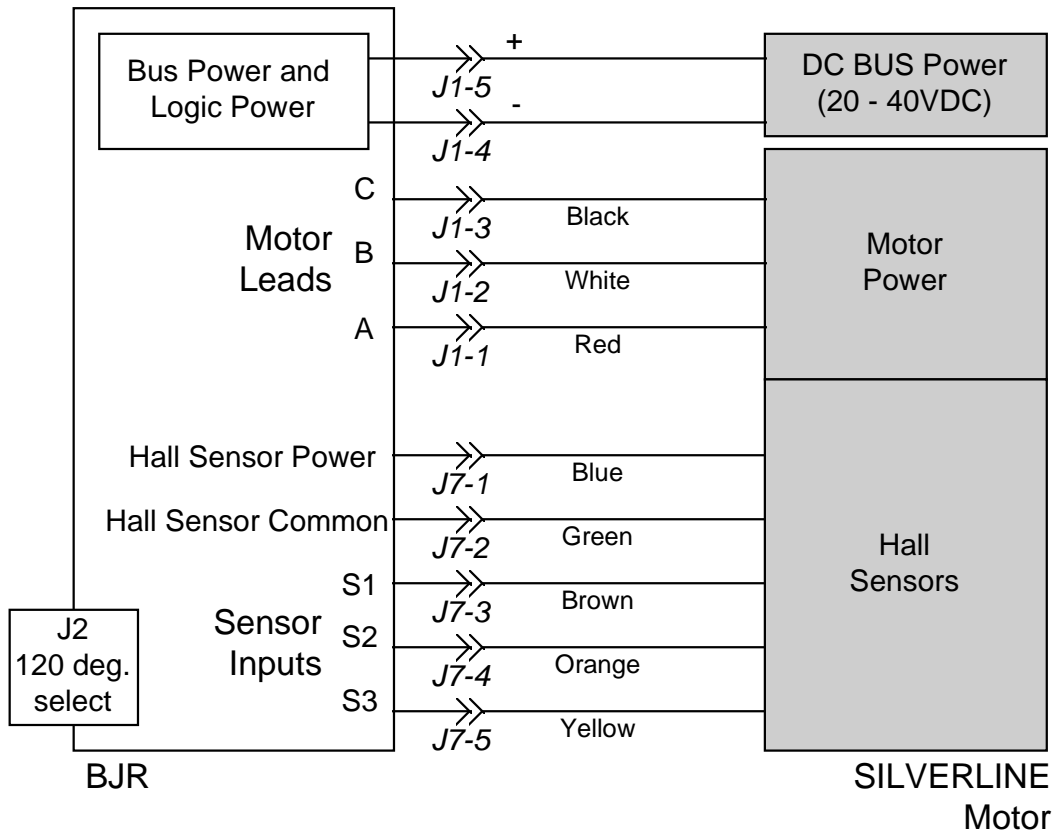


Figure 2.4 BJP Connector Layout
115/230 VAC Supply Option



**Figure 2.5 Connectors J1 and J7
BJR Only**

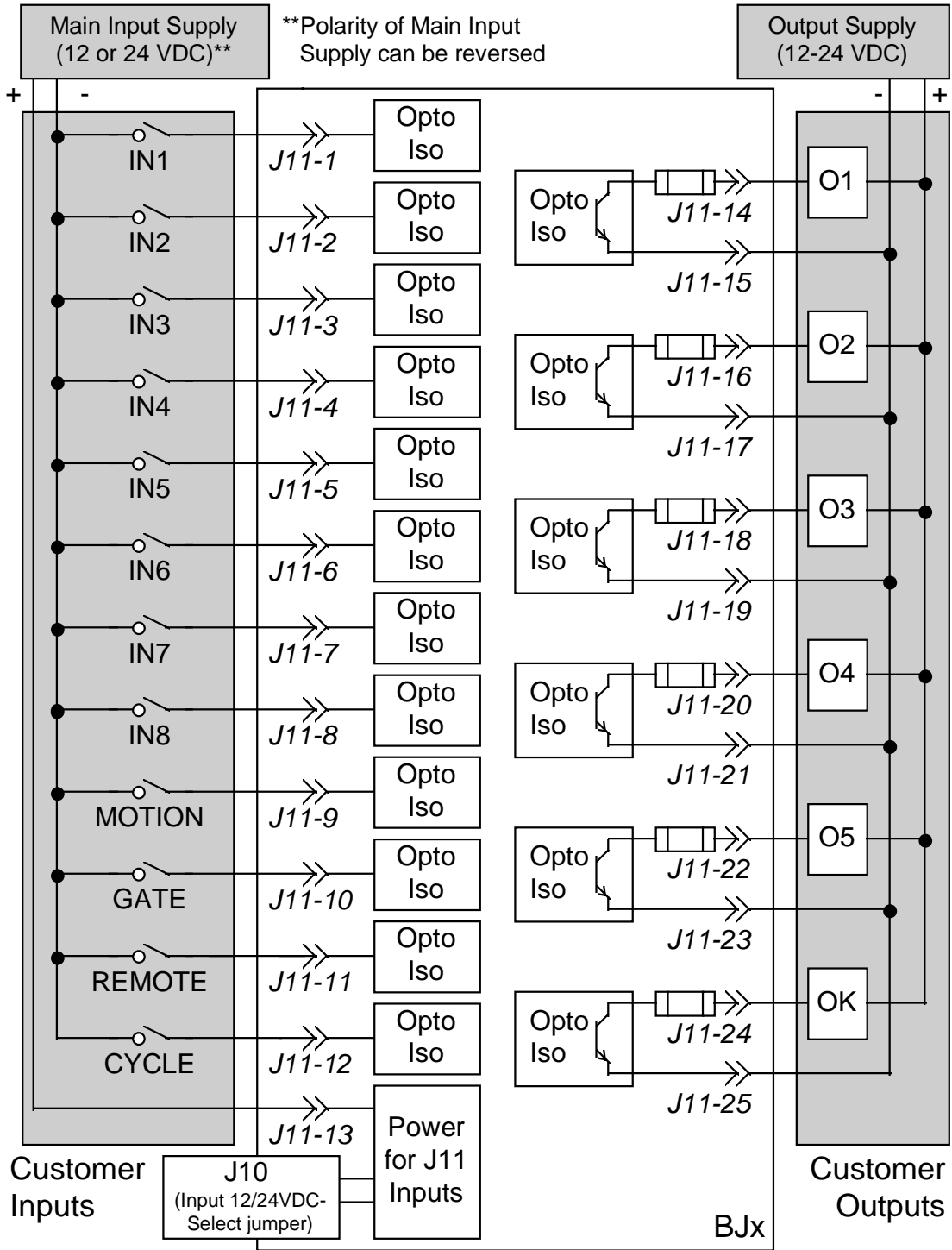
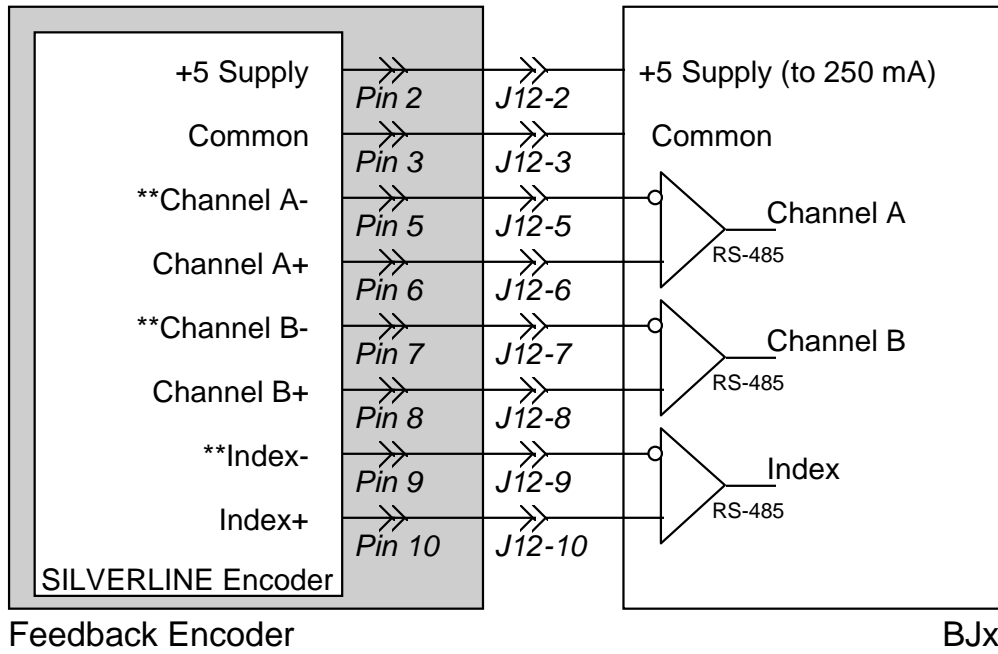
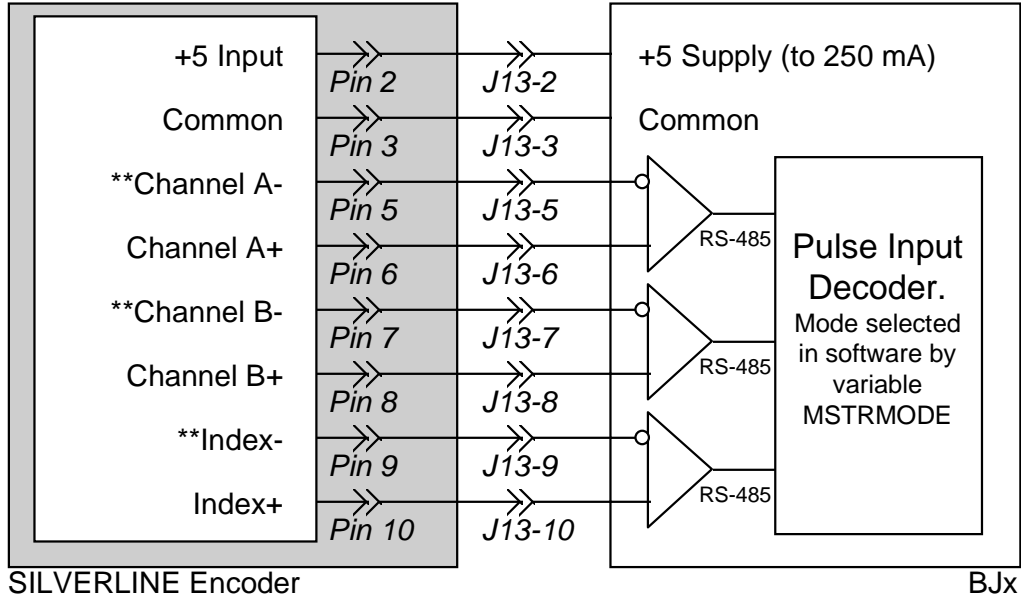


Figure 2.6 Connectors J10 and J11 Main I/O

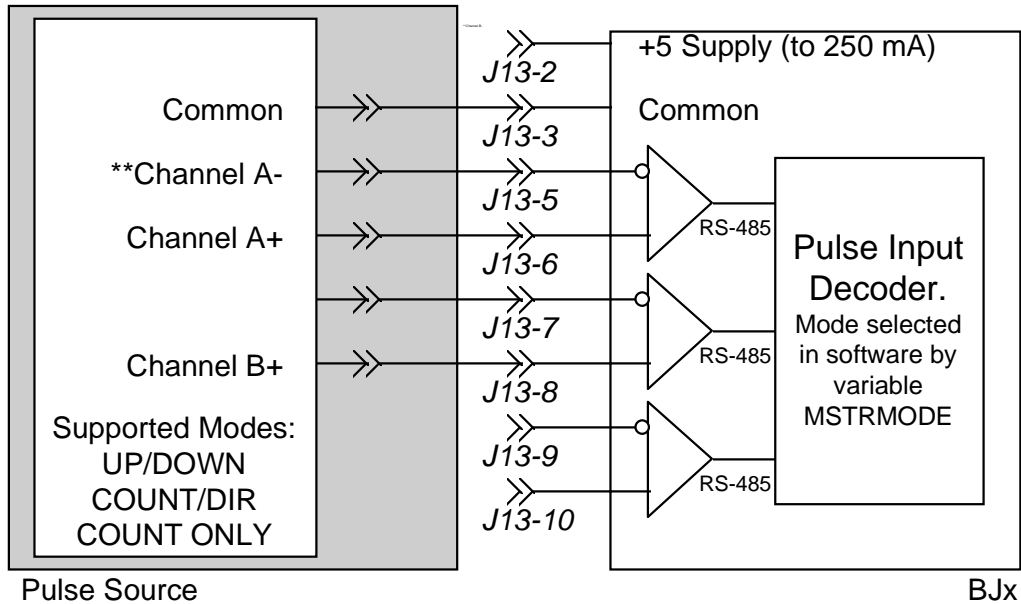


**For single-ended encoder inputs, leave A-, B-, and Index- open circuit.

Figure 2.7 Connector J12 Feedback Encoder



Mode 1: Gearing and Camming



Modes 2-4: Stepper Command

**For single-ended encoder inputs, leave A-, B-, and Index- open circuit.

**Figure 2.8 Connector J13
External Pulse Input**

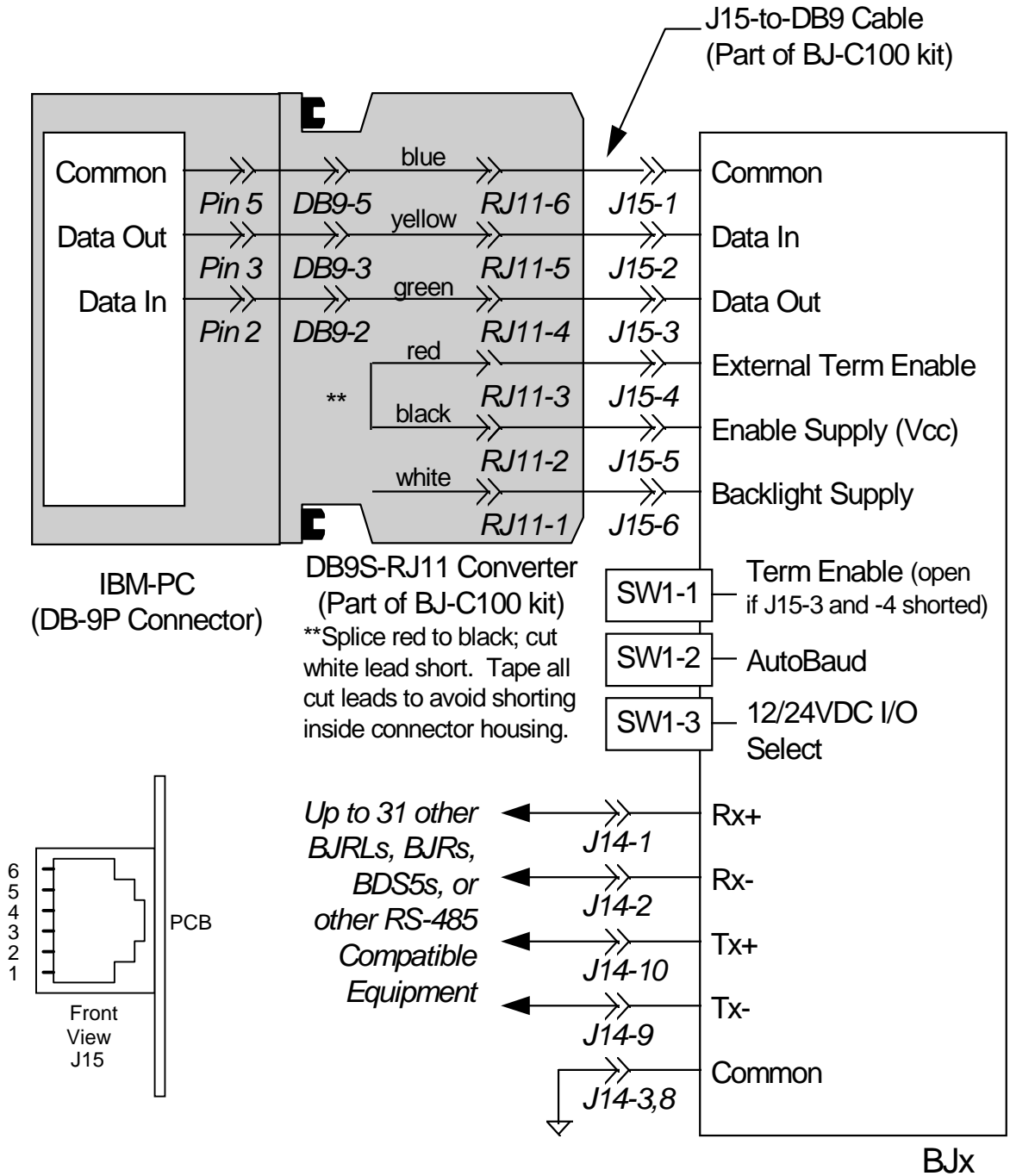
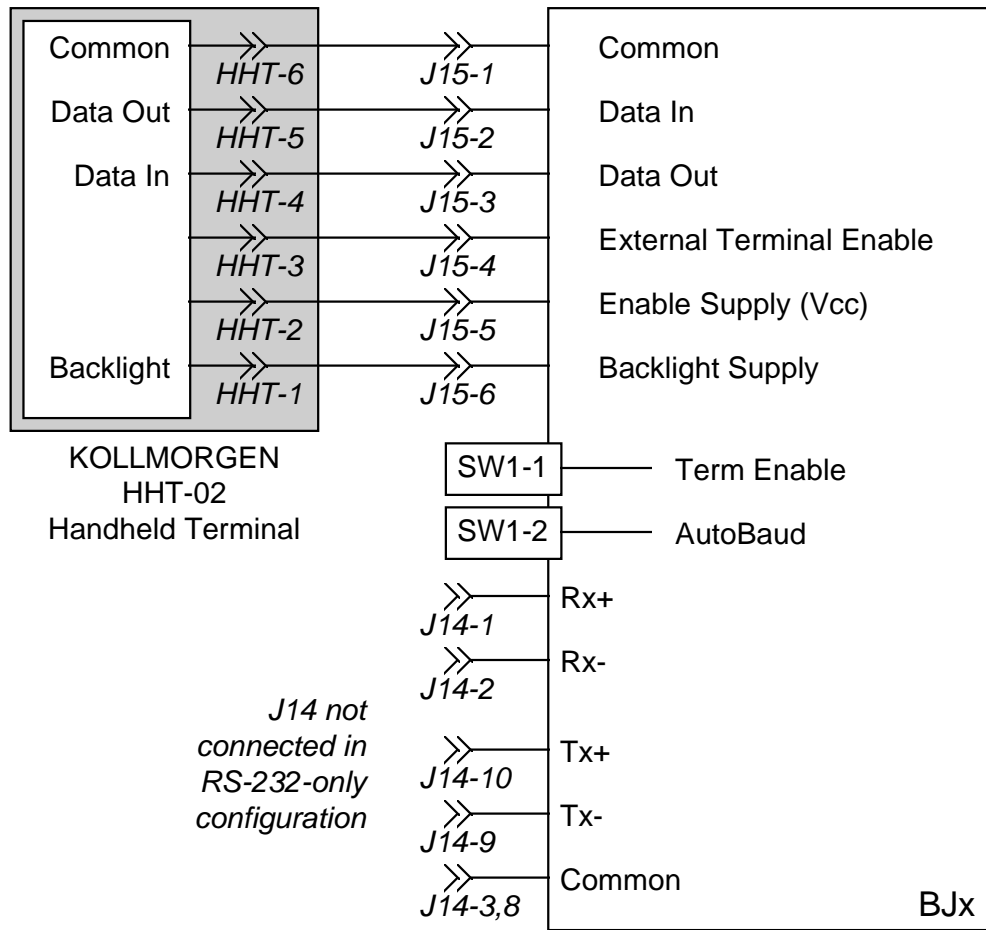
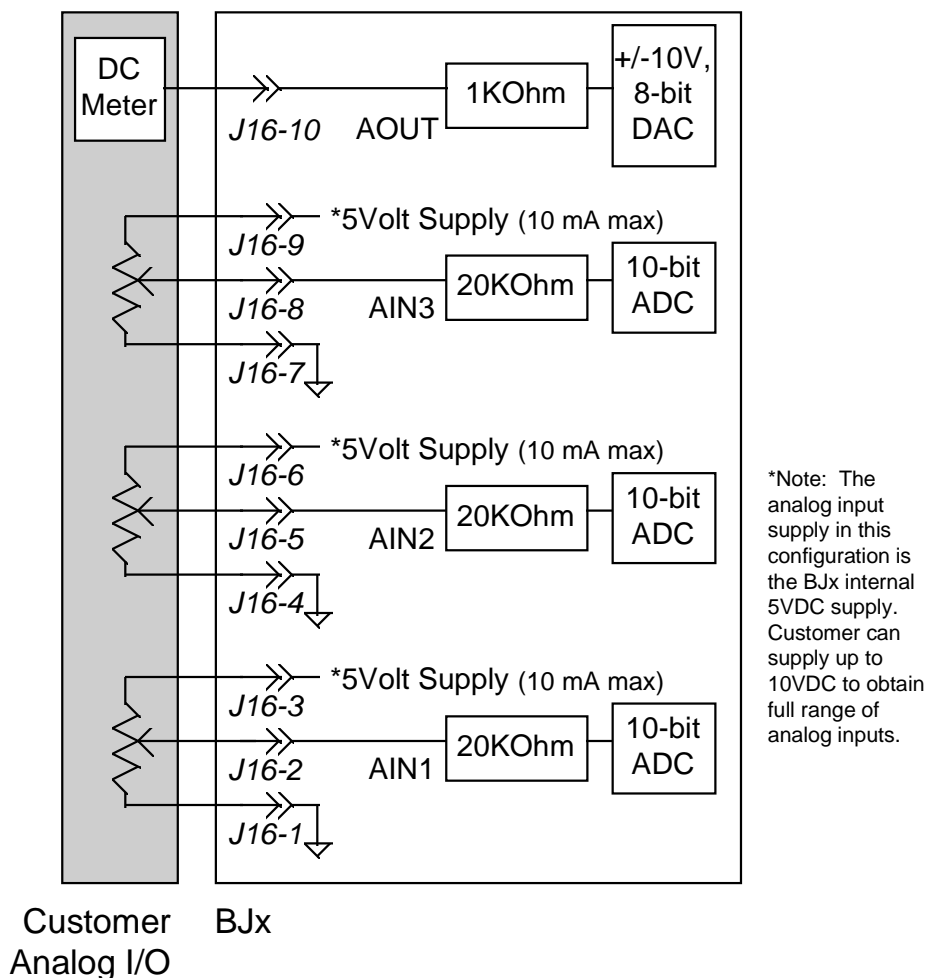


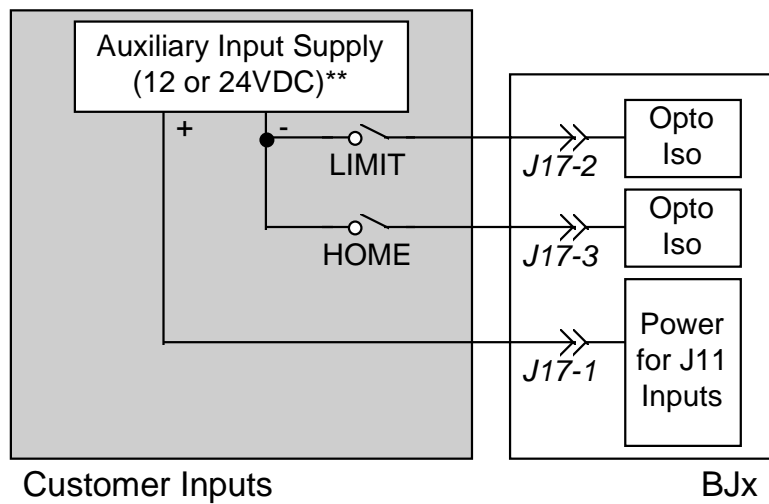
Figure 2.9
Connectors J14 and J15
RS-232 and RS-485 BNet Communications Network



**Figure 2.10 Connector J15
RS-232 Connection to HHT-02**



**Figure 2.11 Connector J16
Analog I/O**



**Polarity of Auxilliary Input Supply can be reversed.
 Auxilliary Input Supply is electrically isolated from Main
 Input Supply (Connector J11)

**Figure 2.12 Connector J17
 Limit and Home**

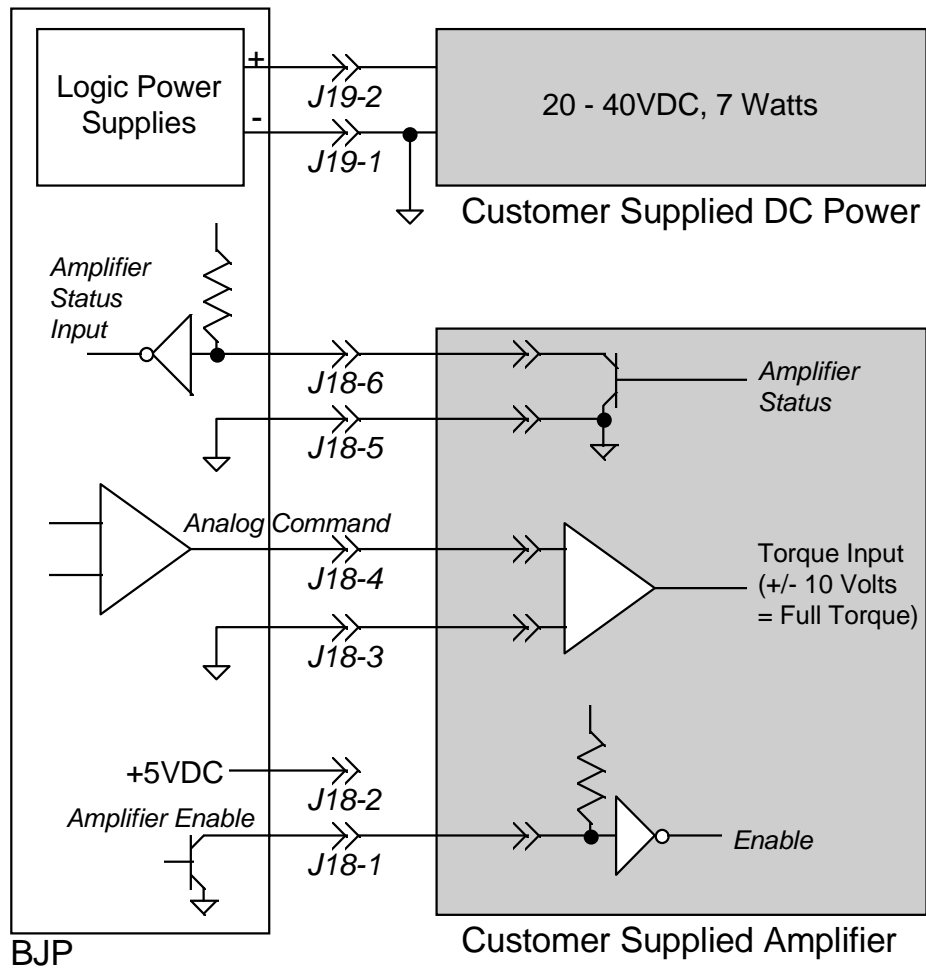


Figure 2.13
Connectors J18 and J19
DC Control Power and Amplifier Status
BJP Only

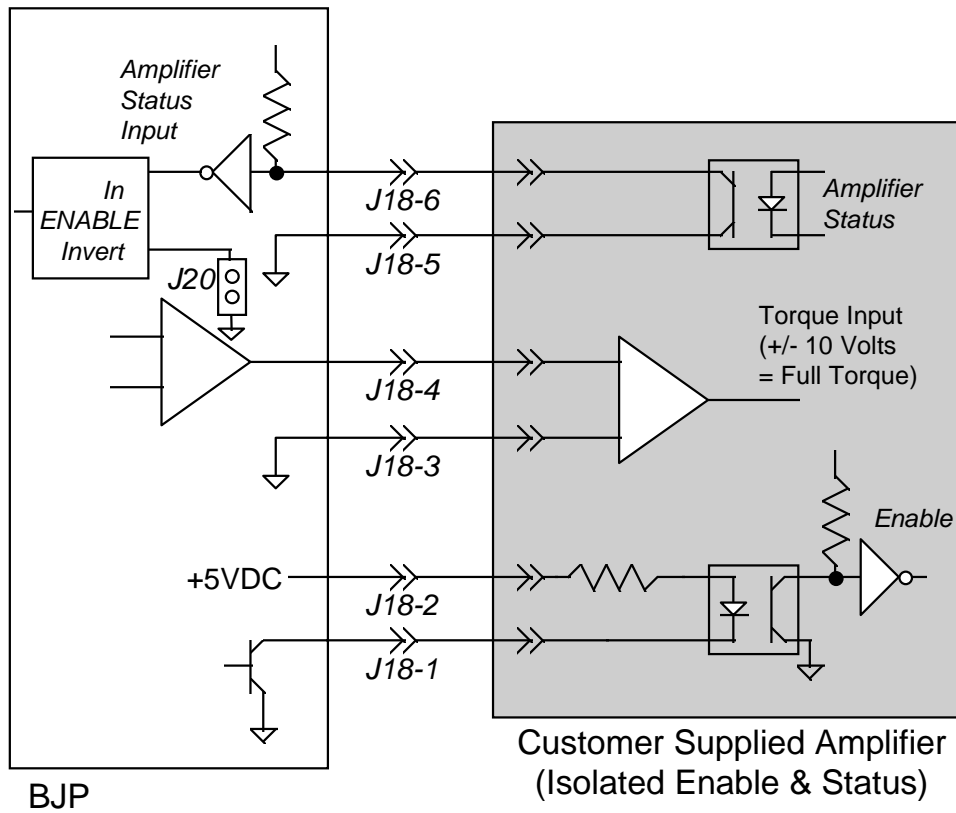


Figure 2.14
Connectors J18
Amplifier Status (Isolated Status)
BJP Only

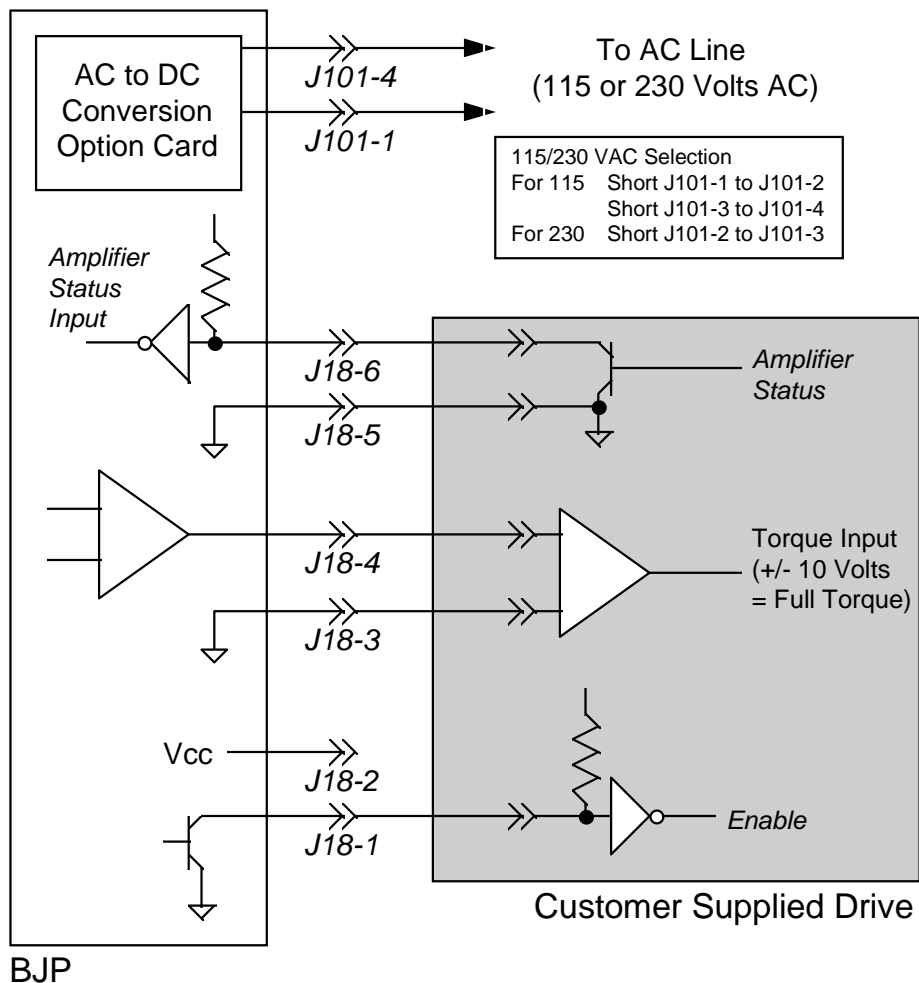


Figure 2.15
Connectors J18 and J101
AC Control Power and Amplifier Status
BJP Only

CHAPTER 3

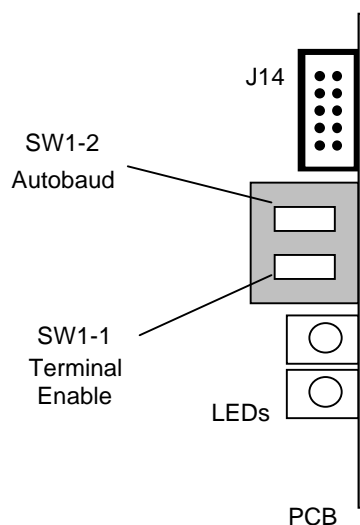
CHECK OUT AND COMMISSIONING

INTRODUCTION

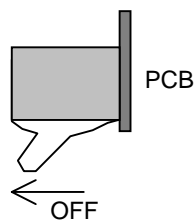
This chapter reviews the steps required to check your wiring and your system components. It is assumed that you have some experience with the BJx language and with Motion Link, the IBM-PC based communications package, both of which are discussed in Chapter 2 of the BJx *User's* manual.

Establishing Communications

Turn SW1-2 on (towards PCB) to configure your BJR/BJP to Autobaud (i.e. automatically sense the communication frequency). Turn SW1-1 on to permanently enable the RS-232 port.



SW1
Front View



SW1
Top View

Connect your serial port to J15 and apply bus power to the BJR/BJP as described in Chapter 2. The BJR/BJP requires the following data format:

Full Duplex
8 bits per character
No parity
1 Start bit
1 Stop bit
Baud rate of 300, 600, 1200, 2400, 4800,
9600, or 19,200.

Virtually all IBM-PC compatibles support this format.

On power-up, the FAULT LED (Red) should blink, indicating that the unit is waiting for serial transmission to determine the baud rate. On your PC, type

```
CD WL
ML
```

to run Motion Link. **Error! Bookmark not defined.** After Motion Link begins execution, your IBM-PC screen should display

```
BJx v02.0.6 10-03-95 14:47:12
(c) 1995 KOLLMORGEN
-->
```

If You Can't Communicate...

If the BJR/BJP does not respond, the following procedure should help you locate the problem.

If your system is configured for multidrop communications, temporarily disconnect J14.

Error! Bookmark not defined. Ensure that both SW1-1 and SW1-2 are on. Note that the BJR/BJP must be powered down and back up to recognize SW1 settings.

If the red FAULT LED never started blinking... then verify that SW1-2 is on (the position nearest the PCB).

If the red FAULT LED is blinking irregularly... then your unit may have a hardware fault. In this case, the LED will blink a few times and pause. The number of "blinks" indicates the error number. Contact the factory.

If the red FAULT LED is blinking regularly... then the BJR/BJP is autobauding; it is waiting for a series of carriage return characters. Motion Link automatically sends these returns on start-up when you select AUTOBAUD. Exit Motion Link and restart; select the Motion Link AUTOBAUD option on initialization.

If the red FAULT LED is still blinking... then you may have a wiring error. The most common problem is reversing pins 2 and 3 in the serial connector. Verify that you have wired the cable to J15 according to the tables and figures in Chapter 2. Verify that you have a reversing cable as described in the discussion of J15 in Chapter 2.

If the red FAULT LED is still blinking... use an oscilloscope to verify that characters are being transmitted to the terminal. Set the time base to 5 milliseconds/division and the voltage sensitivity to 5 volts/division. If you do not have an oscilloscope you may be able to use a digital voltmeter. Many digital voltmeters are quite sensitive and can detect character transmissions. You should see some change in voltage.

Remove the cable from J15 and connect the scope across pin 2 (BJR/BJP receive) and pin 1 (Ground). Press the return key. Verify that the return characters are being transmitted to pin 2. If the characters are transmitted to pin 3, pins 2 and 3 are reversed. If they are transmitted across pins 5 and 6, then you have a non-reversing cable instead of a reversing cable.

If the OK LED has stopped blinking but Motion Link shows the system is not responding... then the BJR/BJP is receiving characters, but the transmissions are not being displayed. Check carefully for miswired cable or broken wires (especially for pin 3).

Initial Check Out

This section contains the procedure for checking most of the wiring on the BJP/BJR before it is enabled. Communications must be established with your system before continuing.

The BJR/BJP will be used to check wiring to most of the inputs and outputs. You will need to enter some BJx commands.

The first command is the print command. You can print the discrete inputs. For example, after the "-->" prompt has printed you can type:

```
P LIMIT
```

and the system will print 1 or 0, 1 meaning that the input is on and contacts are closed, and 0 meaning the input is off and the contacts are open.



NOTE

In this manual, instructions that you enter will be shown in italics and surrounded by a double line box. The response from the BJR/BJP will be in plain upper case letters, surrounded by a single-line box.

Checking Discrete Inputs

You can check the state of all of the discrete inputs with the print command. This process will be demonstrated with the hardware travel limit switch, LIMIT. If you are not using the LIMIT switch, you can substitute another hardware switch.

1. Open the switch contacts.
2. Type:

```
P LIMIT
```

3. The response should be "0."
4. Close the switch contacts.
5. Use your terminal to enter:

```
P LIMIT
```

6. The response should be "1."

Error! Bookmark not defined.
Error!
Bookmark not defined. Repeat this process for

each discrete input that you are using:

```
__I1  __I5  __MOTION  __LIMIT
__I2  __I6  __GATE    __HOME
__I3  __I7  __REMOTE
__I4  __I8  __CYCLE
```

Checking Discrete Outputs

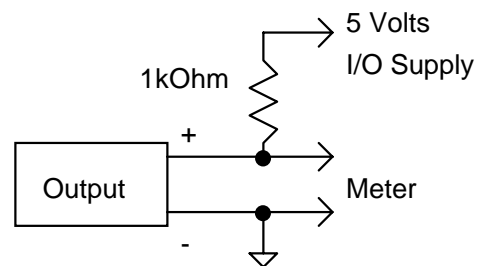
You can check all of the general purpose outputs by turning them on and then off. The procedure in this section will activate all of the general purpose outputs. Be sure that activating an output will not cause a hazard to personnel or damage to equipment.



WARNING

Commands in this section will turn on all general purpose outputs. Be certain that this is not a safety hazard. Make sure this will not damage equipment.

If your output is connected, apply power to the I/O power supply and use a meter to monitor the voltage across the output. If it is not connected at check-out time, you will need to connect a temporary load as shown below. You can use 5 volts from J12, J13, or J16 as a temporary I/O power supply.



Temporary Load

When the output is off, the meter should read a voltage equal to the supply. When the output is on, the meter should read < 2 volts. Use a high impedance meter such as most digital volt meters (DVM).

1. Turn on O1 by typing:

```
O1 ON
```

2. Verify that the output is on.
3. Turn off O1 by typing:

```
O1 OFF
```

4. Verify that the output is off.

Repeat this process for each discrete output that you are using:

```
__O1    __O2    __O3    __O4
__O5    __OK
```

Note that OK should turn on at power-up.

Checking Encoder Input

Connect your encoder to Connector J12. The encoder should not be moving. Type:

```
P PFB
```

Now rotate the encoder. Type:

```
P PFB
```

PFB should have changed when you rotated the encoder shaft.

If the results are not what you expected, use an oscilloscope to verify that all four signals are reaching Connector J12.

ENCDIR controls the direction in which the feedback encoder counts. If you are using a SILVERLINE motor and encoder, set ENCDIR = 1. However, if you are not using a SILVERLINE encoder, or if your encoder is not connected directly to the motor shaft, be advised that it is easy to reverse the direction of the encoder. This will cause the motor to run away when power is applied. If the encoder is reversed, you can invert it by typing

```
ENCDIR = 0
```



WARNING

Reversing encoder will cause the motor to run away when the BJR/BJP is enabled.

Changing ENCDIR has the same effect as reversing the encoder.

Checking Master Input (Optional)

If your system has master input, you will need to generate master pulses to complete check out. Also, you will need to set MSTRMODE appropriately. If your master input is an encoder, type

```
MSTRMODE = 1
```

indicating encoder input, and rotate the encoder by hand. If you are using a pulse format, set MSTRMODE as shown in Chapter 2 (page 19), J13; generate pulse inputs from the master.

Set the external units to counts by typing

```
PXNUM = 1
PXDEN = 1
```

Now observe PEXT. It should increment one count for each positive encoder edge or pulse. If you want to invert the direction of counting, invert the switch MENC DIR.

Checking Analog Inputs

If you are using analog inputs, connect your input voltages to Connector J16. Adjust AIN1 (Pin 2) to zero volts. Type:

```
P AIN1
```

It should be approximately 0. Adjust AIN1 to 5 volts.

```
P AIN1
```


AIN1 should be approximately 255. Repeat for AIN2 (J16-5) and AIN3 (J16-18).

Checking Analog Output

Connect a meter to AOUT (J16-10) and common (J16-1). Set AOUT to -128. The meter should read approximately -10 VDC. Set AOUT to 127. The meter should read approximately +10 VDC.

START-UP AND CHECK OUT

You should now be ready to supply power to test the servo system functions and features. Work with only one axis section at a time.

Appropriate precautions should be taken to stop the machine if necessary. Limit switches and safety devices should be in place.



WARNING

THE MOTOR MAY MOVE UNEXPECTEDLY!

BE PREPARED TO REMOVE POWER FROM THE BJR/BJP!

Commands in this section will enable the BJR/BJP. The system may be unstable. The motor may begin oscillating or run away.

Follow this procedure to enable to BJR/BJP:

1. Turn on (close contacts of) LIMIT, MOTION, and REMOTE if you are using them.

If you are not using LIMIT, MOTION, or REMOTE, disable these functions by typing:

NOMOTION ON

NOLIMIT ON

or

NOREMOTE ON

In these cases, LIMIT, MOTION, and REMOTE can be used as general purpose inputs.

2. Apply bus power.
3. Enable the BJR/BJP. Type:

EN

The motor should be still. If your motor is oscillating, disable the BJR/BJP by typing:

K



WARNING

The drive will be enabled and the motor will turn. Make sure the motor is secured. Even if the BJR/BJP is disabled, it will enable long enough to execute the TUNE command.

If Your System is Unstable...

If the motor was oscillating, you need to retune your system. First, try to stabilize the system with the TUNE command. Type:

TUNE 10 2

Enable the drive. If your system is stable, you can skip ahead to the next section. If you want to improve the response, see the System Tuning section below.

If your system is not stable, disable the BJR/BJP. You need to detune the system. First, disable the position loop. Type:

PL OFF

Disable the integrating velocity loop by enabling the proportional velocity loop. Type:

PROP ON

On power-up, the integrating velocity loop will be enabled (that is, PROP is turned off) and the position loop will be turned on. Be careful to

turn PROP on and PL off every time you power-up until you stabilize the system for an integrating loop.



WARNING

PROP is turned off and PL is turned on at power-up. If you are following this procedure to stop oscillations, be certain to turn PROP on and PL off every time you power-up the drive.

Now enable the drive by typing:

```
EN
```

Reduce the proportional gain (KPROP) until oscillations stop. Type:

```
KPROP = KPROP/2
```

You may need to repeat this command a few times.

After oscillations stop, enable the position loop by typing:

```
PL ON
```

Next, reduce the position loop gain (KP) until oscillations stop. Type:

```
KP = KP/2
```

You may need to repeat this command a few times.

If you need to tune your system for better performance, see the System Tuning section below.

Jogging the Motor

If you can enable the BJR/BJP without motor oscillations, then you can jog the motor. First, temporarily disable the software position limits. Type:

```
PLIM OFF
```

Now type:

```
J 10
```

and the motor should rotate at 10 RPM. If PROP is on, the motion may be unsteady. You need an integrating velocity loop for good low speed performance.

Disable the BJR/BJP and enable the software position limits. Type:

```
DIS  
PLIM ON
```

System Tuning

Feedback systems such as motor controllers require tuning to attain high performance. Tuning is normally a laborious procedure requiring an experienced person. However, the BJR/BJP provides many tools to aid tuning, making it a much simpler process.

Tuning is the process whereby the position and velocity loop gains are set to optimize the performance of a system to a three-part criterion:

- Noise Susceptibility
- Response
- Stability

In a broad sense, the performance of a system is characterized by its noise susceptibility, response, and stability. These quantities tend to be mutually exclusive. The system designer must decide what noise susceptibility (in the form of a "busy" motor) is acceptable.

"Busyness" is random activity in the motor and can often be felt on the motor shaft. Busyness in a motor should not be confused with PWM noise. PWM noise is high pitched, relatively constant noise and cannot be felt on the motor shaft.

Response is a measure of the system's quickness. Response can also be characterized by bandwidth and by rise time in response to a step command. Normally, designers want high bandwidth, though sometimes the response is purposely degraded to reduce stress on mechanical components. This is called *detuning*. Typical

velocity loop bandwidths range from 20 to 60 Hz. Typical position loop bandwidths range from 0.1 to 0.2 times the velocity loop bandwidth.

Stability measures how controlled the system is. Stability can be measured with damping ratio or with overshoot in response to a step command. A discussion of different levels of stability follows.

Critical Damping

Generally, the most desirable amount of damping is Critical Damping. Critically damped systems respond as fast as possible with little or no overshoot. The graph in Figure 3.1 shows the velocity response of a BJR/BJP system to a square wave input when the system is critically damped.

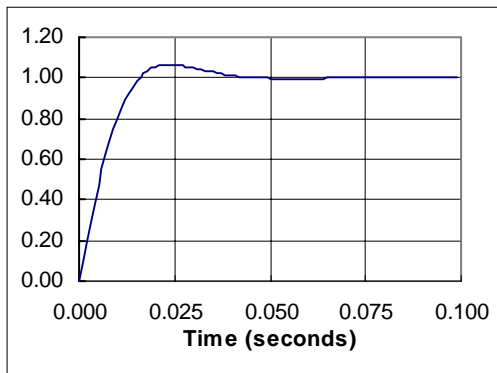


Figure 3.1 Critical Damping

Underdamping

Sometimes the system is tuned for critical damping and the system is still too slow. In these cases, you may be willing to accept less than critical damping. For applications that can work properly with a slightly underdamped system, you may reduce the stability to improve the response. The graph in Figure 3.2 shows a slightly underdamped system.

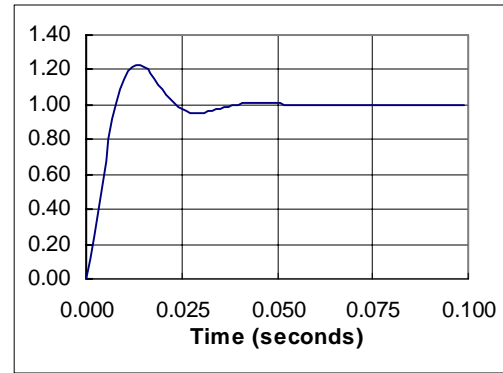


Figure 3.2 Underdamping

Overdamping

An overdamped system is very stable but has a longer response time than critically damped or underdamped systems. Also, overdamped systems are noisier than less damped systems with the same response rate. The graph in Figure 3.3 shows an overdamped system.

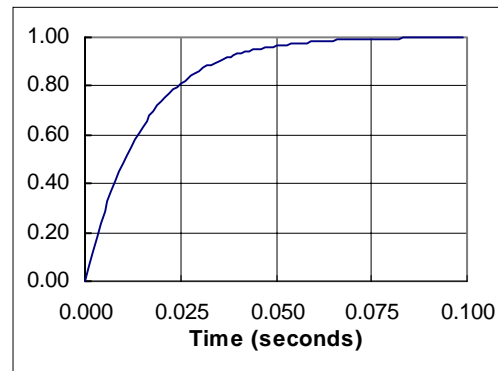


Figure 3.3 Overdamping

Ringling

When you are tuning the BJR/BJP you may tune it so that the response rings. Ringing is caused when you attempt to tune the system for either too rapid response (too high bandwidth) or too much stability (too much damping) or both. Normally, the best solution is to reduce the bandwidth. The graph in Figure 3.4 shows a system that rings.

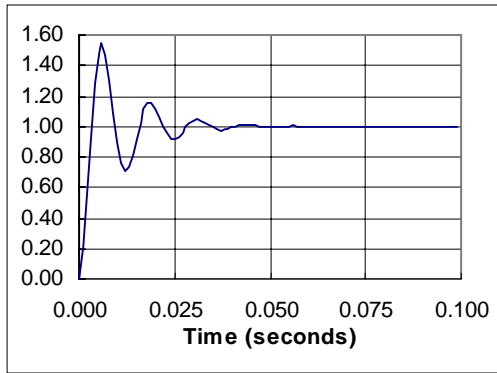


Figure 3.4 Ringing

TUNING



WARNING

The TUNE command shakes the motor vigorously. Secure the motor before tuning.

The BJR/BJP is usually shipped without being tuned to a particular motor. The following section describes how you can re-tune your system.



NOTE

When tuning a system, it may be desirable to disable the BJR/BJP quickly. You can use K, the KILL command, to disable with a one-letter command.

Tuning the BJR Current Loop

The BJR current loop must be tuned to match the electrical characteristics of your motor, amplifier, and applied voltage.

Normally, equations 2.1-2.4 (page 15) provide fast, stable responses. However, you may wish to confirm these values in your system. To do that you will need to:

1. modify your wiring temporarily;
2. enter the short program shown below;
3. observe the current-loop response with an oscilloscope and a current probe (alternatively, you can use test point IFB).

Step 1) Modify wiring

The system must be modified to allow current generation without producing motion. To do this, you can clamp the output shaft.

Alternately, for brushless motors, you can remove the hall sensors (J7) and the 120° commutation jumper (J2).

Step 2) Enter the following program:

```

1$
EN
PL OFF
ILIM 5
X1 25
J 1000
2$
ILIM X1
D 50
ILIM 5
D 1000
GOTO 2

```

Save this program as ILOOP.BDS. Transmit it to your BJR.

Step 3) Observe current.

Connect your current probe onto motor lead A. Set the scope time scale to 50 ms/div and adjust the trigger on normal mode to show the 50 ms pulse. This waveform should respond rapidly--it should settle in about .5 ms with approximately 10% overshoot. If either of the parameters is incorrect, recalculate equations 2.1/2.3 (BJR-4004) or equations 2.2/2.4 (BJR-4008). Confirm that R_L and C_L are correct.

If you do not have access to a current probe, you can connect your oscilloscope to TP6 (IFB) on the top PCB (see Figure 2.2 on page 26). The scaling on this signal is $.4V = \text{peak current}$.

The BJR/BJP provides self-tuning for the velocity and position loops. This feature senses the inertial load of your system and then attempts to set tuning parameters accordingly. Note that self-tuning is not fool-proof. You may need to adjust one or two of the tuning parameters to obtain the response you need.



**THE MOTOR MAY
OSCILLATE!**

Unloaded motors tuned for a large inertia load may become unstable when the system is activated. If the system becomes unstable, remove power immediately.

If Your System Is Completely Unstable...

If your system is completely unstable when you enable it, remove power immediately. After restoring power but before enabling the system, turn off the switch PL, reduce KV to 100, and reduce KVI to 0. This should make the system stable.

```
;TYPE THESE LINES ONLY IF YOUR  
;BJR/BJP IS UNSTABLE WHEN YOU  
;ENABLE IT. REMEMBER TO  
;RESTORE PL WHEN YOU HAVE  
;FINISHED TUNING.  
PL OFF  
KVI = 0  
KV = 100
```

If the BJR/BJP is still unstable, remove power and contact the factory. If it is stable, continue on with tuning. Remember to turn PL back on when you have finished tuning. Also, PL is always turned on during power-up.

Reducing ILIM

You may need to reduce ILIM before executing the TUNE command since the TUNE command causes the motor to "shake" at about 15 Hz and at full torque. This may damage some machines. Also, lightly loaded motors can overspeed if ILIM is too high. Raise ILIM to the highest level that does not cause problems, because the tuning values will be more reliable. If you are not sure how much ILIM is necessary, reduce ILIM to a low value (say 5 or 10%) and gradually raise it. If the tuning is acceptable (that is, it does not ring or overshoot excessively, and it does respond fast enough), then you are done. Remember to restore ILIM to its original value.



NOTE

The TUNE command can cause the motor to overspeed. You may need to reduce ILIM to prevent overspeed errors. Remember to restore ILIM when tuning is complete.



CAUTION

The TUNE command shakes the motor vigorously. You may need to reduce ILIM before executing the TUNE command to protect your machine. Remember to restore ILIM when tuning is complete.

TUNE COMMAND

When you enter a TUNE command, you specify the response time and the stability level. The response time is specified in the form of bandwidth. The higher the bandwidth, the faster the response. The level of stability is specified as follows:

1. Slightly overdamped
2. Critically damped
3. Slightly underdamped

Enable the BJR/BJP and type this command:

TUNE 30 2

The BJR/BJP will shake the motor and set the tuning so that the velocity loop has a bandwidth of approximately 30 Hz and is critically damped. The allowed bandwidths are 5, 10, 15, 20, 25, 30, 40, and 50 Hz.

The tune command does not always provide an acceptable tuning. If not, you can tune the system yourself.

If the motor runs away during tuning, print the value of LSTTUNE. If LSTTUNE is negative, invert the state of ENCDIR and try the TUNE command again.

Low-Pass Filters

The LPF switch enables the low-pass filter. It can be turned on and off when the drive is operating. The frequency of the low-pass filter is stored in LPFHZ in Hz. It can also be changed when the drive is operating. For example, if LPFHZ is 200 and LPF is on, then a 200 Hz low-pass filter is run in the BJR/BJP. The filter can be modeled as two cascaded, low-pass, single-pole filters, both with a 3 dB frequency of 200 Hz. LPFHZ should be set as high as possible, since it degrades the system performance.

For example, the following sequence sets the low-pass filter to 250 Hz and enables the drive.

```

LPF ON ;ENABLE LOW-PASS
      ;FILTER
LPFHZ 250;SET BREAK FREQ. TO
      ;250 HZ

```



NOTE

If the low-pass filter is on, the TUNE command may not work well.

TUNING THE BJR/BJP YOURSELF

If you use the TUNE command and the resulting tuning variables cause the system to oscillate, there are generally two reasons:

1. The bandwidth in the TUNE command is set too high for the system to function properly.
2. The low-pass filter is set too low (this only applies if LPF is on).

In either case, first raise the low-pass filter frequency (LPFHZ) to as high a level as is acceptable. You may even decide to remove it by setting LPF to off.

The next section details how you can tune the system yourself for those cases where the TUNE command does not provide acceptable performance.

Tuning the Velocity Loop



WARNING

The drive will be enabled and the motor will turn. Make sure the motor is secured.

Figure 3.5 shows how to manually tune KV and KVI in an integrating velocity loop. The program records velocity feedback (VFB) for a single acceleration and deceleration. Then you can use Motion Link's PC-SCOPE to display the results.

Response is often measured by the system *bandwidth*. Bandwidth is the frequency with which the system response falls to 70% of the nominal response. For example, if your velocity command was a sine wave with peaks of ± 100 RPM, the bandwidth would be the frequency at which the amplitude of the response fell to ± 70 RPM.

There is a close relationship between the response of the system and the variable KVI. This relationship is shown in Table 3.1.

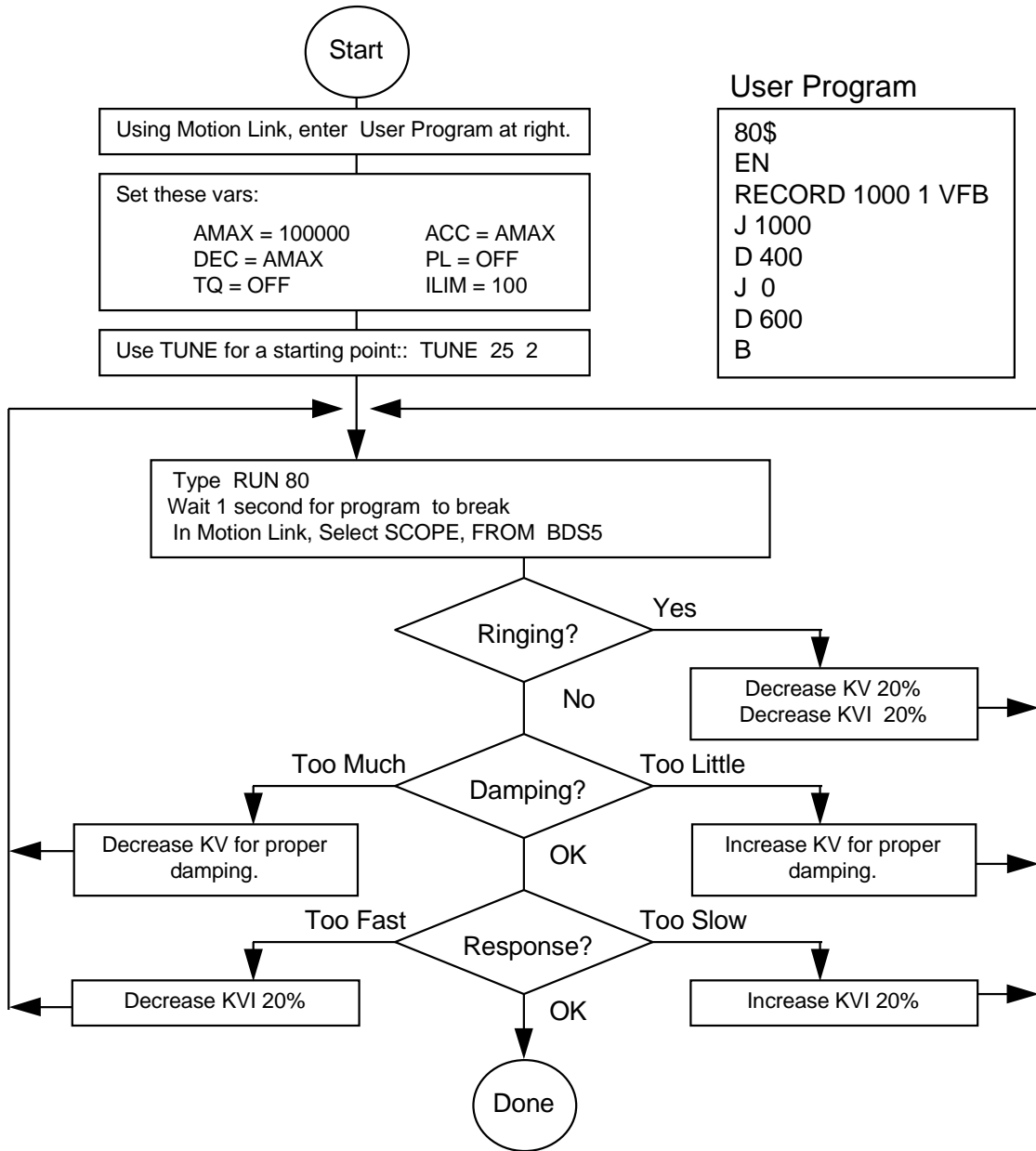


Figure 3.5 Tuning Flow Chart

Table 3.1 Velocity Loop Bandwidth vs. KVI

KVI	VELOCITY LOOP BANDWIDTH
1400	5 Hz
2650	10 Hz
4000	15 Hz
5000	20 Hz
6250	25 Hz
7500	30 Hz
8750	40 Hz
10000	50 Hz

If you are using a proportional velocity loop (PROP is on), then adjust KPROP until the motor is performing appropriately.

Tuning the Position Loop

Once the velocity loop is tuned, you can tune the position loop. Type in the following commands:



The drive will be enabled and the motor will turn. Make sure the motor is secured.

```
PEMAX 30000
ZPE           ;ZERO POSITION
              ;ERROR TO AVOID
              ;POSITION ERROR
              ;OVERFLOW WHEN
              ;ENABLING
POSITION     ;LOOP
PL ON
KF=0
```

This enables the position loop. Run the program from Figure 3.5, and adjust KP up or down until the performance is acceptable. Table 3.2 shows the relationship between a properly tuned position loop (that is, the highest setting for KP) and velocity loop bandwidth. Note that the position loop bandwidth will be substantially lower than the velocity loop bandwidth (usually by a factor of 3 to 8).

Table 3.2 Velocity Loop Bandwidth vs. KP_{MAX}

KP _{MAX}	VELOCITY LOOP BANDWIDTH
500	5 Hz
1000	10 Hz
1500	15 Hz
2000	20 Hz
2500	25 Hz
3000	30 Hz
4000	40 Hz
5000	50 Hz

If you want to eliminate some or all of the following error, you can raise KF as high as unity feed-forward (KF = 16384). However, the higher you raise KF, the more you must reduce KP to eliminate overshoot; this reduces the position loop performance. If you cannot get the desired performance from the position loop, then try reducing ACC and DEC to reduce overshoot. This can be a good way to limit overshoot in the position loop, and you may be able to raise KP slightly (about 20%) to improve performance.

Problems

Sometimes problems arise while tuning. The TUNE command will usually provide a tuning that is either acceptable or close to acceptable. If not, you can tune the system yourself. Sometimes there are physical factors that prevent you from attaining the performance you need. These problems fall into four categories:

1. Overloading the Motor
2. Compliance
3. Non-Linear Mechanics
4. Resonance

Overloading the Motor

An overloaded motor is the most common problem for positioning systems (that is, systems with PL on). If you overload the system, the position error can grow to very large values. When the command stops, the motor "reels in"

the following error and can overshoot excessively. It looks like a tuning problem, but it is actually caused by the motor being undersized, ACC or DEC being set too high, or ILIM being set too low.

An overloaded motor has the following characteristics:

- The system overshoots, sometimes excessively, but does not ring or oscillate.
- Reducing ACC and DEC eliminates the problem.
- Turning off PL eliminates the problem.
- The motor current is near or at saturation during a large part of the move. Use the RECORD function to record ICMD. If ICMD is equal to ILIM for more than a few milliseconds, then your system is saturated.

Overloading the motor can be corrected by the following actions:

- Reducing ACC and DEC.
- Reducing the load on the motor.
- Increasing ILIM (if it is less than IMAX).
- Using an amplifier with a higher current rating.
- Using a motor with more peak stall torque.

Compliance

In compliant systems, the load is not tightly coupled to the motor shaft. If you move the load by hand, you can feel springiness. Compliant systems often are very stable when you tune with lower target bandwidths. However, they oscillate vigorously at low frequencies when you try to tune them for higher bandwidths.

A compliant system has the following characteristics:

- There is springiness between the motor and the load or at the motor mounting plate.

- The TUNE command calculates tuning variables that cause the system to oscillate.
- The frequency of oscillation is less than 100 Hz.

Compliance can be corrected by the following actions:

- Reduce the bandwidth of the system.
- Stiffen the machine so the load is not springy.

Non-Linear Mechanics

BJR/BJP tuning is based on linear control theory. The most important requirement of a linear controller is that the total reflected inertia should not change substantially during operation. Load inertia includes all the inertia reflected to the motor, such as inertia through gearboxes and leadscrews. Inertia can change in ways that are easy to understand, such as the inertia of a spool of cable decreasing when the cable is unrolled. It can also change in less intuitive ways, such as chain drives (which have load in one direction but are unloaded in the other) and systems with excessive backlash (where there is no load when gear teeth are not touching).

When the inertia changes, the system has the following characteristics:

- System performance is excellent when the motor is in some positions and unacceptable when the motor is in other positions.
- Reducing the bandwidth eliminates the problem.

If the system performance is poor because of changing inertia, you can make the following corrections:

- Correct the system mechanics so that inertia is constant.
- Detune (that is, reduce the bandwidth of) the system. If the times when your system will have excessively changing inertia are predictable, you can write your program to detune your system in these regions.

Resonance

Resonance is a high frequency (> 500 Hz) where the system mechanics oscillate. Normally, systems with resonance will be very stable when you tune with lower target bandwidths. As you increase the target bandwidth, you will begin to hear a fairly pure, high pitch. If you want to decrease resonance, use shorter, larger diameter driving shafts. Often, the low-pass filter can help you raise the bandwidth 20% or 30%, but this can be a difficult trial-and-error process of slowly lowering the low-pass filter frequency (LPFHZ) and attempting to raise the target bandwidth for tuning.

When your system has a resonance, it will have the following characteristic:

- The system will emit a clear, high pitch (> 500 Hz). Do not confuse this problem with compliance, which has a low pitch.

If the system performance is poor because of resonance, you can make the following corrections:

- Enable the low-pass filter (LPF) and reduce LPFHZ, if necessary.
- Reduce the bandwidth of the system.
- Shorten the length and increase the diameter of shafts and lead screws.

C

CHAPTER 4

MAINTENANCE

INTRODUCTION

Information in this chapter will enable you to maintain the system components, ensuring smooth, efficient operation of the motor. Preventative maintenance of the equipment is also specified along with periodic maintenance. Follow these practices when operating your servo system.

PREVENTATIVE MAINTENANCE

Preventative maintenance can prevent situations that will damage your equipment. Four types of preventative maintenance are presented below. Following each of the procedures can reduce problems with and add life to your equipment.



CAUTION

Electronic components in this amplifier are static sensitive. Use proper procedures when handling component boards.

Preventative maintenance should be performed with the BJR/BJP system out of operation and disconnected from all sources of power.



CAUTION

Preventative maintenance to this equipment must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the application.

Always take the BJR/BJP system out of operation and disconnect it from all power sources before performing maintenance.

Transient Voltages



NOTE

All transient-producing devices must be properly suppressed.

Solid state controls of the BJR/BJP may be affected by transient voltages. These voltages are in excess of the specified voltage for any given circuit. When these peak voltages occur, even for less than a second, permanent damage can occur.

To help avoid transient voltages that may interfere with electronic circuit functions within the SPS(R) and BJR/BJP, all switched inductive devices or their wiring (solenoids, relay coils, starter coils, etc.) must

be suppressed. A 220 Ohm, 1/2 watt resistor in series with a 0.5 micro farad, 600 volt capacitor or equivalent is suggested.

Surge Current

Excessive current greater than that of the specified limits of the SPS(R) and BJR/BJP can cause permanent damage to the system. Current limiting measures are recommended to protect against these currents.

Electrical Noise

The low levels of energy in the BJR/BJP control circuits may cause them to be vulnerable to electrical noise. Sources of electrical noise are pieces of equipment having large, fast changing voltages and currents when they switch on and off. These devices have the capability of inducing critical current and voltage transients on their respective power lines. Accommodation must be made for these transients using noise immunity provisions.

Error! Bookmark not defined.Electrical noise is prevented with the same methods as Surge Current and Transient Voltages. However, there are other methods of preventing electrical noise, such as:

- Maintain physical separation between electrical noise sources and the BJR/BJP amplifier.
- Maintain physical separation between electrical noise sources and BJR/BJP control wiring. This can be accomplished by using separate conduits or wiring trays for control wiring and power wiring.
- Follow good grounding practices when wiring the SPS(R) and BJR/BJP. Be careful not to create a grounding loop with multiple ground paths. Follow the NEC's provisions on grounding.

Radio Frequency Energy

This equipment is susceptible to, and can radiate, radio frequency energy. It must be installed and used in accordance with this installation manual in order to prevent possible interference with radio communications or other electronic equipment.

PERIODIC MAINTENANCE

Periodically, you will need to inspect your equipment for possible problems to ensure ongoing safe and efficient operation. Periodic maintenance should be performed at scheduled intervals to insure proper equipment performance. It must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the BJR/BJP and its application. Power should be disconnected during all maintenance procedures.

Periodic maintenance includes the following:

- Check that no screw terminals have vibrated loose.
- Check integrity of wires connected to the BJR/BJP.
- Check PCBs for accumulation of contaminants such as fluids, dust, or shavings.
- Check all external circuit breakers to assure that they are within their original ratings as specified by the manufacturer.

Grounding Integrity

The method employed for grounding or insulating the equipment from ground should be checked to assure its integrity on a regular basis. This check should be performed with the power off and the testing equipment grounded.

CHAPTER 5

TROUBLESHOOTING

INTRODUCTION

The information in this chapter will enable you to order spare parts and isolate and resolve common system hardware problems. The BJR/BJP aids in diagnostic evaluation through its LED Status Indicators and the BJx Error Log. Both of these features are explained to assist you in finding solutions. As another part of Kollmorgen's obligation to its customers, Factory Support and Repair is also defined.

SPARE PARTS

BJR/BJP Spare Parts List

Connector Kit Series BJR/BJP: BJ-C100
 Break-out for J15 BJ-BKO-6
 Break-out for J12-14, J16: BJ-BKO-10
 Break-out for J11 BJ-BKO-25

BJ-C100 Connector Kit

The BJ-C100 Connector kit includes:

- 2 DB25M ribbon cable (J11) connectors
- 10ft 25-pin ribbon cable
- 2 10-pin ribbon cable connectors for J12 are provided as standard
- 6 10-pin ribbon cable connectors (J13, J14, J16)

- 50 ft 10-pin ribbon cable
- 7ft serial cable (RJ-11 to RJ-11, reversing) (J15)
- RJ-11 to DE-9 adapter (unwired)
- Strain relief for all ribbon cable connectors
- Fuses for SPS(R)

You can use scissors to cut ribbon cable. A bench vise is necessary to make up ribbon cable connectors. Wire the RJ-11 to DE-9 adapter according to Figure 2.9.

SPS(R) Spare Parts List

1.5 Amp Slow-Blow Glass Fuse	Qty. 2
1.2 Amp Slow-Blow Glass Fuse	Qty. 1

Ordering Information

If you need to order parts for the BJR/BJP and/or SPS(R), you can order them through your local distributor. For a complete list of Kollmorgen representatives contact the ICP regional office (See Appendix C).

ERRORS

The BJR/BJP responds to a variety of conditions, both internal and external, hardware and software. These conditions are grouped into a single broad category: errors. An error indicates that there is a

problem somewhere. The most serious errors are called faults.

Error Levels

The BJR/BJP response to an error depends on the error's severity. There are four levels of severity, listed below in increasing order:

Table 5.1 Error Severity Levels and Actions

1.	Errors that cause warnings.
2.	Errors that cause a program break and stop motion, in addition to Severity 1 actions.
3.	Errors that disable the system, set the FAULT LED, turn off the OK LED/Output, in addition to Severity 2 actions.
4.	Firmware Errors: Errors that disable almost all functions (including communications) and flash the FAULT LED to indicate the error number.

When any error except a firmware error occurs, a message is displayed on the screen. The following items are printed: error number, offending entry, and an abbreviated error message. For example, disable the drive and type in a jog:

```
DIS
J 100
```

The response will be:

```
ERR 50 'J 100'      BJx INHIBITED
```

The error number (50), the offending entry (the whole line), and the error message (you cannot command a jog when the drive is inhibited) are given on one 80-character line. The error message starts at character 40 so that if a 40-character display is used, the error message will not be printed. You can display the line directly with the Motion Link editor (GOTO A LINE NUMBER selection or ^Q^I).

Sometimes only an entry is bad rather than the whole line. In this case only the bad entry is printed. For example,

```
PROP 2
```

generates:

```
ERR 83 '2' ;BAD OR OUT OF RANGE
```

since PROP is a switch and cannot be set to 2. If the error comes from the program, the line number of the offending entry is also printed. Use the Editor to enter these lines at the top of the user program:

```
11$
PROP 2
B
```

Exit the Editor and type:

```
RUN 11
```

and the response should be:

```
ERR 83 LINE 2 '2' ;BAD OR OUT OF
;RANGE
```

This message shows that the error occurred on line 2.

DEP-01

If your system prints to a Data Entry Panel (DEP-01) or any other 40-character wide display, the standard error messages will not print properly, because error messages are based on an 80-character wide display. To correct this problem, the BJR/BJP provides the DEP switch, which cuts all error messages down to 40 characters. Type:

```
DEP ON
```

Error History

The twenty most recent errors are stored in the Error History. To display the entire Error History, type:

```
ERR HIST
```

This causes the Error History to be sent to the terminal, with the most recent error sent first. When the system is powered up, a "DRIVE POWERED UP" message is inserted into Error History even though this is not an error.

To clear the Error History, type:

```
ERR CLR
```

Displaying Error Messages

The ERR command can also be used to display an abbreviated description of the error. For example, type:

```
ERR 50
```

The response will be:

```
ERR 50 BJx INHIBITED
```

You may display messages for errors from 1 through 999. If you type in an error number that the BJR/BJP does not recognize, it will respond with:

```
ERROR NOT FOUND
```

A description of all errors is given in Appendix D of the *User's* manual.

Firmware Errors

Firmware errors indicate a serious problem with the BJR/BJP. These errors stop communications, disable the drive, and flash the FAULT LED. The FAULT LED flashes several times, then turns off and pauses. The number of flashes represents the error number. These error numbers range from 2 to 9. See the *User's* manual for information on these errors. Contact the factory should one of these errors occur.

BJR/BJP LEDs

The BJR/BJP provides two LEDs for diagnostics: OK and FAULT. The OK output (J11-24, J11 -25) is equivalent to the OK LED.

The FAULT LED is cleared on power-up and by the EN (Enable) command. It is set by severity level 3 errors. Often severity level 3 errors indicate that service is required. The FAULT LED is programmable; it can be set and cleared by the user program or from the serial port.

The OK LED is set on power-up. It can be set and cleared in the user program or through the serial port.

FACTORY SUPPORT AND REPAIR POLICIES

Kollmorgen is committed to helping you install, operate, maintain, and troubleshoot your BJR/BJP servo system. If your system did not pass the "Initial Check Out" tests or is not operating properly, then contact the Field Service Department of Kollmorgen ICP. Please see the *User's* manual before calling about software or programming questions. Be prepared to provide the full BJR/BJP and SPS(R) model numbers listed on the front of your units. Contact us at:

Kollmorgen Corporation
ATTN.: Field Service Dept.
201 Rock Road
Radford, VA 24141

TELEPHONE: 540/639-2495
540/731-0847 (FAX)
540/875-3743 (TWX)

APPENDIX A

WARRANTY INFORMATION

Kollmorgen Corporation warrants that equipment delivered by it to the Purchaser will be of the kind and quality described in the sales agreement and/or catalog and that the equipment will be free of defects in design, workmanship, and material.

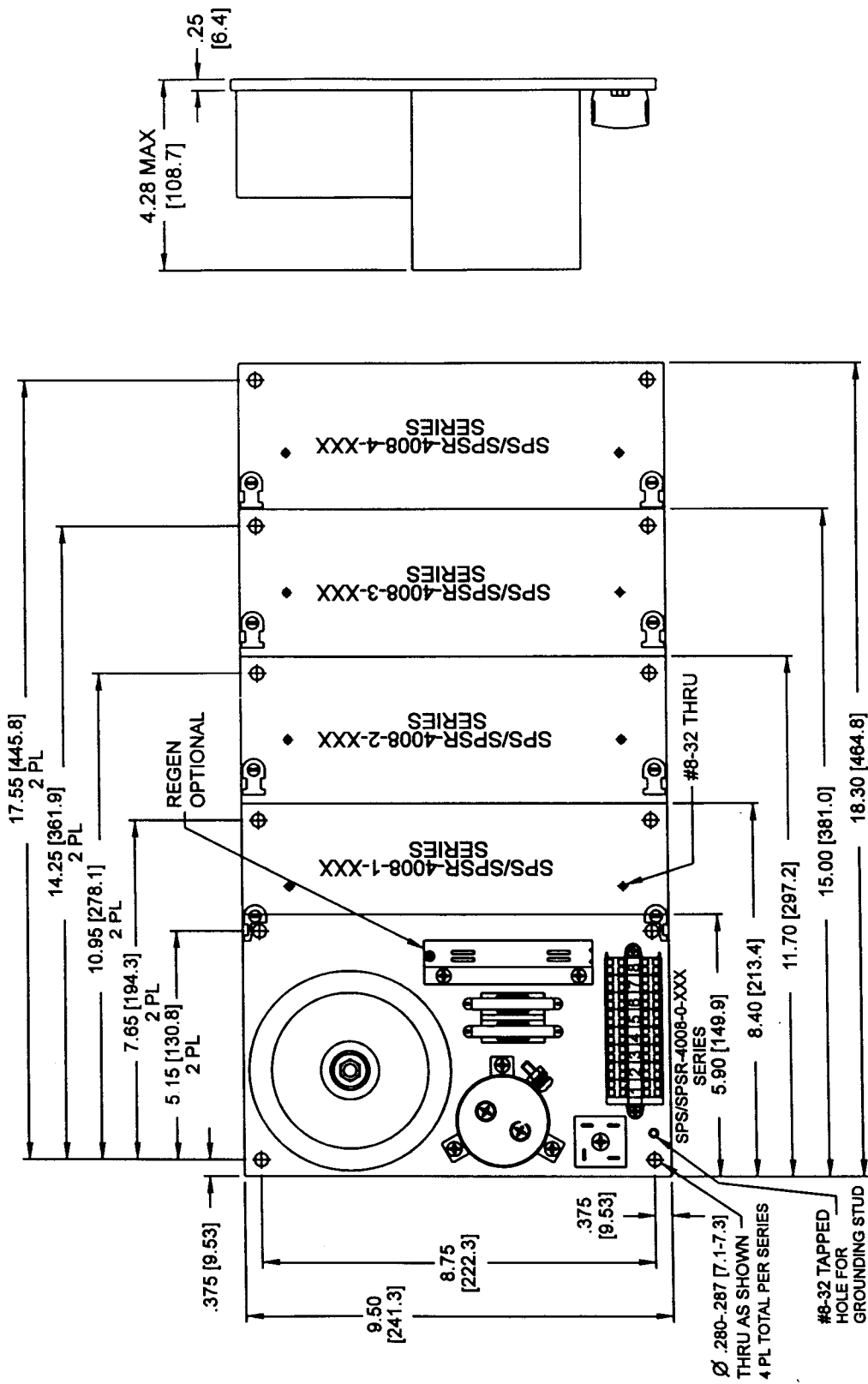
The terms and conditions of this Warranty are provided with the product at the time of shipping or in advance upon request.

The items described in this manual are offered for sale at prices to be established by Kollmorgen and its authorized dealers.

APPENDIX B

OUTLINE DRAWINGS

This appendix contains outline drawings for H-Series motors and BJR/BJP electronics.



[] DENOTES METRIC DIMENSIONS IN MILLIMETERS

Figure B.1 SPS(R) - 4008 Outline

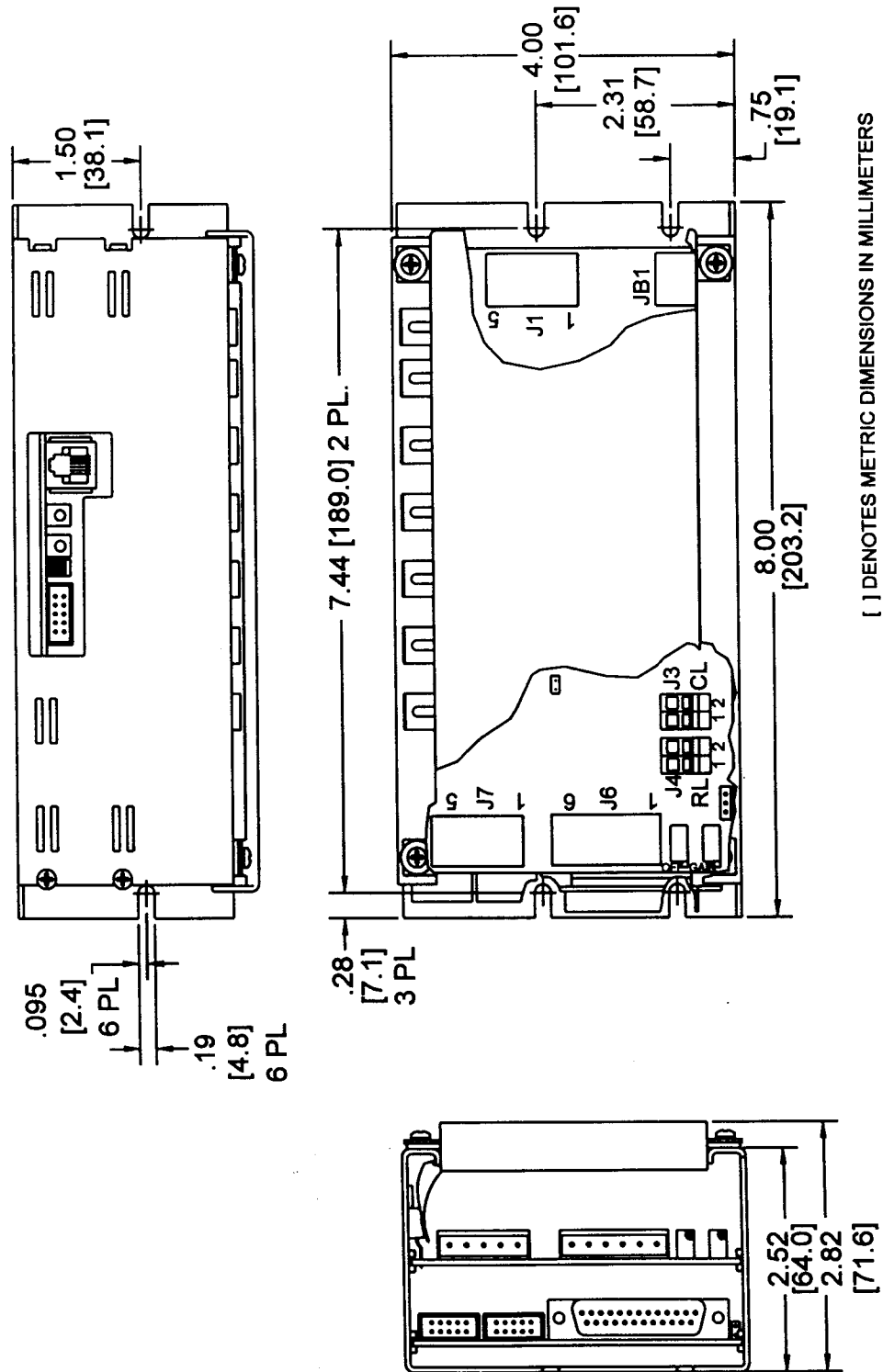


Figure B.2 BJR-400X Outline

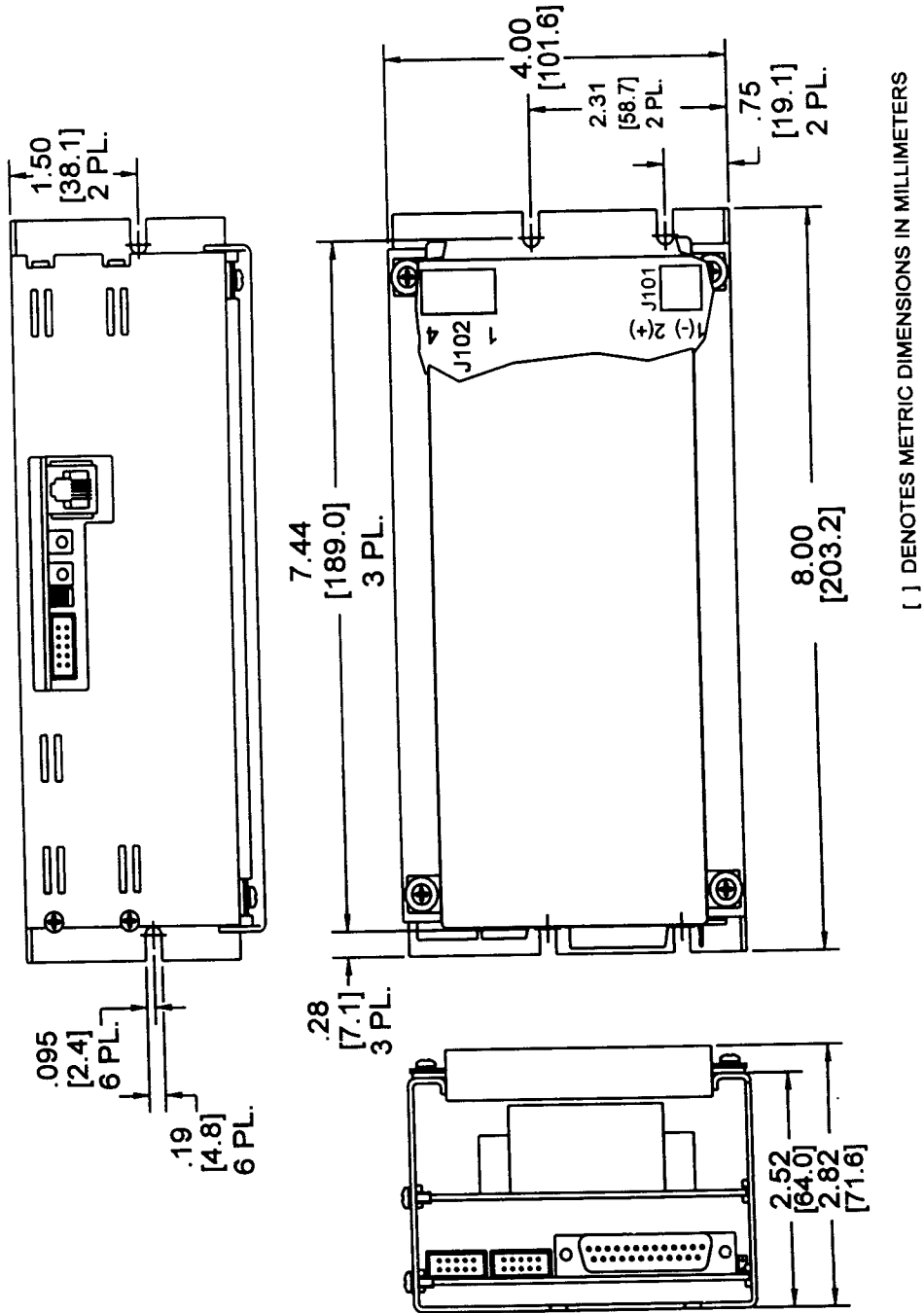


Figure B.3 BJP-xx1xxx Outline

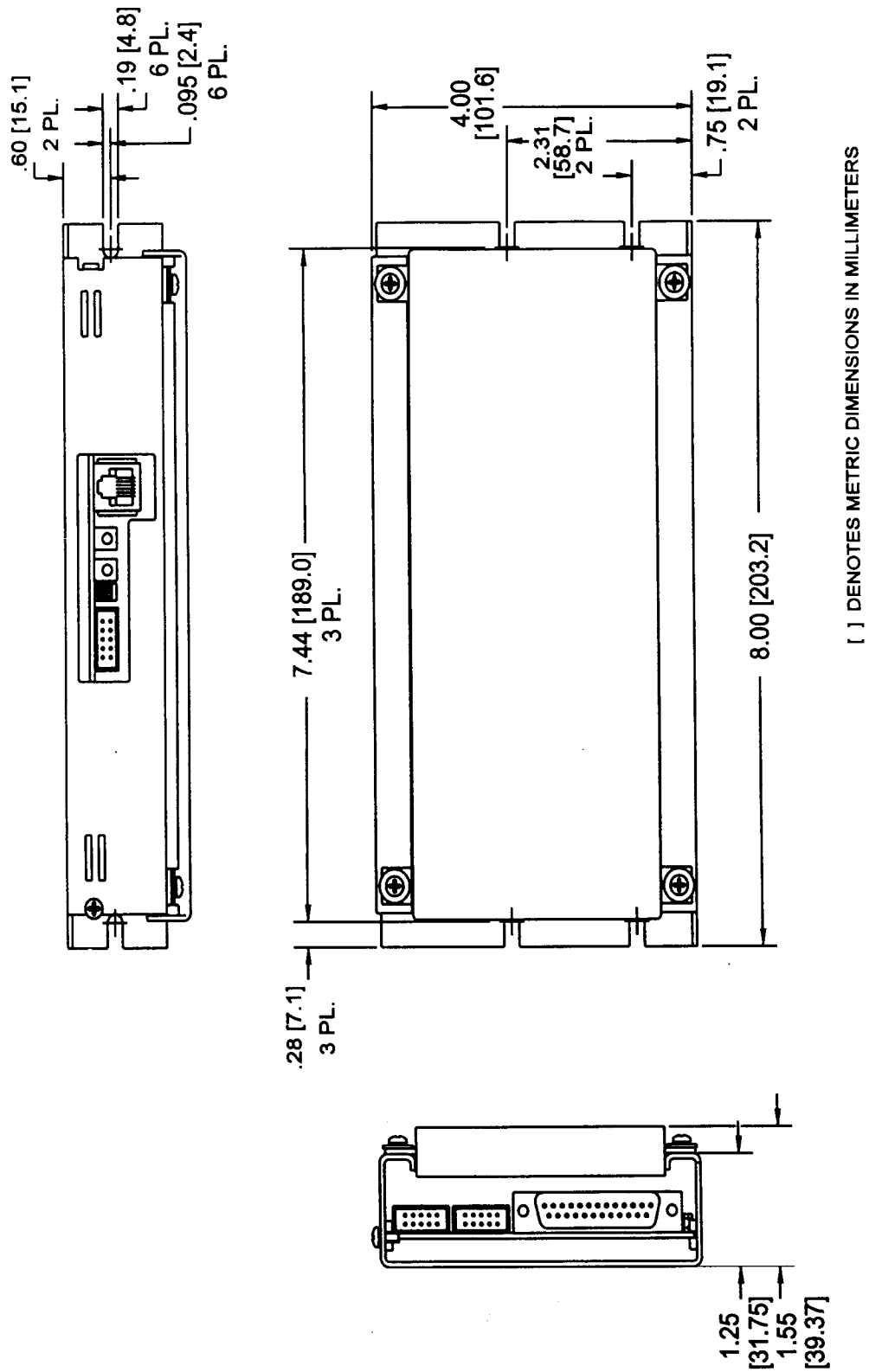


Figure B.4 BJP-xx0xxx

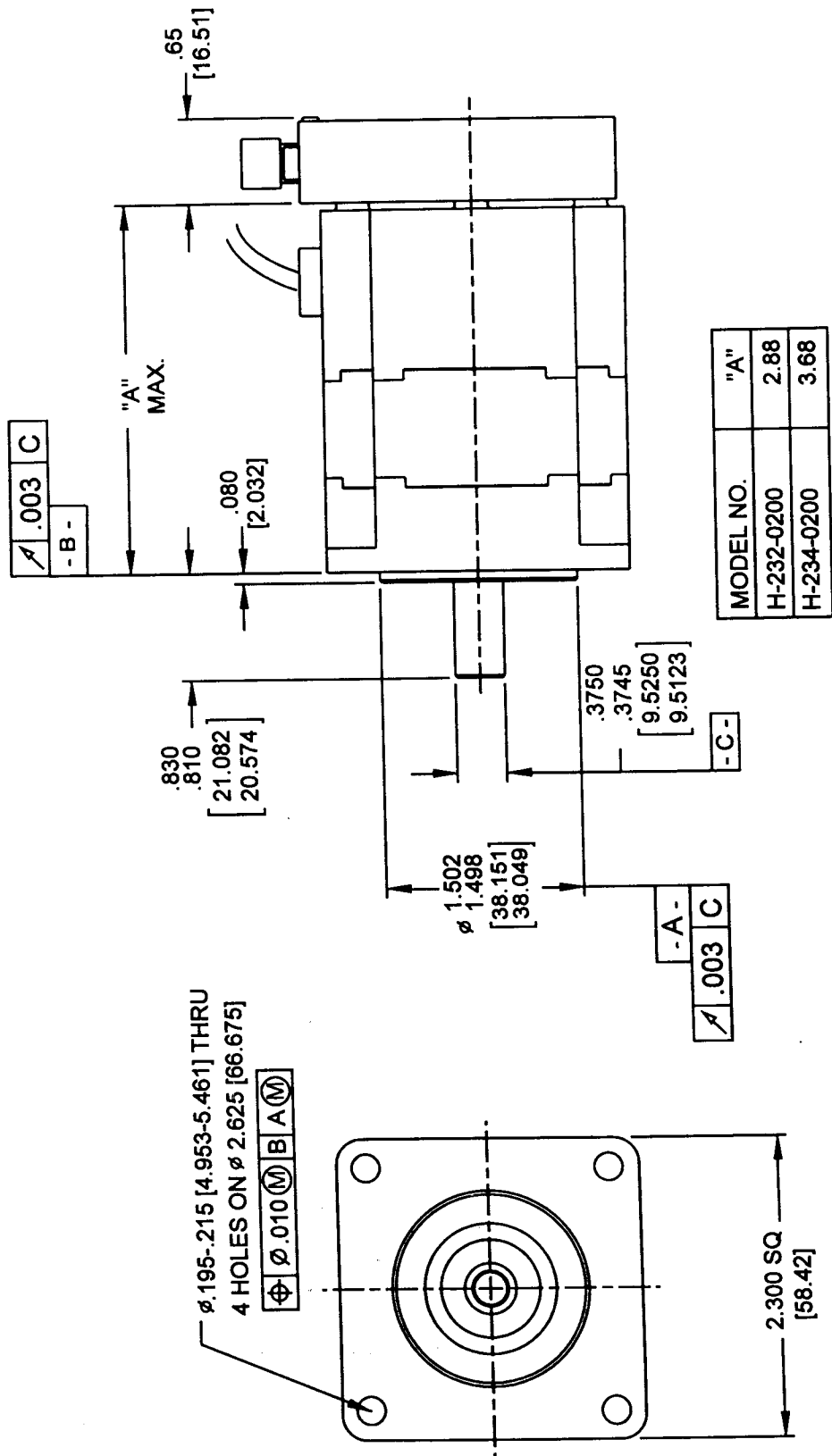


Figure B.5 Size 23 Motor Outline

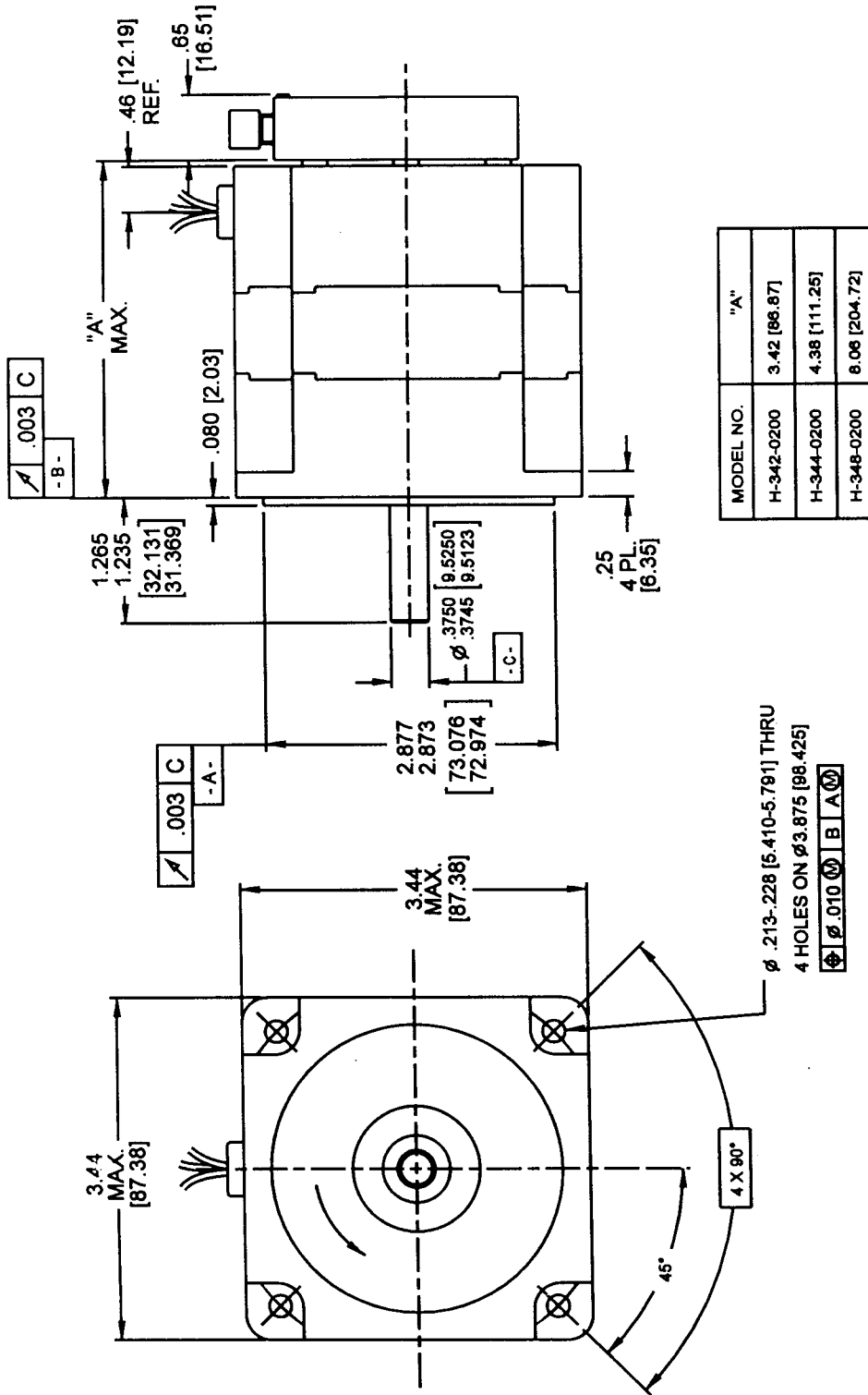


Figure B.6 Size 34 Motor Outline

APPENDIX C

CUSTOMER SUPPORT

Kollmorgen is committed to quality customer service. Our goal is to provide the customer with information and resources as soon as they are needed. This one number provides order status and delivery information, product information and literature, and application and field technical assistance.

Note: If you are unaware of your local sales representative, please contact us at the number below . Visit our web site for MotionLink software upgrades, technical articles, and the most recent version of our product manuals.

Kollmorgen Customer Support Network

203 Rock Road Suite A

Radford, VA 24141

Phone: (888) 774-KCSN (5276)

Fax: (540) 639-1640 Inside Sales

Fax: (540) 639-1574 Technical Support

Email: servo@Kollmorgen.com

Http://www.Kollmorgen.com

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