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## Section 1 General Information

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UL and cUL are registered trademarks of Underwriters Laboratories.

### CE Compliance

A custom unit may be required, contact Baldor. Compliance to Directive 89/336/EEC is the responsibility of the system integrator. A control, motor and all system components must have proper shielding, grounding, and filtering as described in MN1383. Please refer to MN1383 for installation techniques for CE compliance. For additional information, refer to Sections 3 and 7 of this manual.

### Limited Warranty

For a period of two (2) years from the date of original purchase, BALDOR will repair or replace without charge controls and accessories which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. This warranty is in lieu of any other warranty or guarantee expressed or implied. BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some states do not allow exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. No liability is assumed for expendable items such as fuses.

Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.

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## **Product Notice**

Intended use:

These drives are intended for use in stationary ground based applications in industrial power installations according to the standards EN60204 and VDE0160. They are designed for machine applications that require variable speed controlled three phase brushless AC motors.

These drives are not intended for use in applications such as:

- Home appliances
- Medical instrumentation
- Mobile vehicles
- Ships
- Airplanes

Unless otherwise specified, this drive is intended for installation in a suitable enclosure. The enclosure must protect the control from exposure to excessive or corrosive moisture, dust and dirt or abnormal ambient temperatures. The exact operating specifications are found in Section 6 of this manual.

The installation, connection and control of drives is a skilled operation, disassembly or repair must not be attempted.

In the event that a control fails to operate correctly, contact the place of purchase for return instructions.

## **Safety Notice:**

This equipment contains high voltages. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.


This equipment may be connected to other machines that have rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

- System documentation must be available at all times.
- Keep non-qualified personnel at a safe distance from this equipment.
- Only qualified personnel familiar with the safe installation, operation and maintenance of this device should attempt start-up or operating procedures.
- Always remove power before making or removing any connections to this control.

### **PRECAUTIONS:**

Classifications of cautionary statements.

 **WARNING:** Indicates a potentially hazardous situation which, if not avoided, could result in injury or death.

 **Caution:** Indicates a potentially hazardous situation which, if not avoided, could result in damage to property.

Continued on next page.

- 
- ⚠ WARNING:** Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Be sure that you are completely familiar with the safe operation of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury.
- ⚠ WARNING:** Be sure all wiring complies with the National Electrical Code and all regional and local codes or CE Compliance. Improper wiring may cause a hazardous condition.
- ⚠ WARNING:** Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that grounds are connected. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Improper operation of control may cause violent motion of the motor shaft and driven equipment. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.
- ⚠ WARNING:** Motor circuit may have high voltage present whenever AC power is applied, even when motor is not rotating. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** If a motor is driven mechanically, it may generate hazardous voltages that are conducted to its power input terminals. The enclosure must be grounded to prevent a possible shock hazard.
- ⚠ WARNING:** When operating a motor with no load coupled to its shaft, remove the shaft key to prevent injury if it were to fly out when the shaft rotates.
- ⚠ WARNING:** The motor shaft will rotate during the autotune procedure. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment.
- ⚠ WARNING:** A DB Resistor may generate enough heat to ignite combustible materials. To avoid fire hazard, keep all combustible materials and flammable vapors away from brake resistors.
- ⚠ WARNING:** The user must provide an external hard-wired emergency stop circuit to disable the control in the event of an emergency.
- ⚠ Caution:** Suitable for use on a circuit capable of delivering not more than the RMS symmetrical short circuit amperes listed here at rated voltage.
- | <u>Horsepower</u> | <u>RMS Symmetrical Amperes</u> |
|-------------------|--------------------------------|
| 1–50              | 5,000                          |
- ⚠ Caution:** To prevent equipment damage, be certain that the input power has correctly sized protective devices installed as well as a power disconnect.

Continued on next page.

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- ⚠ Caution:** Avoid locating control immediately above or beside heat generating equipment, or directly below water or steam pipes.
  - ⚠ Caution:** Avoid locating control in the vicinity of corrosive substances or vapors, metal particles and dust.
  - ⚠ Caution:** For UL installations, do not connect any resolver cable shields to the motor frame. At a minimum, resolver signal integrity will be compromised and damage to the control may result.  
For CE installations, refer to CE guidelines stated in Sections 3 and 7 of this manual.
  - ⚠ Caution:** Do not connect AC power to the control terminals U, V and W. Connecting AC power to these terminals may result in damage to the control.
  - ⚠ Caution:** Baldor recommends not using “Grounded Leg Delta” transformer power leads that may create ground loops and degrade system performance. Instead, we recommend using a four wire Wye.
  - ⚠ Caution:** Logic signals are interruptible signals; these signals are removed when power is removed from the drive.
  - ⚠ Caution:** Controls are intended to be connected to a permanent main power source, not a portable power source. Suitable fusing and circuit protection devices are required.
  - ⚠ Caution:** The safe integration of the drive into a machine system is the responsibility of the machine designer. Be sure to comply with the local safety requirements at the place where the machine is to be used. In Europe this is the Machinery Directive, the ElectroMagnetic Compatibility Directive and the Low Voltage Directive. In the United States this is the National Electrical code and local codes.
  - ⚠ Caution:** Controls must be installed inside an electrical cabinet that provides environmental control and protection. Installation information for the drive is provided in this manual. Motors and controlling devices that connect to the drive should have specifications compatible to the drive.
  - ⚠ Caution:** Violent jamming (stopping) of the motor shaft during operation may damage the motor and control.
  - ⚠ Caution:** Do not tin (solder) exposed wires. Solder contracts over time and may cause loose connections.
  - ⚠ Caution:** Electrical components can be damaged by static electricity. Use ESD (electro-static discharge) procedures when handling this control.
  - ⚠ Caution:** Ensure that resolver or encoder wires are properly connected. Incorrect installation may result in improper rotation or incorrect commutation.
  - ⚠ Caution:** The holes in the top and bottom of the enclosure are for cable clamps. Be sure to use an M4 bolt 12mm in length. Longer bolts may short circuit the electrical components inside the control.

## Section 2

### Product Overview

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<b>Overview</b>	The BSC product is designed to serve the needs of machine designers and manufacturers. Baldor products have both UL and CE approvals.
<b>Motors</b>	Baldor servo controls are compatible with many motors from Baldor and other manufacturers. Motor parameters are provided with the PC software making the setup easy. Baldor compatible motors include: <ul style="list-style-type: none"><li>• BSM-4R / 63A / 80A / 80B Series motors</li><li>• BSM-6R Series motors</li><li>• BSM-4F / 6F / 8F / 90A / 90B Series motors</li></ul>
<b>General Information</b>	The BSC1000/1100 is a resolver based servo control designed to be used with brushless servo motors. The control accepts a standard $\pm 10$ VDC to control brushless servo motors in either a velocity or current (torque) loop. The standard BSC 1100 series includes an internal power supply; the standard BSC 1000 series requires an external supply. Physically, the two units are identical.





## Section 3 Installation

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### Receiving & Inspection

Baldor Controls are thoroughly tested at the factory and carefully packaged for shipment. When you receive your control, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your control.
2. Remove the control from the shipping container and remove all packing materials. The container and packing materials may be retained for future shipment.
3. Verify that the part number of the control you received is the same as the part number listed on your purchase order.
4. Inspect the control for external physical damage that may have been sustained during shipment and report any damage immediately to the commercial carrier that delivered your control.
5. If the control is to be stored for several weeks before use, be sure that it is stored in a location that conforms to published storage humidity and temperature specifications stated in this manual.

### Location Considerations

The location of the control is important. Installation should be in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance of the control.

Several other factors should be carefully evaluated when selecting a location for installation:

1. For effective cooling and maintenance, the control should be mounted on a smooth, non-flammable vertical surface.
2. At least 0.6 inches (15mm) top and bottom clearance must be provided for air flow. Refer to Section 6 for mounting dimensions.
3. **Altitude derating.** Up to 3300 feet (1000 meters) no derating required. Derate the continuous and peak output current by 1.1% for each 330 feet (100 meters) above 3300 feet.
4. **Temperature derating.** From 5°C to 45°C ambient no derating required. Above 45°C, derate the continuous and peak output current by 2.9% per °C above 45°C. Maximum ambient is 55°C.

### Mechanical Installation

Mount the control to the mounting surface. The control must be securely fastened to the mounting surface by the control mounting holes. The location of the mounting holes is shown in Section 6 of this manual.

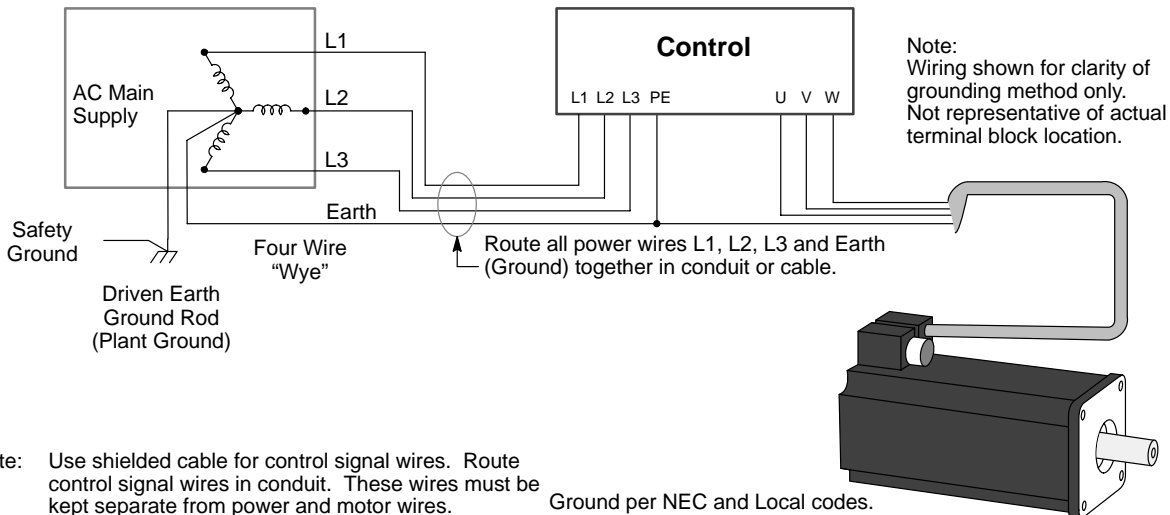
#### Power Loss Ratings

Control Type	1002	1005	1010	1015
Power Loss (Watts) (For BSC11XX units, add 55Watts)	19	19	54	85

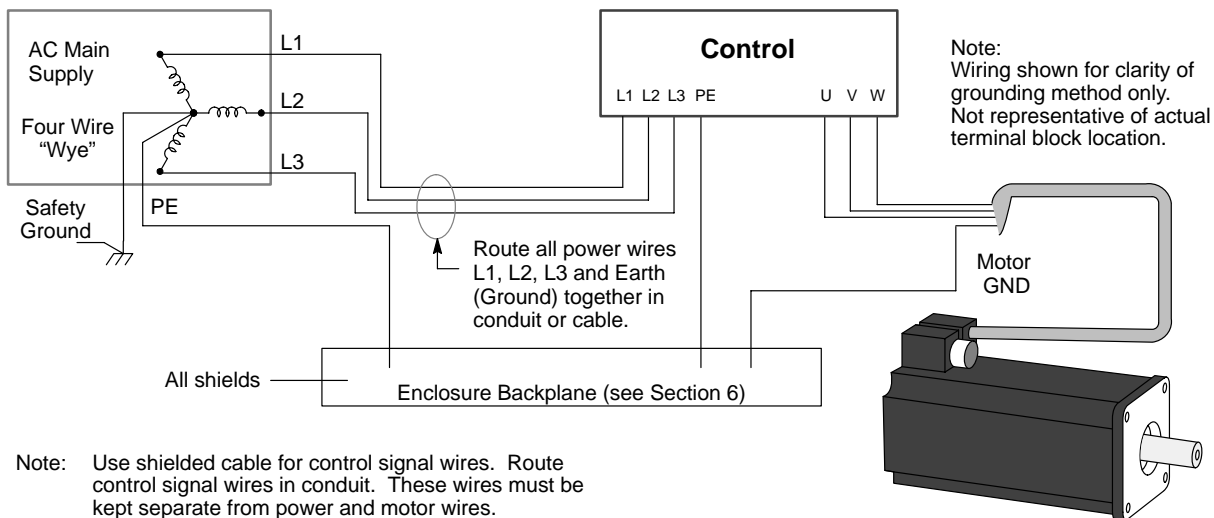
**Electrical Installation** All interconnection wires between the control, AC power source, motor, host control and any operator interface stations should be in metal conduits. Use listed closed loop connectors that are of appropriate size for wire gauge being used. Connectors are to be installed using crimp tool specified by the manufacturer of the connector. Only class 1 wiring should be used.

**System Grounding** Baldor controls are designed to be powered from standard single and three phase lines that are electrically symmetrical with respect to ground. System grounding is an important step in the overall installation to prevent problems. The recommended grounding method is shown in Figure 3-1 for UL compliant systems (Figure 3-2 for CE compliant systems).

**Figure 3-1 Recommended System Grounding (3 phase) for UL**



**Figure 3-2 Recommended System Grounding (3 phase) for CE**



## System Grounding Continued

### Ungrounded Distribution System

With an ungrounded power distribution system it is possible to have a continuous current path to ground through the MOV devices. To avoid equipment damage, an isolation transformer with a grounded secondary is recommended. This provides three phase AC power that is symmetrical with respect to ground.

### Input Power Conditioning

Baldor controls are designed for direct connection to standard single and three phase lines that are electrically symmetrical with respect to ground. Certain power line conditions must be avoided. An AC line reactor or an isolation transformer may be required for some power conditions.

- If the feeder or branch circuit that provides power to the control has permanently connected power factor correction capacitors, an input AC line reactor or an isolation transformer must be connected between the power factor correction capacitors and the control.
- If the feeder or branch circuit that provides power to the control has power factor correction capacitors that are switched on line and off line, the capacitors must not be switched while the control is connected to the AC power line. If the capacitors are switched on line while the control is still connected to the AC power line, additional protection is required. TVSS (Transient Voltage Surge Suppressor) of the proper rating must be installed between the AC line reactor or an isolation transformer and the AC input to the control.

**Power Disconnect** A power disconnect should be installed between the input power service and the control for a fail-safe method to disconnect power. The control will remain in a powered-up condition until all input power is removed from the control and the internal bus voltage is depleted.

**Protection Devices** The control must have a suitable input power protection device installed. Input and output wire size is based on the use of copper conductor wire rated at 75 °C. Table 3-1 describes the wire size to be used for power connections and the ratings of the protection devices.

**Table 3-1 Wire Size and Protection Devices**

Catalog Number	Incoming Power				
	Nominal Input Voltage	Continuous Output Amps (RMS)	Input Fuse (A)	Wire Gauge	
				AWG (USA)	mm <sup>2</sup> (Europe)
BSC1002 <sup>†</sup>	–	2	6	14	2.5
BSC1102	115V (3 $\phi$ )	2	6	14	2.5
BSC1105-1	115V (1 $\phi$ )	5	10	14	2.5
BSC1005 <sup>†</sup>	–	5	10	14	2.5
BSC1105	230V (3 $\phi$ )	5	10	14	2.5
BSC1110-1	115V (1 $\phi$ )	10	20	12	2.5
BSC1010 <sup>†</sup>	–	10	20	12	2.5
BSC1110	230V (3 $\phi$ )	10	20	12	2.5
BSC1115-1	115V (1 $\phi$ )	15	30	10	5.26
BSC1015 <sup>†</sup>	–	15	30	10	5.26
BSC1115	230V (3 $\phi$ )	15	30	10	5.26

Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 25°C ambient, maximum continuous control output current and no harmonic current.

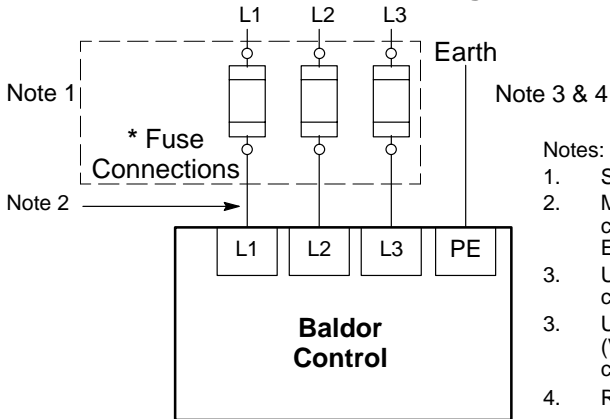
<sup>†</sup> Requires separate DC Bus input voltage. No AC input or internal power supply available in this model.

**AC Power Connections** The location of the X7 connector is shown in Figure 3-6.

Each BSC control must be fused separately. All interconnection wires between the control, AC power source, motor and any operator interface stations should be in metal conduits. Only class 1 wiring should be used.

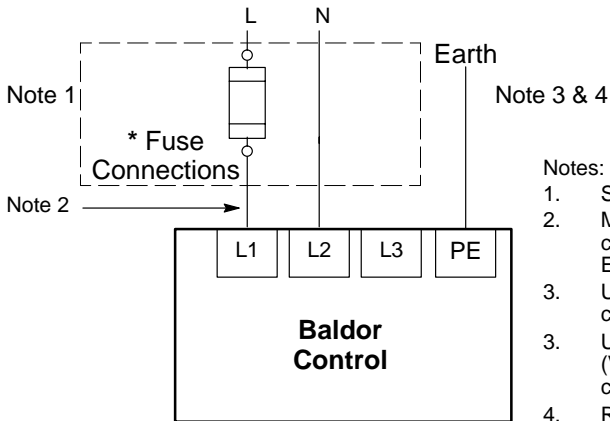
Wire and Fuses should be of the correct size specified in Table 3-1. Connect the AC power connections as shown in Figures 3-3 (three phase) or 3-4 (single phase). For single phase installations, do not connect any wires to L3.

**Figure 3-3 3 Phase Power Connections**



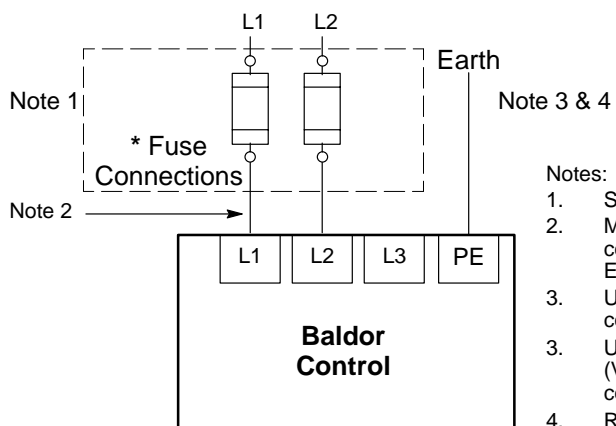
- Notes: \* Components not provided with Control.
1. See Protection Device description in this section.
  2. Metal conduit or shielded cable should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
  3. Use the same gauge wire for Earth as used for L1, L2, L3 connections.
  3. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm<sup>2</sup> minimum). For CE compliance, connect "PE" to the backplane of the enclosure.
  4. Reference EMC wiring in Section 7.

**Figure 3-4 Single Phase Power Connections (115V 1 $\phi$  only)**



- Notes: \* Components not provided with Control.
1. See Protection Device description in this section.
  2. Metal conduit or shielded cable should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
  3. Use the same gauge wire for Earth as used for L1 and L2 connections.
  3. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm<sup>2</sup> minimum). For CE compliance, connect "PE" to the backplane of the enclosure.
  4. Reference EMC wiring in Section 7.

**Figure 3-5 Single Phase Power Connections (230V 1 $\phi$  only)**

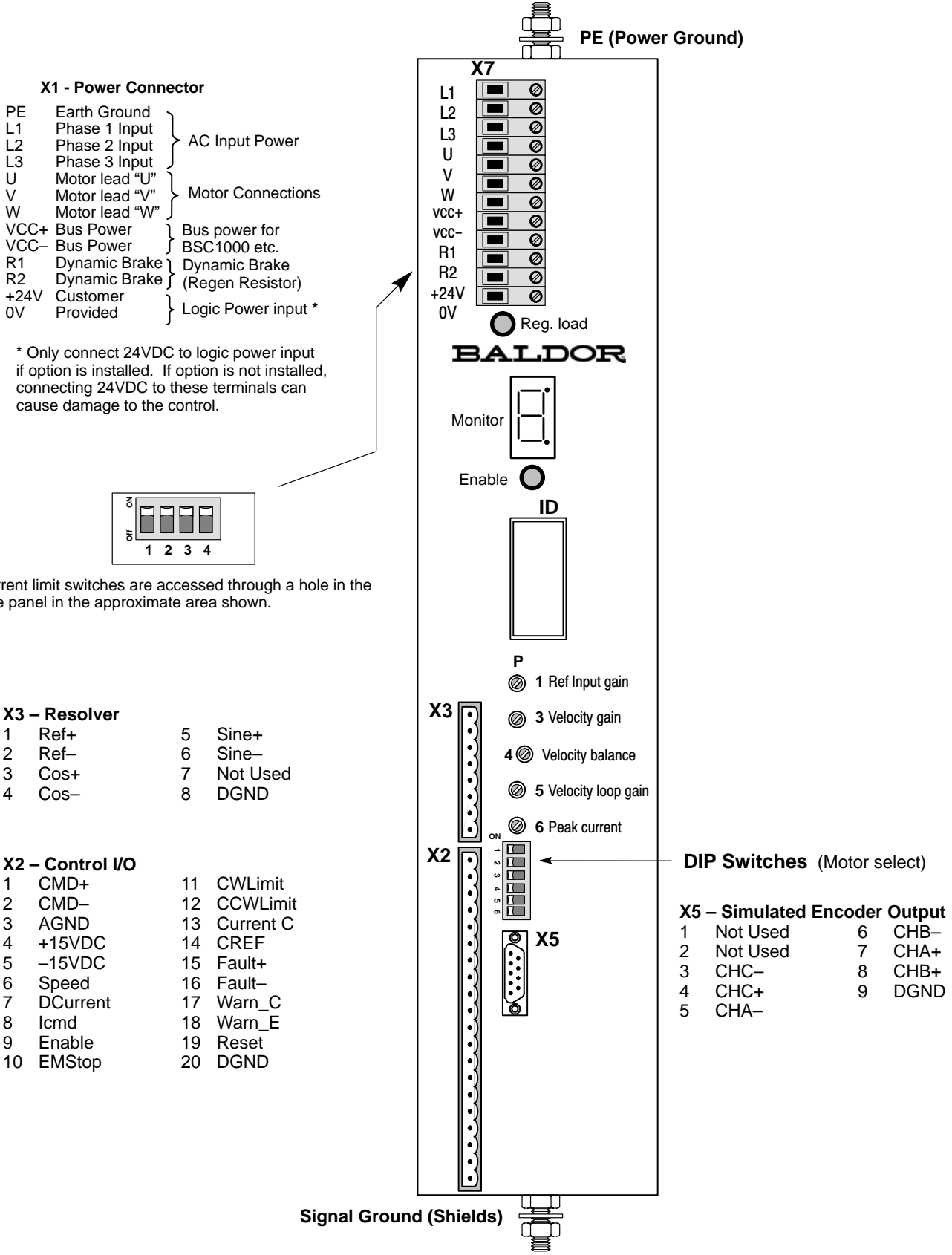


\* Components not provided with Control.

Notes:

1. See Protection Device description in this section.
2. Metal conduit or shielded cable should be used. Connect conduits so the use of a Reactor or RC Device does not interrupt EMI/RFI shielding.
3. Use the same gauge wire for Earth as used for L1 and L2 connections.
3. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm<sup>2</sup> minimum). For CE compliance, connect "PE" to the backplane of the enclosure.
4. Reference EMC wiring in Section 7.

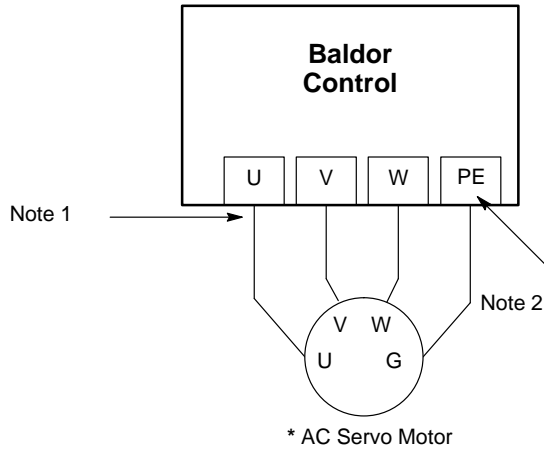
**Figure 3-6 Connector Locations**



## Motor Connections

Motor connections are shown in Figure 3-7. (Connections U, V and W are shown in Figure 3-6). If connected wrong, erratic operation including moves at peak force may occur until the overcurrent limit trips. If erratic movement of the motor occurs, turn off power immediately and check the connections of the motor.

**Figure 3-7 Motor Connections for U.L.**

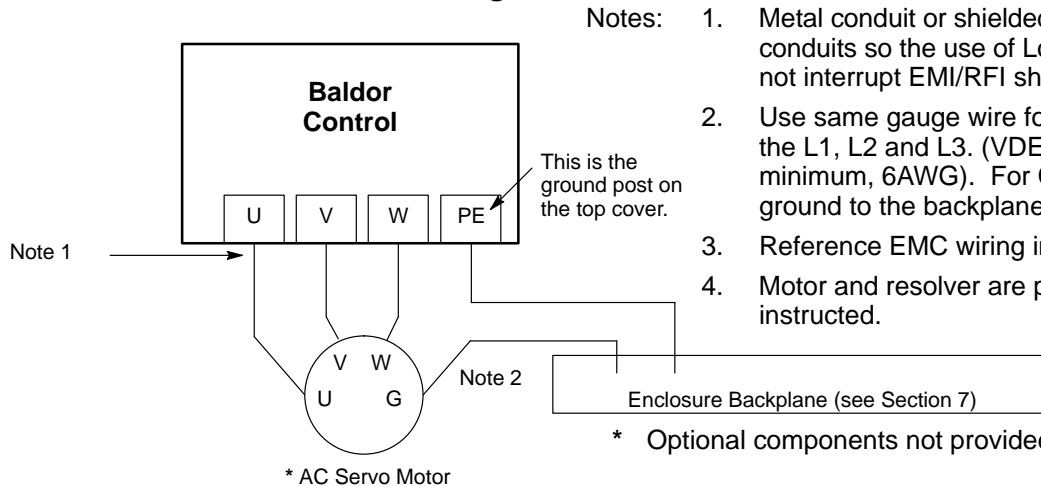


- Notes:
1. Metal conduit or shielded cable should be used. Connect conduits so the use of Load Reactor\* or RC Device\* does not interrupt EMI/RFI shielding.
  2. Use same gauge wire for Earth ground as is used for the L1, L2 and L3. (VDE (Germany) requires 10mm<sup>2</sup> minimum, 6AWG). For CE compliance, connect motor ground to the backplane of the enclosure.
  3. Reference EMC wiring in Section 7.
  4. Motor and resolver are phase sensitive. Connect only as instructed.

This is the ground post on the top cover.

\* Optional components not provided with control.

**Figure 3-8 Motor Connections for CE**



- Notes:
1. Metal conduit or shielded cable should be used. Connect conduits so the use of Load Reactor\* or RC Device\* does not interrupt EMI/RFI shielding.
  2. Use same gauge wire for Earth ground as is used for the L1, L2 and L3. (VDE (Germany) requires 10mm<sup>2</sup> minimum, 6AWG). For CE compliance, connect motor ground to the backplane of the enclosure.
  3. Reference EMC wiring in Section 7.
  4. Motor and resolver are phase sensitive. Connect only as instructed.

\* Optional components not provided with control.

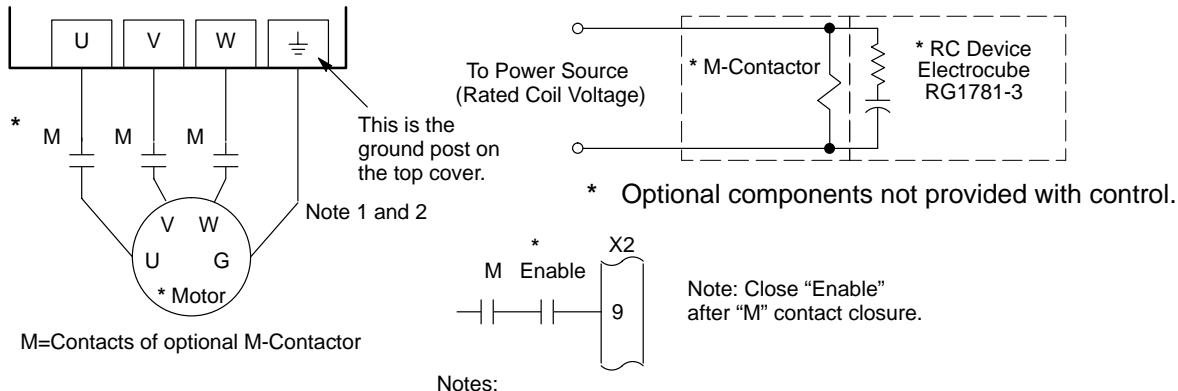
Note: For CE compliant installations, connect unused leads within the motor cable to "PE" on both ends of the cable.



## M-Contactor

If required by local codes or for safety reasons, an M-Contactor (motor circuit contactor) may be installed. However, incorrect installation or failure of the M-contactor or wiring may damage the control. If an M-Contactor is installed, the control must be disabled for at least 20msec before the M-Contactor is opened or the control may be damaged. M-Contactor connections are shown in Figure 3-9.

**Figure 3-9 Optional M-Contactor Connections**

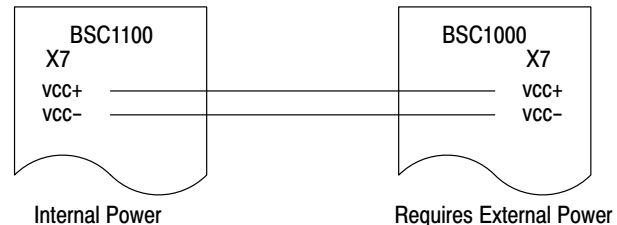


## BUS Power

For multi-axis applications, the second control may not have an internal supply. Bus power for the second control can be connected as shown in Figure 3-10.

**Figure 3-10**

A control with an internal supply can provide bus power to a maximum of one control that requires an external power source. Simply connect the X7 VCC+ of the first control to the VCC+ of the second control. Then connect the X7 VCC- of the first control to the VCC- of the second control.



**Dynamic Brake Resistor** An external DB (dynamic brake or regen resistor) resistor is required to dissipate excess power from the DC bus during motor deceleration operations. An external 320 watt resistor must be connected at the X7 terminals R1 and R2. Refer to Section 6 for selection information or contact Baldor.

## 24VDC Logic Power

If the control is equipped with the internal 24VDC logic power circuit (BSC1XXX-24-X), 24VDC may be connected to this input to maintain voltage on the logic circuits at all times. An external 24VDC (20V to 60V source) supply must be used. This supply must remain on when AC power to the control is disconnected. Connect the power supply leads to X7 input terminals +24V and 0V.

Note: All units are marked 24V and 0V. Do not connect an external 24VDC source to these terminals unless the control is equipped with the internal 24VDC logic power circuit (BSC1XXX-24-X).

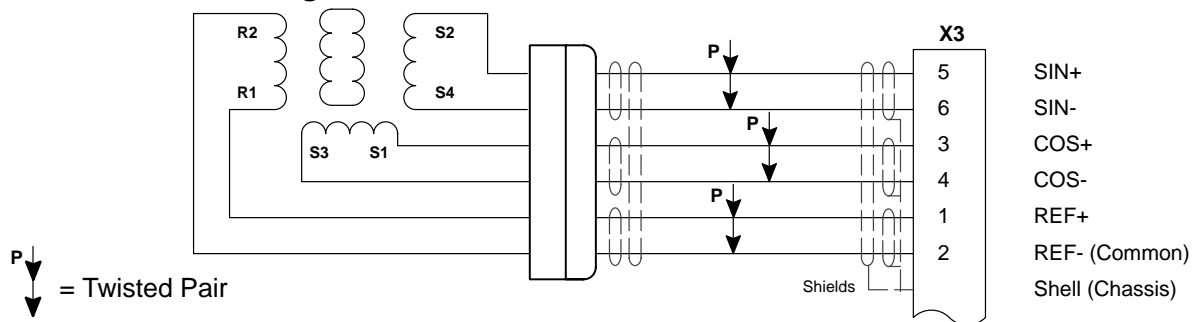
## Resolver Feedback

The resolver connections are made at the X3 connector as shown in Figure 3-11 or 3-12. The resolver cable must be shielded twisted pair #22 AWG (0.34mm<sup>2</sup>) wire minimum. The cable must also have an overall shield. Maximum wire-to-wire or wire-to-shield capacitance is 50pf per foot.

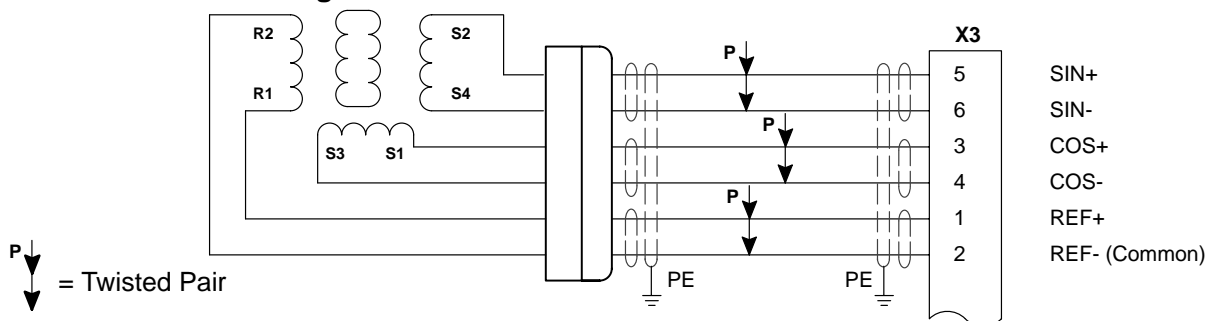
Resolver wiring must be separated from power wiring. Separate parallel runs of resolver and power cables by at least 3". Cross power wires at right angles only. Insulate or tape ungrounded end of shields to prevent contact with other conductors or ground.

Note: Motor and resolver are phase sensitive. Connect only as instructed.

**Figure 3-11 Resolver Cable Connections for UL Installations**



**Figure 3-12 Resolver Cable Connections for CE Installations**



## Simulated Encoder Output

The control provides a simulated encoder output at connector X5. This output may be used by external hardware to monitor the encoder signals. It is recommended that this output only drive one circuit load. Refer to Table 3-2.

**Table 3-2 Simulated Encoder Output at X5 Connector**

X5 Pin	Signal Name
1	Not Used
2	Not Used
3	CHC-
4	CHC+
5	CHA-
6	CHB-
7	CHA+
8	CHB+
9	DGND
Shell	* Chassis (Cable Shield)

\* For UL Installations ONLY. For CE Installations, connect the outer shield on each end of the cable to the signal ground (shields) at the bottom of the control.

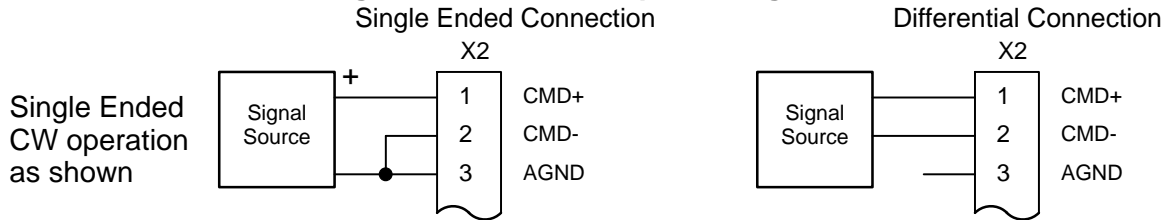
**X2 Control I/O Connections** 18AWG wire is sufficient for all X2 connections.

**Analog I/O**

**Command Input**

X3 pins 1, 2 and 3 allows connection of an external analog command input. This input can accept a 0-10VDC or  $\pm 10$ VDC signal and can be wired as a single ended or differential input, shown in Figure 3-13.

**Figure 3-13 Control Input Wiring**



**15VDC Output**

X2 pins 4 and 5 provide 15VDC output @100mA maximum. (X2-3 is common).

**Speed Output**

X2 pins 6 provides a motor velocity test point. (X2-3 is common).  
Motor RPM = VDC X 600

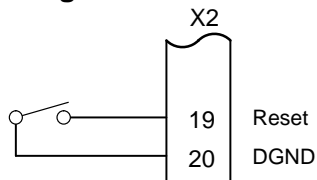
**Output Current**

X2 pins 7 provides a test point to measure actual motor current. (X2-3 is common).  
Scaled 0 to 10VDC (where 10VDC =  $I_{peak}$ )

**Icmd**

X2 pins 7 provides a test point to measure commanded motor current. (X2-3 is common).  
Scaled  $\pm 10$ VDC (where  $\pm 10$ VDC =  $I_{peak}$ )

**Figure 3-14 Reset Wiring**



Close X2-19 to reset an over voltage, under voltage, over current, over temperature, resolver fault or electronic fusing ( $I^2T$ ) fault.

## Digital I/O

### X2 Digital Inputs - (uses CREF, X2-14)

**Active High (Sourcing)** - If pin X2-14 is grounded, an input is active when it is at +24VDC (+12VDC to +30VDC).

**Active Low (Sinking)** - If pin X2-14 is at +24VDC (+12VDC to +30VDC), an input is active when it is grounded.

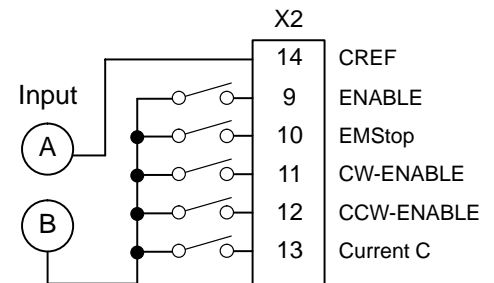
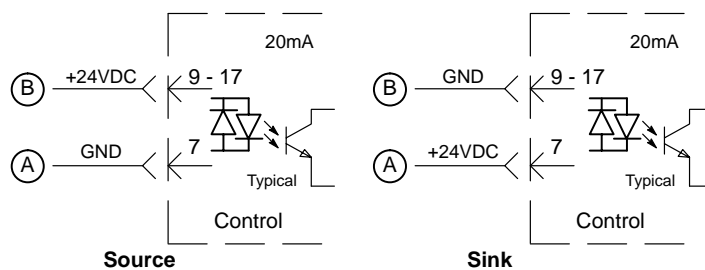
Logic input connections are made at terminal strip X2. Input connections can be wired as active High or active Low as shown in Figure 3-15. X2 pin 14 is the Control Reference point (CREF) for the Isolated Input signals.

Note: An internal 24VDC power supply connection is not available from the control to power the Input circuits. A customer provided external power source must be used as indicated in Figure 3-15.

**Figure 3-15 Active HIGH /LOW Relationship**

Active Low (Sink)	Active High (Source)	Input
+24VDC	GND	A
GND	+24VDC	B

Note: All inputs are referenced to CREF, X2-14.



**Table 3-1 Digital Input Signal Conditions**

Pin Number	Signal Name	Switch = Closed (active)	Switch = Open (not active)
X2-9	Enable	Drive enabled.	Drive disabled.
X2-10	EMStop (Emergency Stop)	Motor enabled.	Motor disabled.
X2-11	CW-Enable	Clockwise rotation enabled.	Clockwise rotation disabled.
X2-12	CCW-Enable	Counter-clockwise rotation enabled.	Counter-clockwise rotation disabled.
X2-13	Current C (Torque/Velocity)	Current mode (Torque).	Velocity mode.

Current C Use Current mode (X2-13 Closed) for positioning applications.  
Use Velocity mode (X2-13 Open) for speed control applications.

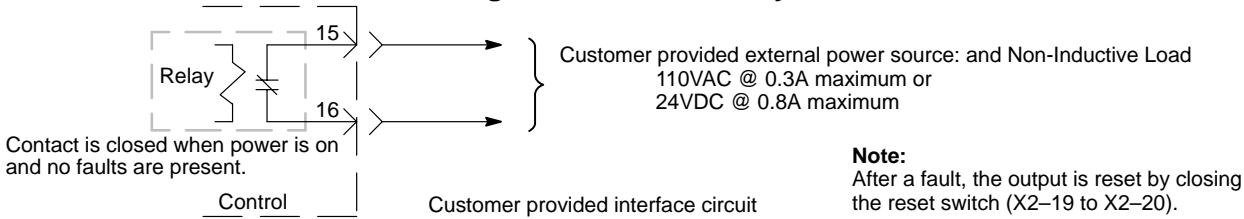
### Signal Name Digital Input Signal Definition

<b>Enable</b>	CLOSED allows normal operation. OPEN disables the control and motor coasts to a stop.
<b>EMStop</b>	CLOSED allows normal operation. OPEN commands zero velocity and motor coasts to a stop.
<b>CW-Enable</b>	CLOSED allows normal operation in the CW direction. OPEN to disable CW rotation. The motor decels to a stop.
<b>CCW-Enable</b>	CLOSED allows normal operation in the CCW direction. OPEN to disable CCW rotation. The motor decels to a stop.
<b>Current C</b>	CLOSED current mode operation is enabled. OPEN velocity mode operation is enabled.

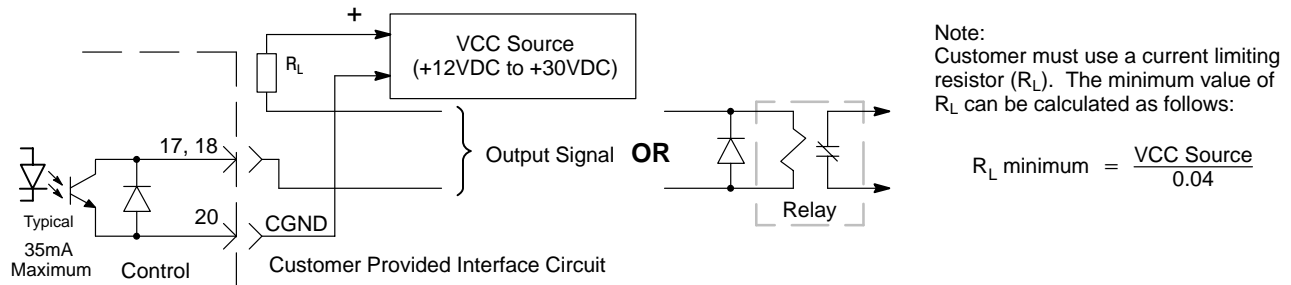
## X2 Digital Outputs

The control outputs are located on the X2 connector. A customer provided, external power supply must be used if digital outputs are to be used. The outputs provide status information and are not required for operation.

**Figure 3-16 Fault Relay Connections**



**Figure 3-17 Warning “C” and “E” Output Connections**



**Table 3-2 Output Signal Conditions**

Pin Number	Signal Name	Switch = Closed (active)	Switch = Open (not active)
X2-15	Fault +	Drive OK - no faults detected.	Fault is detected.
X2-16	Fault -	Drive OK - no faults detected.	Fault is detected.
X2-17	WarnC	No Overcurrent fault detected.	I <sup>2</sup> T Overcurrent condition is detected.
X2-18	WarnE	No Over temperature fault detected.	Over temperature condition is detected.

**Fault Relay** A normally closed relay contact that opens if a fault occurs. The contact is rated: 24VDC @ 0.8A maximum or 110VAC @ 0.3A maximum.

**WarnC** Over Current limit (I<sup>2</sup>T electronic fusing warning). Output can be connected to an external alarm circuit. Each output is rated 30VDC @ 35mA maximum.

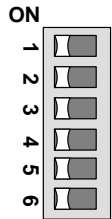
**WarnE** Overtemperature warning. Output can be connected to an external alarm circuit. This output is rated 30VDC @ 35mA maximum.

## Section 4 Switch Setting and Start-Up

**Introduction** These procedures are performed with the power off. Do not apply power until you are instructed to do so. This means AC power and 24VDC Logic power must both be disconnected.

**DIP Switch Settings** (Refer to Section 3 for location)

**Motor Select** (on front panel)



Six DIP switches are located on the front panel. Refer to Table 4-1 to determine the correct setting of these switches.

Note: All switches are shown in the "ON" position.

**Table 4-1 Control Address Setting**

Switch						Description
1	2	3	4	5	6	
ON	OFF	OFF				For motors BSM 4R / 63A / 80A / 80B
OFF	ON	OFF				For motor BSM 6R
ON	ON	OFF				For motors BSM 4F / 6F / 8F / 90A / 90B
			OFF	OFF		Encoder Simulation of 1024 Pulse per Revolution
			ON	OFF		Encoder Simulation of 1000 Pulse per Revolution
			OFF	ON		Encoder Simulation of 500 Pulse per Revolution
			ON	ON		Encoder Simulation of 250 Pulse per Revolution
					OFF	Off = Integral part of the velocity loop is active.
					ON	On = Proportional loop only (no integral part).

**Current Limit** (on side panel)



Current limit switches are accessed through a hole in the side panel. These switches reduce both the continuous and peak current by the same ratio.

**Table 4-2 Current Limit Setting**

Switch				Description
1	2	3	4	
OFF	OFF	OFF	OFF	25% of full rated output current
ON	ON	OFF	OFF	50% of full rated output current
OFF	OFF	ON	ON	75% of full rated output current
ON	ON	ON	ON	100% of full rated output current

**Potentiometer Initial Settings**

The potentiometers must be pre-set. Refer to Section 3 for location. Set the potentiometers to the pre-set positions indicated in Table 4-3.

**Table 4-3 Potentiometer Initial Preset Positions**

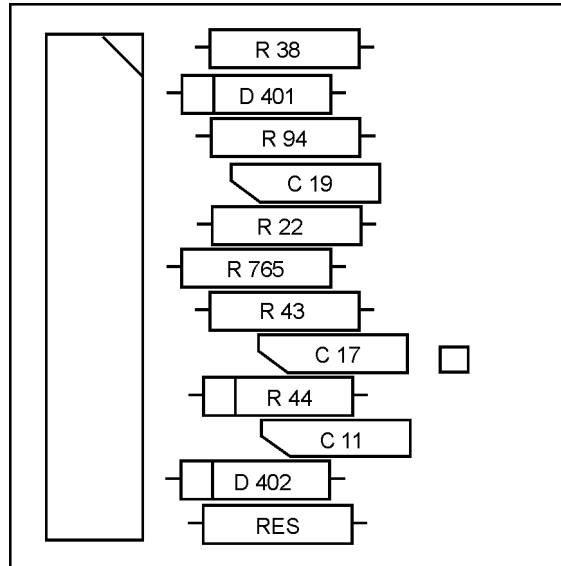
Potentiometer	Function	Initial Setting (Factory settings)
P1	Reference Input Gain	CW for maximum input gain
P3	Velocity Feedback Gain	CW for maximum gain
P4	Velocity Balance (Drift Adjustment)	Standstill at zero point command
P5	Velocity Loop Gain (Prop Gain)	CCW for minimum gain
P6	Peak Current	CCW for reduced current

## Identity Module

The Identity Module must be fully inserted into its socket to allow control operation. Several components are mounted on this module. Refer to Figure for their location and to Table 4-4 for their description.

Note: If the Identity Module is not completely inserted, the unit will not operate.

**Figure 4-1 Identity Module Component Locations**



**Table 4-4 Identity Module Component Descriptions**

Component	Description	Factory Value
R38	Speed Scaling (4000 RPM) <sup>[1]</sup>	4.99 kΩ
D401	Plug-in protection	–
R94	P-gain for velocity loop	100 kΩ
C19	I-gain for velocity loop	47 nF
R22	I <sup>2</sup> T-switching threshold (nom. current) <sup>[2]</sup>	–
R765	Special function	26.7 kΩ
R43	P-gain for current loop phase U	150 kΩ
C17	I-gain for current loop phase U	4.7 nF
R44	P-gain for current loop phase V	150 kΩ
C11	I-gain for current loop phase V	4.7 nF
D402	Plug-in protection	–
RES	Reserved for special applications	–

- <sup>[1]</sup> R38 is used to set the maximum speed of the control/motor combination. The standard factory value is a 4.99 kΩ resistor for 4000 RPM. If the motor's maximum speed for a given application is not 4000 RPM, this resistor should be replaced with one of the following resistor values below depending on the maximum required speed:
- 0 Ω for 6000 RPM
  - 4.99 kΩ for 4000 RPM
  - 10 kΩ for 3000 RPM
  - 20 kΩ for 2000 RPM
- Contact Baldor for applications over 6000 RPM.
- <sup>[2]</sup> R22 is used to limit the continuous current of the control (without affecting peak current). The standard factory arrangement is to not insert R22. If an I<sup>2</sup>T limit is desired, the value of R22 can be determined from Table 4-5.

**Table 4-5 Current Limit Value Determination**

Value of R22 Ohms	BSC 1002/1102 $I_{peak} = 4A$	BSC 1005/1105 $I_{peak} = 10A$	BSC 1010/1110 $I_{peak} = 20A$	BSC 1015/1115 $I_{peak} = 30A$
Open ( $\infty$ )	$I_{cont} = 2.0A$	$I_{cont} = 5.0A$	$I_{cont} = 10.0A$	$I_{cont} = 15.0A$
20k $\Omega$	$I_{cont} = 1.6A$	$I_{cont} = 4.0A$	$I_{cont} = 8.0A$	$I_{cont} = 12.0A$
10k $\Omega$	$I_{cont} = 1.3A$	$I_{cont} = 3.3A$	$I_{cont} = 6.7A$	$I_{cont} = 10.0A$
5k $\Omega$	$I_{cont} = 1.0A$	$I_{cont} = 2.5A$	$I_{cont} = 5.0A$	$I_{cont} = 7.5A$

**Start-up Procedure**

**Power Off Checks**

Before you apply power, it is very important to verify the following:

1. Disconnect the load from the motor shaft until instructed to apply a load. If this cannot be done, disconnect the motor wires at X7-U, V and W.
2. Verify that switches are set correctly.
3. Verify the AC line voltage at the source matches the control rated voltage.
4. Inspect all power connections for accuracy, workmanship and tightness.
5. Verify that all wiring conforms to applicable codes.
6. Verify that the control and motor are properly grounded to earth ground.
7. Check all signal wiring for accuracy.

**Power On Checks**

If using a transformer, switch the primary side only, and check that the secondary voltage is 115 VAC for single phase units and between 115 VAC and 230 VAC for three phase units.

1. Temporarily disconnect the input speed command signal ( $\pm 10$  VDC) from the Control Signal Connector X2 inputs CMD + (pin 1) and CMD – (pin 2) and jumper the CMD + and CMD – inputs together.
2. Switch on the main power. The motor may run away “out of control” if the resolver wires are connected incorrectly. Turn power off immediately and check resolver wires. If the motor shaft rotates in the wrong direction, check the wiring of the motor and the resolver. Turn power on.
3. Verify that the “READY” LED is green, and the Status Monitor LED display on the front panel shows a decimal point on the bottom right. This verifies that power is applied, and the unit is enabled. If the motor is slowly rotating, adjust the Velocity Balance pot P4 for no rotation.
4. Adjust P6 Peak Current CW (clockwise), and verify that the motor has holding torque. If the motor has no holding torque, make sure that the Identity Module is fully inserted, and check the wiring of the Control Signal Connector X2 pins: CW limit (pin 11), CCW limit (pin 12), ENABLE (pin 9), EMStop (pin 10). If the motor runs away or if Error 5 or 7 is displayed on the Status Monitor, switch off the main power immediately and check the resolver and motor wiring.
5. Again, switch off the main power, and reconnect the input speed command signal ( $\pm 10$  VDC) to the CMD + and CMD – inputs. Switch on the main power and apply a small input speed command (5V or less is suggested). Positive command voltage will cause CW shaft rotation and negative command voltage will cause CCW (counterclockwise) shaft rotation.

Note: When using single ended input, positive voltage input to CMD + causes CW shaft rotation, and positive voltage input to CMD – causes CCW shaft rotation.



## Adjustment Procedure

The following procedure yields proper potentiometer adjustment for optimum servo control operation. For best results, read the entire procedure before making adjustments.

1. Apply a signal input command between 0 and 10 VDC at the Control Signal Connector X2 inputs CMD + (pin 1) and CMD – (pin 2). +5 VDC (for CW shaft rotation) or –5 VDC (for CCW shaft rotation) is suggested. If the motor shaft rotates in the wrong direction for a given polarity of the signal input voltage, check the wiring of the motor and resolver. If the shaft still rotates in the wrong direction, reverse the CMD + and CMD – inputs.

Note: When using single-ended input, positive voltage input to CMD + causes CW shaft rotation, and positive voltage input to CMD – causes CCW shaft rotation.

2. Slowly turn the Peak Current (P6) pot 1/4 turn CW, observing that the motor shaft speed may increase and stabilize.
3. If connected, verify that the CW and CCW limit switches properly inhibit the machine travel in the direction defined.
4. If the motor shaft drifts, or rotates when sent a zero velocity (“don’t move”) command, slowly adjust the Velocity Balance (P4) pot to eliminate any motor shaft rotation.

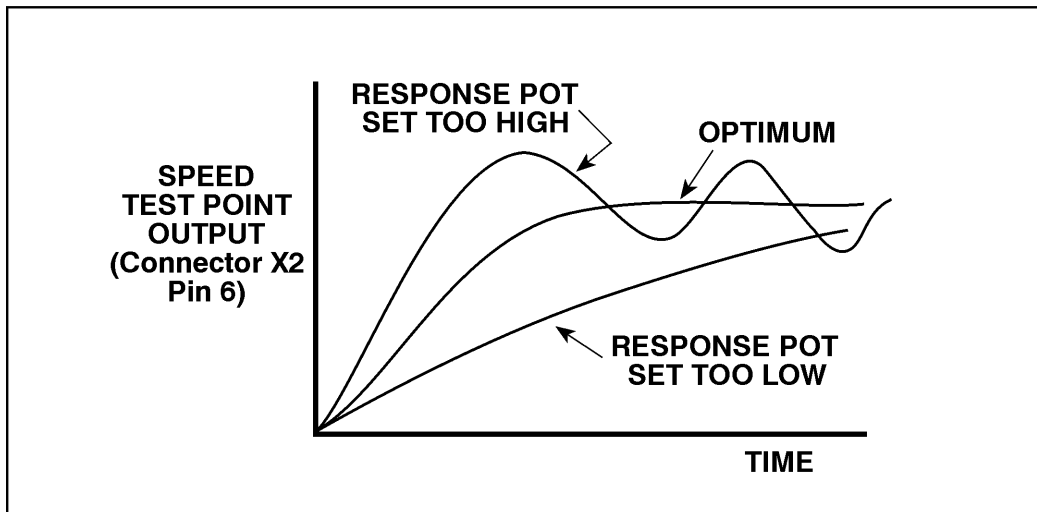
Note: The setting of potentiometers P1 and P3 must allow the control to reach the maximum velocity for the command input before P5 can be correctly adjusted. Begin with both P1 and P3 set fully CW.

5. The adjustment of the Velocity Loop Gain (P5) pot may be accomplished by either of two methods:
  - a. Slowly turn the Velocity Loop Gain pot CW until the axis becomes unstable and then turn the pot back 1/8 turn CCW.
  - b. Using a step input command with an amplitude of 10% of full desired speed and a suggested duration of 1 second on/1 second off, adjust the Velocity Loop Gain pot CW while monitoring the speed test point signal (Control Signal Connector X2 pin 6) on a scope until the desired response is obtained. Refer to Figure 4-2 for typical responses.

Note: If the servo control is unstable at all pot settings there is probably a mechanical resonance.

6. If the motor shaft overshoots when stopping, turn the Tacho Gain (P3) pot CCW, being careful not to turn to full CCW. Full CCW on the Tacho Gain pot may cause the motor shaft speed to become uncontrollable.
7. The Input Gain (P1) pot can now be used to “fine tune” and optimize the maximum response for the given signal input voltage range. Note that steps 4 thru 6 may have to be repeated.

**Figure 4-2 Typical Response**



# Section 5 Troubleshooting

## Overview

The BSC Control requires very little maintenance and should provide years of trouble free operation when installed and applied correctly. Occasional visual inspection and cleaning should be considered to ensure tight wiring connections and to remove dust, dirt, or foreign debris which can reduce heat dissipation.

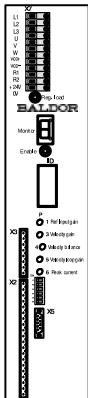
Operational failures called "Faults" will be displayed as they occur. A comprehensive list of these faults, their meaning and related information is provided in this section.

Before attempting to service this equipment, all input power should be removed to avoid the possibility of electrical shock. The servicing of this equipment should be handled by a qualified electrical service technician experienced in the area of high power electronics.

It is important to familiarize yourself with the following information before attempting any troubleshooting or service of the control. Most troubleshooting can be performed using only a digital voltmeter having an input impedance exceeding 1 megohm. In some cases, an oscilloscope with 5 MHz minimum bandwidth may be useful. Before consulting the factory, check that all power and control wiring is correct and installed per the recommendations given in this manual.

## BPS Troubleshooting Procedure

### BPS LEDs' Display Identification



The system troubleshooting procedures involves observing the status of the "Enable" LED, the "Reg. Load" LED and the "Monitor" 7 segment display. Table 5-1 provides information related to the indications provided by these devices.

**Table 5-1 Status and Fault Indications**

Enable	Monitor	Status
OFF	OFF	BSC is powered off
Green	Decimal Point	Normal operation, Control enabled and no faults
Red	1	Bus overvoltage
Red	2	Bus undervoltage
Red	3	Over current
Red	4	Overtemperature
Red	5	Resolver fault
Red	6	Electronic fusing
Green	7	I <sup>2</sup> T warning. After 2–3 seconds, control switches off then monitor displays "6"

### "Reg. Load" LED

The Reg Load LED is located on the panel. The Reg Load LED is on (green) whenever DB (Dynamic Brake) power is dissipated into the DB resistor. The DB resistor is also called a Regen resistor.

**Table 5-2 Troubleshooting Information**

Symptom	Corrective Action
Decimal point does not appear.	Make sure that power is applied to the unit. Check wiring and polarity of the ENABLE line (Connector X2, pin 9, pin 14). Make sure Identity Module (ID) is fully inserted. (Remove power, remove ID module, Re-insert ID module, apply power)
Motor shaft accelerates when main power is switched on.	Check wiring of the Resolver (Connector X3).
Motor has no holding torque.	Make sure Identity Module (ID) is fully inserted. (Remove power, remove ID module, re-insert ID module, apply power). Check the wiring and polarity of the Connector X2 pins: CW limit (pin 11) CCW limit (pin 12) ENABLE (pin 9) EMStop (pin 10) Reference (pin 14)
Motor does not reach rated speed.	Check Motor Voltage Phase connections (Connector X3 terminals U2, V2, W2). Refer to Section 3 (Identity Module) to check the value of R38 on the Identity Module (ID). Refer to Table 4-1 and Table 4-2 to check the DIP Switch settings. Check that potentiometers P1 and P3 are set to allow the control to reach the maximum velocity for the command input.
Monitor displays a 1 during deceleration.	Increase decel time or add a Regeneration Resistor.

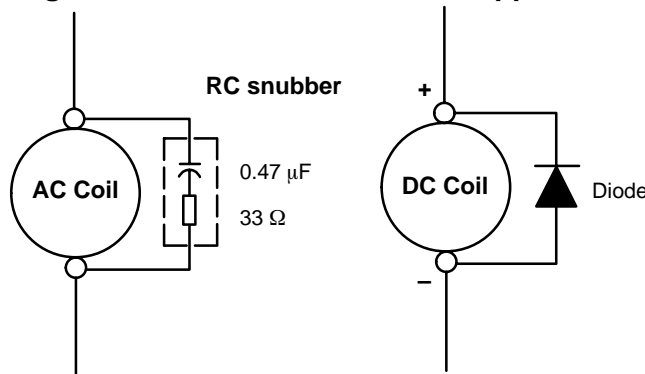
**Electrical Noise Considerations** All electronic devices are vulnerable to significant electronic interference signals (commonly called “Electrical Noise”). At the lowest level, noise can cause intermittent operating errors or faults. From a circuit standpoint, 5 or 10 millivolts of noise may cause detrimental operation. For example, analog speed and torque inputs are often scaled at 5 to 10 VDC maximum with a typical resolution of one part in 1,000. Thus, noise of only 5 mV represents a substantial error.

At the extreme level, significant noise can cause damage to the drive. Therefore, it is advisable to prevent noise generation and to follow wiring practices that prevent noise generated by other devices from reaching sensitive circuits. In a control, such circuits include inputs for speed, torque, control logic, and speed and position feedback, plus outputs to some indicators and computers.

**Relay and Contactor Coils** Among the most common sources of noise is the coil of a contactor or a relay. When these highly inductive coil circuits are opened, transient conditions often generate spikes of several hundred volts in the control circuit. These spikes can induce several volts of noise in an adjacent wire that runs parallel to a control-circuit wire.

Figure 5-1 illustrates noise suppression for AC and DC operated coils.

**Figure 5-1 AC & DC Coil Noise Suppression**

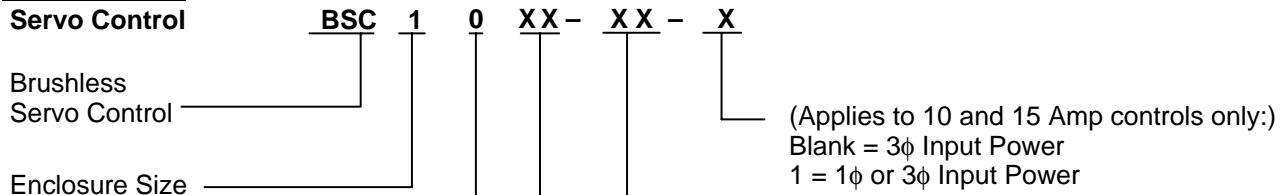


# Section 6 Specifications and Product Data

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## Identification

### Servo Control



0 = Requires external Bus supply  
 1 = No external Bus supply required

### Control Current Rating

02 = 2 Amps  
 05 = 5 Amps  
 10 = 10 Amps  
 15 = 15 Amps  
 27 = 27.5 Amps

Blank = 24V Logic option is not installed.  
 24 = 24V Logic option is installed.

Note: If 24V Logic option is not installed, do not connect 24VDC to X7 terminals.

## Specifications:

### BSC Servo Control Specifications: (115 / 230VAC)

Description	Unit	1002 / 1102	1105-1	1005 / 1105	1110-1	1010 / 1110	1115-1	1015 / 1115
Input voltage 115VAC (100-120) 230VAC (200-250)	VAC	115-1 $\phi$ / 230-3 $\phi$	115-1 $\phi$	230-3 $\phi$ ①	115-1 $\phi$	230-3 $\phi$ ①	115-1 $\phi$	230-3 $\phi$ ①
Nominal Bus Volts 160 (140-170) 300 (280-350)	VDC	160 / 300	160	300	160	300	160	300
Continuous Bus Current	A <sub>RMS</sub>	2	5		10		15	
Peak Bus Current (1.5s $\pm$ 5s)	A <sub>RMS</sub>	4	10		20		30	
Recommended Fuse Size ②	A	6	10		20		30	
Continuous Output Power Rating	kVA	0.87	1.0	2.1	2.1	4.3	3.1	6.5
Simulated Encoder Output	ppr	250/500/1000/1024						
Efficiency	%	>95						
Nominal Switching Frequency	kHz	8.5						
Minimum Load Inductance	$\mu$ H	200						
Analog Command Input	VDC	$\pm$ 10						
Speed Command Potentiometer		5k $\Omega$ or 10k $\Omega$ , 0.5watt						
Balance (Offset Drift)	RPM	Adjustable to 0						
Resolver Signal Resolution	Bits	12						
Mounting	-	Panel						
Weight	lb (kg)	10.0 (4.54)						
Operating Altitude	ft(M)	To 3300ft (1000M). Above 3300 ft, derate 11% per 3300ft (1000M).						
Operating Shock	G	1G according to DIN IEC 68-2-6/ 29						
Operating Vibration	G	1.0G (10-60Hz) according to DIN IEC 68-2-6/ 29						
Operating Temperature Range	$^{\circ}$ C	5 to 45 $^{\circ}$ C ③						
Humidity	%	10-90 Non-Condensing; according to IEC 68-2-38						
Storage Temperature Range	$^{\circ}$ C	-25 to +70 $^{\circ}$ C						
Class of Protection		IP20						

All values at ambient temperature of 25 $^{\circ}$ C unless otherwise stated.

#### Notes:

- ① When a 3 $\phi$  is connected to a 1 $\phi$  input, derate the output power to 5A, to avoid excessive ripple.
- ② Standard fuse sizes are determined as follows:  
Single unit IFUSE = 1.25 x ICONT.  
Multiple units IFUSE = the sum of the ICONT of all the linked units.
- ③ Derate output current by 2.9% per  $^{\circ}$ C over 45 $^{\circ}$ C to a maximum ambient temperature of 55 $^{\circ}$ C .
- ④ All BSC11XX units have internal power supplies capable of 15 Amps continuous and 30 Amps peak.

### DB (Regen) Resistor

Description	Unit	1002 / 1102	1105-1	1005 / 1105	1110-1	1010 / 1110	1115-1	1015 / 1115
Switching Threshold 155VAC controls 230VAC controls	VDC				188-195 370-410			
Nominal Peak Power	kW	7.5-15						
Maximum Inductive Load	$\mu$ H	100						
Regen Switching Current (maximum)	A	40						
Regen Resistor Value (320watt)	$\Omega$	18	18	18	10 ①	18 ①	4.7	10 ①
Resistor Part Number		RG18	RG18	RG18	RG10 ①	RG18 ①	RG4.7	RG10 ①

#### Note:

- ① Recommended regeneration resistor/part number for single axis operation only.

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## 24VDC Option (Logic Power)

Description	Unit	1002 / 1102	1105-1	1005 / 1105	1110-1	1010 / 1110	1115-1	1015 / 1115
Input Voltage Range	VDC	20-60						
Input Current at 24VDC	A	1.4						
Surge Current at Power On	A	2.5 for 100ms						

## Bus Supply Voltage

Description	Unit	1002	1005	1010	1015
Nominal Bus Voltage	VDC	160	300	300	300
Bus Voltage Range (absolute Minimum/Maximum)	VDC	50/170	50/350	50/350	50/350
Bus Voltage Range with 24VDC option (absolute Min./Max.)	VDC	0/170	0/350	0/350	0/350



## Section 7 CE Guidelines

### CE Declaration of Conformity

Baldor indicates that the products are only components and not ready for immediate or instant use within the meaning of "Safety law of appliance", "EMC Law" or "Machine directive".

The final mode of operation is defined only after installation into the user's equipment. It is the responsibility of the user to verify compliance.

The product conforms with the following standards:

DIN VDE 0160 / 05.88	Electronic equipment for use in electrical power installations
DIN VDE 0100	Erection of power installations with nominal voltages up to 1000V
DIN IEC 326 Teil 1 / 10.90	Design and use of printed boards
DIN VDE 0110Teil 1-2 / 01.89	Dimensioning of clearance and creepage distances
DIN VDE 0110Teil 20 / 08.90	Distances
EN 60529 / 10.91	Degrees of protection provided by enclosures

### EMC – Conformity and CE – Marking

The information contained herein is for your guidance only and does not guarantee that the installation will meet the requirements of the council directive 89/336/EEC.

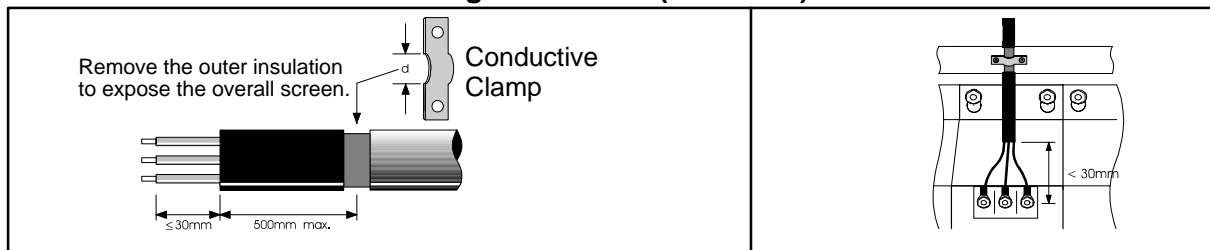
The purpose of the EEC directives is to state a minimum technical requirement common to all the member states within the European Union. In turn, these minimum technical requirements are intended to enhance the levels of safety both directly and indirectly.

Council directive 89/336/EEC relating to Electro Magnetic Compliance (EMC) indicates that it is the responsibility of the system integrator to ensure that the entire system complies with all relative directives at the time of installing into service.

Motors and controls are used as components of a system, per the EMC directive. Hence all components, installation of the components, interconnection between components, and shielding and grounding of the system as a whole determines EMC compliance.

The CE mark does not inform the purchaser which directive the product complies with. It rests upon the manufacturer or his authorized representative to ensure the item in question complies fully with all the relative directives in force at the time of installing into service, in the same way as the system integrator previously mentioned. Remember, it is the instructions of installation and use, coupled with the product, that comply with the directive.

### **Wiring of Shielded (Screened) Cables**



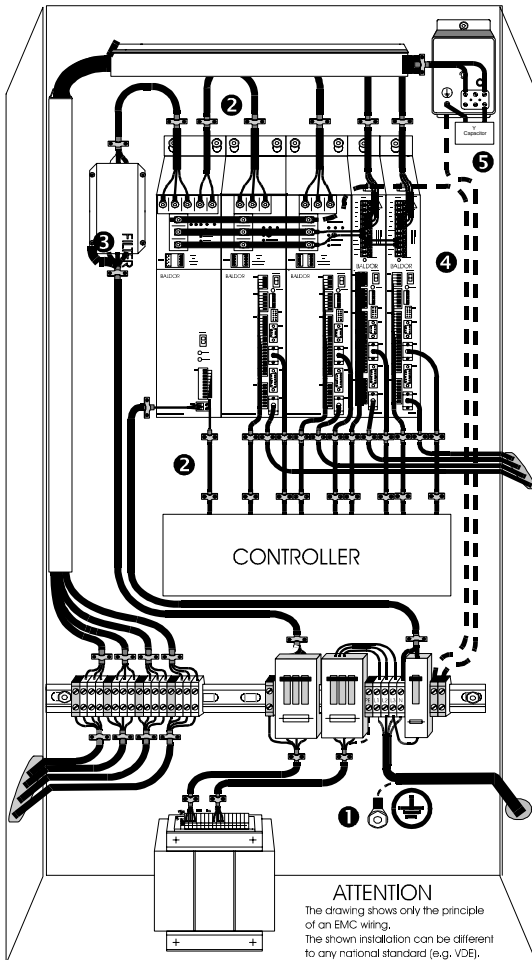


## Using CE approved components will not guarantee a CE compliant system!

1. The components used in the drive, installation methods used, materials selected for interconnection of components are important.
2. The installation methods, interconnection materials, shielding, filtering and grounding of the system as a whole will determine CE compliance.
3. The responsibility of CE mark compliance rests entirely with the party who offers the end system for sale (such as an OEM or system integrator).

Baldor products which meet the EMC directive requirements are indicated with a "CE" mark. A duly signed CE declaration of conformity is available from Baldor.

### EMC Wiring Technique



#### 1 CABINET

The drawing shows an electroplated zinc coated enclosure, which is connected to ground.

This enclosure has the following advantages:

- All parts mounted on the back plane are connected to ground.
- All shield (screen) connections are connected to ground.

Within the cabinet there should be a spatial separation between power wiring (motor and AC power cables) and control wiring.

#### 2 SCREEN CONNECTIONS

All connections between components must use shielded cables. The cable shields must be connected to the enclosure. Use conductive clamps to ensure good ground connection. With this technique, a good ground shield can be achieved.

#### 3 EMC – FILTER

The EMI or main filter should be mounted next to the power supply (here BPS). For the connection to and from the main filter screened cables should be used. The cable screens should be connected to screen clamps on both sides. (Exception: Analog Command Signal).

#### 4 Grounding (Earth)

For safety reasons (VDE0160), all BALDOR components must be connected to ground with a separate wire. The diameter of the wire must be at minimum AWG#6 (10mm<sup>2</sup>). Ground connections (dashed lines) must be made from the central ground to the regen resistor enclosure and from the central ground to the Shared Power Supply.

#### 5 Y-CAPACITOR

The connection of the regeneration resistor can cause RFI (radio frequency interference) to be very high. To minimize RFI, a Y-capacitor is used. The capacitor should only be connected between the dynamic brake resistor housing and terminal pin R1 (lead from Flex).

Recommendation: 0,1µF / 250VAC Type: PME265  
BALDOR-Ordering-No.: ASR27104

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## EMC Installation Instructions

To ensure electromagnetic compatibility (EMC), the following installation instructions should be completed. These steps help to reduce interference. Consider the following:

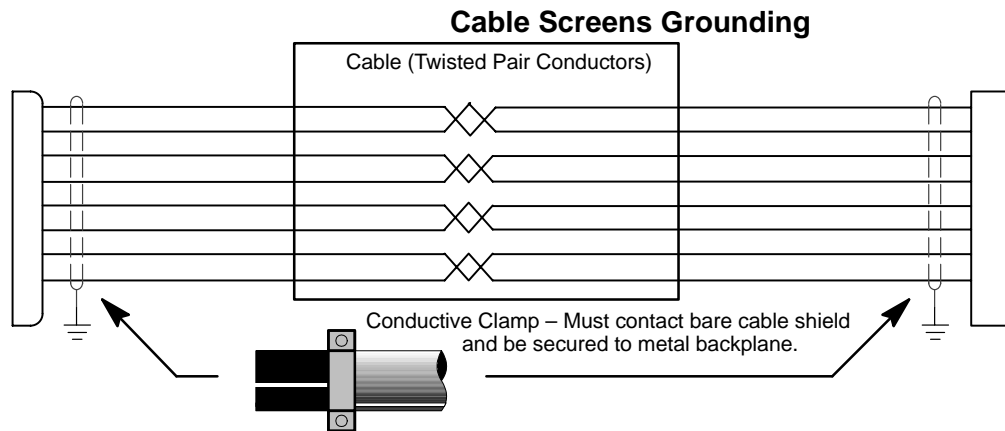
- Grounding of all system elements to a central ground point
- Shielding of all cables and signal wires
- Filtering of power lines

A proper enclosure should have the following characteristics:

- A) All metal conducting parts of the enclosure must be electrically connected to the back plane. These connections should be made with a grounding strap from each element to a central grounding point . [1]
- B) Keep the power wiring (motor and power cable) and control wiring separated. If these wires must cross, be sure they cross at 90 degrees to minimize noise due to induction.
- C) The shield connections of the signal and power cables should be connected to the screen rails or clamps. The screen rails or clamps should be conductive clamps fastened to the cabinet. [2]
- D) The cable to the regeneration resistor must be shielded. The shield must be connected to ground at both ends.
- E) The location of the AC mains filter has to be situated close to the drive so the AC power wires are as short as possible.
- F) Wires inside the enclosure should be placed as close as possible to conducting metal, cabinet walls and plates. It is advised to terminate unused wires to chassis ground. [1]
- G) To reduce ground current, use at least a 10mm<sup>2</sup> (6 AWG) solid wire for ground connections.

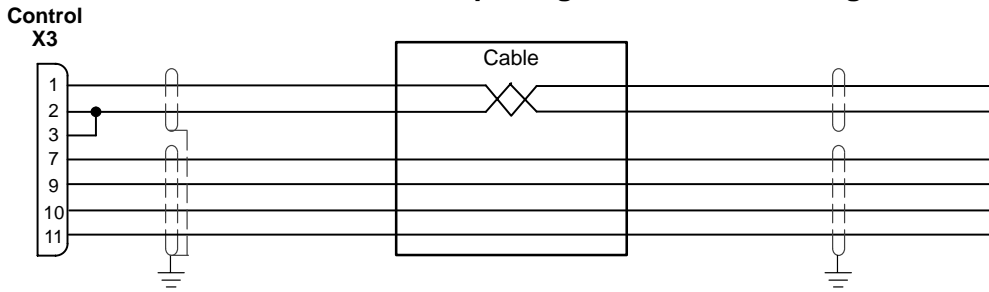
[1] Grounding in general describes all metal parts which can be connected to a protective conductor, e.g. housing of cabinet, motor housing, etc. to a central ground point. This central ground point is then connected to the main plant (or building) ground.

[2] Or run as twisted pair at minimum.

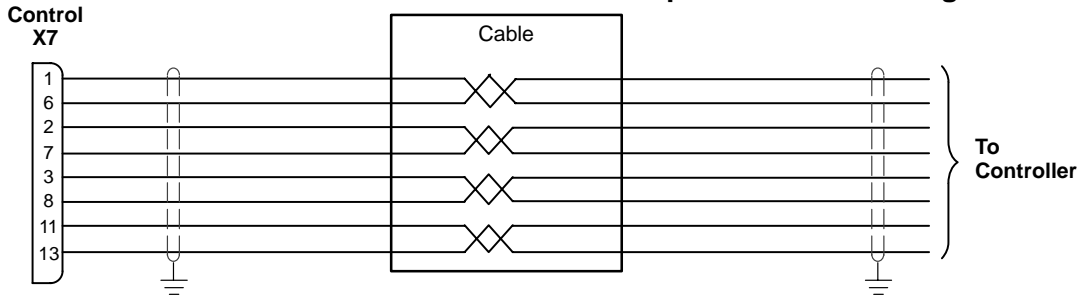


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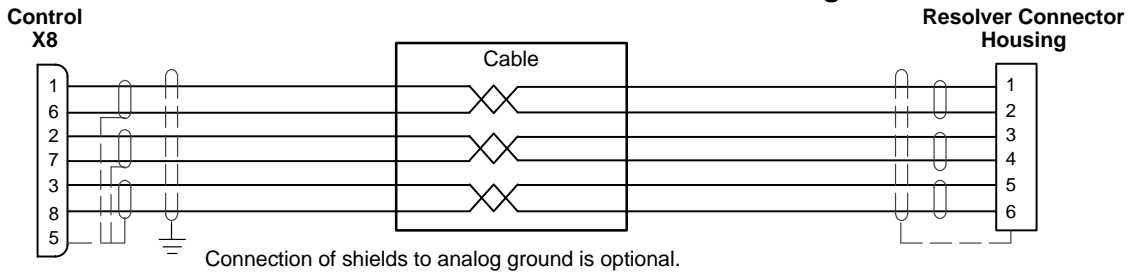
### Input Signal Cable Grounding



### Simulated Encoder Output Cable Grounding



### Resolver Cable Grounding



# **BALDOR<sup>®</sup>** **MOTORS AND DRIVES**

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