BALDOR®
MOTORS AND DRIVES

SERVO DRIVE

MacroDrive
Servo Control

Installation & Operating Manual

10/00

MN1286

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Section 1
General Information

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 8 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.

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 7 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.**

PRECAUTIONS:

⚠ 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: **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.**

Horsepower	RMS Symmetrical Amperes
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.

⚠ **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 8 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.**
⚠ **Caution:**	**If the I^2T protection values are set incorrectly, a Series B motor can be demagnetized.**

Section 2
Product Overview

Overview

The *Macro*Drive product is designed to serve the needs of machine designers and manufacturers. Baldor products have both UL and CE approvals. The *Macro*Drive is a servo amplifier for use with brushless servo motors.

The Motion Control with Macro (PMAC2) permits digital closure of the motor current loops, mathematically creating phase voltage commands from numerical registers representing commanded and actual current values. These numerical phase voltage commands are converted to PWM format through digital comparison to an up/down counter that creates a digital saw tooth waveform. The analog current measurements are converted to digital signals with ADC's for closed loop feedback.

By using this direct PWM control of amplifiers, the Macro motion control performs all of the control tasks for the motor, including commutation and digital current loop closure. The MacroDrive only performs the power conversion task. In this mode, the *Macro*Drive outputs a PWM voltage for each phase of the motor.

MACRO Defined

(**M**otion **a**nd **C**ontrol **R**ing **O**ptical) is a digital interface for connection of multi–axis motion controllers, amplifiers and other I/O devices on a fiber optic or twisted pair copper (RJ45 connector) ring.

MACRO operates in a ring topology. Data is transmitted serially. Each station on the ring has an "in" port for receiving data and an "out" port for transmitting data. Nodes, residing at a station, can be amplifier axes, I/O banks or communication interfaces to other devices. A station can have one or several nodes, allowing for multi–axis amplifiers with a single "in" and single "out" port. Data packets, (groups of 96 bits of serial data), from the motion controller or master node, are addressed to a specific amplifier, or slave node. If the data packet is not for an amplifier, it is passed on, unchanged. If it is for the node, it copies the contents of the data packet (typically commands), places feedback data into a packet and transmits the data packet.

MACRO's advantages are:

1. **Single–plug connections** between controls and amplifiers. A single fiber optic strand can provide a controller with: position feedback, flag status (limits, home flag, registration prox status), amplifier status and machine input status. This same strand can communicate to the amplifier and other devices on the MACRO network (Amplifier enable & amplifier command signals, machine outputs, commands to D/A converters; all can be implemented with a single plug connection).
2. **Noise Immunity**. Fiber–optic cable transmits light, not electricity. Unlike electricity light is immune to electromagnetic noise, capacitive coupling, ground loops, and other wiring problems.

Continued on next page

3. **Speed**. MACRO's operation is 125 Mbits/second. This is at least 25 times faster than other digital motion control interfaces.
4. **One ring, multiple masters**. In a ring network, several motion controllers ("masters") can be on one ring. Each controller controls several axes.
5. **Simplicity**. Transmission within the MACRO ring requires no software intervention. The information sent to all nodes is written to a memory location, and the MACRO hardware takes care of the rest.

Motors

The MacroDrive servo control is compatible with many motors from Baldor and other manufacturers. Baldor compatible motors include:

- BSM–A–Series motors
- BSM–B–Series motors (see I^2T protection values in Figure 5-1).
- BSM–N–Series motors

Refer to the Speed/Torque curves in the BR1202 catalog or contact your local Baldor distributor or sales representative for assistance with motor sizing and compatibility.

Section 3
Receiving and Installation

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. At least 0.4 inches (10mm) clearance is required between controls (each side).
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 0°C to 40°C ambient no derating required. Above 40°C, derate the continuous and peak output current by 2.5% per °C above 40°C. Maximum ambient is 50°C.

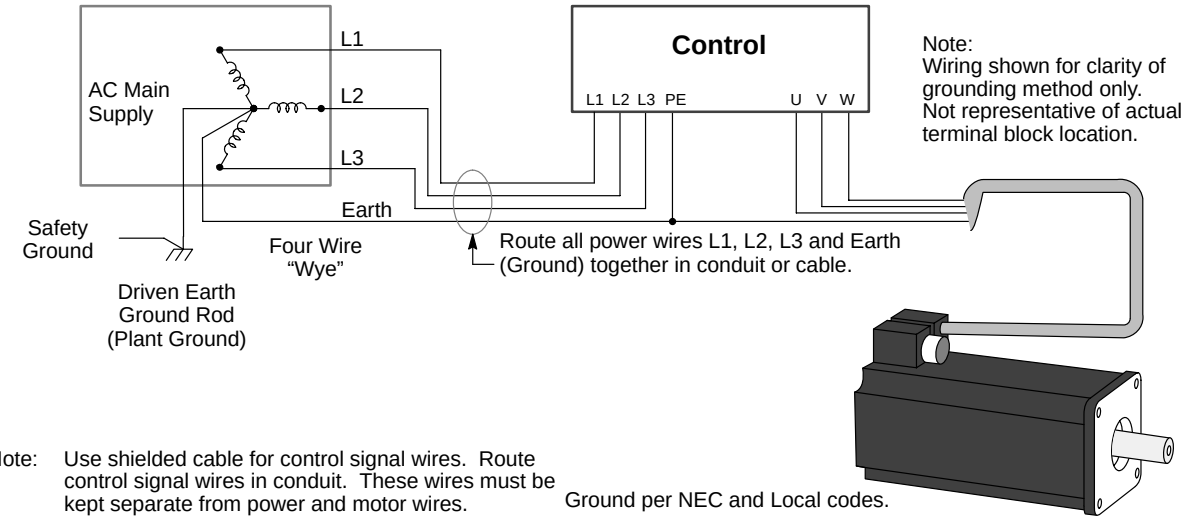
Mechanical Installation

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 7 of this manual.

Electrical Installation All interconnection wires between the control, AC power source, motor, motion controller 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.

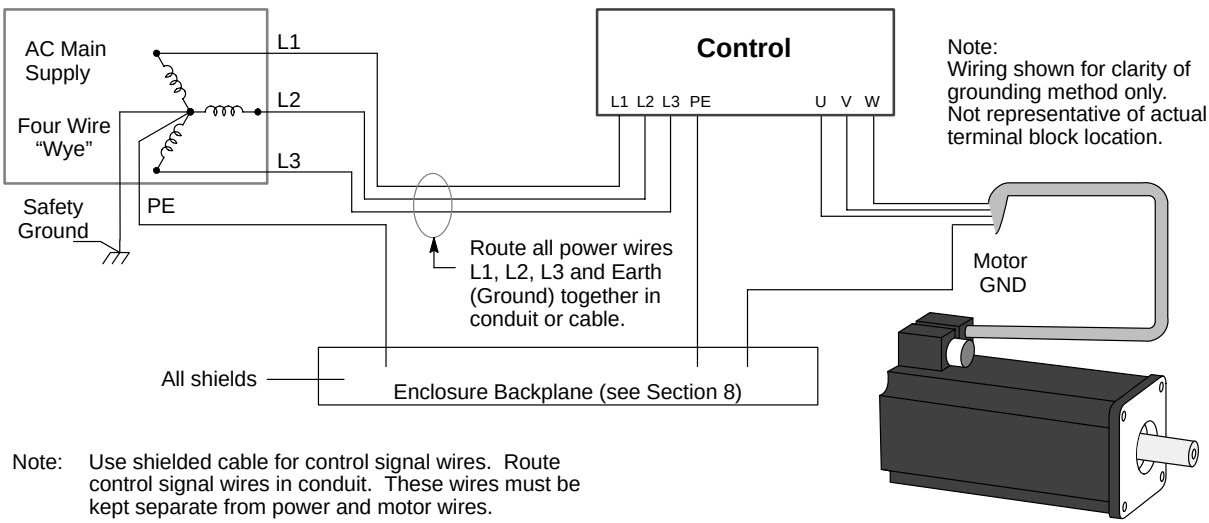
System Grounding Baldor controls are designed to be powered from standard single and three phase lines that are electrically symmetrical with respect to ground. System grounding is an important step in the overall installation to prevent problems. The recommended grounding method is shown in Figure 3-1 and 3-3 for UL compliant systems (Figure 3-2 and 3-4 for CE compliant systems).

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



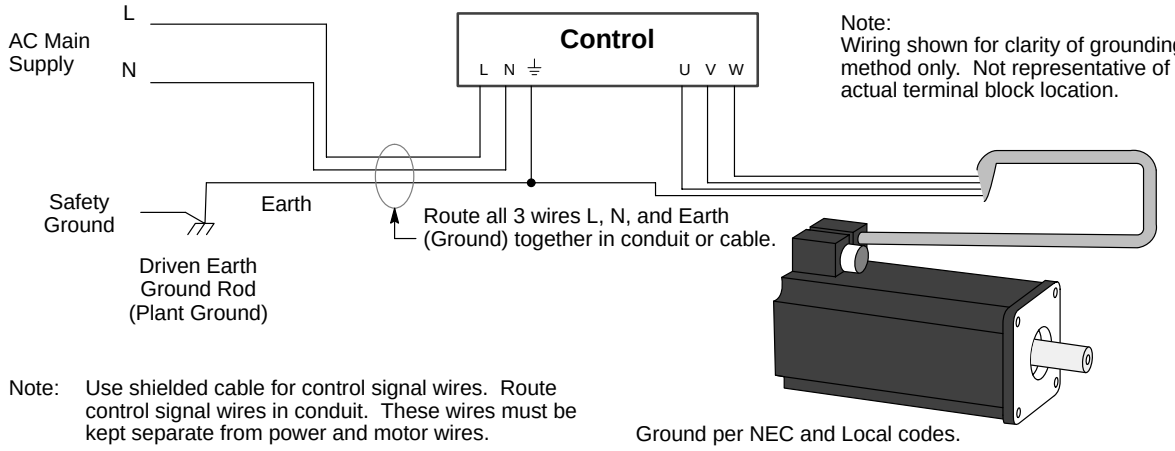
Note: Use shielded cable for control signal wires. Route control signal wires in conduit. These wires must be kept separate from power and motor wires.

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



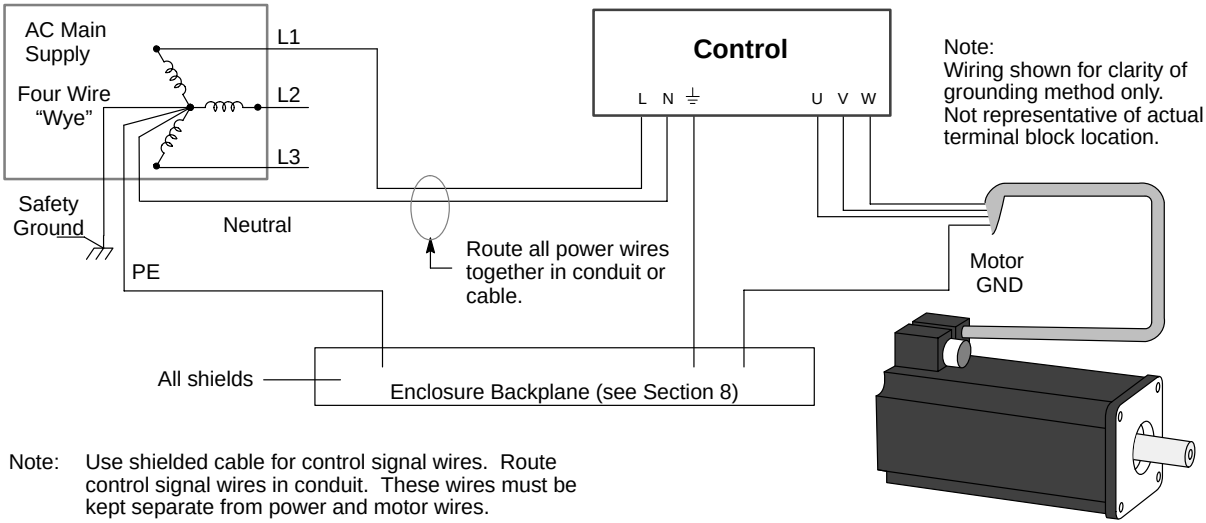
Note: Use shielded cable for control signal wires. Route control signal wires in conduit. These wires must be kept separate from power and motor wires.

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



Note: Use shielded cable for control signal wires. Route control signal wires in conduit. These wires must be kept separate from power and motor wires.

Figure 3-4 Recommended System Grounding (1 phase) for CE



Note: Use shielded cable for control signal wires. Route control signal wires in conduit. These wires must be kept separate from power and motor wires.

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 and 3-2 describes the wire size to be used for power connections and the ratings of the protection devices. Use the recommended circuit breaker or fuse types as follows:

Circuit Breaker:	1 phase, thermal magnetic. Equal to GE type THQ or TEB for 115 or 230 VAC 3 phase, thermal magnetic. Equal to GE type THQ or TEB for 230 VAC or GE type TED for 460 VAC.
Time Delay Fuses:	Buss FRN on 230 VAC or Buss FRS on 460 VAC or equivalent.

Recommended fuse sizes are based on the following:

UL 508C suggests a fuse size of four times the continuous output current of the control.
Dual element, time delay fuses should be used to avoid nuisance trips due to inrush current when power is first applied.

For European installations, you may want to consider the following fast acting fuse: Gould Shawmut Cat. No. ATMR15 for up to 15 amperes.

Table 3-1 Wire Size and Protection Devices (for units with Power Supply)

Catalog Number	Incoming Power					
	Nominal Input Voltage	Continuous Output Amps (RMS)	Input Breaker (A)	Input Fuse Time Delay (A)	Wire Gauge	
					AWG (USA)	mm² (Europe)
MA1A02SR-XXXX	115V (1ϕ)	2.0A	8	8	14	2.5
MA2A02SR-XXXX	230V (3ϕ)	2.5A	10	10	14	2.5
MA1A02TR-XXXX	115V (1ϕ)	2.0A	8	8	14	2.5
MA2A02TR-XXXX	230V (1ϕ)	2.5A	10	10	14	2.5
MA4A02TB-XXXX	400/460V (3ϕ)	2.5A	10	10	14	2.5
MA1A05SR-XXXX	115V (1ϕ)	5A	20	20	14	2.5
MA1A05SR-XXXX	230V (3ϕ)	5A	20	20	14	2.5
MA1A05TR-XXXX	115V (1ϕ)	5A	20	20	14	2.5
MA2A05TR-XXXX	230V (1ϕ)	5A	20	20	14	2.5
MA4A05TB-XXXX	400/460V (3ϕ)	5A	20	20	14	2.5
MA1A07TR-XXXX	115V (1ϕ)	7.5A	30	30	14	2.5
MA2A07TR-XXXX	230V (1ϕ)	7.5A	30	30	14	2.5
MA4A07TR-XXXX	400/460V (3ϕ)	7.5A	30	30	14	2.5
MA1A10SR-XXXX	115V (1ϕ)	10A	40	40	14	2.5
MA2A10SR-XXXX	230V (3ϕ)	10A	40	40	14	2.5
MA1A15SR-XXXX	115V (1ϕ)	15A	60	60	12	2.5
MA2A15SR-XXXX	230V (3ϕ)	15A	60	60	12	2.5
MA4A15TR-XXXX	400/460V (3ϕ)	15A	60	60	12	2.5

Table 3-2 Wire Size (for units without Power Supply)

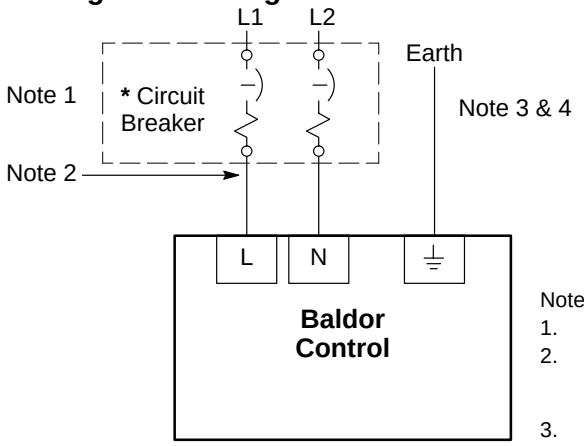
Catalog Number	Bus Voltage	Continuous Output Amps	Wire Gauge	
			AWG (USA)	mm² (Europe)
MA1A02PO-XXXX	160VDC	2.0A	14	2.5
MA2A02PO-XXXX	300VDC	2.5A	14	2.5
MA1A05PO-XXXX	160VDC	5.0A	14	2.5
MA2A05PO-XXXX	300VDC	5.0A	14	2.5
MA1A10PO-XXXX	160VDC	10.0A	12	2.5
MA2A10PO-XXXX	300VDC	10.0A	12	2.5
MA1A15PO-XXXX	160VDC	15.0A	10	2.5
MA2A15PO-XXXX	300VDC	15.0A	10	2.5

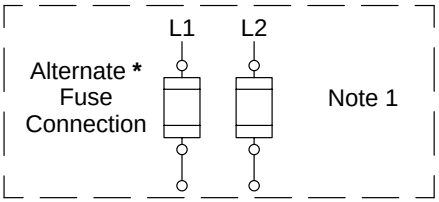
Note: All wire sizes are based on 75°C copper wire. Higher temperature smaller gauge wire may be used per NEC and local codes. Recommended fuses/breakers are based on 25°C ambient, maximum continuous control output current and no harmonic current.

X1 Power Connections

Power connections are shown in Figures 3-5 through 3-8.

Figure 3-5 Single Phase AC Power Connections (MA1AxxT & MA2AxxT only)





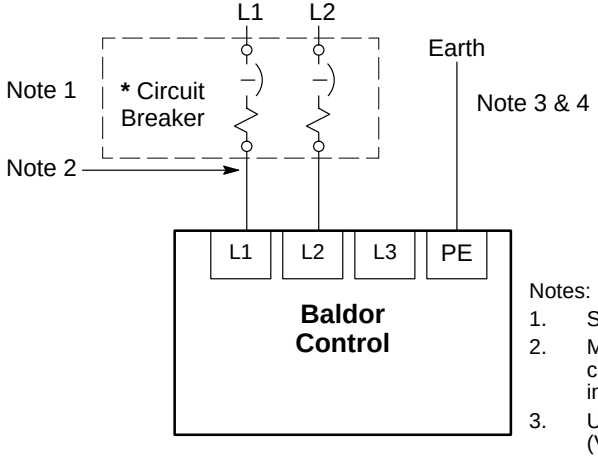
* Components not provided with Control.

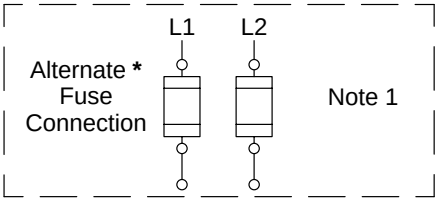
For CE Compliance, refer to Section 8 of this manual.

Notes:

1. See “Protection Devices” described 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 same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm^2 minimum). For CE Compliance, connect ⏚ to the backplane of the enclosure.
4. Reference EMC wiring in Section 8.

Figure 3-6 Single Phase AC Power Connections (MA1AxxS only)





* Components not provided with Control.

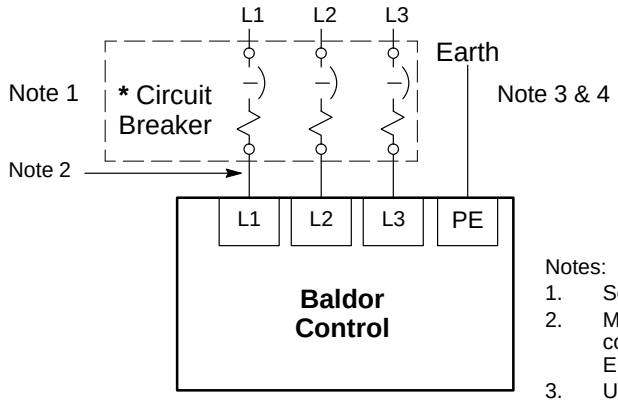
For CE Compliance, refer to Section 8 of this manual.

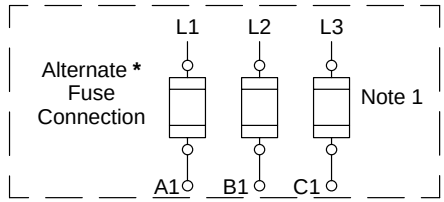
Notes:

1. See “Protection Devices” described 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 same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm^2 minimum). For CE Compliance, connect ⏚ to the backplane of the enclosure.
4. Reference EMC wiring in Section 8.

Note: These MacroDrive versions are not designed for use with 400/460VAC connections.

Figure 3-7 3 Phase Power Connections (MA2AxxS & MA4AxxT 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, L2, L3 connections.
3. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm^2 minimum). For CE compliance, connect "PE" to the backplane of the enclosure.
4. Reference EMC wiring in Section 8.

For CE Compliance, refer to Section 8 of this manual.

A shared supply configuration is shown in Figure 3-8. The first drive must have an internal power supply such as an Option "S" control.

Figure 3-8 Shared Supply Power Connections

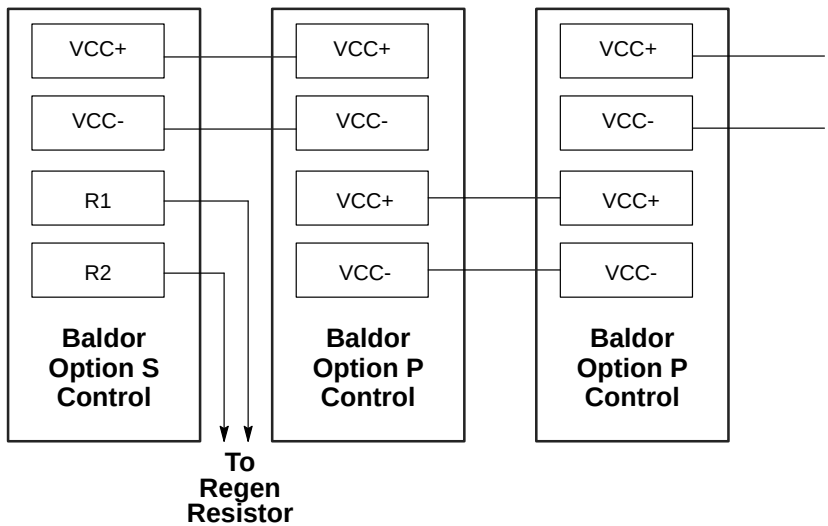
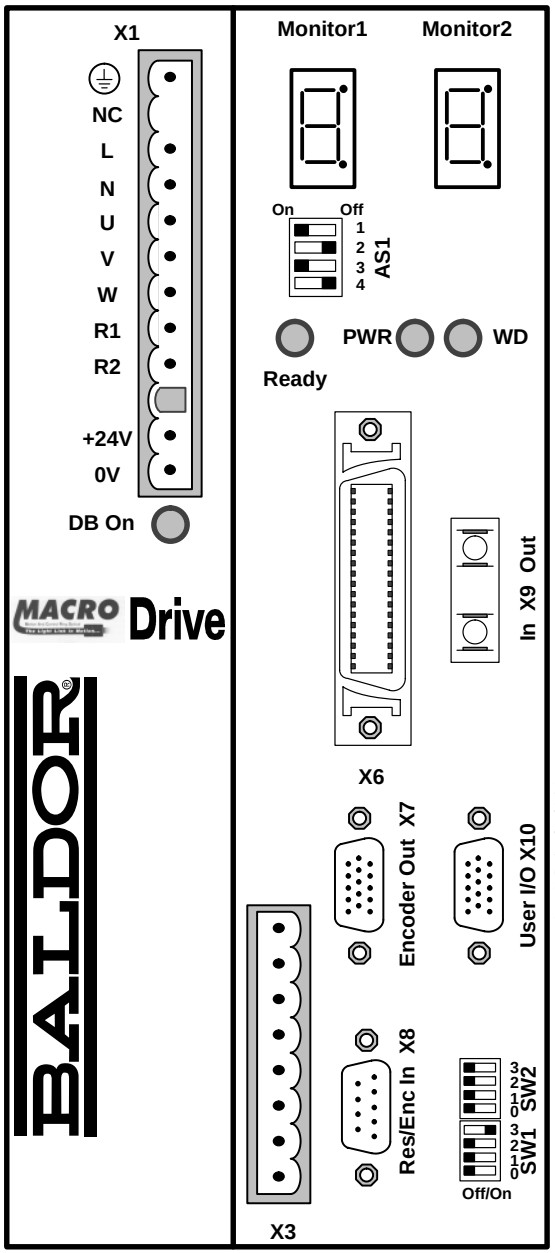


Figure 3-9 Connector Locations (Single Phase Controls)



X1 - Power Connector

⏚	Earth	Input Power
L	AC Line	
N	Neutral	
U	Motor lead "U"	Motor
V	Motor lead "V"	
W	Motor lead "W"	
R1	Dynamic Brake	Regen
R2	Dynamic Brake	Resistor
+24V	Customer	MAxAxxxx-xx03 only [1]
0V	Provided	

Terminal tightening torque is 0.5 lb-in (0.6Nm)

X3 - Control Signals & Digital I/O

1	+15VDC
2	Motor Overtemp + (Optocoupler)
3	Motor Overtemp – (Optocoupler)
4	Ground
5	+15VDC
6	Hardware Enable + (Optocoupler)
7	Hardware Enable – (Optocoupler)
8	Ground

X7 - Encoder Output

1	CHA+	9	Hall3+
2	CHB+	10	Hall2+
3	CHC+	11	+5VDC
4	Hall1+	12	N.C.
5	Hall1–	13	Ground
6	CHA-	14	Hall3–
7	CHB-	15	Hall2–
8	CHC-		

X8 - Resolver Input

1	REF+	6	REF– (GND)
2	COS+	7	COS–
3	SIN+	8	SIN–
4	N.C.	9	N.C.
5	Ground		

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.

X6 - MacroDrive

1	Reserved	19	Reserved
2	Reserved	20	Reserved
3	ADC_CLK+	21	ADC_CLK–
4	ADC_STB+	22	ADC_STB–
5	Current A+	23	Current A–
6	Current B+	24	Current B–
7	AENA+	25	AENA–
8	Fault+	26	Fault–
9	PWM A+	27	PWM A–
10	Reserved	28	Reserved
11	PWM B+	29	PWM B–
12	Reserved	30	Reserved
13	PWM C+	31	PWM C–
14	Reserved	32	Reserved
15	Ground	33	Ground
16	+5VDC	34	+5VDC
17	Reserved	35	Reserved
18	Reserved	36	Reserved

X10 - User I/O

1	In Comm	9	Output 0
2	Input 2	10	Output Pos.
3	Home	11	Input 1
4	N.C.	12	Ext. Error In.
5	Output 2	13	LIM. Sw. In+
6	Input 0	14	Output 1
7	Input 3	15	Out Comm.
8	LIM. Sw. In–		

X8 - Encoder Input

1	CHA+	9	Hall3+
2	CHB+	10	Hall2+
3	CHC+	11	+5VDC
4	Hall1+	12	N.C.
5	Hall1–	13	Ground
6	CHA-	14	Hall3–
7	CHB-	15	Hall2–
8	CHC-		

[1] **Important:**
MAxAxxxx-xx03 only.
A separate 24VDC supply to the "Logic Power" input is required for operation. An MAxAxxxx-xx03 control will not operate without 24VDC on this input.

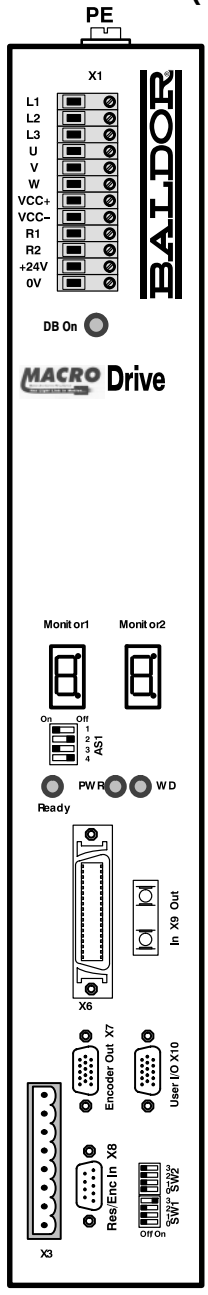
Note: Reserved means no connection is required and no connection should be made to this terminal. It is reserved for future use.

Figure 3-10 Connector Locations (Three Phase Controls)

X1 - Power Connector

PE	Earth	
L1	Phase 1 Input	Input Power
L2	Phase 2 Input	
L3	Phase 3 Input	
U	Motor lead "U"	Motor
V	Motor lead "V"	
W	Motor lead "W"	
R1	Dynamic Brake	Dynamic Brake (Regen Resistor)
R2	Dynamic Brake	
+24V	Customer	**MAxAxxxx-xxx3 only** [1]
0V	Provided	

Terminal tightening torque is 0.5 lb-in (0.6Nm)



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.

X6 - MacroDrive

1	Reserved	19	Reserved
2	Reserved	20	Reserved
3	ADC_CLK+	21	ADC_CLK–
4	ADC_STB+	22	ADC_STB–
5	Current A+	23	Current A–
6	Current B+	24	Current B–
7	AENA+	25	AENA–
8	Fault+	26	Fault–
9	PWM A+	27	PWM A–
10	Reserved	28	Reserved
11	PWM B+	29	PWM B–
12	Reserved	30	Reserved
13	PWM C+	31	PWM C–
14	Reserved	32	Reserved
15	Ground	33	Ground
16	+5VDC	34	+5VDC
17	Reserved	35	Reserved
18	Reserved	36	Reserved

X10 - User I/O

1	In Comm	9	Output 0
2	Input 2	10	Output Pos.
3	Home	11	Input 1
4	N.C.	12	Ext. Error In.
5	Output 2	13	LIM. Sw. In+
6	Input 0	14	Output 1
7	Input 3	15	Out Comm.
8	LIM. Sw. In–		

X3 - Control Signals & Digital I/O

1	+15VDC
2	Motor Overtemp + (Optocoupler)
3	Motor Overtemp – (Optocoupler)
4	Ground
5	+15VDC
6	Hardware Enable + (Optocoupler)
7	Hardware Enable – (Optocoupler)
8	Ground

X7 - Encoder Output

1	CHA+	9	Hall3+
2	CHB+	10	Hall2+
3	CHC+	11	+5VDC
4	Hall1+	12	N.C.
5	Hall1–	13	Ground
6	CHA-	14	Hall3–
7	CHB-	15	Hall2–
8	CHC-		

X8 - Resolver Input

1	REF+	6	REF– (GND)
2	COS+	7	COS–
3	SIN+	8	SIN–
4	N.C.	9	N.C.
5	Ground		

X8 - Encoder Input

1	CHA+	9	Hall3+
2	CHB+	10	Hall2+
3	CHC+	11	+5VDC
4	Hall1+	12	N.C.
5	Hall1–	13	Ground
6	CHA-	14	Hall3–
7	CHB-	15	Hall2–
8	CHC-		

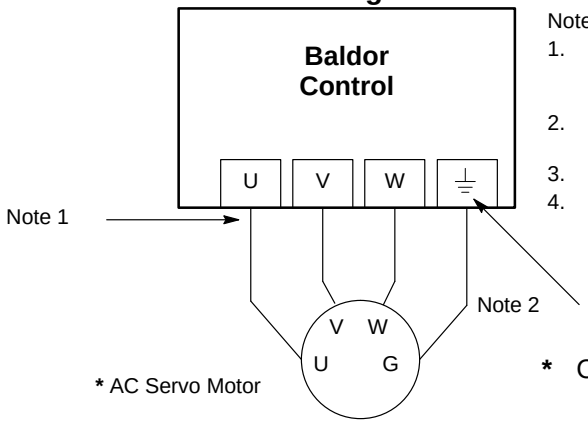
[1] **Important:**
MAxAxxxx-xx03 only.
A separate 24VDC supply to the "Logic Power" input is required for operation. An MAxAxxxx-xx03 control will not operate without 24VDC on this input.

Note: Reserved means no connection is required and no connection should be made to this terminal. It is reserved for future use.

X1 Motor Connections Motor connections are shown in Figure 3-11 and Figure 3-12.

It is important to connect the motor leads U, V and W correctly at the X1 connector of the control. Incorrect wiring can cause erratic operation including moves at peak force until the overcurrent limit trips. This will result in a display of "7" and a "6" on the monitor. If erratic movement of the motor occurs, turn off power immediately and check the connections of the motor, resolver or hall sensors and encoder.

Figure 3-11 Motor Connections for UL



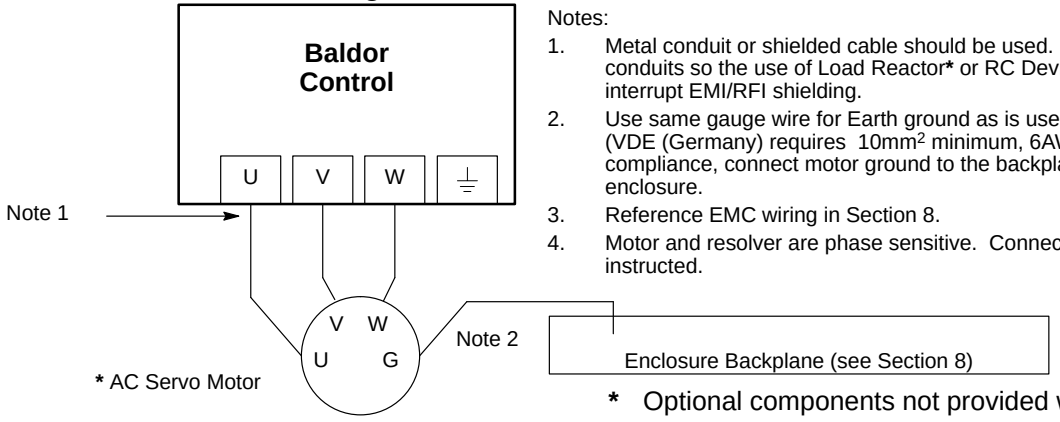
Notes:

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 L and N. (VDE (Germany) requires 10mm^2 minimum, 6AWG).
3. Reference EMC wiring in Section 8.
4. Motor and resolver are phase sensitive. Connect only as instructed.

For three phase controls, this is labeled "PE".

* Optional components not provided with control.

Figure 3-12 Motor Connections for CE



Notes:

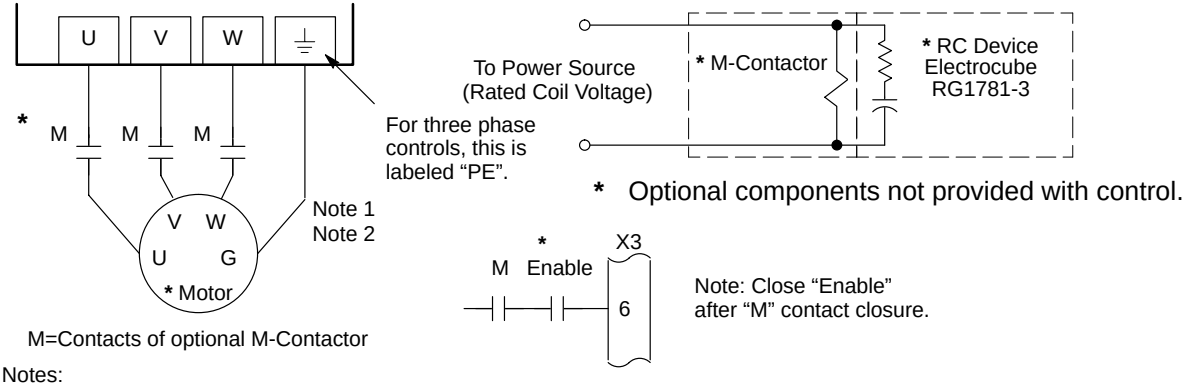
1. Metal conduit or shielded cable should be used. Connect conduits so the use of Load Reactor* or RC Device* does not interrupt EMI/RFI shielding.
2. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm^2 minimum, 6AWG). For CE compliance, connect motor ground to the backplane of the enclosure.
3. Reference EMC wiring in Section 8.
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 3-13.

Figure 3-13 Optional M-Contactor Connections



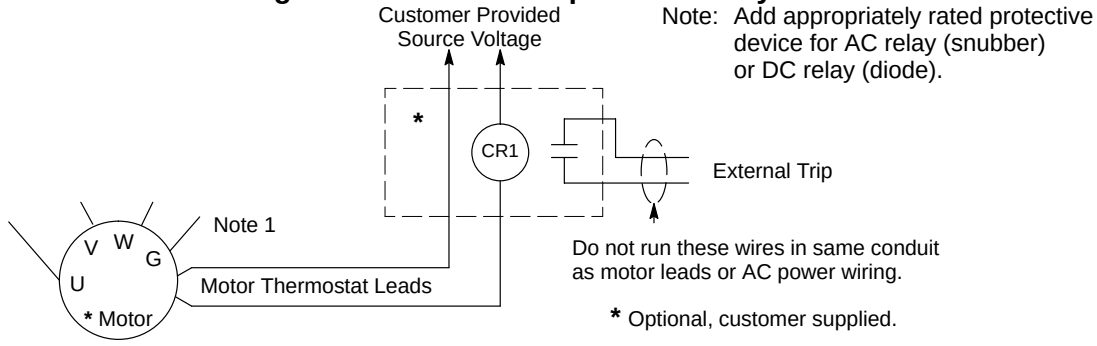
Notes:

1. Use same gauge wire for Earth ground as is used for L and N. (VDE (Germany) requires 10mm^2 minimum, 6AWG).
2. For UL installations, connect motor ground to ⏚ of the control as shown.
   For CE installations, connect motor ground to the enclosure backplane (see Figure 3-12).

Motor Thermostat A relay contact can be used to isolate the motor thermostat leads for use with other devices, shown in Figure 3-14. The thermostat or overload relay should be a dry contact type with no power available from the contact. The optional relay (CR1) shown provides the isolation required and the N.O. contact is open when power is applied to the relay and the motor is cold. If the motor thermostat is tripped, CR1 is de-energized and the N.O. contact closes.

Connect the External Trip Input wires (N.O. relay contact) to a PLC or other device. Note that a machine input may be used and the PLC software of the MacroDrive can define the thermal protection. Do not place these wires in the same conduit as the motor power leads.

Figure 3-14 Motor Temperature Relay



Note:

1. For UL installations, connect motor ground to ⏚ of the control as shown.
   For CE installations, connect motor ground to the enclosure backplane (see Figure 3-12).

X1 Dynamic Brake Resistor An external DB (dynamic brake or regen resistor) resistor may be required to dissipate excess power from the DC bus during motor deceleration operations. Some controls have an internal resistor. For selection of the DB resistor, refer to the specifications located in Section 7 and the regeneration resistor specifications in Section 9 of this manual. DB hardware is connected at R1 and R2 terminals of the X1 connector, Figure 3-9 and 3-10.

X1 +24VDC Logic Supply For MAxAxxxx-xx03 only. A separate 24VDC supply to the "Logic Power" input is required for operation. An external 24 VDC power source must be used. If bus power is lost, the logic circuits are still active if the 24VDC is present. This is important to maintain position reference, for example.

If the control was not ordered with this option, do not connect any voltage to these pins.

X3 – 8 pin Phoenix, Control Signals & Digital I/O

Pin	Signal Name
1	+15VDC
2	Motor Overtemperature + (Optocoupler)
3	Motor Overtemperature – (Optocoupler)
4	Ground
5	+15VDC
6	Hardware Enable + (Optocoupler)
7	Hardware Enable – (Optocoupler)
8	Ground

X7 – 15 pin Sub D, Simulated Encoder Feedback

Pin	Signal Name
1	CHA+
2	CHB+
3	CHC+
4	SYNC_U+
5	Reserved
6	CHA-
7	CHB-
8	CHC-
9	SYNC_W+
10	SYNC_V+
11	+5VDC
12	N.C.
13	Ground
14	Reserved
15	Reserved

X8 – 9 pin Sub D, Resolver Feedback

The resolver connections are the standard feedback on Macro drives and connections are made at the X8 connector as shown in Figure 3-15. The resolver cable must be shielded twisted pair #22 AWG (0.34mm^2) wire minimum. The cable must also have an overall shield. Maximum wire-to-wire or wire-to-shield capacitance is 50pf per foot. Maximum cable length is 80 ft (25 meters).

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 3-15 Resolver Cable Connections for UL Installations

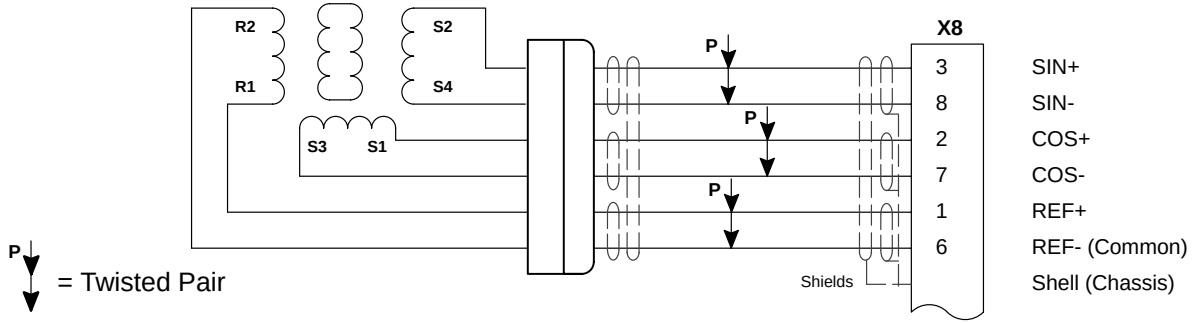
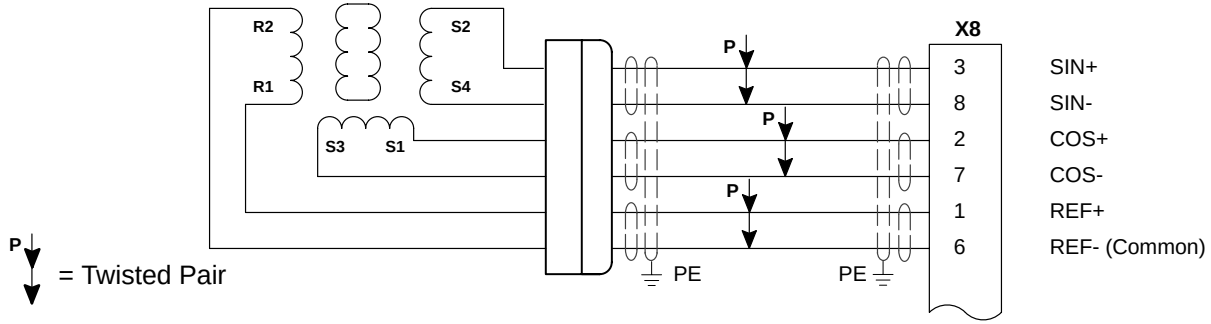


Figure 3-16 Resolver Cable Connections for CE Installations



X8 – 15 pin Sub D, Encoder Feedback

Twisted pair shielded wire with an overall shield should be used. Figure 3-17 shows the electrical connections between the encoder and the encoder connector. Maximum cable length is 80 ft (25 meters).

Note: If the control was ordered with option E (Encoder/Hall feedback, catalog MAxAxxxx-Exxx) it is not possible to connect the handwheel.

Figure 3-17 Encoder with Hall Tracks Connections for UL Installations

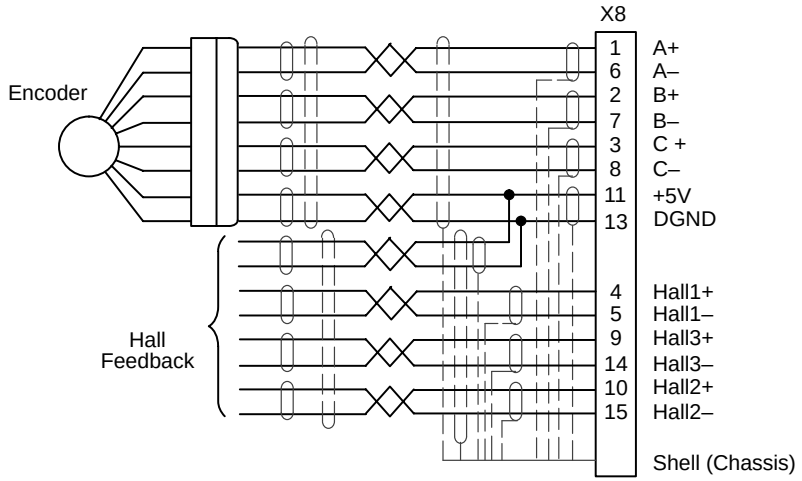
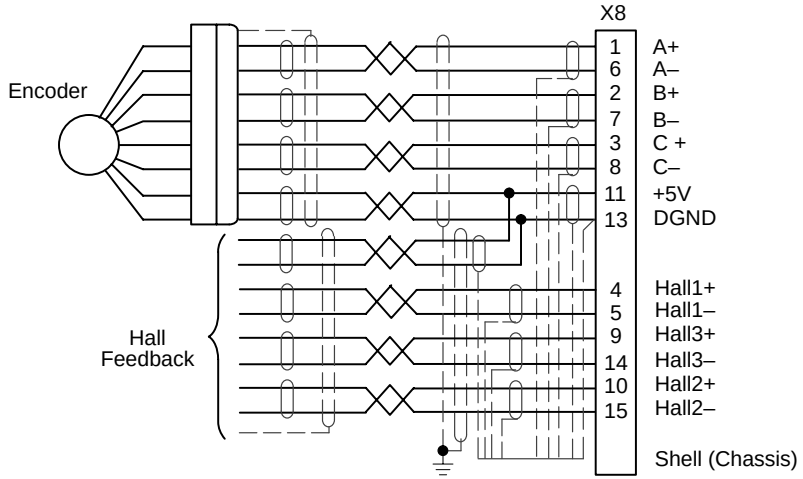


Figure 3-18 Encoder with Hall Tracks Connections for CE Installations

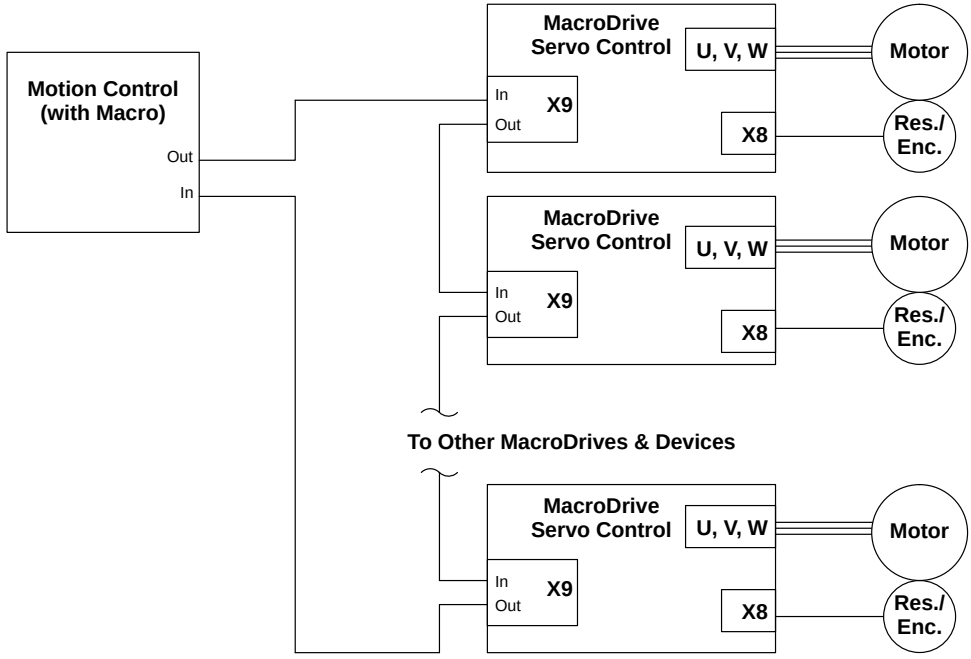


X10 – 15 pin Sub D, User I/O

These inputs operate from a customer provided 24VDC (20 – 30VDC @ 20mA) power source.

Pin	Signal Name
1	Input Ground
2	Input 2
3	Input Home
4	N.C.
5	Output 2
6	Input 0
7	Input 3
8	Limit Switch input (–)
9	Output 0
10	Output position
11	Input 1
12	External Error Input
13	Limit Switch input (+)
14	Output 1
15	Common High for all Outputs

Figure 3-19 MacroDrive System Connection Diagram



Section 4
Switch Setting and Start-Up

Switch Settings

AS1 – Motor and Resolver Definition

AS1 switches are located on the front panel below the “Monitor” LEDs.

Note: All switches are shown in the “OFF” position.

AS1–	**Function**
1	**Pole Pair** (only for resolver commutation). Off Motor with 4 pole pairs, ie, 8 poles On Motor with 2 pole pairs, ie, 4 poles
2	**Resolver resolution** (only for resolver commutation). Off Resolver Resolution = 4096 counts / Rev On Resolver Resolution = 1024 counts / Revolution
3	**Motor with/without Over Temperature Sensor** Off Motor with Over Temperature Sensor On Motor without Over Temperature Sensor
4	Not Used

SW1 (Servo Node) Description

SW1=	Switch Number			
	3	**2**	**1**	**0**
0	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	ON
2	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON
4	OFF	ON	OFF	OFF
…				
E	ON	ON	ON	OFF
F	ON	ON	ON	ON

SW1 establishes how many servo nodes (0 – 15), and which servo nodes will be used on the MACRO station. It also establishes the mapping of MACRO node numbers to MACRO Station channel numbers. This mapping information is important during software setup.

Note: All switches shown in “OFF” position.

SW2 (Master IC) Description

SW2=	Switch Number			
	3	**2**	**1**	**0**
0	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	ON
2	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON
4	OFF	ON	OFF	OFF
…				
E	ON	ON	ON	OFF
F	ON	ON	ON	ON

SW2 establishes the “Master” number for communication with the MACRO station. The factory setting is 0, so the Macro station will respond to Master0.

Note: All switches shown in “OFF” position.

Node Number	SW1	SW2
0	0	0
1	1	0
4	4	0
5	5	0
8	8	0
9	9	0
12	C	0
13	D	0
16	0	1
17	1	1
20	4	1
21	5	1
24	8	1
25	9	1
28	C	1
29	D	1
32	0	2
33	1	2
36	4	2
37	5	2
40	8	2
41	9	2
44	C	2
...	...	...

For MacroDrives with firmware version **2.114–24.01.00** or later. This table describes node number settings using switches SW1 and SW2.

After switches SW1 and SW2 are set, go to the terminal window of the MacroDrive Setup software and set the variable

```
MSx,i942-$7FFFFE
```

Other variables will be set by the setup software.

Note: This variable must be set after a reset command is issued (`MS$$$***x,`).

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 X1-U, V and W.
2. Verify that switches AS1, SW1 and SW2 are set correctly.
3. Verify the AC line voltage at the source matches the control rated voltage.
4. Verify the “Logic Power” is +24VDC (only if the option is present on your MacroDrive).
5. Inspect all power connections for accuracy, workmanship and tightness.
6. Verify that all wiring conforms to applicable codes.
7. Verify that the control and motor are properly grounded to earth ground.
8. Check all signal wiring for accuracy.

Power On Checks

After successful power–up, the Monitor 1 and 2 LED’s should display the following:

d Monitor 1 LED display.

A Monitor 2 LED display (“A” or “O” depends on MSX, I18 setting. This is the amplifier fault polarity within the PMAC2.)

Procedure:

1. Apply logic power (only if your control is equipped with this option).
2. Apply AC power.
3. Continue if the Monitor 1 and 2 LED’s display shows a successful power–up. Otherwise disconnect AC power and refer to Section 6.
4. Start and run the setup program (P2–Setup or Turbo PMAC Setup program version 1.3.0.0 or greater).
5. Disconnect AC power.
6. Connect the load to the motor shaft (or connect the motor wires at X1).
7. Apply AC power.
8. Program the motion control as required for the application. Refer to Section 6 of this manual.

The drive is now ready for use.

Note: To protect the internal fuse, allow at least 1 minute after power down before turning power on (power Off/On cycle).

Table of MacroDrive Variables

Node No. Motor No.	Node 0 1	Node 1 2	Node 4 3	Node 5 4	Node 8 5	Node 9 6	Node 12 7	Node 13 8
MI18	MS0, MI18 =$FF	MS1, MI18 =$FF	MS4, MI18 =$FF	MS5, MI18 =$FF	MS8, MI18 =$FF	MS9, MI18 =$FF	MS12, MI18 =$FF	MS13, MI18 =$FF
MI101	MS0, MI101 =$10	MS1, MI101 =$11	MS4, MI101 =$10	MS5, MI101 =$11	MS8, MI101 =$10	MS9, MI101 =$11	MS12, MI101 =$10	MS13, MI101 =$11
MI102	MS0, MI102 =$11	MS1, MI102 =$10	MS4, MI102 =$11	MS5, MI102 =$10	MS8, MI102 =$11	MS9, MI102 =$10	MS12, MI102 =$11	MS13, MI102 =$10
MI103	MS0, MI103 =$12	MS1, MI103 =$13	MS4, MI103 =$12	MS5, MI103 =$13	MS8, MI103 =$12	MS9, MI103 =$13	MS2, MI103 =$12	MS3, MI103 =$13
MI104	MS0, MI104 =$13	MS1, MI104 =$12	MS4, MI104 =$13	MS5, MI104 =$12	MS8, MI104 =$13	MS9, MI104 =$12	MS12, MI104 =$13	MS13, MI104 =$12
MI105	MS0, MI105 =$14	MS1, MI105 =$15	MS4, MI105 =$14	MS5, MI105 =$15	MS8, MI105 =$14	MS9, MI105 =$15	MS12, MI105 =$14	MS13, MI105 =$15
MI106	MS0, MI106 =$15	MS1, MI106 =$14	MS4, MI106 =$15	MS5, MI106 =$14	MS8, MI106 =$15	MS9, MI106 =$14	MS12, MI106 =$15	MS13, MI106 =$14
MI107	MS0, MI107 =$16	MS1, MI107 =$17	MS4, MI107 =$16	MS5, MI107 =$17	MS8, MI107 =$16	MS9, MI107 =$17	MS12, MI107 =$16	MS13, MI107 =$17
MI108	MS0, MI108 =$17	MS1, MI108 =$16	MS4, MI108 =$17	MS5, MI108 =$16	MS8, MI108 =$17	MS9, MI108 =$16	MS12, MI108 =$17	MS13, MI108 =$16
MI910	MS0, MI910 Resolver:7 Encoder:3	MS1, MI910 Resolver:7 Encoder:3	MS4, MI910 Resolver:7 Encoder:3	MS5, MI910 Resolver:7 Encoder:3	MS8, MI910 Resolver:7 Encoder:3	MS9, MI910 Resolver:7 Encoder:3	MS12, MI910 Resolver:7 Encoder:3	MS13, MI910 Resolver:7 Encoder:3
MI912	MS0, MI912 =$1	MS1, MI912 =$1	MS4, MI912 =$1	MS5, MI912 =$1	MS8, MI912 =$1	MS9, MI912 =$1	MS12, MI912 =$1	MS13, MI912 =$1
MI916	MS0, MI916 =$0	MS1, MI916 =$0	MS4, MI916 =$0	MS5, MI916 =$0	MS8, MI916 =$0	MS9, MI916 =$0	MS12, MI916 =$0	MS13, MI916 =$0
MI942	MS0, MI942 =$7FFFFE	MS1, MI942 =$7FFFFE	MS4, MI942 =$7FFFFE	MS5, MI942 =$7FFFFE	MS8, MI942 =$7FFFFE	MS9, MI942 =$7FFFFE	MS12, MI942 =$7FFFFE	MS13, MI942 =$7FFFFE
MI974	MS0, MI974 =$1	MS1, MI974 =$1	MS4, MI974 =$1	MS5, MI974 =$1	MS8, MI974 =$1	MS9, MI974 =$1	MS12, MI974 =$1	MS13, MI974 =$1
MI976	MS0, MI976 =$2222	MS1, MI976 =$1111	MS4, MI976 =$2222	MS5, MI976 =$1111	MS8, MI976 =$2222	MS9, MI976 =$1111	MS12, MI976 =$2222	M13S, MI976 =$1111
MI994	MS0, MI994 =$0	MS1, MI994 =$0	MS4, MI994 =$0	MS5, MI994 =$0	MS8, MI994 =$0	MS9, MI994 =$0	MS12, MI994 =$0	MS13, MI994 =$0
MI995	MS0, MI995 =$0080	MS1, MI995 =$0080	MS4, MI995 =$0080	MS5, MI995 =$0080	MS8, MI995 =$0080	MS9, MI995 =$0080	MS12, MI995 =$0080	MS13, MI995 =$0080

PWM Frequency	6.0kHz	8.0kHz
Phase Clock	6.0kHz	8.0kHz
Servo Clock	1.5kHz	2.0kHz
MSX, MI992	4914	3685
MSX, MI997	1	1
MSX, MI998	3	3

Section 5
Operation

Introduction

(**M**otion **a**nd **C**ontrol **R**ing **O**ptical) is a digital interface for connection of multi–axis motion controllers, amplifiers and other I/O devices on a fiber optic or twisted pair copper (RJ45 connector) ring.

MACRO operates in a ring topology. Data is transmitted serially. Each station on the ring has an “in” port for receiving data and an “out” port for transmitting data. Nodes, residing at a station, can be amplifier axes, I/O banks or communication interfaces to other devices. A station can have one or several nodes, allowing for multi–axis amplifiers with a single “in” and single “out” port. Data packets, (groups of 96 bits of serial data), from the motion controller or master node, are addressed to a specific amplifier, or slave node. If the data packet is not for an amplifier, it is passed on, unchanged. If it is for the node, it copies the contents of the data packet (typically commands), places feedback data into a packet and transmits the data packet.

MacroDrive Node Setup (P2–Setup program)

Several hardware and software operations must be performed in a specific sequence when using the MacroDrive digital current loop closure, see Table 5-1. Programming of the PMAC2 motion control must properly set the current loop and direct the PWM output operation. This is quickly accomplished using the setup software provided with the PMAC2 control.

Table 5-1 Motion Control Settings for MacroDrive

Menu Item	Entry
Motion Type Selection:	DC–Brushless
This Motor is:	Rotary (on Macro)
Commutation Method:	Digital Current Loop
PWM Frequency: Phase clock: Servo clock:	8kHz 8kHz (Default) 2kHz (Default)
PWM and Current Feedback Channel:	This motor is assigned to Macro node ...
Set MI942	Set MI942 = $7FFFFE (in the terminal window).
Voltage Check: (Ixx66 will be modified)	Enter the bus voltage of your MacroDrive (160 or 300VDC).
Duty Cycle:	Use 5% (Default). If problems occur, increase the duty cycle in small increments (max = 10%).
On–Going Commutation feedback:	Encoder: 1 (Default); Quadrature default: 4 (Default).
Duty Cycle:	Use 5% (Default). If problems occur, increase the duty cycle in small increments (max = 10%).
Commutation size verification: Counts per revolution:	(Counts per revolution) x 4. Depends on AS1 setting and resolution of feedback device. For example, for high resolution resolver (AS1–2=OFF); (4096 x 4) = 16384 counts per revolution. Activate: autodetect the number of poles.
Motor 1 Input Channel:	Flag Input Channel 1 (default) Amplifier fault (A fault) signal is: High=True Amp fault. Limit switches Disabled/Enabled depending on system wiring.

After current loop tuning, “Current Protection” is next.

Table 5-1 Motion Control Settings for MacroDrive Continued

Menu Item *	**Entry**
Current Loop Tuning:	Use autotune feature. Activate “Auto–Select Bandwidth”. If problems occur, change “Test Scale Factor”. (Check Ixx66 after changing the “Test Scale Factor”)
What is the max time....	Enter the I^2t time of the MacroDrive as follows: 2.5A / 5A = 2.88 seconds 7.5A = 15A = 1.25 seconds
Duty Cycle:	Use 5% (Default). If problems occur, increase the duty cycle in small increments (max = 10%).
Open Loop Test	Perform this test with the default values.
Fine Phasing Calibration	DO NOT perform the “Fine phasing calibration”!!!! Skip this step by pressing “Continue”.
Applying the Phase Register Value:	Incremental Encoder. (Hall effect)
Position Loop Feedback Sensor Setup:	Incremental Encoder (default).
Position Encoder Channel Selection:	Encoder Quadrature Decode *4 (default)
Velocity Loop Feedback Sensor Setup:	Incremental Encoder (default)
Velocity Encoder Channel Selection:	Encoder Quadrature Decode *4 (default)
Position Loop Tuning:	Choose Autotuning. Select: “Choose an initial bandwidth” All other values as default. Press “Begin PID Loop Autotuning” Deactivate “Choose an initial bandwidth for me” Increase the Desired Bandwidth by 2 or 3 times. Damping Ratio = 0.7 and click “Autotune again”. Activate “Auto–Select Velocity Feedforward” and “Auto–Select Accel Feedforward”. Choose the feature “I want my integral action to be” Click Autotune again Implement new gains and exit Autotune.
Motor Referencing (Homing) Setup: I will reference (home) on:	C–channel “high” (default). Use only when home limit switch is not wired. Otherwise it depends on the limit switch wiring.
** Incremental Encoder Fine Phasing:	Homing speed will be: 32 cts/msec (default) The exact value for a **Baldor Resolver** is Mx71= (I x 71) 0.5 The exact value for a **Baldor Encoder** is Mx71= (I x 71) 0.333

***** Refer to Figure 5-1 for I^2t calculations.

****** For this setting you could use the “TurboPMAC Setup” program. This is described on page 5–5 “Motor 1 Input Channel” and “Incremental Encoder Fine Phasing”.

All parameters are set. Parameter values should be downloaded and saved.
To save the values, change to terminal mode and enter the “Save” command to store the value in PMAC flash memory. Next, enter the “MSSAVEX” command to save all macro data to the macro flash memory. (X is the node number for the MacroDrive you are setting up. This process must be repeated for each MacroDrive.)

Rough and fine phasing

Rough phasing is required for incremental encoders. PMAC must first perform "rough phasing" after a reset (see PMAC2 software reference, variable IX80). The setup program sets the variable to IX80=2, i.e. "phasing search on "$" command only" is used. Setting of IX80=3 is not possible because during macro operation no automatic "rough phasing" is possible upon power–up (see PMAC2 software reference, IX80).

Variables IX73 and IX74 must be set to the correct values (motor under/without load). Rough phasing must be manually performed by input of "#X00" (motor no. X, 00 = enable) and by input of "#X$" (motor no. X, $ = rough phasing).

Now, the program for "fine phasing" may be started. Enter "I5=2" and "enable plc1X" (X = motor no.), then the motor is ready to operate.

Using the function "upload PLC program" in the File menu of the program PEWIN32, it is possible to edit the program "fine phasing" generated by the setup program. In this program, by adding the following lines, after a reset, "rough phasing" and "fine phasing" may be automatically executed:

The following lines have been inserted to perform automatic "rough phasing" and "fine phasing" after reset, in this example: motor 1, node 0.

This PLC must in turn be downloaded, set I5=2 and store everything in PMAC. This causes the necessary steps to be automatically executed after reset.

8 Axis Control

Generally, 8 MacroDrives can be controlled by one motion controller (PMAC2). SW1 is used to tell the MacroDrive which node it is (0, 1, 4, 5, 8, 9, 12 or 13).

Table 5-2 SW1 Node Definitions (For firmware 1.113 only).

SW1	Node
8	0 and 1
9	4 and 5
10	8 and 9
11	12 and 13

Nodes 0, 4, 8, 12 (For firmware 1.113 only).

1. First, connect 4 MacroDrives and the PMAC station into a macro ring. Set each of the MacroDrives to a different node address (SW1 = 8, 9, 10, 11).
2. Now, the power supply is switched on for all terminals and all nodes are enabled (in the setup program for motor 0, motor 4, motor 8 and motor 12, in each case execute step 1 "macro ring node", in each case allocate the preset values).
3. At the terminal, input "MS0, MI974=$1", MS4,MI974=$1", MS8,MI974=$1", MS12,MI974=$1", then "MS0, MI976=$2", MS4,MI976=$20", MS8,MI976=$200", MS12,MI976=$2000".
4. By inputting "MSSAVE0", "MSSAVE4", "MSSAVE8", "MSSAVE12", the modifications are stored.
5. After reset by input of "MS$$$0", "MS$$$4", "MS$$$8", "MS$$$12", the devices now react (depending on SW1) to the nodes 0, 4, 8, 12.

Nodes 1, 5, 9, 13 (For firmware 1.113 only).

1. First, connect 4 MacroDrives and the PMAC station into a macro ring. Set each of the MacroDrives to a different node address (SW1 = 8, 9, 10, 11).

Note: As delivered, the MacroDrives are now at nodes 0, 4, 8, 12. This will be changed later in this procedure.

2. Now, the power supply is switched on for all terminals and all nodes are enabled (in the setup program for motor 0, motor 4, motor 8 and motor 12, in each case execute step 1 “macro ring node”, in each case allocate the preset values).
3. At the terminal, input “MS0, MI974=$1”, MS4,MI974=$1”, MS8,MI974=$1”, MS12,MI974=$1”, then “MS0, MI976=$1”, MS4,MI976=$10”, MS8,MI976=$100”, MS12,MI976=$1000”.
4. Then, at the terminal, input “MS0, MI101=$11”, “MS0, MI102=$10”, “MS4, MI103=$13”, “MS4, MI104=$12”, “MS8, MI105=$15”, “MS8, MI106=$14” “MS12, MI107=$17”, “MS12, MI108=$16.
5. By inputting “MSSAVE0”, “MSSAVE4”, “MSSAVE8”, “MSSAVE12”, the modifications are stored.

   Reset each MacroDrive by input of “MS$$$0”, “MS$$$4”, “MS$$$8”, “MS$$$12”, the devices are now nodes 1, 5, 9, 13.

Note: The MacroDrives are now at nodes 1, 5, 9, 13.

Now, all 8 devices may be controlled on a macro ring by one motion controller. The PMAC2 may assign a different motor number than the node number. For example, Motor 4 attached to Node 5 etc. (See Table 5-3).

Table 5-3 Motor Number vs Node Number

Motor Number	Node Number
1	0
2	1
3	4
4	5
5	8
6	9
7	12
8	13

Monitor2 Error After correct and successful setup, Monitor2 still displays “A” amplifier fault because its’ input is not used. To correct this, input “MS0, MI18=$FF” at the terminal to set all error inputs to “high active”. After storing using “MSSAVEX” (separately for each node X) and after reset using “MS$$$X”, the display of “A” disappears on monitor 2.

Using X10 (User I/O)

To be able to use these inputs and outputs, the I/O states (high/low) must first be configured.

Inputs limit+, limit–, fault_ext and home are set by the setup program (“Motor 1 Input Channel:” and “Incremental Encoder Fine Phasing:“), these inputs are inverted (voltage at the input –> bit is low).

Motor 1 Input Channel:	Flag Input Channel 1 (default) My amplifier fault (A fault) signal is: High=True Amp fault. Limit switches Disabled/Enabled depending on system wiring.

Incremental Encoder Fine Phasing:	My homing speed will be: 32 cts/msec (default)

(Firmware 1.113 and 2.114 24.01.00)

The inputs In0, In1, In2, In3 as well as the outputs Out0, Out1, Out2 are configured by entering the following commands at the terminal:

Note: This must be separately executed for each node X address.

```
MS(node), MI198 = $40C085 ;   Y:Memory, 8 bit, address $C085
MS(node), MI199 = $00FF ;     Enable bits
MS(node), MI198 = $B0C081 ;   X:Memory, 8 bit, address $C081
MS(node), MI199 = $00F0 ;     Set inputs and outputs
MS(node), MI198 = $40C081 ;   Y:Memory, 8 bit, address $C081
MS(node), MI199 ;             Now, read or write the data bits. Remember the
                              upper bits are output and the lower bits are input.
```

The inputs are read using “MSX, MI199” (inputs are inverted, no voltage applied = bit is high). The lower 4 bits (the smallest hex number) represent the 4 inputs.

Examples:
In 0 : low; In 1 : low; In 2: low; In 3: low –> MSX, MI199 –> $00000000000F
In 0 : low; In 1 : high; In 2: low; In 3: high –> MSX, MI199 –> $00000000000A
In 0 : high; In 1 : low; In 2: low; In 3: low –> MSX, MI199 –> $00000000000E

The outputs are read using the command “MSX, MI199=$Y0”. The lower 3 bits of Y represent the outputs, binary coded, as a hex number:

Examples:
MSX,MI199=$10: Out 0: high; Out 1: low; Out 2: low
MSX,MI199=$10: Out 0: low; Out 1: high; Out 2: high

Using x10 (User I/O) – (Firmware 2.114 updated 12.04.00)
The I/O are now automatically set (IN0, IN1, IN2, IN3, OUT0, OUT1, OUT3).

`MI980:` Reading `MI980` will input Macro Gates "`I024 – I027`" (IN).

`MI982:` Allows individual bit inversion of the Macro Gates "`I024 – I027`" (IN) data.
A bit value of "1" will invert the data read.

`MI983:` Setting `MI981=1` will initialize the 4 bit I/O ports and set `MI984 = MI985.` It is automatically done at $$$ and Ring Break. It can be done anytime and `MI983` automatically clears – returns to zero.

`MI984:` Writing to `MI984` will output to lines "`I028 – I031`" (OUT) of the Macro Gate.

`MI985:` `MI985` is the value written to `MI984` when `MI983` is set to "1".

`MI986:` Allows individual bit inversion of the Macro Gates "`I028 – I031`" (OUT).
A bit value of "1" will invert the data written.

Figure 5-1 I^2t formula: Example of Current Protection Calculations

Note: I_{Cont} = Continuous Current of the Control
I_{Peak} = Peak Current of the Control
(Choose the smallest I_{Cont} and I_{Peak} values from the Control or Motor data, see example below)
$I_{A/D}$ = 1.25 x I_{peak} (Current from the A/D Converter of the control)

Caution: If these I^2T protection values are set incorrectly, a Series B motor can be demagnetized.

$$IX57 = \frac{I_{Cont}}{I_{A/D}} \times cos30^\circ \times 32768$$

$$IX69 = \frac{I_{Peak}}{I_{A/D}} \times cos30^\circ \times 32768$$

$$IX58 = \frac{(IX69)^2 - (IX57)^2}{(32768)^2} \times Servo\ update\ rate\ (Hz) \times I^2t\ time\ (seconds)$$

$$IX58 = \frac{(I_{Peak})^2 - (I_{Cont})^2}{(I_{A/D})^2} \times (cos\ 30^\circ)^2 \times Servo\ update\ rate\ (Hz) \times I^2t\ time\ (seconds)$$

$$IX58 = \frac{(I_{Peak})^2 - (I_{Cont})^2}{(I_{A/D})^2} \times 0.75 \times Servo\ update\ rate\ (Hz) \times I^2t\ time\ (seconds)$$

Example:

Control = MA2A07T . . .
I_{Cont} = 7.5A (RMS)
I_{Peak} = 15A (RMS)
$I_{A/D}$ = 1.25 * 15A (RMS) = 18.75A (RMS)
I^2t time = 1.25 seconds (for MA2A05 2.88 seconds)

Motor = BSM 63A–333AA
I_{Cont} = 6.4A (RMS)
I_{Peak} = 24A (RMS)

Choose smallest values for I_{Cont} and I_{Peak}

PMAC2Ultra–Lite: Servo update rate = 2000Hz, PWM Frequency = 8kHz. (I992=3685, I997=1, I998=3)

$$IX57 = \frac{6.4A}{18.75A} \times cos30^\circ \times 32768 = 9686$$

$$IX69 = \frac{15A}{18.75A} \times cos30^\circ \times 32768 = 22702$$

$$IX58 = \frac{(15A)^2 - (6.4A)^2}{(18.75A)^2} \times 0.75 \times 2000\ (Hz) \times 1.25 = 982$$

⚠ **Caution:** **Incorrect tuning of the Current Loop can cause current overshoot and a Series B motor can be demagnetized. Verify calculated values with the TurboPMAC Setup program. For best performance, you may select gain values up to 4 times greater or less than the calculated values.**

Figure 5-2 Setting PI Gains for PMAC Current Loop

I_{PD} = Peak drive current (RMS)
l_{p-p} = Motor phase to phase inductance (henries)
R_{p-p} = Motor phase to phase resistance (ohms)

1. `Ixx66` = (`1.1`) x (`I6800`)
PWM Frequency = 8kHz
Bus Voltage = 320VDC

$$Ki = \left(44.27297 \times 10^{-3}\right) \times L_{p-p} \times \left(\frac{I_{PD}}{4}\right) = Ixx61$$

$$Kp = \left(\frac{I_{PD}}{4}\right) \times \left[\left(1.0522 \times L_{p-p}\right) - \left(\frac{R_{p-p}}{1253.959}\right)\right] = Ixx62 \text{ or } Ixx76$$

2. `Ixx66` = (`1.1`) x (`I6800`)
PWM Frequency = 6kHz
Bus Voltage = 320VDC

$$Ki = \left(59.031 \times 10^{-3}\right) \times L_{p-p} \times \left(\frac{I_{PD}}{4}\right) = Ixx61$$

$$Kp = \left(\frac{I_{PD}}{4}\right) \times \left[\left(1.0522 \times L_{p-p}\right) - \left(\frac{R_{p-p}}{1253.959}\right)\right] = Ixx62 \text{ or } Ixx76$$

3. `Ixx66` = (`1.1`) x (`I6800`)
PWM Frequency = 8kHz
Bus Voltage = 560VDC

$$Ki = \left(25.2995 \times 10^{-3}\right) \times L_{p-p} \times \left(\frac{I_{PD}}{4}\right) = Ixx61$$

$$Kp = \left(\frac{I_{PD}}{4}\right) \times \left[\left(0.601 \times L_{p-p}\right) - \left(\frac{R_{p-p}}{2194.364}\right)\right] = Ixx62 \text{ or } Ixx76$$

4. `Ixx66` = (`1.1`) x (`I6800`)
PWM Frequency = 6kHz
Bus Voltage = 560VDC

$$Ki = \left(33.7328 \times 10^{-3}\right) \times L_{p-p} \times \left(\frac{I_{PD}}{4}\right) = Ixx61$$

$$Kp = \left(\frac{I_{PD}}{4}\right) \times \left[\left(0.601 \times L_{p-p}\right) - \left(\frac{R_{p-p}}{2194.364}\right)\right] = Ixx62 \text{ or } Ixx76$$

Section 6
Troubleshooting

Overview

The system troubleshooting procedures involves observing the status of the "Ready" LED, the "DB On" LED and the "Monitor 2" 7 segment display. The tables in this section provide information related to the indications provided by these devices. If operation is normal, Monitor 1 should display a "d" or "." and the Ready LED is GREEN. If an error is detected, the Ready LED is RED.

Note: The "Ready" LED can display RED, YELLOW or GREEN color.

Table 6-1 LED Functions

LED	Function
DB ON	The "DB ON" LED is on whenever dynamic brake power is dissipated into the db (dynamic brake) resistor. The DB resistor is also called a regen resistor.
Ready	If a PSM fault occurs, the "Ready" LED will be RED. If no faults are present, the LED is GREEN.
PWR	If voltage is applied to the control, the "PWR" LED is on.
WD	The "WD" LED (software watch dog timer) is ON if a watchdog error occurred.

Note: To protect the internal fuse, allow at least 1 minute after power down before turning power on (power Off/On cycle).

It is important to connect the motor leads U, V and W correctly at the X1 connector of the control. Incorrect wiring can cause erratic operation including moves at peak force until the overcurrent limit trips. If erratic movement of the motor occurs, turn off power immediately and check the connections of the motor, hall sensors and encoder.

Monitor 1 The Monitor 1 LED can display the error codes shown in Table 6-2.

Table 6-2 Monitor 1 Error Display

Error Code	Description
1	Overvoltage – Amplifier DC Bus voltage too high.
2	BPS Fault – BPS Power Supply error.
3	Overcurrent – IPM error (IPM: overcurrent, overtemperature or power supply error)
4	Voltage Fault – Voltage fault in the logic supply.
5	Encoder/Resolver Fault At encoder – Missing encoder signal (check connections). At Resolver – Missing resolver connection (check connections). or velocity is too high.
6	Overtemperature – Overtemperature of the power stage is detected.
7	Not applicable.
8	Overfrequency – PWM frequency is too high (> 10kHz).
9	Motor overtemperature – Motor temperature is too high. (AS1–3 selects if temperature is to be monitored).

All errors except “2” are stored on the PWM interface card memory. Reset an error with the Enable line or “o0” in the PMAC terminal program.

In addition to error codes, Table 6-3 lists the operation status that can be displayed by the Monitor 1 display.

Table 6-3

Status Code	Description
d	Disabled – Amplifier is disabled (not active).
.	Enabled – Amplifier is enabled (active).

Monitor 2 Display The Monitor 2 LED can display the error codes shown in Table 6-4.

Table 6-4 Monitor 2 Error Display

Error Code	Description
A	Amplifier Fault – Power stage fault (PWM card).
b	Ring Break – Communication on the Macro Ring is broken.
C	CPU Fault – Failure detected in RAM or PROM.
d	Ring Error – Communication error detected on the Macro Ring.
E	Encoder Fault – Error detected in the encoder feedback.
F	Temporary Fault – No action taken.

In addition to error codes, Table 6-5 lists the operation status that can be displayed by the Monitor 2 display.

Table 6-5 Monitor 2 Status Display

Status Code	Description
0	0 axes are active.
1	1 axis is active.

Section 7
Specifications & Product Data

Identification

Servo Amplifier **MA X A XX X X –R M 0 3**

MacroDrive

Input Voltage
1=115VAC
2=230VAC
4=460/400VAC

Current Rating
A02 = 2 / 2.5 Amps
A05 = 5 Amps
A07 = 7.5 Amps
A10 = 10 Amps
A15 = 15 Amps
A20 = 20 Amps

Enclosure Type
T= Panel Mount w/internal power supply
P= Panel Mount w/external power supply
S = Panel Mount w/internal power supply (suitable for sharing with other controls).

Braking (Option)
R = Requires external regen resistor
B = Built-in regen resistor
O = No internal regen capability

Logic Supply (Option)
0 = Internal 24VDC Supply
3 = External customer provided 24VDC required

No Serial Port

Macro Bus

Feedback Device (Option)
R = Resolver
E= Encoder

Specifications for 115 and 230VAC models only.

Description	Unit	MAx A02T	MAx A05T	MAx A07T	MAx [2] A02S	MAx [2] A05S	MAx [2] A010S	MAx [2] A015S
Input Voltage Range Nominal Minimum Maximum	VAC	115 / 230 92 / 184 132 / 265						
Input Frequency	Hz	50/60 ±5%						
Nominal Output Bus (@ 115 / 230 input) Nominal Minimum Maximum	VDC	160 / 320 88 / 176 180 / 360						
Nominal Phase Current (±10%)	A_{RMS}	2.5	5.0	7.5	2.0	5.0	10	15
Peak Phase Current (±10%); for 2.4sec (+0.5s/–0sec) maximum [1]	A_{RMS}	5	10	15	4	10	20	30
Nominal Output Power	KVA	1.01	2.17	2.99	0.87	2.17	4.33	5.2
Output Frequency	Hz	0 – 500						
Efficiency	%	>95						
Nominal Switching Frequency	KHz	8.0 (software selectable)						
Mounting	–	Panel						
Package Size	–	A	B	C	E	E	E	E
Operating Altitude	Feet (Meters)	To 3300 feet (1000 meters). Derate the continuous and peak output current by 1.1% for each 330 feet (100 meters) above 3300 feet.						
Operating Temperature	°C	+0 to 40. Above 40°C, derate the continuous and peak output current by 2.5% per °C above 40°C. Maximum ambient is 50°C.						
Rated Storage Temperature	°C	–25 to +70						
Humidity	%	10% to 90% non-condensing						
Class of Protection (Enclosure)		IP20						
Shock		10G (according to DIN IEC 68–2–6/29)						
Vibration		1G @ 10 – 150 Hz (according to DIN IEC 68–2–6/29)						

[1] Valid for zero current initial condition.

[2] These specifications also apply to model MAXAxxP except it has DC input (no AC input).

All values at ambient temperature of 25°C unless otherwise stated.

Specifications Continued for 400/460VAC models only.

Description	Unit	MA4 A02TB	MA4 A05TB	MA4 A07TR	MA4 A15TR	MA4 A20TR
Input Voltage Range Nominal Minimum Maximum	VAC	460 @ 60Hz / 400 @ 50Hz 400 / 360 528 / 480				
Input Frequency	Hz	50/60 ±5%				
Nominal Output Bus (@ 400 / 460 input) Nominal Minimum Maximum	VDC	565 / 678 509 / – – / 746				
Nominal Phase Current (±10%)	A_{RMS}	2.5	5	7.5	15	20
Peak Phase Current (±10%); 2.4s +0.5s/–0s [1]	A_{RMS}	5	10	15	30	40
Nominal Output Power	KVA	1.9	3.8	5.7	11.4	15.2
Output Frequency	Hz	0 – 500				
Efficiency	%	>95				
Nominal Switching Frequency	KHz	8.0 (software selectable)				
Mounting	–	Panel				
Package Size	–	G	G	G	H	H
Operating Altitude	Feet (Meters)	To 3300 feet (1000 meters). Derate the continuous and peak output current by 1.1% for each 330 feet (100 meters) above 3300 feet.				
Operating Temperature	°C	+0 to 40. Above 40°C, derate the continuous and peak output current by 2.5% per °C above 40°C. Maximum ambient is 50°C.				
Rated Storage Temperature	°C	–25 to +70				
Humidity	%	10% to 90% non-condensing				
Class of Protection (Enclosure)		IP20				
Shock		10G (according to DIN IEC 68–2–6/29)				
Vibration		1G @ 10 – 150 Hz (according to DIN IEC 68–2–6/29)				

[1] Valid for zero current initial condition.

All values at ambient temperature of 25°C unless otherwise stated.

For safe operation, allow a clearance distance between each control and on all sides of each control.

24VDC Logic Power Input (Option MAXAxxxx–xxx3 ONLY) for 115 and 230VAC models only.

Description	Unit	MAx A02T	MAx A05T	MAx A07T	MAx A02S	MAx A05S	MAx A10S	MAx A15S
Input Voltage (maximum ripple = ±10%)	VDC	20 – 30						
Input Current @ 24VDC	A_{RMS}	1.2 [1]			1.4			
Power On surge current (24VDC 100msec)	A_{RMS}	4.0			4.0			

[1] Depends on installed options.

24VDC Logic Power Input Continued (Option MA4Axxxx–xxx3 ONLY)

Description	Unit	MA4 A02	MA4 A05	MA4 A07	MA4 A15	MA4 A20
Input Voltage (maximum ripple = ±10%)	VDC	20 – 30				
Input Current @ 24VDC	A_{RMS}	1.6	1.6	1.6	1.8	1.8
Power On surge current (24VDC 100msec)	A_{RMS}	4.0	4.0	4.0	4.0	4.0

Resolver Feedback

Description	Unit	All
Resolution (Depends on AS1 setting.)	bit	Velocity < 6100RPM → Resolution 14 bits Velocity > 6100RPM → Resolution 12 bits
Pole Pairs		1
Resolver Winding Ratio		0.5

Simulated Encoder Output

Description	Unit	All
Signal		RS422
Encoder Resolution (set by switch AS1)	ppr	1024, 4096 [1]

Encoder Input

Description	Unit	All
Signal Type		RS422
Operating Mode		A / B Quadrature
Maximum Input Frequency	kHz	125
Cycle Time	msec	1

[1] Factory Setting

Regeneration

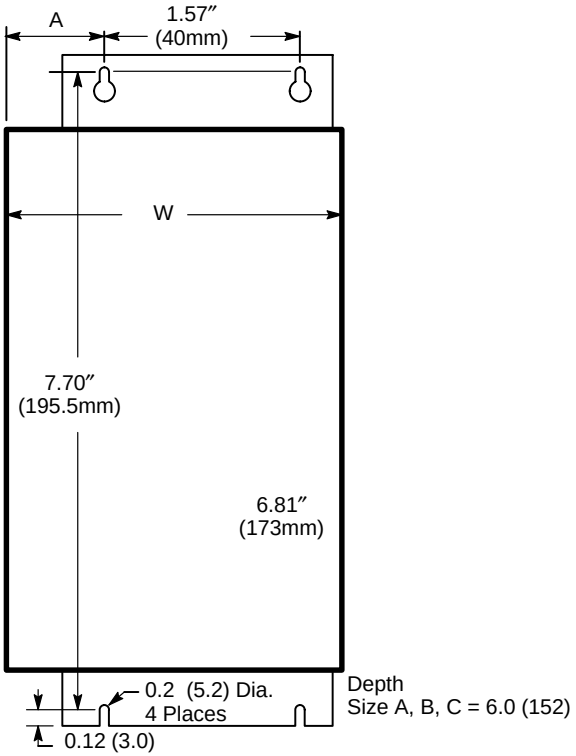
Description	Unit	MAx A02T	MAx A05T	MAx A07T	MAx A02S	MAx A05S	MAx A10S	MAx A15S
Switching Threshold 115VAC 230VAC	VDC	ON: OFF: 188 - 195 183 - 188 373 - 383 362 - 372			ON: OFF: 180 200 388 375			
Nominal / Peak Power (10% Duty Cycle)	kW	0.25 / 2.7						
Maximum Regeneration Switching Current	A	10						
Maximum Load Inductance	µH	100						

Regeneration Continued

Description	Unit	MA4 A02	MA4 A05	MA4 A07	MA4 A15	MA4 A20
Switching Threshold 400/460VAC	VDC	ON: 794 OFF: 764				
Nominal / Peak Power (10% Duty Cycle)	kW	0.94 / 9.4			2.9 / 29	2.9 / 29
Maximum Regeneration Switching Current	A	15			40	40
Maximum Load Inductance	µH	100				

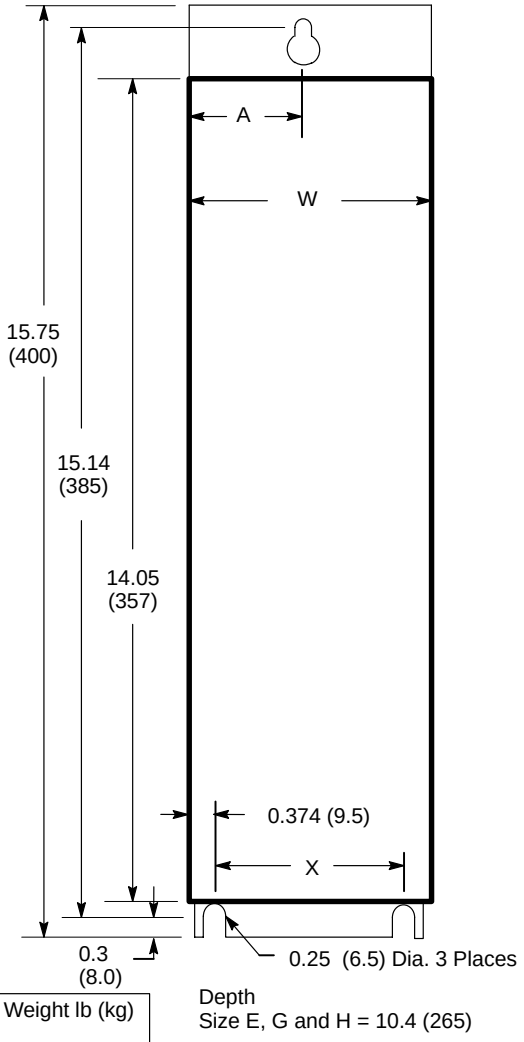
Dimensions

Size A, B and C



Clearance Requirements (all sizes):
0.06″ (15mm) top and bottom
0.04″ (10mm) left and right side

Size E, G and H



Package Size	Dimensions in (mm) A	W	X	Weight lb (kg)
A	0.59 (15)	3.3 (84)	–	2.73 (1.24)
B	0.90 (23)	4.3 (109)	–	4.69 (2.13)
C	0.90 (23)	4.3 (109)	–	4.8 (2.19)
E	1.08 (27.5)	2.17 (55)	1.42 (36)	11 (5)
G	1.28 (32.5)	2.6 (65)	1.81 (46	10.1 (4.6)
H	2.6 (65)	5.3(130)	4.37 (111)	20.9 (9.5)

For safe operation, allow a clearance distance between each control and on all sides of each control.

Section 8
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
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.

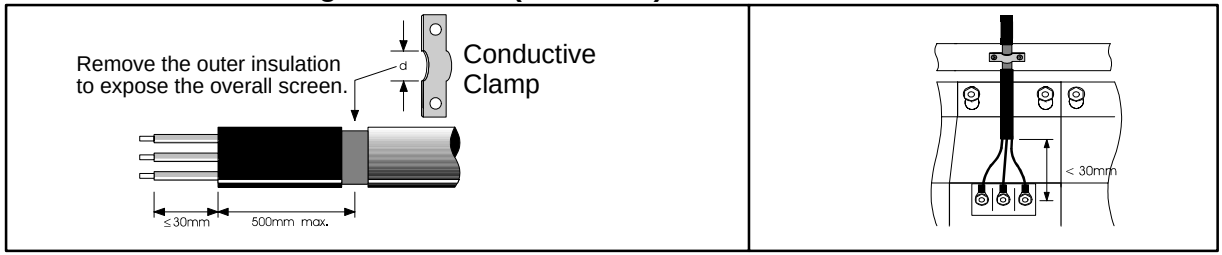
The purpose of the EEC directives is to state a minimum technical requirement common to all the member states within the European Union. In turn, these minimum technical requirements are intended to enhance the levels of safety both directly and indirectly.

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

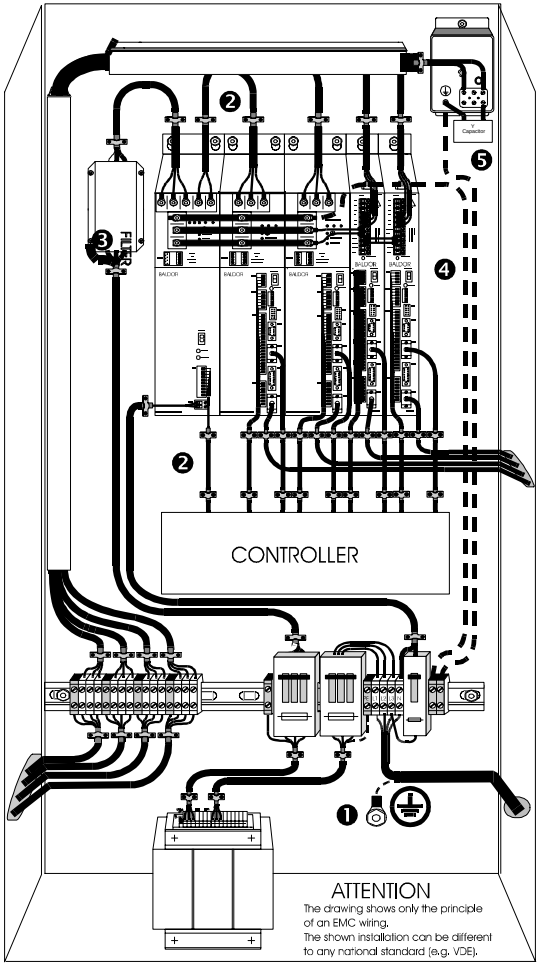


Using CE approved components will not guarantee a CE compliant system!

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^2). 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

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.

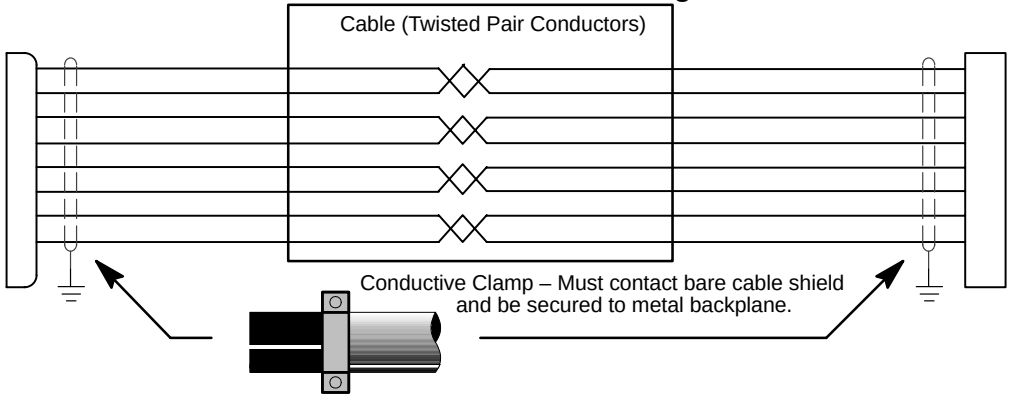
F) Wires inside the enclosure should be placed as close as possible to conducting metal, cabinet walls and plates. It is advised to terminate unused wires to chassis ground. [1]

G) To reduce ground current, use at least a $10mm^2$ (6 AWG) solid wire for ground connections.

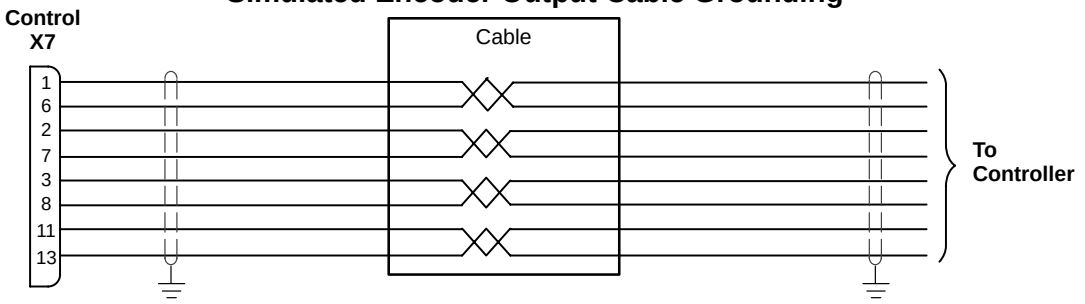
[1] Grounding in general describes all metal parts which can be connected to a protective conductor, e.g. housing of cabinet, motor housing, etc. to a central ground point. This central ground point is then connected to the main plant (or building) ground.

[2] Or run as twisted pair at minimum.

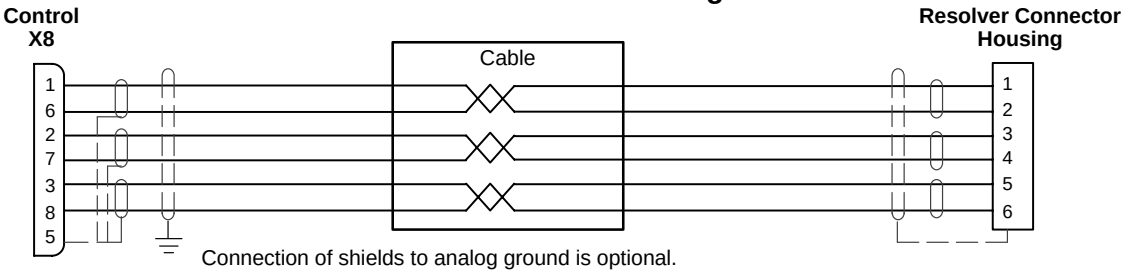
Cable Screens Grounding



Simulated Encoder Output Cable Grounding

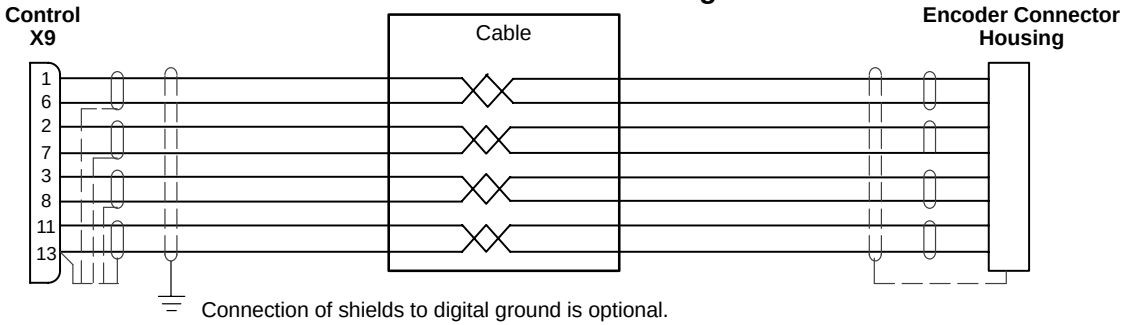


Resolver Cable Grounding



Connection of shields to analog ground is optional.

Encoder Cable Grounding



Connection of shields to digital ground is optional.

Section 9
Accessories and Options

Cables

Shielded (Screened) cable provides EMI / RFI shielding and are required for compliance to CE regulations. All connectors and other components used must be compatible with this shielded cable.

Motor Power Cable

Cable Rated Current	Cable Assembly Description	Baldor Catalog Number	Length	
			Feet	Meters
10 Amps	Power Cable Assembly CE Style Threaded Connector	CBL030SP–MHCE CBL061SP–MHCE CBL091SP–MHCE CBL152SP–MHCE	10 20 30 50	3.0 6.1 9.1 15.2
	Power Cable No Connectors	CBL030SP–M CBL061SP–M CBL091SP–M CBL152SP–M	10 20 30 50	3.0 6.1 9.1 15.2
20 Amps	Power Cable Assembly Threaded connector (Standard-Metric Style)	CBL030SP–FHM CBL061SP–FHM CBL091SP–FHM CBL152SP–FHM	10 20 30 50	3.0 6.1 9.1 15.2
	Power Cable Assembly CE Style Threaded Connector	CBL030SP–FHCE CBL061SP–FHCE CBL091SP–FHCE CBL152SP–FHCE	10 20 30 50	3.0 6.1 9.1 15.2
	Power Cable No Connectors	CBL030SP–F CBL061SP–F CBL091SP–F CBL152SP–F	10 20 30 50	3.0 6.1 9.1 15.2
30 Amps	Power Cable No Connectors	CBL030SP–E CBL061SP–E CBL091SP–E CBL152SP–E	10 20 30 50	3.0 6.1 9.1 15.2

Connectors

Mating Connector by connector number (for spare parts)

X1 – #ASR29714 (9 pin, Female) Phoenix Part No. MVSTBW2,5/9–ST
X1 – #ASR29715 (2 pin, Female) Phoenix Part No. MVSTBW2,5/2–ST
X3 – #ASR10467 (8 pin, Female) Phoenix Part No. MVSTBR2,5/8–ST
X6 – (Centronic 36 pin, Male) – Parallel Printer Connector
X7 – #ASR16215 (9 pin, Male)
X8 – #ASR23345 (9 pin, Female) Resolver
X8 – #ASR25828A (15 pin, Male) Encoder
X9 – Fiber Optic Connector (see your fiber optic installer)

Resolver Feedback Cable

Motor Type	Cable Assembly Description	Baldor Catalog Number	Length	
			Feet	Meters
BSM 50/63/80/90/100	Resolver Feedback Cable Assembly Threaded connector (Standard-Metric Style)	CBL030SF–ALM CBL061SF–ALM CBL091SF–ALM CBL152SF–ALM	10 20 30 50	3.0 6.1 9.1 15.2
	Resolver Feedback Cable Assembly CE Style Threaded Connector	CBL030SF–ALCE CBL061SF–ALCE CBL091SF–ALCE CBL152SF–ALCE	10 20 30 50	3.0 6.1 9.1 15.2
BSM 50/63/80/90/100	Resolver Feedback Cable No Connector	CBL030SF–A CBL061SF–A CBL091SF–A CBL152SF–A	10 20 30 50	3.0 6.1 9.1 15.2

EMC AC Mains Filter AC filters remove high frequency noise to protect the control. These filters also prevent high frequency signals from being transmitted back onto the power lines and help meet CE requirements. To select the proper filter, you must know the voltage and current used by the drive and the impedance of the AC line.

For package size A, B and C (Model T – 1 Phase)

Filter Type	Rated Volts	Rated Amps @ 40°C	Leakage Current mA	Weight lbs (kg)	Baldor No.
FN 2070 - 12	250	12	0.4	1.61 (0.73)	30548

For package size E, G and H (Model S – 3 Phase)

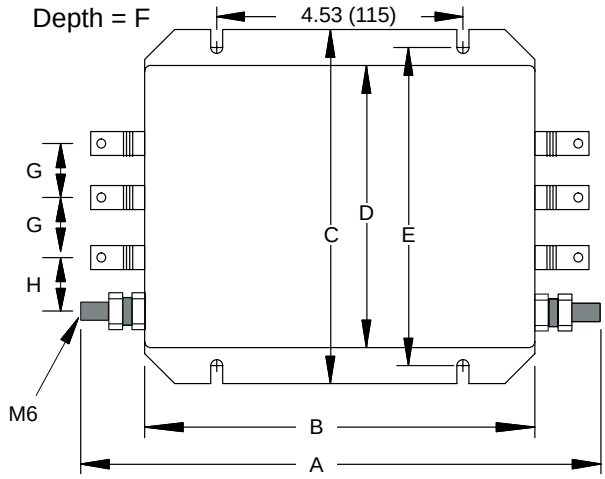
Filter Type	Rated Volts	Rated Amps @ 40°C	Leakage Current mA	Power Losses Watts	Weight lbs (kg)	Baldor No.
FN 351 - 8 - 29	440	8	16	8.0	3.97 (1.8)	ASR24667
FN 351 - 16 - 29	440	16	16	9.0	3.97 (1.8)	ASR24668
FN 351 - 25 - 33	440	25	170	9.0	6.61 (3.0)	ASR24669
FN 351 - 36 - 33	440	63	170	10.5	6.61 (3.0)	ASR24670
FN 351 - 50 - 33	440	50	190	12.5	6.83 (3.1)	ASR24671

For package size E, G and H (Model T – 3 Phase Required for MA4xx)

Filter Type	Rated Volts	Rated Amps @ 40°C	Leakage Current mA	Weight lbs (kg)	Baldor No.
FN 3258 - 30 - 47	480	30	184.7	2.64 (1.2)	ASR30521
FN 3258 - 7 - 45	480	7	172.4	0.11 (0.5)	ASR30522

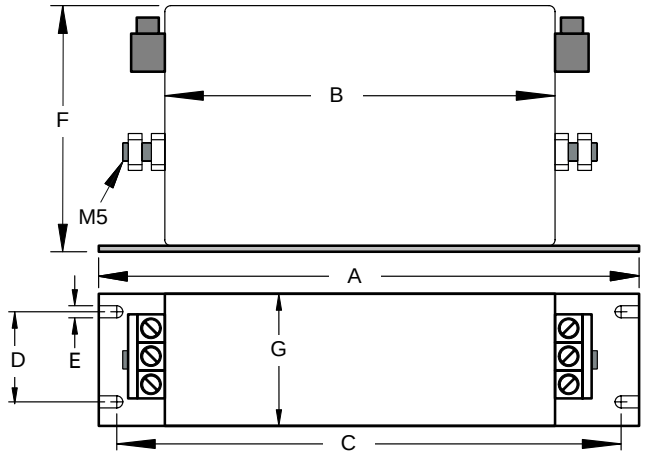
AC Filter Dimensions Continued

Dim.	For FN350	For Filters: FN 351 - 8 - 29	16 - 29	25 - 33	36 - 33	50 - 33
A	5.4 (139)	8.6 (220)	9.45 (240)	9.84 (250)		
B	3.9 (99)	7.1 (180)	7.87 (200)	7.87 (200)		
C	4.2 (105)	4.5 (115)	5.9 (150)	5.9 (150		
D	3.32 (84.5)	3.35 (85)	4.7 (119.5)	4.72 (120)		
E	3.73 (95)	3.93 (100)	5.31 (135)	5.31 (135)		
F	2.24 (57)	2.36 (60)	2.55 (65)	2.55 (65)		
G	0.39 (10)	0.39 (10)	0.39 (10)	0.78 (20)		
H	1.74 (19)	0.76 (19.5)	1.22 (31)	0.83 (21)		



AC Filter Dimensions Continued

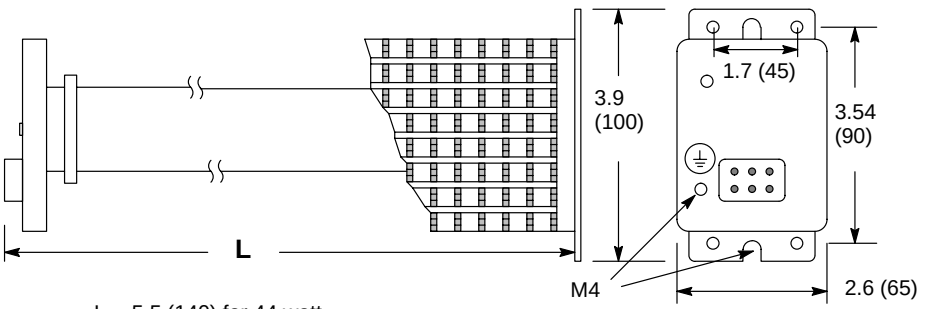
Dim.	For Filters: FN3358-7-45	FN3358-30-47
A	7.48 (190)	10.63 (270)
B	6.29 (160)	9.45 (240)
C	7.08 (180)	10.04 (255)
D	0.79 (20)	1.18 (30)
E	0.18 (4.5)	0.21 (5.4)
F	2.75 (70)	3.35 (85)
G	1.57 (40)	1.97 (50)



Regeneration Resistor Some controls are shipped with an internal regen resistor. If an internal resistor is not present, a regeneration resistor should be installed to dissipate energy during braking if a Fault "1" (over-voltage) occurs.

Control Rated Amps	Package Size	Baldor Catalog Number					
		115VAC Controls		230VAC Controls		400/460VAC Controls	
		Resistor Catalog No.	Resistor Watts	Resistor Catalog No.	Resistor Watts	Resistor Catalog No.	Resistor Watts
2.5	A	RG27	44	RG56	44		
5	B	RG27	44	RG56	44		
7.5	C	RG22	100	RG39	100		
2.5	G					* RG68	320
5	G					* RG68	320
7.5	G					RG68	320
15	H					RG27A	320
22.5	H					RG23	640
2	E	RG4.7	320	RG10	320		
5	E	RG4.7	320	RG10	320		
10	E	RG4.7	320	RG10	320		
15	E	RG4.7	320	RG10	320		

***** "TB" controls have a 200 ohm, 50 watt resistor installed.
"TR" controls require an external REGEN resistor (RG68).



L = 5.5 (140) for 44 watt
8.9 (228) for 100 watt
13.2 (337) for 320/640 watt

Clearance Requirements (all sizes):
2″ (51mm) top and bottom
1″ (26mm) left and right side

For safe operation, allow a clearance distance between each control and on all sides of each control.

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