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Automation

p/n 88-020714-01 A

E-DC Drive Hardware Installation Guide

Effective: May 22, 2002



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IMPORTANT

User Information

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E Series products are used to control electrical and mechanical components of motion control systems. You should test your motion system for safety under all potential conditions. Failure to do so can result in damage to equipment and/or serious injury to personnel.

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CHAPTER ONE

1 Introduction

IN THIS CHAPTER

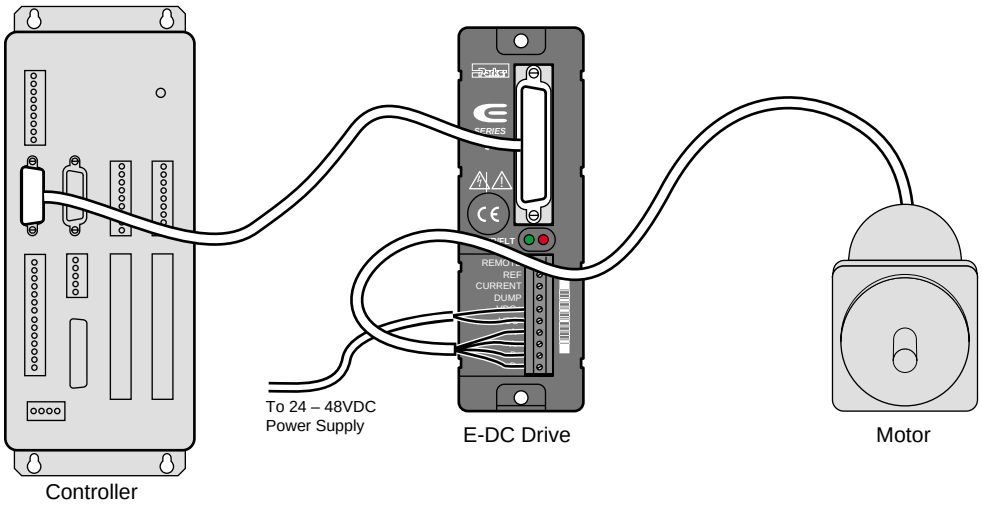
- E-DC Drive Description
- Compatible Motors
- Compumotor Products

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E-DC DRIVE – DESCRIPTION

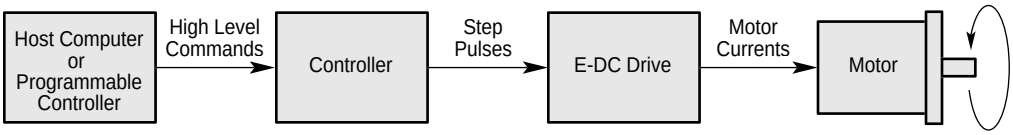
The E-DC Drive is a microstepping drive that runs two-phase step motors. It operates from an external DC power supply, in the range of 24 - 48VDC.

A typical system is shown below.



System Components

The controller sends step and direction signals to the drive. For each step pulse it receives, the drive will commutate the motor to increment rotor position. This is shown in the next drawing.



Block Diagram of E-DC Drive System

The host computer or programmable controller may or may not be necessary, depending upon the controller's capabilities.

The motor can be wired in series or parallel; the amount of current the drive sends to the motor is set by DIP switches.

DIP SWITCHES

DIP switches are located inside the E-DC Drive. During the installation procedure, you will set these DIP switches to configure the drive for motor current, resolution, waveform, and other functions.

CAUTION

Remove power before changing DIP switches

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Inputs and Outputs

All communications with the controller take place through the E-DC Drive's 25 pin D-connector. Available inputs and outputs are:

- Step Input
- Direction Input
- Remote Input
- Fault Output
- Gear Shift Input

Anti-Resonance

All step motors are subject to resonance, and to ringing after quick transient moves. The E-DC Drive has an anti-resonance circuit. This is a general purpose damping circuit that provides aggressive and effective damping. Anti-resonance can be disabled with a DIP switch.

Protective Circuits

Several circuits in the E-DC Drive automatically provide protection for the drive.

- Overtemperature Protection
- Short Circuit Protection
- Power Dump for Regeneration (requires a user-supplied external resistor)

Mounting

The drive is fully enclosed—it does not have air vents. It uses a heatplate technique to provide a heat dissipation path. You must attach the E-DC's heatplate to a suitable heat-dissipating mounting surface.

E-DC Drive – Compatible Motors

Compumotor offers a wide range of motors that are compatible with the E-DC Drive. See *Chapter 2 – Installation* for recommended motors.

Inductance Range

If you use a non-Compumotor motor, its inductance must be above 0.2 mH. For best performance, motor inductance should be between 1 mH and 10 mH, but motors with inductance ratings as low as 0.2 mH or as high as 80 mH may be used.

Compumotor Family of Products

The E-DC Drive is compatible with Compumotor's broad range of microstepper controllers (single-axis and multi-axis) and motion control products.

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CHAPTER TWO

2 Installation

IN THIS CHAPTER

- Product Ship Kit
- Automatic Test
- Motor Selection and Wiring
- Drive Configuration – DIP Switches and I/O
- Mounting the Drive and Motor; Attaching the Load
- Connecting DC Power
- Testing the Installation

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WHAT YOU SHOULD HAVE *(SHIP KIT)*

Inspect your shipment carefully. You should have received one or more of the following:

Part	Part Number
E-DC Drive	E-DC
E-DC Drive Quick Reference Guide	88-020592-01

You may have ordered a motor from one of the following families of Compumotor motors:

OS Motors

VS Motors

INSTALLATION OVERVIEW

Topics in this chapter are arranged to lead you through the installation process in a step–by–step manner. Complete each step before proceeding to the next.

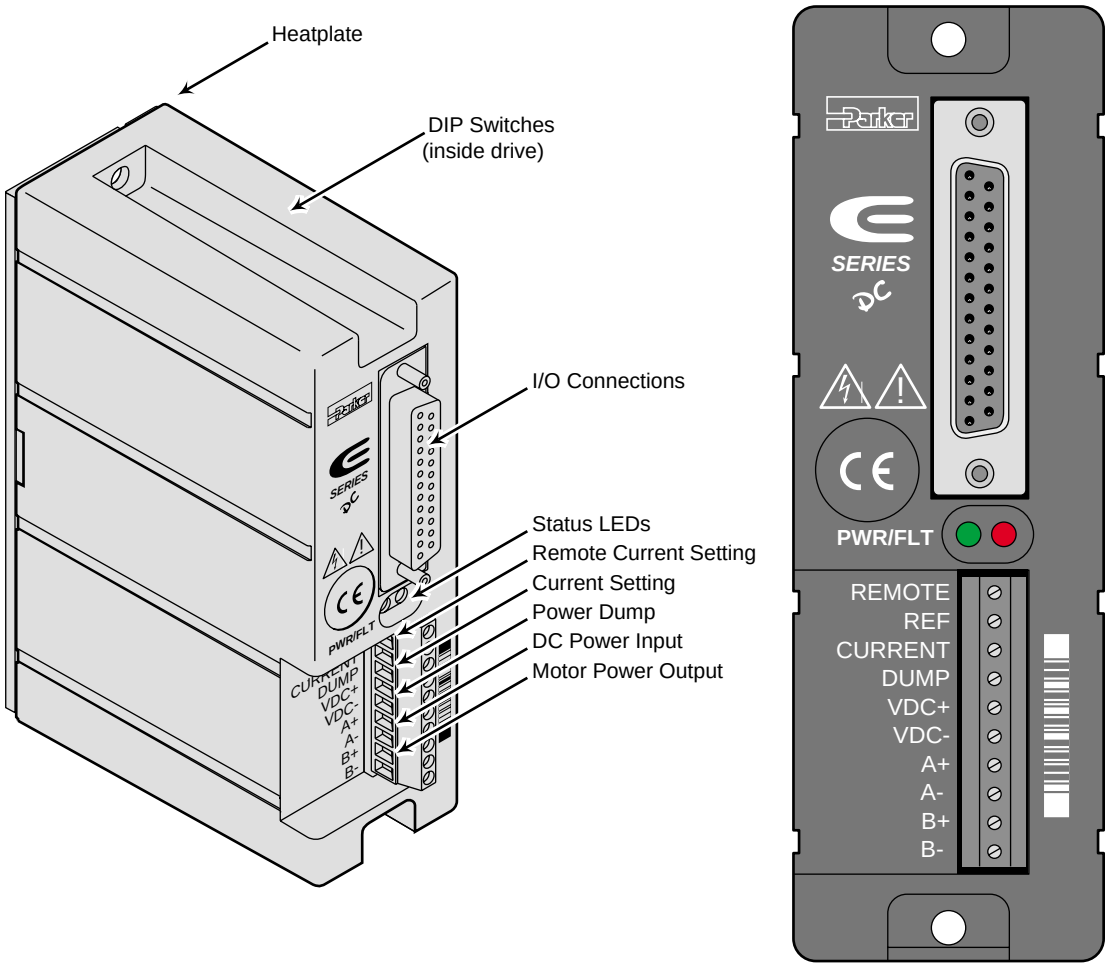
The order of topics in the installation procedure is:

- Automatic Test
- Motor selection: specifications, speed/torque curves and dimensions
- DIP switch configuration
- Motor wiring
- Controller connections and 25 pin D-connector input/output schematic
- Drive mounting
- Motor mounting
- Connecting the load
- Connecting DC power
- Testing the installation

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INSTALLATION PROCEDURE

The next drawing shows locations and names of the various connectors, switches and LEDs that you will encounter during the installation procedure.



Component Locations

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AUTOMATIC TEST

Follow this procedure to have your E-DC Drive perform its *automatic test* function. Once you set DIP switches, connect the motor, and apply DC power, the automatic test will begin—the motor shaft will turn in an alternating mode until you remove power. This will verify that the drive, motor, and motor cable work properly as a system.

This is a *bench top* procedure—you can perform it before you connect a controller, mount the drive, or mount the motor. Full installation instructions follow this *Automatic Test* section.

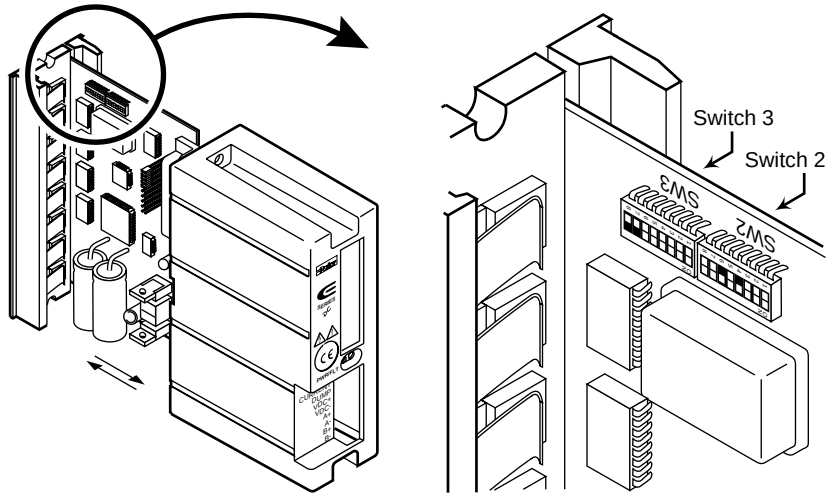
CAUTION

The drive and motor should be mounted to a heatsink. Drive mounting does not affect the following tests, but operating the E-DC Drive and motor for extended periods without proper mounting can cause the drive to fault due to overheating. Possible motor damage may occur. When you complete the automatic test, remove power to the drive.

Perform installation and test procedures in a properly grounded environment. Compumotor recommends the use of a grounding strap.

1. REMOVE THE COVER

Remove the cover by applying pressure to the 25 pin D-connector. The DIP location is shown in the next drawing.



DIP Switch Location

2. SET DIP SWITCH 3-#3 TO THE OFF POSITION

To test the system you will use the *Automatic Test* function. Setting DIP switch SW3-#3 to the *off* position enables the function. When power is applied to the drive, the Automatic Test will rotate the motor in an alternating mode approximately 6 revolutions at 1 rps.

If you are testing an E-DC Drive with a controller, you will use the controller to command the motor to turn; you will not use the Automatic Test. Set DIP switch SW#-#3 to the *on* position to disable the Automatic Test .

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3. Set Current Loop Gain DIP Switches, SW3-#4 – SW3-#6

If you use a Compumotor OS Series or VS Series motor, you can leave the switches in their default position for the purposes of this Automatic Test (SW3-#4 = on, SW3-#5 = on, SW3-#6 = off).

The current loop gain adjustment allows you to configure the drive to maximize your system's performance. If you use the default switch position for this Automatic Test now, be sure that when you complete your final installation later, you reset these switches for your particular motor. For instructions see *DIP Switch Functions* following this *Automatic Test* section.

If you use a non-Compumotor motor, see *DIP Switch Functions* following this *Automatic Test* section for instructions on setting the current loop gain DIP switches. After you properly set the switches, proceed to Step 4 below.

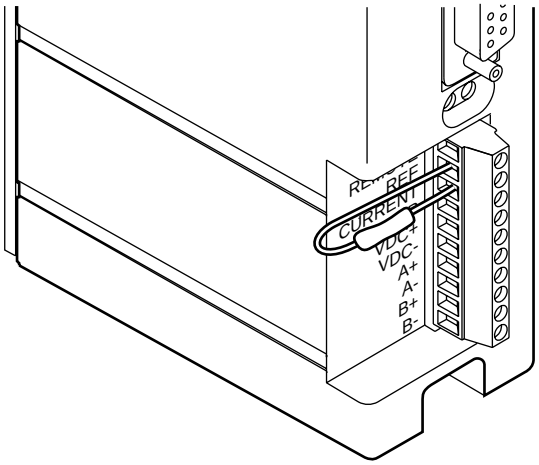
4. Slide the Drive Cover Back On

5. Connect the Motor

Connect your motor cable to the drive's motor terminals (A+, A-, B+, B-). Use a flathead screwdriver (1/10"). Full motor wiring instructions are presented later in this chapter.

6. Set Motor Current

To set motor current, connect a 1/4 watt resistor between **REF** and **CURRENT**, as shown in the drawing below.



Motor Current Selection Resistor

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Motor Current/Resistor Settings for Compumotor Motors

The next table shows motor current settings for Compumotor OS and VS motors. Choose a resistor from the table that matches the drive current to the motor your are using. DIP switches that set the current range—SW3-#7 and SW3-#8—should be in the *off* position for these resistor values (*off* is the factory default position).

OS Series Motors

Size 23	**Current**	**Resistor**
OS2HA **S**	3.0A	7.68 KΩ
OS21A **S**	4.8A	0 Ω
OS22A **S**	4.8A	0 Ω

VS Series Motors

Size 17	**Current**	**Resistor**
VS12B **P**	3.0A	7.68 KΩ
VS13B **P**	3.0A	7.68 KΩ
Size 23	**Current**	**Resistor**
VS21B **P**	4.8A	0 Ω
VS22B **P**	4.0A	2.80 KΩ
VS23B **P**	4.8A	0 Ω
Size 34	**Current**	**Resistor**
VS31B **P**	4.8A	0 Ω
VS32B **P**	4.8A	0 Ω

S: Series Configuration P: Parallel Configuration

Motor Current/Resistor Settings for Other Motors

If you use a non-OS or non-VS motor, carefully follow the motor manufacturer's instructions regarding motor wiring and the proper operating current. Compumotor recommends a motor inductance of between 1 mH and 10 mH, measured in series or parallel (0.2 mH – 80 mH is acceptable). The next table shows resistor values that you must use to properly set motor current when using the E-DC with a non-OS or non-VS Series motor. The drive can generate from 0.13 to 4.8 amps, determined by the ***motor current range DIP switches*** (SW3-#7 and SW3-#8).

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SW3–#7 Off / #8 Off

Current (amps*)	Resistance (ohms)
4.80	0 Ω
4.68	205 Ω
4.62	412 Ω
4.56	619 Ω
4.49	825 Ω
4.43	1.02 kΩ
4.37	1.27 kΩ
4.30	1.54 kΩ
4.24	1.78 kΩ
4.18	2.05 kΩ
4.11	2.26 kΩ
4.05	2.55 kΩ
3.99	2.80 kΩ
3.92	3.09 kΩ
3.86	3.32 kΩ
3.80	3.57 kΩ
3.73	3.92 kΩ
3.67	4.22 kΩ
3.61	4.53 kΩ
3.54	4.87 kΩ
3.48	5.11 kΩ
3.42	5.49 kΩ
3.35	5.76 kΩ
3.29	6.19 kΩ
3.23	6.49 kΩ
3.17	6.81 kΩ
3.10	7.32 kΩ
3.04	7.68 kΩ
2.98	8.06 kΩ
2.91	8.45 kΩ
2.85	8.87 kΩ
2.79	9.53 kΩ
2.72	10.0 kΩ
2.66	10.5 kΩ
2.60	11.0 kΩ
2.53	11.5 kΩ
2.47	12.1 kΩ
2.41	12.7 kΩ
2.34	13.3 kΩ
2.28	13.7 kΩ
2.22	14.3 kΩ
2.15	15.0 kΩ
2.09	15.8 kΩ
2.03	16.5 kΩ
1.96	17.4 kΩ
1.90	18.2 kΩ
1.84	19.1 kΩ
1.77	20.0 kΩ
1.71	20.5 kΩ
1.65	21.5 kΩ
1.58	22.6 kΩ

SW3–#7 On / #8 Off

Current (amps*)	Resistance (ohms)
1.58	0 Ω
1.52	619 Ω
1.46	1.27 kΩ
1.39	2.05 kΩ
1.33	2.80 kΩ
1.27	3.57 kΩ
1.20	4.53 kΩ
1.14	5.49 kΩ
1.08	6.49 kΩ
1.01	7.68 kΩ
0.95	8.87 kΩ
0.89	10.5 kΩ
0.82	12.1 kΩ
0.76	13.7 kΩ
0.70	15.8 kΩ
0.63	18.2 kΩ
0.57	20.5 kΩ
0.51	22.6 kΩ

SW3–#7 Off / #8 On

Current (amps*)	Resistance (ohms)
1.27	0 Ω
1.20	787 Ω
1.14	1.62 kΩ
1.08	2.49 kΩ
1.01	3.57 kΩ
0.95	4.64 kΩ
0.89	5.90 kΩ
0.82	7.32 kΩ
0.76	8.87 kΩ
0.70	10.7 kΩ
0.63	13.0 kΩ
0.57	15.4 kΩ
0.51	18.2 kΩ
0.44	21.5 kΩ

SW3–#7 On / #8 On

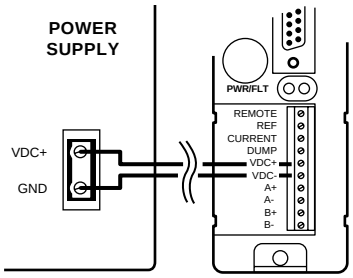
Current (amps*)	Resistance (ohms)
0.50	0 Ω
0.38	2.21 kΩ
0.32	5.36 kΩ
0.25	10.0 kΩ
0.19	16.2 kΩ
0.13	27.4 kΩ

*NOTE: Current is specified in I_{pk}, or *peak* amperes per phase. I_{pk} is related to the average current value, I_{rms}, as follows: $I_{pk} = \sqrt{2}(I_{rms})$

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7. Connect a DC Power Supply

Connect a 24VDC – 48VDC power supply to **VDC+** and **VDC-**, as shown in the next drawing.



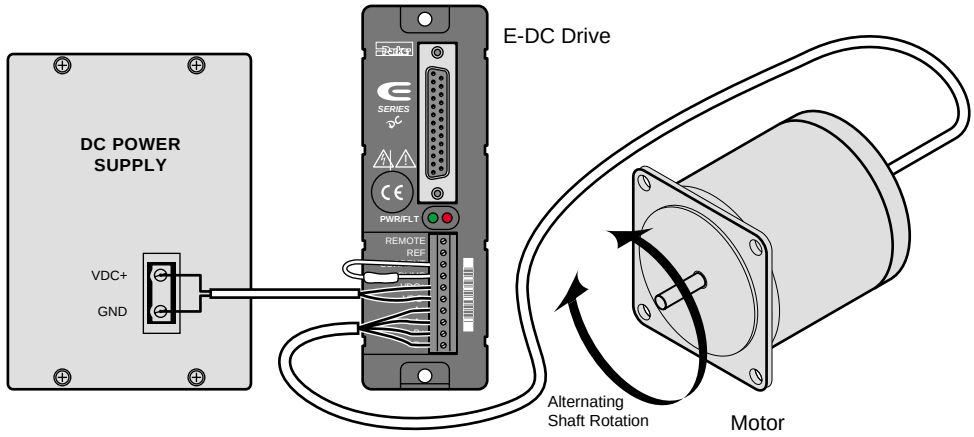
Power Supply Connections

CAUTION

Do not reverse VDC+ and VDC-. Reversing these connections can seriously damage the drive.

If you are testing the E-DC Drive with a controller, skip *Step 8* below, and proceed to the next section.

The next drawing shows the complete E-DC test configuration with a motor and a DC power supply.



Automatic Test Configuration

8. Apply Power

Apply power. The drive's green **POWER** LED should be on. If the red **FAULT** LED is on, consult *Chapter 3, Troubleshooting*. After verifying that the motor moves clockwise and counterclockwise, turn off power.

- Disconnect cables and resistor.
- Remove cover
- Turn DIP SW3-#3 on to disable the automatic test.
- Replace cover.

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TEST SETUP WITH CONTROLLER

If you are testing the E-DC with a controller, follow these steps to command the motor to turn (rather than using the drive's automatic test function to command the motor to turn, as described in the previous section).

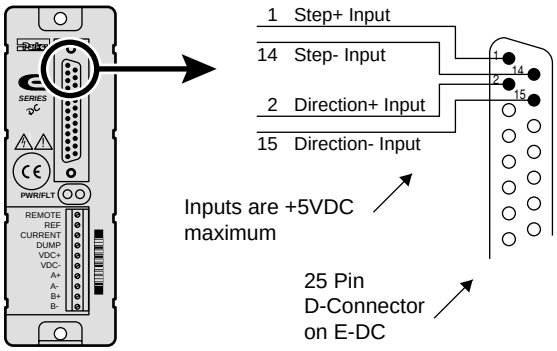
1. TURN DIP SW3-#3 *ON*

Complete steps 1 – 7 from the *Automatic Test* section, but turn DIP SW3-#3 *on* to disable the automatic test function.

2. CONNECT A CONTROLLER

To connect a Compumotor controller to the E-DC's 25 pin D-connector, use the cable provided with the controller. Plug the cable into the E-DC's 25 pin D-connector. No additional wiring is necessary. Refer to the controller's user guide for specific instructions for operating the Compumotor controller.

To connect a non-Compumotor controller, connect step and direction outputs from the controller to the E-DC's 25 pin D-connector, according to the next drawing.



Test Configuration – E-DC Step and Direction Inputs

3. APPLY POWER

Apply power. The drive's green **POWER** LED should be on. If the red **FAULT** LED is on, consult *Chapter 3, Troubleshooting*.

This test assumes that your controller's motor resolution is set to 25,000 steps/rev. This is the default motor resolution setting for the E-DC Drive.

4. COMMAND CLOCKWISE (CW) MOTION

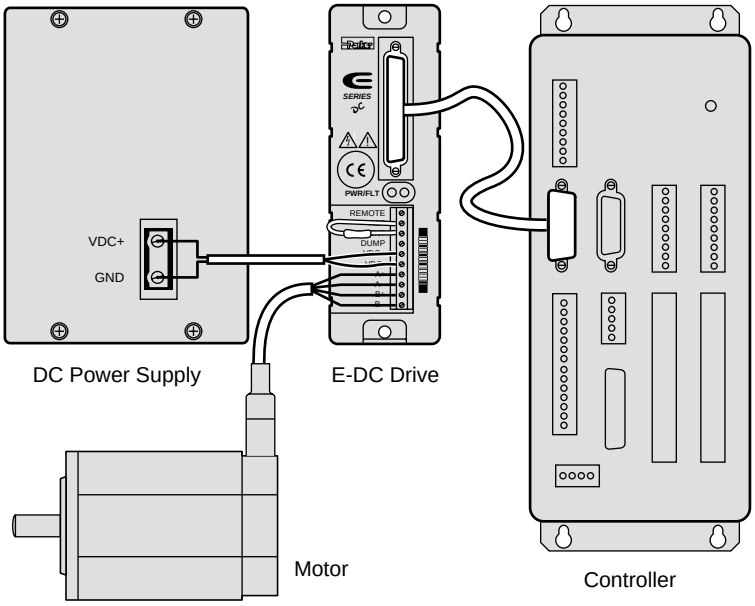
Using the controller, send step pulses to the drive that will rotate the motor one **CW** revolution (25,000 step pulses) at 1 rps (25,000 steps per second).

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5. COMMAND COUNTERCLOCKWISE (CCW) MOTION

Using the controller, send step pulses to the drive that will rotate the motor one **CCW** revolution at 1 rps. The drive's default direction is CCW (i.e., if the direction input is not activated, the motor will rotate CCW—if the direction input is activated, the motor will rotate CW). If the motor does not rotate in the desired direction, remove drive power and reverse the direction sense for your system by reversing the motor leads going to the A+ and A- terminals.

The next drawing shows the test configuration with a controller, a motor and a DC power supply.



Test Configuration with Controller

CAUTION

Never connect or disconnect any component to or from the drive with power applied. System damage or personal injury may occur.

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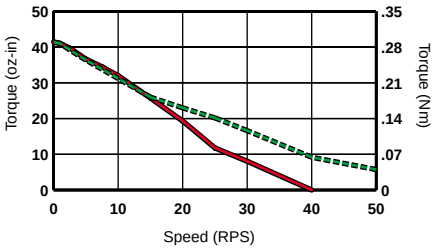
The procedures in the rest of this chapter will lead you through the steps required to permanently install your E-DC Drive and motor.

1 – SELECT A MOTOR

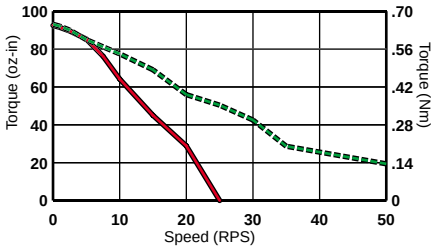
Speed/Torque curves, specifications, and motor dimensions for Compumotor motors are shown below.

SPEED/TORQUE CURVES

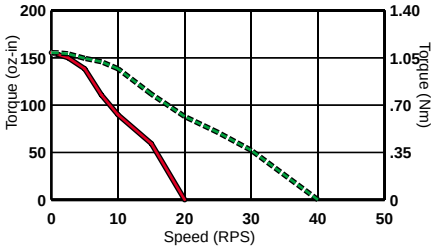
OS2HA/E-DC



OS21A/E-DC

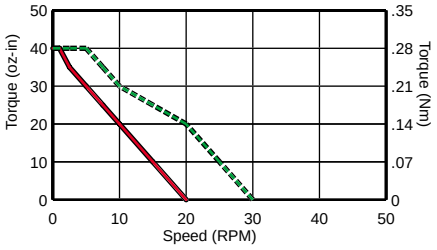


OS22A/E-DC

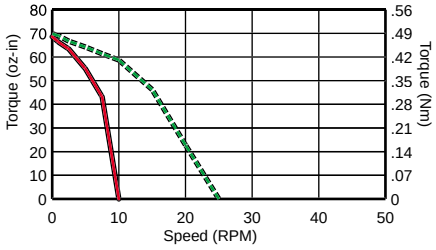


24V 48V (Series Motor Wiring)

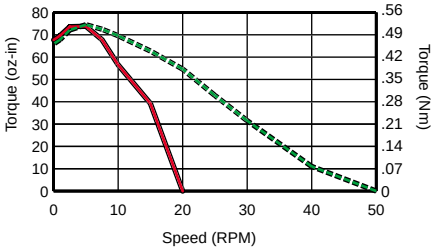
VS12B/E-DC



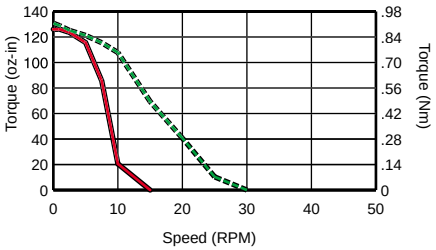
VS13B/E-DC



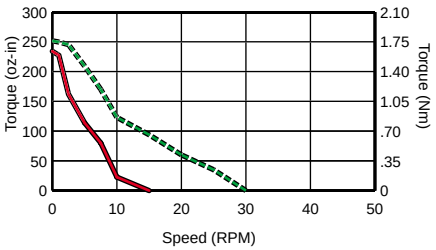
VS21B/E-DC



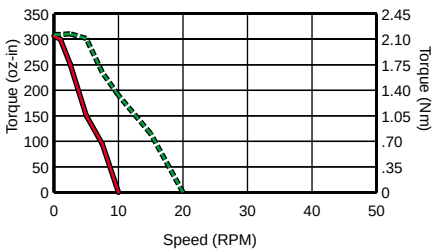
VS22B/E-DC



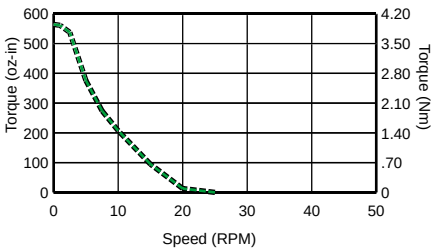
VS23B/E-DC



VS31B/E-DC



VS32B/E-DC



24V 48V (Parallel Motor Wiring)

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Motor Specifications

OS Motors

		Size 23 Frame		
Parameters	**Units**	**OS2HA**	**OS21A**	**OS22A**
Static torque	oz-in (Nm)	49.1 (0.35)	114 (0.81)	186 (1.31)
Rotor inertia	oz-in^2 (kg-cm^2)	0.39 (0.07)	0.66 (0.12)	1.39 (0.25)
Drive Current (Apk)(Arms)	Series Parallel	3.0 (2.12) NA	4.8 (3.39) NA	4.8 (3.39) NA
Phase Inductance (mH)	Series Parallel	1.7 NA	1.8 NA	2.8 NA
Detent Torque	oz-in (N-m)	2.5 (0.02)	4.0 (0.03)	7.0 (0.05)
Bearings Information				
Thrust Load	lb (kg)	13 (5.9)	13 (5.9)	13 (5.9)
Radial Load	lb (kg)	20 (9.1)	20 (9.1)	20 (9.1)
End Play (Reversing load equal to 1 lb)	in (mm)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)
Radial Play (Per 0.5 lb load)	in (mm)	0.0008 (0.02)	0.0008 (0.02)	0.0008 (0.02)
Motor Weight	lb (kg)	1 (0.5)	1.5 (0.7)	2.5 (1.1)
Certifications	UL recognized CE (LVD) CE (EMC & LVD)	Pending Yes No	Pending Yes No	Pending Yes No

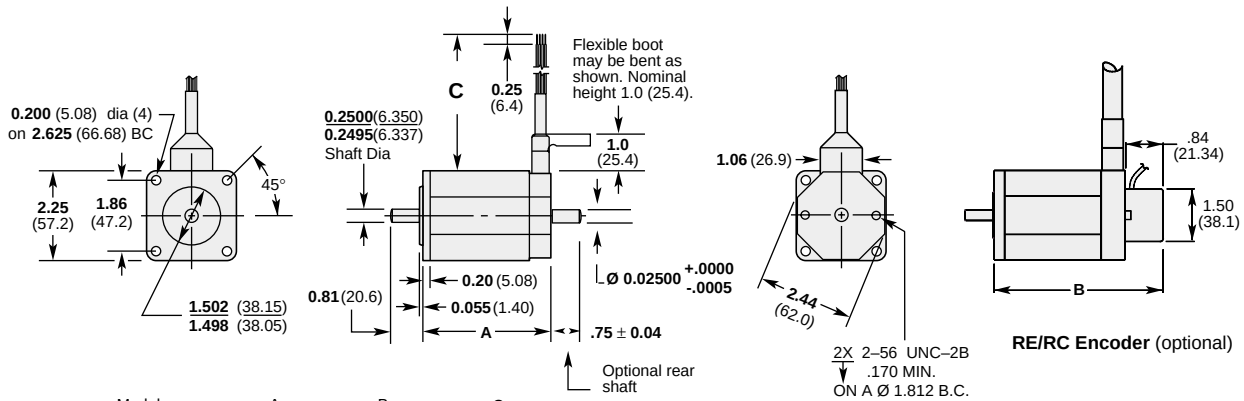
VS Motors

		Size 17 Frame		Size 23 Frame			Size 34 Frame	
Parameters	**Units**	**VS12B**	**VS13B**	**VS21B**	**VS22B**	**VS23B**	**VS31B**	**VS32B**
Static torque	oz-in (Nm)	58 (0.41)	81 (0.57)	115 (0.81)	156 (1.10)	330 (2.33)	442 (3.12)	664 (4.69)
Rotor inertia	oz-in^2 (kg-cm^2)	0.3 (0.054)	0.37 (0.068)	0.66 (0.12)	1.64 (0.3)	2.62 (0.48)	7.65 (1.4)	14.8 (2.7)
Drive Current (Apk)(Arms)	Series Parallel	NA 3.00 (2.12)	NA 3.00 (2.12)	NA 4.8 (3.39)	NA 4.0 (2.83)	NA 4.8 (3.39)	NA 4.8 (3.39)	NA 4.8 (3.39)
Phase Inductance (mH)	Series Parallel	NA 3.2	NA 2.8	NA 1.25	NA 3.0	NA 3.85	NA 3.95	NA 6.25
Detent Torque	oz-in (N-m)	2.5 (0.02)	4.0 (0.03)	7.0 (0.05)	8.8 (0.06)	18.0 (0.13)	27.0 (0.19)	50 (0.35)
Bearings Information								
Thrust Load	lb (kg)	11.0 (5)	11.0 (5)	17.6 (8)	17.6 (8)	17.6 (8)	35.3 (16)	35.3 (16)
Radial Load	lb (kg)	7.7 (3.5)	7.7 (3.5)	15.0 (6.8)	15.0 (6.8)	15.0 (6.8)	30.9 (14)	30.9 (14)
End Play (with 2.2 lbs axial load)	in (mm)	0.003 (0.075)	0.003 (0.075)	0.003 (0.075)	0.003 (0.075)	0.003 (0.075)	0.0032 (0.080)	0.0032 (0.080)
Radial Play (with 1.1 lb radial load)	in (mm)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.0008 (0.020)	0.0008 (0.020)
Motor Weight	lb (kg)	0.55 (0.25)	0.77 (0.35)	1.03 (0.47)	1.54 (0.7)	2.2 (1.0)	3.86 (1.75)	6.18 (2.8)

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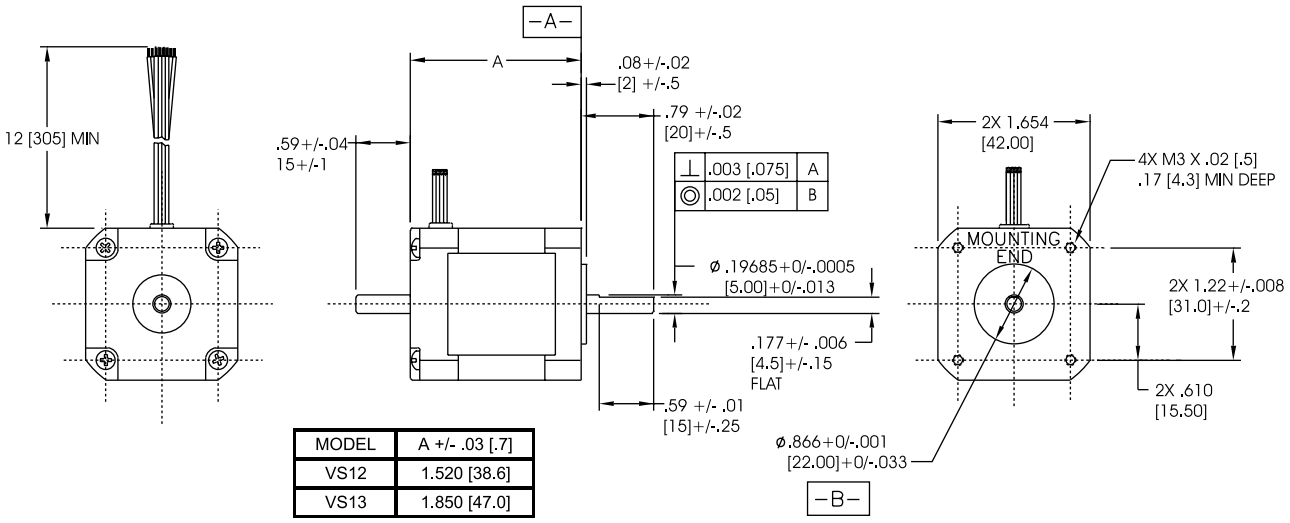
MOTOR DIMENSIONS

Dimensions in inches (mm)



Model	A	B	C
OS2HA, OS2HB	**1.60** (40.7)	**2.44** (62.0)	For flying leads (FLY) – 13.5 (343) min.
OS21A, OS21B	**2.06** (52.4)	**2.90** (73.7)	For 10 ft cable (L10) – 120.0 (3048)
OS22A, OS22B	**3.10** (78.8)	**3.94** (100.1)	

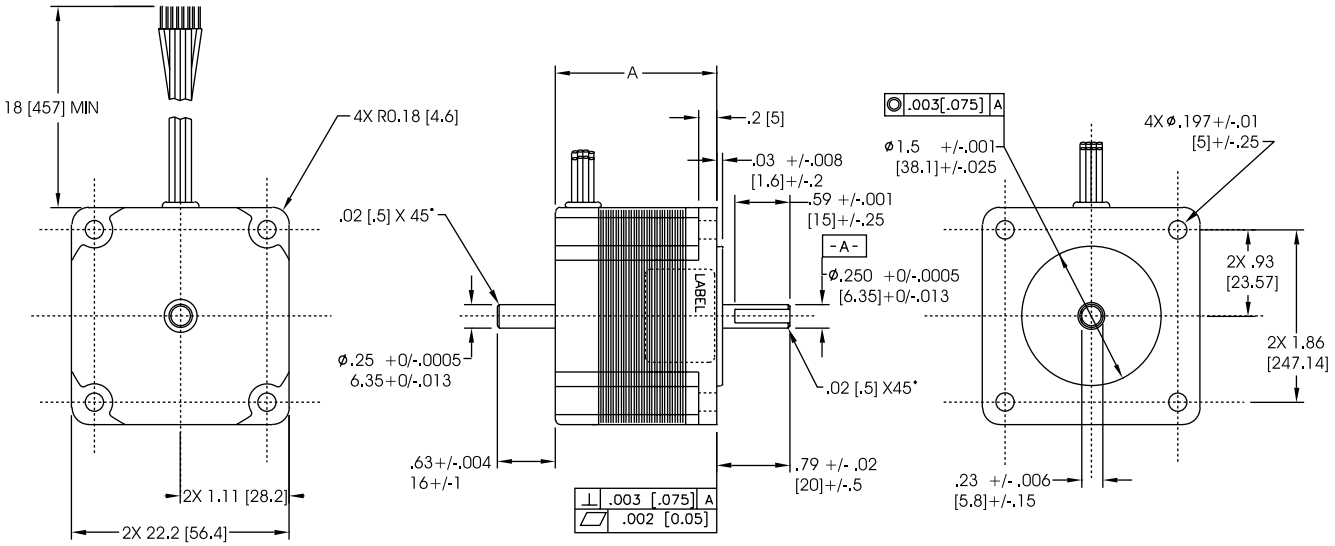
OS Motors – Frame Size 23 – Dimensions



MODEL	A +/- .03 [.7]
VS12	1.520 [38.6]
VS13	1.850 [47.0]

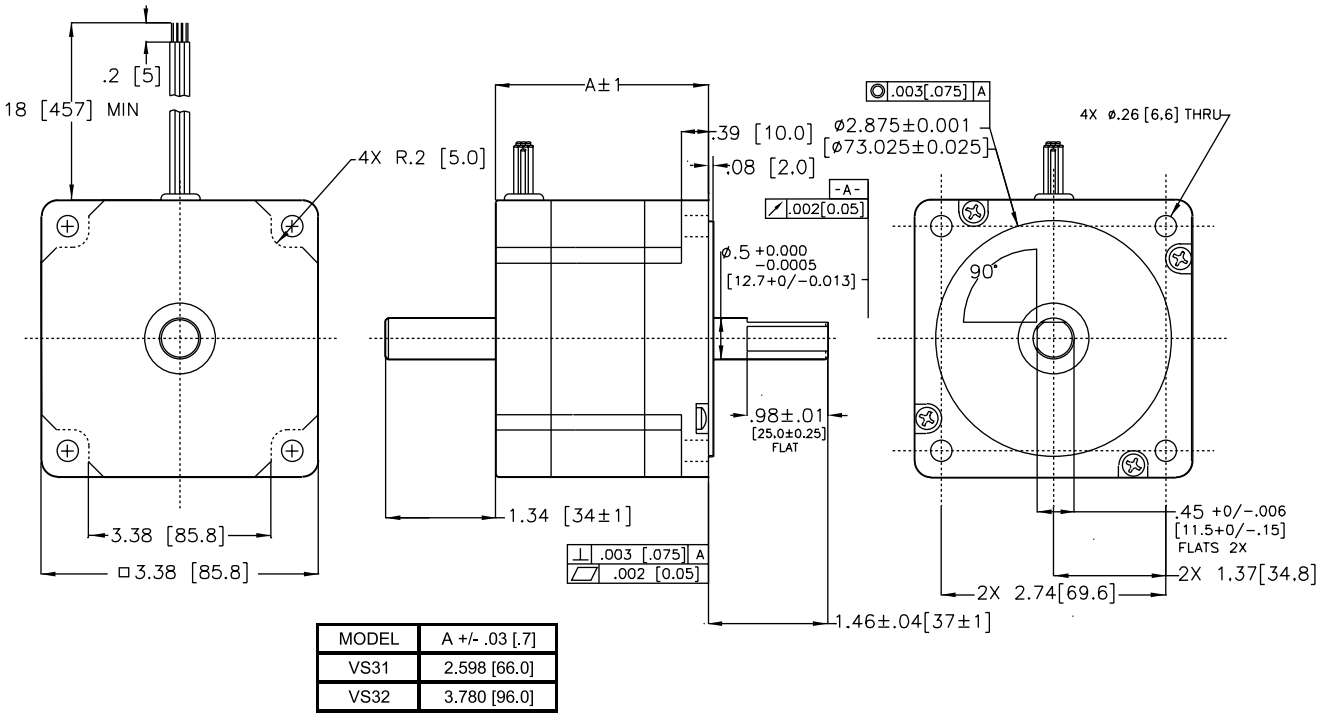
VS Motors – Frame Size 17 – Dimensions

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MODEL	A +/- .03 [.7]
VS21	1.732 [44.0]
VS22	2.165 [55.0]
VS23	3.051 [77.5]

VS Motors – Frame Size 23 – Dimensions



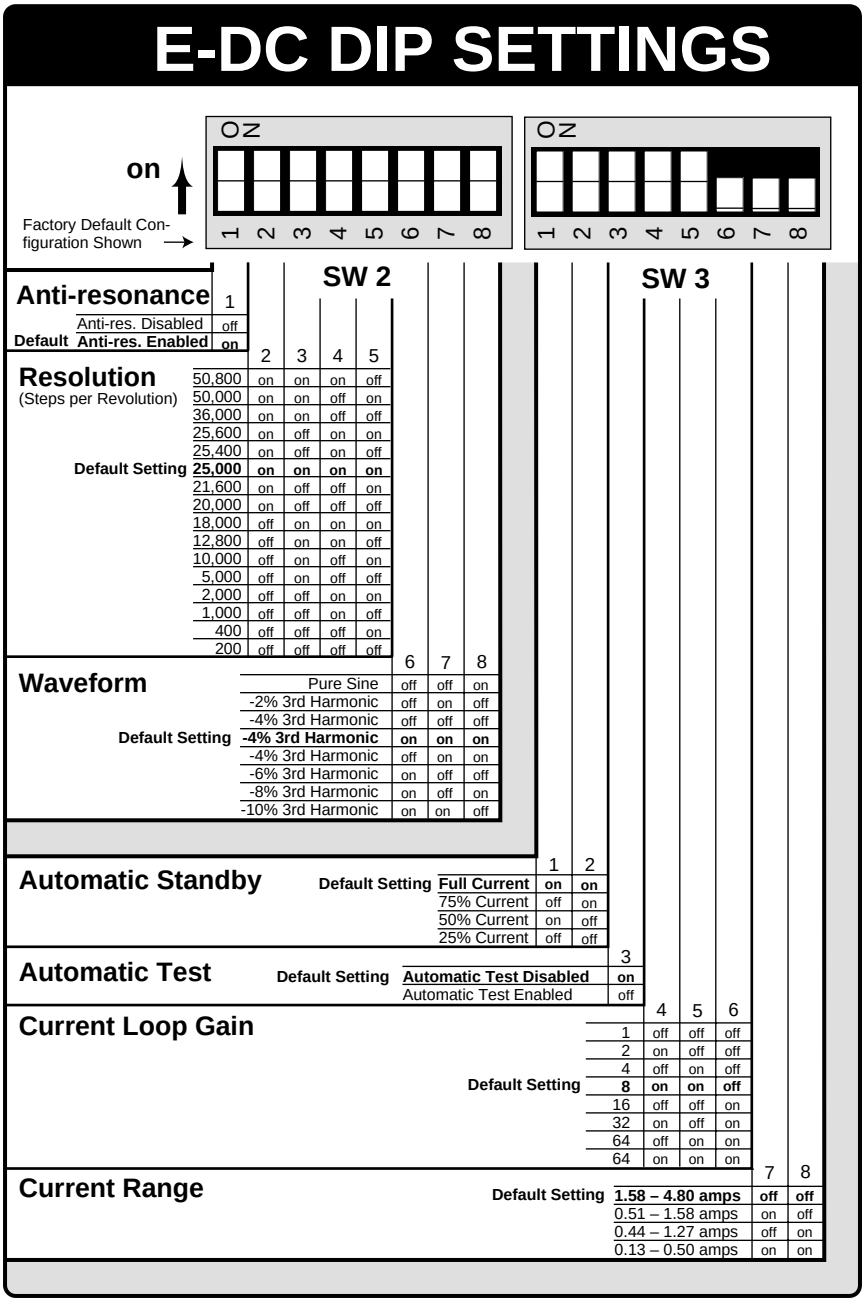
MODEL	A +/- .03 [.7]
VS31	2.598 [66.0]
VS32	3.780 [96.0]

VS Motors – Frame Size 34 – Dimensions

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2 – SET DIP SWITCHES

Configure the drive's two 8-position DIP switches for your motor and application. See the *Automatic Test* section for switch location. The following table and descriptions summarize switch settings.



E-DC DIP SETTINGS

on

Factory Default Configuration Shown →

ON 1 2 3 4 5 6 7 8

ON 1 2 3 4 5 6 7 8

Anti-resonance (SW 2, switch 1)

Anti-res. Disabled	off
Default Anti-res. Enabled	**on**

Resolution (Steps per Revolution) (SW 2, switches 2–5)

	2	3	4	5
50,800	on	on	on	off
50,000	on	on	off	on
36,000	on	on	off	off
25,600	on	off	on	on
25,400	on	off	on	off
Default Setting 25,000	**on**	**on**	**on**	**on**
21,600	on	off	off	on
20,000	on	off	off	off
18,000	off	on	on	on
12,800	off	on	on	off
10,000	off	on	off	on
5,000	off	on	off	off
2,000	off	off	on	on
1,000	off	off	on	off
400	off	off	off	on
200	off	off	off	off

Waveform (SW 2, switches 6–8)

	6	7	8
Pure Sine	off	off	on
-2% 3rd Harmonic	off	on	off
-4% 3rd Harmonic	off	off	off
Default Setting -4% 3rd Harmonic	**on**	**on**	**on**
-4% 3rd Harmonic	off	on	on
-6% 3rd Harmonic	on	off	off
-8% 3rd Harmonic	on	off	on
-10% 3rd Harmonic	on	on	off

Automatic Standby (SW 3, switches 1–2)

	1	2
Default Setting Full Current	**on**	**on**
75% Current	off	on
50% Current	on	off
25% Current	off	off

Automatic Test (SW 3, switch 3)

	3
Default Setting Automatic Test Disabled	**on**
Automatic Test Enabled	off

Current Loop Gain (SW 3, switches 4–6)

	4	5	6
1	off	off	off
2	on	off	off
4	off	on	off
Default Setting 8	**on**	**on**	**off**
16	off	off	on
32	on	off	on
64	off	on	on
64	on	on	on

Current Range (SW 3, switches 7–8)

	7	8
Default Setting 1.58 – 4.80 amps	**off**	**off**
0.51 – 1.58 amps	on	off
0.44 – 1.27 amps	off	on
0.13 – 0.50 amps	on	on

DIP Switch Settings

ANTI-RESONANCE DISABLE

SW2-#1 should be *on* for the anti-resonance circuit to be enabled. Normally, you will want anti-resonance to be enabled; therefore, this switch should be *on*. If you are using pulse placement for positioning, you may need to disable anti-resonance. You can disable anti-resonance by turning SW2-#1 *off*.

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Drive Resolution

Set DIP switches SW2-#2 — SW2-#5 for drive resolution. There are sixteen settings, which range from 200 to 50,800 steps per revolution. The default setting is 25,000 steps per revolution.

Waveform

Set SW2-#6 — SW2-#8 to select a current waveform. There are six choices: one is a pure sine wave; the others reduce the current waveform's 3rd harmonic by 2%, 4%, 6%, 8% and 10%. In most cases, the default setting (*all three switches on = -4% 3rd harmonic*) provides the best performance.

Step motor manufacturers design step motors to operate with sinusoidal current waveforms. However, due to physical limitations, most motors operate best with a current waveform other than a pure sine wave.

The purpose of adjusting motor current waveforms is to cause the step motor to move with equal step sizes as the current waveforms are sequenced through the motor. This waveform adjustment will also help the motor run more smoothly.

Automatic Standby

SW3-#1 and SW3-#2 should be *on* if you do not use automatic standby (this is the default position). If you use a controller and encoder for position maintenance, we recommend that you do not use automatic standby.

The *automatic standby* function allows the motor to cool when it is not commanded to move. Automatic standby reduces motor current (by 25%, 50%, or 75%) if the drive does not receive a step pulse for one second. Full current is restored upon the first step pulse that the drive receives. ***Be aware that reduced current results in reduced holding torque.***

Automatic Test

Set SW3-#3 to the *off* position to select the automatic test function. The automatic test turns the motor shaft slightly less than six revolutions in an alternating mode at 1 rps. Automatic standby and drive resolution settings are disabled when you use the automatic test.

The default position for SW3-#3 is *on*, which disables the automatic test function.

Current Loop Gain

Set the current loop gain DIP switches to maximize your system's performance.

Your system has a gain. Its value is determined by three parameters: power supply voltage, motor inductance, and current loop gain. If you increase power supply voltage or decrease motor inductance, the system will have more gain. Conversely, if you decrease power supply voltage or increase motor inductance, the system will have less gain. Too much gain may cause oscillations, resulting in audible noise and excess motor heating.

In most applications, power supply voltage and motor inductance are determined by the application's requirements. To set your system's gain at

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its optimum value, you can adjust the third parameter—the current loop—by setting three *current loop gain* DIP switches. There are seven loop gain settings, which range from 1 to 64, as shown in the *E-DC DIP Settings* table.

Use the next equation to determine your *ideal* loop gain:

Current Loop Gain = (Motor inductance/Power Supply Voltage) * 364,000

Note: inductance is in henrys; supply voltage is in VDC. For inductance, use small signal inductance value measured using an ordinary inductance bridge or meter. Large signal inductance is found by measuring the actual generator AC flux linkage and generator short circuit current under dynamic conditions.

Small signal inductance * 1.5 ≈ large signal inductance

To determine your *actual* loop gain, choose a value from the *DIP Settings* table that is less than or equal to the ideal value.

Example:

An OS2HA motor is used with a 48VDC power supply. The ideal current loop gain is:

Current Loop Gain = (0.0016 H / 48VDC) * 364,000 = 12.1

From the DIP switch table, select a current loop gain of 8, because 8 is less than 12.1

The next table shows settings for Compumotor motors.

OS Motors Size 23	Connection	Inductance (small signal)	Loop Gain at 24VDC	Loop Gain at 48VDC
OS2HA	Series	1.6 mH	16	8
OS21A	Series	1.7 mH	16	8
OS22A	Series	2.6 mH	32	16
VS Motors Size 17				
VS12B	Parallel	2.9 mH	32	16
VS13B	Parallel	2.9 mH	32	16
Size 23				
VS21B	Parallel	1.3 mH	16	8
VS22B	Parallel	0.3 mH	32	16
VS23B	Parallel	3.9 mH	32	16
Size 34				
VS31B	Parallel	4.0 mH	32	16
VS32B	Parallel	6.3 mH	64	32

Current Range

Set SW3-#7 and SW3-#8 to select a range for motor current settings. In *Step 6* of the *Automatic Test* you installed a resistor that determines motor current. Be sure that SW3-#7 and SW3-#8 are set to the proper current range for the resistor you installed.

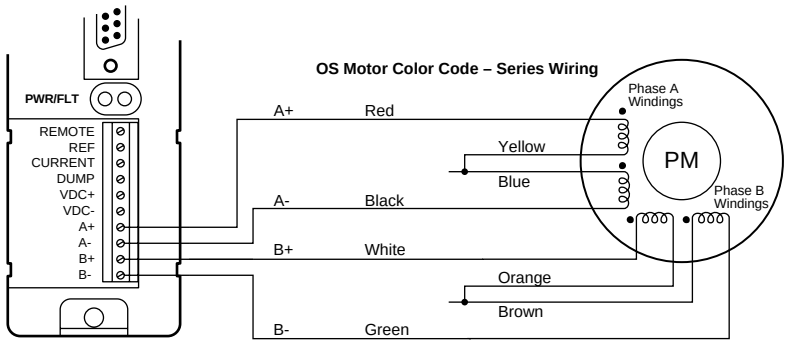
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3 – Connect the Motor to the Drive – Wiring

Most Compumotor motor windings—phase A and phase B—are *bifilar* windings made from double-stranded copper wire. Each phase has two half-windings, which can be wired together in series or parallel.

OS Motor Connections

Connect OS motors in *series*, as shown in the following diagram.

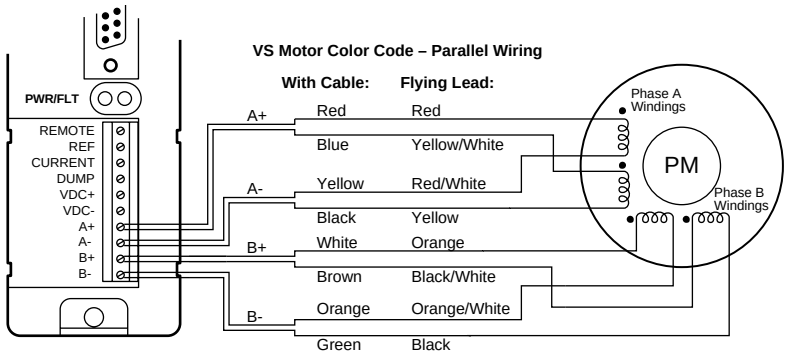


*Motor Connections – OS Motors Wired for **SERIES** Motor Current*

Be sure to insulate the *center tap* connections; these are the wires shown joined together in the drawing above, but not connected to the drive.

VS Motor Connections

Connect VS motors in *parallel*, as shown in the following diagram.

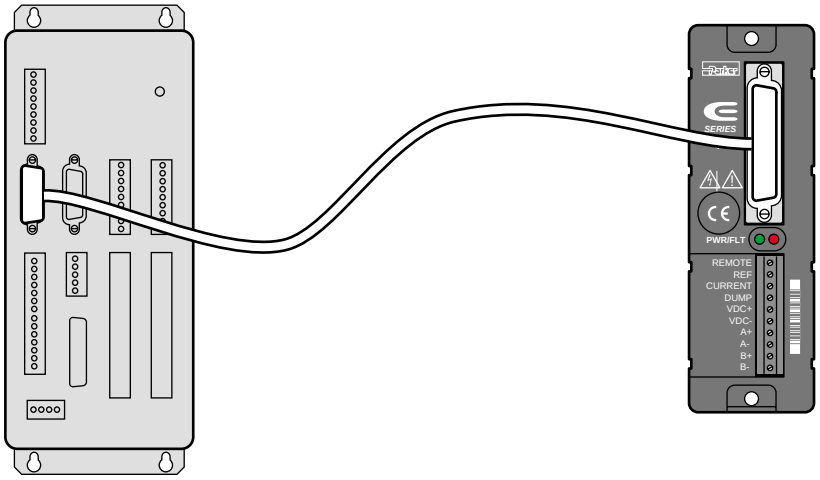


*Motor Connections – VS Motors Wired for **PARALLEL** Motor Current*

4 – Connect a Controller – Inputs & Outputs

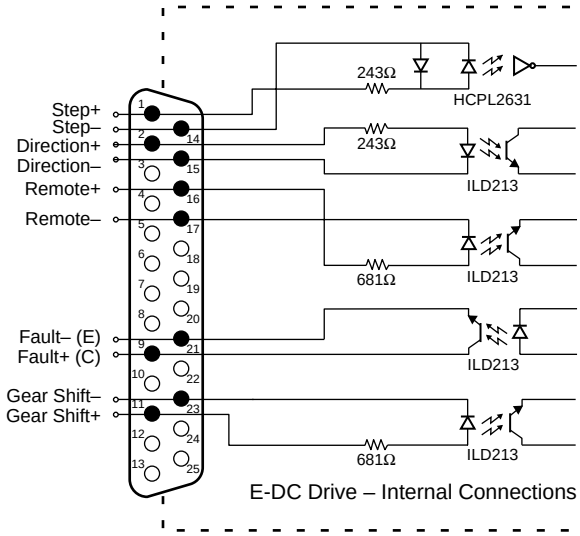
Connect your controller cable to the 25 pin D-connector on the front of the drive. The cable that comes with Compumotor controllers is prewired for compatibility with the E-DC Drive—you can plug the cable directly into the drive's 25 pin D-connector.

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Connecting a Compumotor Controller

If you make your own cable, or use a non-Compumotor controller, consult the drawing below when you wire your cable and connector.



Inputs and Outputs – E-DC Schematic

Descriptions of each function on the 25 pin D-connector follow.

STEP INPUT

For every step pulse it receives on its step input, the drive will commutate the motor to increment rotor position. To send a step pulse to the drive, apply a positive voltage to **STEP+** with respect to **STEP-**. The drive registers the pulse on the rising edge.

The step input is optically isolated. Driving the step input differentially will provide the best noise immunity. Your input driver must provide a minimum of 6.5 mA—*approximately 3.5 VDC.* With no external current limiting resistor, the current is controlled by the applied voltage. This is due to a fixed voltage drop of 1.7VDC on the opto LED and the internal

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series resistor (243Ω). Increased voltage will result in increased current.

Operate the step pulse input within the following guidelines:

- 200 nanosecond pulse – minimum
- 40% – 60% duty cycle (2 MHz maximum pulse rate)

Direction Input

While a positive voltage is applied to **DIRECTION+** with respect to **DIRECTION-**, the drive will commutate the motor in the clockwise (positive) direction as it receives step pulses on its step input.

While zero voltage (or a negative voltage) is applied to **DIRECTION+** with respect to **DIRECTION-**, the drive will commutate the motor in the counter-clockwise (negative) direction as it receives step pulses.

The input is optically isolated. You can drive the input differentially, or from a single-ended source.

CAUTION

Reverse voltage in excess of 6VDC may damage this device.

Your input driver must provide a minimum of 8mA at 3.5VDC to ensure proper operation. With no external current limiting resistor, the current is controlled by the applied voltage. This is due to a fixed voltage drop of 1.5VDC on the opto LED and the internal series resistor (243Ω).

Direction Change: Direction may change polarity coincident with the last step pulse. The direction input must be stable for at least 200 microseconds before the drive receives the first pulse.

Remote Input

The remote input is an optically isolated input. It requires a minimum of 3.5 mA—*approximately 4.0 VDC*—to ensure proper system operation. This input may be differentially driven.

CAUTION

Reverse voltage in excess of 6VDC may damage this device.

With no external current limiting resistor, the current is controlled by the applied voltage. This is due to a fixed voltage drop of 1.5VDC on the opto LED and the internal series resistor (681Ω).

This input allows you to reduce current to a motor from a remote location. This is accomplished by changing the current select resistor via the remote input. When the remote input is enabled, the open collector transistor internally connected to the REMOTE screw terminal will conduct to ground.

To reduce motor current to zero, short the CURRENT and REMOTE terminals together (with a wire).

You can also reduce motor current by a percentage if you short CURRENT and REMOTE with the appropriate resistor (R_{REMOTE}). To calculate R_{REMOTE}, first select R_C, the resistor associated with your normal operating current

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(see resistor selection tables in the *Automatic Test* section). Next select R_S, the resistor in the same section of the table that is associated with your desired standby current. Then use the following equation to find R_{REMOTE}.

$$R_{REMOTE} = -13{,}300\ (3750 + R_C)\ /\ (R_C - R_S)$$

R_C = Resistor associated with the operating current

R_S = Resistor associated with the desired standby current

Fault Output

The fault output is an open-collector, open emitter output from an ILD213 OPTO isolator. The output transistor will conduct when the drive is functioning properly. The transistor will not conduct when any of the following conditions exist.

- No power is applied to the drive
- There is insufficient voltage (<24VDC)
- The drive detects a motor fault
- The remote input is enabled

The fault output has the following electrical characteristics:

- V_{CEO} = 70VDC
- V_{CESAT} = 0.3VDC
- Collector Current = 10 mA maximum (e.g. 2.4 KΩ at 24VDC)
- Maximum Dissipation = 55 mW

Gear Shift Input

The gear shift input is an optically isolated input. The GS+ terminal (pin 11) is connected to the anode of the OPTO lead via a 681Ω current limiting resistor. The GS- terminal (pin 23) is connected to the cathode of the OPTO lead. The OPTO requires a minimum of 3.5 mA—*approximately 4.0 VDC*—to ensure proper system operation. This input may be differentially driven.

CAUTION

Reverse voltage in excess of 6VDC may damage this device.

With no external current limiting resistor, the current is controlled by the applied voltage. This is due to a fixed voltage drop of 1.5VDC on the opto LED and the internal series resistor (681Ω).

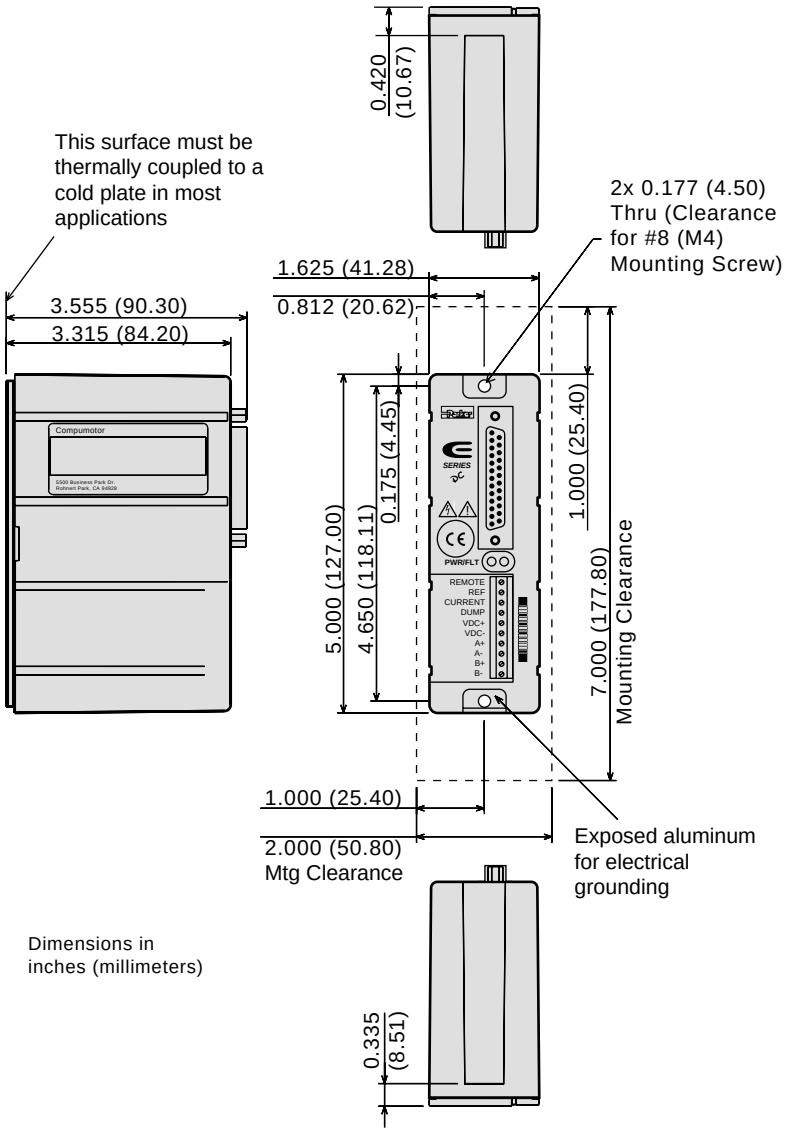
The gear shift function allows a user with a limited frequency generator to achieve higher velocities while using high resolution settings. The drive multiplies each step pulse it receives by a factor of 8. This function may be invoked *on-the-fly*; however, to prevent stalling and to keep track of motor position, it should only be invoked when the motor is not moving.

Using the gear shift function is equivalent to changing drive resolution, and may have an adverse effect on low speed performance (smoothness). We recommend that you do not use the gear shift with resolution settings less than 10,000 steps per revolution.

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5 – MOUNT THE DRIVE

The E-DC Drive is designed for a *minimum area* mounting configuration. An optional heatsink can be used for a *minimum depth* configuration.



Dimensions – E-DC Drive

PANEL LAYOUT

If you mount the E-DC in an enclosure, observe the following guidelines:

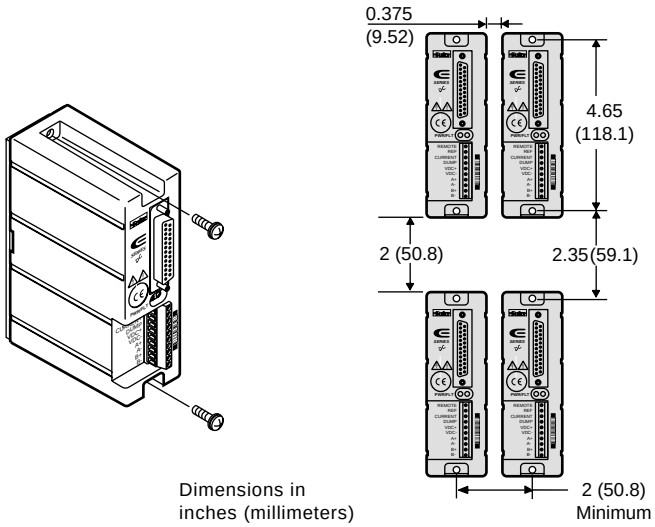
- Do not mount large, heat-producing equipment directly beneath the E-DC.
- Do not mount the E-DC directly below a controller or other heat sensitive equipment (the drive produces more heat than a controller).
- Fan cooling may be necessary.

Refer to the instructions and diagrams in this section for specific mounting information about your configuration.

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Mounting Without a Heatsink

If you use the E-DC without a heatsink, the next drawing shows the minimum recommended panel layout. Additional space may be required if heat dissipation is an issue.



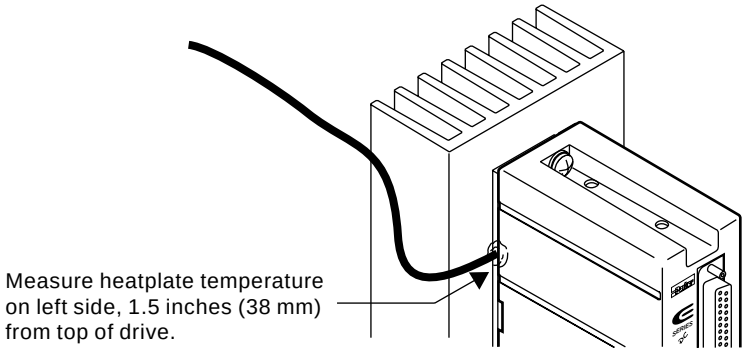
Panel Layout Dimensions

The E-DC uses a heatplate design to dissipate heat. The drive should never be operated for more than a few minutes without properly mounting the drive to an adequate thermal heatsink.

Overtemperature Protection

The E-DC is overtemperature protected. The drive is designed to operate in a maximum 50°C (122°F) ambient with a maximum heatplate temperature of 55°C (131°F). ***Do not allow the drive's heatplate temperature to exceed 55°C.*** The drive will fault if its heatplate temperature exceeds 55°C.

To measure drive temperature under operating conditions, position a thermal probe on the left edge of the heatplate, approximately 1.5 inches (38 mm) from the top of the drive, as shown in the next drawing.



Heatplate Temperature Measurement

To ensure that the over-temperature protection does not unexpectedly shut down the drive, mount the drive to a suitable heat-dissipating sur-

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face. If you operate the drive in high ambient temperatures—greater than 40°C (104°F)—ensure there is unobstructed airflow over the drive.

Do not use a star washer between the back of the drive's heatplate and the mounting surface. The mounting surface must be flat. Use thermal grease or thermal pads to facilitate heat transfer from the drive's heatplate to your mounting surface.

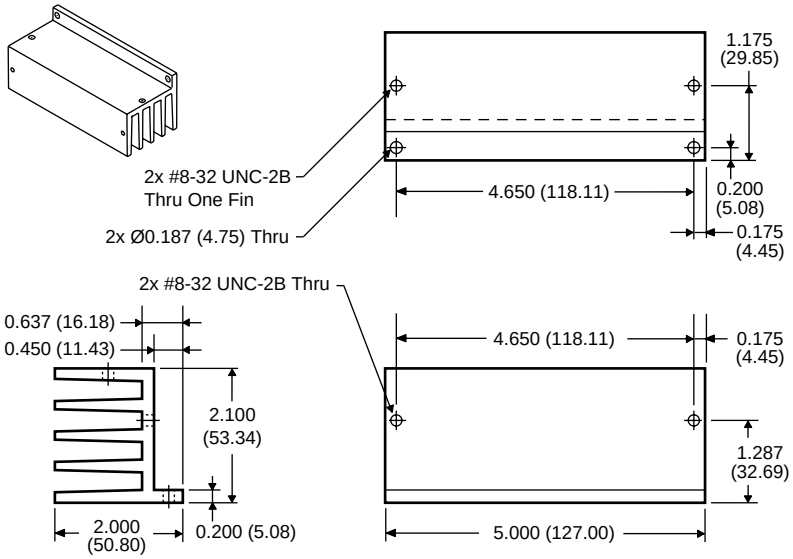
An optional heatsink, the OEM-HS1, can be used for applications that do not have an adequate mounting surface.

Mounting With OEM-HS1 Heatsink

The OEM-HS1 heatsink may be purchased as an option. It is intended to be used with a current setting up to 4.8A peak in still air, at an ambient temperature of 25°C (77°F). If the drive is mounted in ambient temperatures hotter than 25°C, active cooling (forced air) may be required to maintain the heatplate temperature below 55°C (131°F).

Mount the E-DC to the OEM-HS1 heatsink with two #8-32 screws. (A heatsink with holes tapped for metric screws is available. Its part number is OEM-HS1-M4. Consult your Compumotor sales guide for more information.)

Use a *star washer* on the bottom screw to ensure proper electrical grounding. To facilitate heat transfer, use thermal grease or a thermal pad between the drive and the heatsink. Secure the drive and heatsink to your mounting surface with two #8 screws.

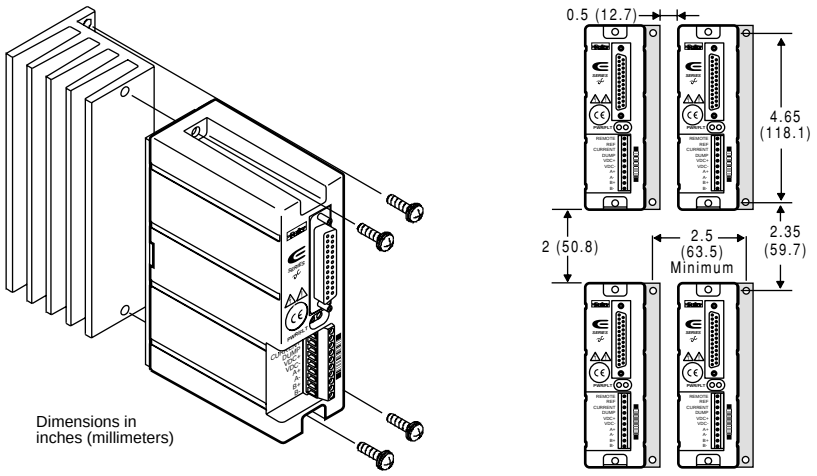


OEM-HS1 Dimensions

You can mount the drive in two different configurations with the OEM-HS1. One is a *minimum area* configuration—it uses the least amount of panel area. The other is a *minimum depth* configuration.

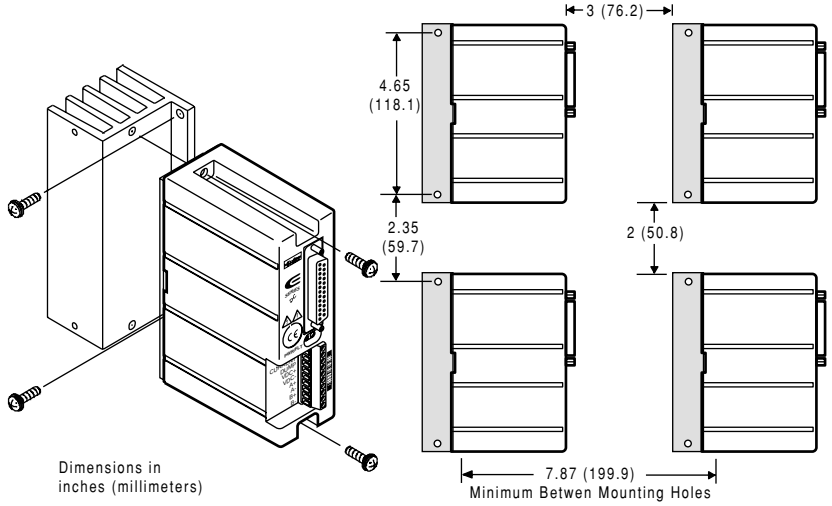
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Panel layout for minimum area is shown in the next figure.



OEM-HS1 Minimum Area Panel Layout

Panel layout for minimum depth is shown in the next figure.



OEM-HS1 Minimum Depth Panel Layout

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6 – MOUNT THE MOTOR

Use the flange bolt holes to mount rotary step motors. The *pilot*, or centering flange on the motor's front face, should fit snugly in the pilot hole.

Do not use a foot-mount or cradle configuration, because the motor's torque is not evenly distributed around the motor case. When a foot mount is used, for example, any radial load on the motor shaft is multiplied by a much longer lever arm.

Step motors can produce very high torques and accelerations. If the mounting is inadequate, this combination of high torque/high acceleration can shear shafts and mounting hardware. Because of shock and vibration that high accelerations can produce, you may need heavier hardware than for static loads of the same magnitude.

Under certain move profiles, the motor can produce low-frequency vibrations in the mounting structure that can cause fatigue in structural members. A mechanical engineer should check the machine design to ensure that the mounting structure is adequate.

WARNING

Improper motor mounting can jeopardize personal safety, and compromise system performance.

For Compumotor motor dimensions, see *Select a Motor* earlier in this chapter.

MOTOR TEMPERATURE & COOLING

The motor's face flange is used not only for mounting—it is also a heat dissipating surface. Mount the face flange to a large thermal mass, such as a thick steel or aluminum plate, which should be unpainted, clean, and flat. Heat will be conducted from inside the motor, through the face flange, and dissipated in the thermal mass. This is the best way to cool the motor. If conduction through the flange does not provide enough cooling, you can also use a fan to blow air across the motor for increased cooling.

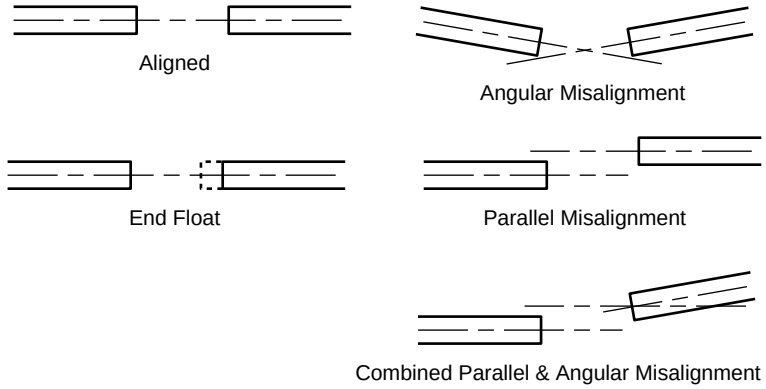
MOTOR MODIFICATIONS

Modifying or machining the motor shaft will void the motor warranty. Contact a Compumotor Applications Engineer (800-358-9070) about shaft modifications as a custom product.

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7 – Connect the Motor to the Load – Couplers

Align the motor shaft and load as accurately as possible. In most applications, some misalignment is unavoidable, due to tolerance buildups in components. However, excessive misalignment may degrade your system's performance. The three misalignment conditions, which can exist in any combination, are illustrated and described below.



Misalignment Condition

- Angular Misalignment: The center lines of two shafts intersect at an angle other than zero degrees.
- Parallel Misalignment: The offset of two mating shaft center lines, although the center lines remain parallel to each other.
- End Float: A change in the relative distance between the ends of two shafts.

The type of misalignment in your system will affect your choice of coupler.

Single-Flex Coupling

Use a single-flex coupling when you have angular misalignment only. Because a single-flex coupling is like a hinge, one and only one of the shafts must be free to move in the radial direction without constraint. *Do not use a double-flex coupling in this situation*: it will allow too much freedom and the shaft will rotate eccentrically, which will cause large vibrations and catastrophic failure. *Do not use a single-flex coupling with a parallel misalignment*: this will bend the shafts, causing excessive bearing loads and premature failure.

Double-Flex Coupling

Use a double-flex coupling whenever two shafts are joined with parallel misalignment, or a combination of angular and parallel misalignment (the most common situation).

Single-flex and double-flex couplings may or may not accept end play, depending on their design.

Rigid Coupling

Rigid couplings are generally not recommended, because they cannot compensate for *any* misalignment. They should be used only if the motor or load is on some form of floating mounts that allow for alignment compensation. Rigid couplings can also be used when the load is supported entirely by the motor's bearings. A small mirror connected to a motor shaft is an example of such an application.

Coupling Manufacturers

HUCO	ROCOM CORP.	HELI-CAL
70 Mitchell Blvd, Suite 201	5957 Engineer Drive	P.O. Box1069
San Rafael, CA 94903	Huntington Beach, CA 92649	Santa Maria, CA 93456
(415) 492-0278	(714) 891-9922	(805) 928-3851

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8 – CONNECT DC POWER

At this point in your permanent installation procedure, you should have mounted your drive and motor, coupled the motor to the load, and connected the controller and motor cables to the drive.

The E-DC Drive does not have an *on/off* switch. When you apply power to the drive, the drive will turn on. Therefore, before you apply power, verify the following:

- Motor should be properly secured
- Motor cable should be connected to drive
- Drive should be properly mounted
- Controller cable should be connected to drive
- Controller cable should not be in close physical proximity to motor cable

APPLYING POWER

See the *Automatic Test* section, earlier in this chapter, for instructions on connecting a 24VDC – 48VDC power supply to **VDC+** and **VDC-**.

CHOOSING A POWER SUPPLY

The next table contains power ratings to help you choose a power supply. Combinations of motors and current levels other than those shown may result in power values that are not recommended.

OS Motors Size 23	Connection	Motor Current (amps peak)	Peak Shaft Power (watts)	Drive Heat (watts)	Supply Total* (watts)
OS2HA	Series	3	38	9.72	47.72
OS21A	Series	4.8	56	16.43	72.43
OS22A	Series	4.8	40	16.43	56.43
VS Motors					
Size 17					
VS12B	Parallel	1.2	18	5.02	23.02
VS13B	Parallel	1.5	30	5.66	35.66
Size 23					
VS21B	Parallel	4.8	37	16.43	53.43
VS22B	Parallel	4.0	37	13.20	50.20
VS23B	Parallel	4.8	63	16.43	79.43
Size 34					
VS31B	Parallel	4.8	70	16.43	86.43
VS32B	Parallel	4.8	84	16.43	100.43

* User must supply this level of wattage

CONVERSIONS

- To convert watts to horsepower, **divide by 746**
- To convert watts to BTU/hour, **multiply by 3.413**
- To convert watts to BTU/minute, **multiply by 0.0569**

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Motor Type

Compumotor's OS and VS Series motors are custom-made for use with the E-DC Drive. These motors are not available as a standard model from any other manufacturer. They are designed for low loss at rest and at high speed. Motors in the same frame size from other manufacturers may sustain considerably higher iron losses than an E-DC motor. OS and VS motors are wound to render inductances within a range suitable for E Series products. If you do not use an OS or VS motor, you should consult Compumotor's Applications Engineering Department for assistance (800-358-9070).

The E-DC Drive is designed to run 2-phase PM step motors only. Do not use variable reluctance or DC motors.

Current (Amps)

We have chosen motor current values (shown earlier) so the motors can produce the highest possible torque, while maintaining smoothness. Higher currents will produce higher static torque; but, the motor will run roughly and may overheat.

Power Dump

The E-DC Drive has built-in power dump circuitry to monitor power supply surges caused by a regenerative load. The power dump circuit is used in conjunction with an externally mounted power resistor. You must connect the power resistor from the **VDC+** terminal to the **DUMP** terminal. The circuitry effectively closes a "switch" to ground when the power supply voltage exceeds 85VDC. This "switch" terminal is connected at the screw terminal labeled **DUMP**. The power dump feature dissipates the energy created by a regenerative load (100 joules maximum). ***The power dump is <u>not</u> designed to protect the drive from overvoltage caused by a poorly regulated or faulty power supply.*** A 35 ohm, 10 watt power resistor (such as a Dale RH-10) is the recommended power dump resistor. You must heat sink the resistor for it to meet its rated wattage.

CAUTION

Never allow the voltage supplied by the power supply to exceed 80VDC. Damage to the power dump resistor may result.

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9 – Test the Installation

System installation should be complete at this point. Perform the test procedure below to verify that your system is functioning properly.

In the test procedure, you will command single revolution moves in the clockwise and counterclockwise direction. If your mechanics do not permit such moves, choose a move that allows you to easily verify correct system response.

Test Procedure

1. Apply DC power. The green LED labeled **PWR** should illuminate.
2. Command a slow move of one revolution in the clockwise direction. Verify that the motor turns as commanded.
3. Command a slow move of one revolution in the counterclockwise direction. Verify that the motor turns as commanded.

Successful completion of this procedure will verify that your controller and motor are correctly connected to the E-DC Drive, and that the drive is functioning properly.

If the test is unsuccessful, proceed to *Chapter 3 Troubleshooting* for problem identification and solution procedures.

Performance Specifications

Accuracy	±5.0 arcminutes typical (unloaded, bidirectional) with Compumotor OS Series or VS Series motors.
Repeatability	±5 arcseconds typical (unloaded, bidirectional).
Hysteresis	Less than 2 arcminutes—0.0334° (unloaded, bidirectional).

Environmental Specifications

Operating Temperature	0°C – 50°C (32°F – 122°F)
Storage Temperature	-40°C – 80°C (-40°F – 176°F)
Humidity	0 – 95%, non-condensing
Drive Weight	0.8 pounds (0.4 kg)

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CHAPTER THREE

3 Troubleshooting

IN THIS CHAPTER

- Diagnostic LEDs
- Protective Circuits
- Resonance Problems
- Motor Problems
- Automatic Test
- Common Problems and Solutions
- Product Return Procedure

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TROUBLESHOOTING BASICS

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you have accomplished this, you can effectively begin to resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to exchange them with existing components in your system to help identify the source of the problem.

Determine if the problem is mechanical, electrical, or software-related. Can you repeat or recreate the problem? Random events may appear to be related, but they are not necessarily contributing factors to your problem.

You may be experiencing more than one problem. You must isolate and solve one problem at a time. Log (document) all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you have isolated a problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter.

DIAGNOSTIC LEDS

The E-DC Drive has two LEDs on its front panel. The following table summarizes LED functions:

LED Name	Color	Function
PWR (POWER)	Green	Illuminates when drive's internal power supply is operating and providing +5V
FLT (FAULT)	Red	Indicates short circuit in motor or cabling; or, Drive overtemperature

SHORT CIRCUIT PROTECTION

The E-DC is protected against phase-to-phase and phase-to-ground short circuits. Never short circuit the motor leads for motor braking.

When the drive detects a short circuit in the motor or motor cabling, it illuminates the **FAULT** LED, and stops producing motor current. This is a latched condition. To restart the drive, first remove power to the drive; fix the short in the motor or cable; then reapply power.

OVERTEMPERATURE PROTECTION

To protect against damage from high temperatures, the E-DC Drive has an internal temperature sensor. If the sensor reaches 55°C (131°F) it will

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trigger an overtemperature fault. The red **FAULT** LED will illuminate, and the drive will shut down. This is a latched fault. To restart the drive, first remove power to the drive; allow it to cool; then reapply power.

LOW SPEED RESONANCE

Resonance exists in all step motors and is a function of the motor's mechanical construction. It can cause the motor to stall at low speeds. Most full step motor controllers jump the motor to a set minimum starting speed that is greater than the resonance region. The E-DC Drive's micro-stepping capability allows you to operate a motor smoothly at all speeds.

Motors that will not accelerate past one rps may be stalling due to resonance. You can add inertia to the motor shaft by putting a drill chuck on the shaft. The drill chuck may provide enough inertia to test the motor when it is not connected to the intended load.

ANTI-RESONANCE DISABLE

All step motors are subject to mid-range instability. This instability, or oscillation, may stall the motor at speeds from 6 to 16 rps. The E-DC includes an *anti-resonance circuit* to help suppress these oscillations. This feature is normally enabled, but may be disabled by DIP SW2-#1 (see *Set DIP Switches* in *Chapter 2*) if it has an adverse effect on your system.

REDUCING ELECTRICAL NOISE

For detailed information on reducing electrical noise in your system, refer to *Appendix B, EMC Installation Guide*.

DRIVE MAINTENANCE

Ensure that the drive's heatplate has proper thermal contact with the mounting surface. Enclosures must be connected to earth ground through a grounding electrode conductor to provide a low-impedance path for ground-fault or noise-induced currents (use a star washer with the lower mounting screw on the drive). All earth ground connections must be continuous and permanent. Periodically check the mounting screws to ensure they are tight.

MOTOR MAINTENANCE

Inspect the motor regularly to ensure that no bolts or couplings have become loose during normal operation. This will prevent minor problems from developing into more serious problems.

Inspect the motor cable periodically for signs of wear. This inspection interval is duty-cycle, environment, and travel-length dependent. The

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cable should not have excessive tensile force applied to it and should not be bent beyond a one-inch radius of curvature during normal operation. Tighten all cable connectors.

TESTING THE MOTOR

If the motor fails to move, you should test the motor with an ohmmeter to examine the resistance between the motor connections. If the motor is not malfunctioning, the source of the problem is probably within the drive. If you operate a faulty drive with a reliable motor, you may damage the motor. If you find that the drive is not faulty, remove power, and remove the motor from the drive. Use the following steps to test the motor.

1. Remove power from the system. Detach the motor from the drive.
2. With the motor detached from the system, use an ohmmeter to check the resistance across Phase A. It should be low but measurable, approximately 1 – 10 ohms (depending on the motor).
3. Use the ohmmeter to check the resistance across Phase B. It should also be low but measurable, approximately 1 – 10 ohms. (*The resistance across Phase A and Phase B should be nearly identical*).
4. Use the ohmmeter to check the resistance between Phase A and Phase B. **It should be infinite**.
5. Use the ohmmeter to check the resistance between Phase A and Earth (the motor case shaft). **It should be infinite**.
6. Use the ohmmeter to check the resistance between Phase B and Earth (the motor case shaft). **It should be infinite**.
7. Turn the shaft manually. There should be a small amount of detent torque, but no holding torque.

If the motor responds as described to each of these steps, it is probably functioning properly. The source of the problem is may be within the drive.

AUTOMATIC TEST

Often in diagnosing a problem, it is helpful to rule out possible causes. If you disconnect the load and controller from the drive, four components remain—the drive, motor, motor cable, and power cable.

You can then configure the drive to run the automatic test function. See instructions near the beginning of *Chapter 2 Installation*. If the motor turns as expected—in an alternating mode—then the drive, motor, and cables are probably *not* the cause of the problem. The cause may lie with the controller, power supply, software, mechanics, etc.

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COMMON PROBLEMS AND SOLUTIONS

The following table will help you eradicate problems you might have with the E-DC Drive.

Symptom	Probable Causes	Solutions
The drive loses pulses at high speed	Controller is overdriving step input	Verify that the step input current is not greater than 15 mA
	Controller is underdriving step input	Verify that the step input current is greater than 6.25 mA
	Controller is sending pulses too fast	Verify that the controller is not exceeding the 2 Mhz maximum pulse rate
	Motor is out of torque	Verify that the motor is sized correctly for your application
The motor stalls at high speeds	The velocity is too high	The drive can handle a maximum of 2 MHz or 50 rps, whichever comes first; decrease the velocity
	Motor current is not set correctly	Check the current select resistor and verify that the current is set correctly
	Current loop gain is not set correctly	Verify correct current loop gain setting for the motor inductance and supply voltage you are using
	Motor is undersized for application	Verify that the motor is sized correctly for your application
The motor stalls during acceleration	Motor current is not set correctly	Check the current select resistor and verify that the current is set correctly
	The acceleration is set too high	Decrease the acceleration
	There is insufficient rotor inertia	Add inertia to the motor shaft
	Current loop gain is not set correctly	Verify correct current loop gain setting for the motor inductance and supply voltage you are using
	Motor is undersized for application	Verify that the motor is sized correctly for your application
The motor (unloaded) stalls at nominal speed	Current loop gain is not set correctly	Verify correct current loop gain setting for the motor inductance and supply voltage you are using
	There is insufficient rotor inertia	Add inertia to the motor shaft
	Mid-frequency resonance	Verify anti-resonance is enabled
Motor does not move commanded distance	Motor resolution is set incorrectly	Determine the resolution on your controller and verify that the drive resolution setting is the same
Motor will not change direction as commanded	The direction input is not being enabled	Verify that the direction input is being enabled (6.4 mA to 15 mA)

(table continued on next page)

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Symptom *(continued)*	**Probable Causes** *(continued)*	**Solutions** *(continued)*
Controller moves motor in wrong direction	There is a direction conflict within the controller	Change direction within your controller or by swapping motor leads A+ and A- at the drive connector
Power LED is not on (illuminated)	The drive is not receiving adequate DC voltage	Verify the VDC+ and VDC- connection
		Verify your power supply is producing adequate power
		Verify that there is DC voltage at the drive and at the VDC+ and VDC- connection
	Drive screw terminals are loose	Tighten screws – do not tin wires
Power LED is flashing	DC line voltage is too low	Check DC line voltage (24 VDC minimum)
	I/O incorrectly connected	Remove 25 pin D-connector to isolate the problem
	Drive may have internal damage	Return the drive to Compumotor for servicing
There is little or no holding torque; the power LED is on; the fault LED is off	The incorrect current select resistor is being used	Verify the current select resistor with the correct table; measure the resistor with an ohmmeter
	The current select resistor is not installed or is loose	Check for current select resistor, tighten screws, check wiring
	Current range switches not set correctly	Verify setting. See *Chapter 2, Installation*
	Remote input signal activated	Remove 25 pin D-connector to isolate problem
	Auto standby function enabled	Check DIP switches SW3-1, SW3-2
The fault LED is on	The drive has detected a short circuit in the motor wiring	Check for miswiring—carefully check the motor wires for loose strands shorting the windings
	The drive is overheating	Verify that the drive's heatsink does not exceed 55°C
	Drive may have internal damage	Return the drive to Compumotor for servicing
The motor moves erratically at low speeds	Motor current is not set correctly	Check the current select resistor and verify that the current is set correctly
	Controller pulses are being sent to the drive erratically	Verify, with an oscilloscope, that the controller pulses are being sent at a constant rate and are not being frequency modulated
	Motor resolution is set for 200 or 400 steps per revolution	Full and half step modes will cause the motor to run roughly at low speeds
	Current loop gain is not set correctly	Verify correct current loop gain setting for the motor inductance and supply voltage you are using
	One motor phase is open	Check wiring. Measure motor winding resistance at the drive (**remove power**)

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TECHNICAL SUPPORT

If you cannot solve your system problems using this documentation, contact your local Automation Technology Center (ATC) or distributor for assistance. If you need to talk to our in-house application engineers, contact Parker Compumotor's Applications Department at (800) 358-9070.

PRODUCT RETURN PROCEDURE

If you must return your E-DC Drive for repairs, use the following steps:

1. Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined to be out of warranty.
2. Before you return the unit, have someone from your organization with a technical understanding of the E-DC Drive and its application include answers to the following questions:
   - What is the extent of the failure/reason for return?
   - How long did the unit operate?
   - Did any other items fail at the same time?
   - What was happening when the unit failed (e.g., installing the unit, cycling power, starting other equipment, etc.)?
   - How was the unit configured (in detail)?
   - What, if any, cables were modified and how?
   - With what equipment is the unit interfaced?
   - What was the application?
   - What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
   - What upgrades, if any, are required (hardware, cables, etc.)?
3. In the USA, call your Automation Technology Center (ATC) for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. If you cannot obtain an RMA number from your ATC, call Parker Compumotor's Customer Service Department at (800) 722-2282.

   Ship the unit to:
   Parker Hannifin Corporation
   Compumotor Division
   5500 Business Park Drive, Suite D
   Rohnert Park, CA 94928
   Attn: RMA # xxxxxxx
4. In Europe, call Parker's Electromechanical Division for a GRA (Goods Returned Authorization) number. Returned products cannot be accepted without a GRA number. Contact information is:

   Europe *(non-German speaking)*:
   Electromechanical Division (EMD) – Europe
   Parker Hannifin plc
   21 Balena Close
   Poole, Dorset
   England BH17 7DX
   Telephone: +44 (0)1202 69 9000
   Fax: +44 (0)1202 69 5750

   Germany, Austria, Switzerland:
   Electromechanical Division (EMD) – Germany
   Parker Hannifin GmbH
   Postfach: 77607-1720
   Robert-Bosch-Str. 22
   D-77656 Offenburg
   Telephone: +49 (0)781 509-0
   Fax: +49 (0)781 509-176
5. Elsewhere: Contact the distributor who supplied the equipment.

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APPENDIX A

LVD Installation Instructions

IN THIS APPENDIX

- Electrical Connections
- Mechanical Connections

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LVD Installation Instructions

For more information about LVD, see 73/23/EEC and 93/68/EEC, published by the European Economic Community (EEC).

Environmental Conditions

Pollution Degree

The E-DC is designed for pollution degree 2.

Installation Category

The E-DC is designed for installation category II.

Electrical

Connecting and Disconnecting Power

The E-DC Drive's protective earth connection is provided through its chassis terminal via the heatsink. You must reliably earth the E-DC's protective earth connection.

Attach or remove the E-DC's power connections only while input power is OFF.

The E-DC's supply voltage is limited to 48 VDC.

Connecting the Chassis Terminal to Earth

You must provide a connection from the E-DC Drive's chassis terminal to a reliable earth point.

The chassis terminal is marked with a label near the drive's lower mounting hole. The label bears the following symbol:



Chassis Terminal Marking

To connect the chassis terminal to earth:

Use a ring terminal in combination with a star washer to make good contact with the exposed metal surface surrounding the lower mounting hole on the E-DC Drive. (The dimension drawing in *Chapter 2 – Installation* indicates that the lower mounting hole has exposed metal.)

Mechanical

Installing in an Enclosure

The E-DC Drive must be installed within an enclosure. The enclosure's interior must not be accessible to the operator. The enclosure should be opened only by skilled or trained service personnel.

Do Not Operate the E-DC Drive Without Cover

The cover provides mechanical support to the circuit assemblies inside.

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Servicing the E-DC Drive

Changing Firmware

Only skilled or trained personnel should change firmware.

Thermal Safety

The Motor May Be Hot

The motor may reach high temperatures during normal operations, and may remain hot after power is removed.

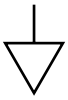
Sonic Pressure

High Sound Level

The sound level from some large frame step motors (NEMA 34, NEMA 42, and larger) may exceed 85 dBA. Actual sound level is application dependent, and varies with motor loads and mounting conditions. Measure the sound level in your application; if it exceeds 85 dBA, install the motor in an enclosure to provide sound baffling, or provide ear protection for personnel.

Table of Graphic Symbols and Warnings

The following symbols may appear in this user guide, and may be affixed to the products discussed in this user guide.

Symbol	Description
	Earth Terminal
	Protective Conductor Terminal
	Frame or ChassisTerminal
	Equipotentiality
	Caution, Risk of Electric Shock
	Caution, Refer to Accompanying Text
	Hot Surface

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APPENDIX B

EMC Installation Guide

IN THIS APPENDIX

- General Considerations
- E-DC Drive Connections
- Motor Connections

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General Product Philosophy

Meeting requirements for electromagnetic compatibility (EMC) compliance will require specific measures to be taken during installation of the E-DC Drive. The ultimate responsibility for ensuring that the EMC requirements are met rests with the systems builder.

It is important to remember that for specific installations, the full protection requirements of the EMC Directive 89/336/EEC need to be met before the system is put into service. This must be verified either by inspection or by testing. The following EMC installation recommendations are intended to assist in ensuring that the requirements of the EMC directive are met. It may be necessary to take additional measures in certain circumstances and at specific locations.

Although these recommendations are based on expertise acquired during tests carried out on the E-DC Drive, it is impossible for Compumotor to guarantee the compliance of any *particular* installation. Compliance will be strongly influenced by the physical and electrical details of the installation and the performance of other system components. Nevertheless it is important to follow ***all*** the installation instructions if an adequate level of compliance is to be achieved.

Safety Considerations

These products are intended for installation according to the appropriate safety procedures including those laid down by the local supply authority regulations. The recommendations provided are based on the requirements of the Low Voltage Directive and specifically on EN61010. It should be remembered that safety must never be compromised for the purpose of achieving EMC compliance. Therefore in the event of a conflict occurring between the safety regulations and the following recommendations, ***the safety regulations always take precedence.***

General Considerations

External Enclosures

The measures described in these recommendations are primarily for the purpose of controlling conducted emissions. To control radiated emissions, all drive and control systems must be installed in a steel equipment cabinet which will give adequate screening against radiated emissions. This external enclosure is also required for safety reasons. There must be no user access while the equipment is operating. This is usually achieved by fitting an isolator switch to the door assembly. The E-DC Drive must be mounted to a conductive, earthed panel. If this has a paint finish, it will be necessary to remove the paint in certain areas where specified.

To achieve adequate screening of radiated emissions, all panels of the enclosure must be bonded to a central earth point. The enclosure may also contain other equipment and the EMC requirements of these must be considered during installation. Always ensure that drives are mounted in such a way that there is adequate ventilation.

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AC Supply Filtering

These recommendations are based on the use of proprietary screen filter units which are readily available. However the full EMC test includes a simulated lightning strike which will damage the filter unless adequate surge suppression devices are fitted. These are not normally incorporated into commercial filters since the lightning strike test can be destructive. This test is normally carried out on the overall system and not on individual components, therefore the surge protection should be provided at the system boundary.

Try to arrange the layout of drive, power supply and filter so that the mains power cable is kept away from the filter output leads. It is preferable for the current path to be as linear as possible without doubling back on itself—this can negate the effect of the filter. Mount the filter within 2 inches (50mm) of the power supply or transformer, if required, and run the input cable and any earth cables close to the panel.

Control Signal Connections

High-quality braided-screen cable should be used for control connections. In the case of differential inputs, it is preferable to use cable with twisted pairs to minimize magnetic coupling. This applies to both analog and digital signals. Control cables leaving the enclosure should have the cable screen returned to a local ground point near the product. Where screened leads are used in control circuits that are only opto-isolated at one end, the screen must be referenced to earth at the non-isolated end. Where there is isolation at both ends of the connection, earth the screen at the receiving end. This is to give protection against coupled noise impulses and fast transient bursts.

Remember to route control signal connections well away from relays and contactors—at least 8 inches (200 mm). Control wiring should not be laid parallel to power or motor cables and should only cross the path of these cables at right angles. Bear in mind that control cables connected to other equipment within the enclosure may interfere with the controller or drive, particularly if they have come from outside the cabinet. Take particular care when connecting external equipment with the cabinet door open, for instance a computer or terminal; static discharge may cause damage to unprotected inputs.

Motor Cabling

In order to prevent electrical cross-talk, motor cables not incorporating a braided screen shield must remain within earthed metal conduit the entire exposed length of travel. It is advised that each high power motor cable utilize its own conduit.

Ferrite Absorber Specifications

The absorbers described in these installation recommendations are made from a low-grade ferrite material which has high losses at radio frequencies. They therefore act as a lossy element in this waveband.

The recommended components are produced by Parker Chomerics (617-935-4850)

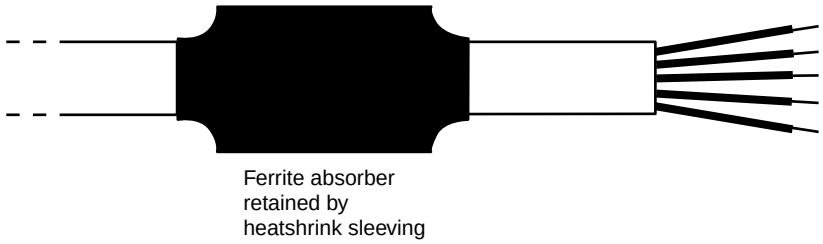
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and are suitable for use with cable having an outside diameter up to 10 – 13mm. The specification is as follows:

Chomerics part number	83-10-M248-1000	83-10-M637-1000
Outside diameter	17.5mm (0.69 in.)	28.5mm (1.12 in.)
Inside diameter	9.5mm (0.375 in.)	13.77mm (0.54 in.)
Length	28.5mm (1.12 in.)	28.57mm (1.13 in.)
Impedance at 25MHz	115 Ω	158 Ω
Impedance at 100MHz	170 Ω	250 Ω
Curie temperature	130°C	130°C
(*the device should not be operated near this temperature*)		

Handling and Installing the Ferrite Absorbers

Take care when handling the absorbers—they can shatter if dropped on a hard surface. For this reason the suggested method of installation is to use a short length of heat-shrink sleeving, as shown below. This gives a degree of physical protection while the cable is being installed. The sleeving should have a shrink ratio of at least 2.5:1. Cable ties may be used as an alternative; however, they give no physical protection to the absorber.



Ferrite Sleeve Installation

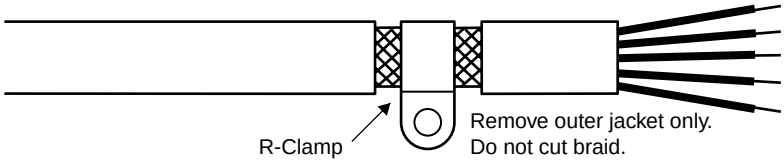
R-Clamp Installation Details

The function of the R-clamp is to provide a 360 degree metallic contact and thus a convenient means of ensuring a proper radio frequency ground. When dealing with electromagnetic interference issues, it is important to remember that continuity—a DC connection—does not at all speak to the integrity of an AC (high-frequency) bond. High-frequency bonding typically involves wide, flat cabling to establish a suitable system ground. When applied properly, the R-clamp has been shown to give an adequate high-frequency contact.

When installing an R-clamp, as shown in the next figure, install it as close to the cable end as possible. Mount the R-clamp to a suitable ground, backplane, earth stud or bus bar—this may require removing paint from a cabinet or panel.

Remove only the outer (vinyl) jacket of the braided screen cable; this allows the braid to continue to the cable connector. Be careful not to damage the braid. Snap the R-clamp over the exposed braid, and adjust for a tight fit. Secure the clip to the designated ground with a machine screw and lock washer. The use of brass or other inert conductive metal R-clamp is recommended. Cover any exposed bare metal with petroleum jelly to resist corrosion.

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R-Clamp Installation

E-DC Drive Connections

Please read this section in conjunction with the general considerations applicable to all products.

External Enclosure

Before mounting the drive, ensure that the mounting location is flat and free from paint or other non conductive surface coatings; if necessary remove paint from the corresponding mounting area. This is to guarantee a good high-frequency connection between the drive case and the cabinet. After mounting the unit use petroleum jelly on the exposed metal to minimize the risk of future corrosion. Do not forget to insert a thermally conductive strip or apply thermal paste between the drive and mounting area, if the mounting location is to serve as a heatsink.

Filtering the DC Power Supply

In most installations, the DC power supply (providing DC voltage to the E-DC Drive) will require fitting of a mains filter. A suitable filter and particular mounting recommendations should be made available by the power supply manufacturer.

Mount the filter within 2 inches (50mm) of the power supply (see the next figure). Ensure that there is no paint on the mounting panel under the filter mounting lugs - it is vital that there is a large-area conductive contact between the filter and the panel.

Connect the incoming AC supply cable to the push-on terminals on the filter, with the earth lead connected to a local earth stud, bus bar or metal backplane. Route the supply cable so that it runs close to the walls of the enclosure. Connect the earth terminal on the filter case to the earth stud.

Fit a ferrite absorber over the cable before wiring the filter output terminals to the AC input on the power supply. Locate the absorber as close as possible to the power supply using heat-shrink sleeving (see the next figure). Take the power supply earth connection from the same stud that retains the filter case earth.

Attach the DC power supply output to the E-DC, using 2-core 1.0mm^2 (AWG 16) (SWG 18) twisted wiring, as shown in the next figure. Route these wires away from motor cables and other high current cabling, while keeping their length as short as possible.

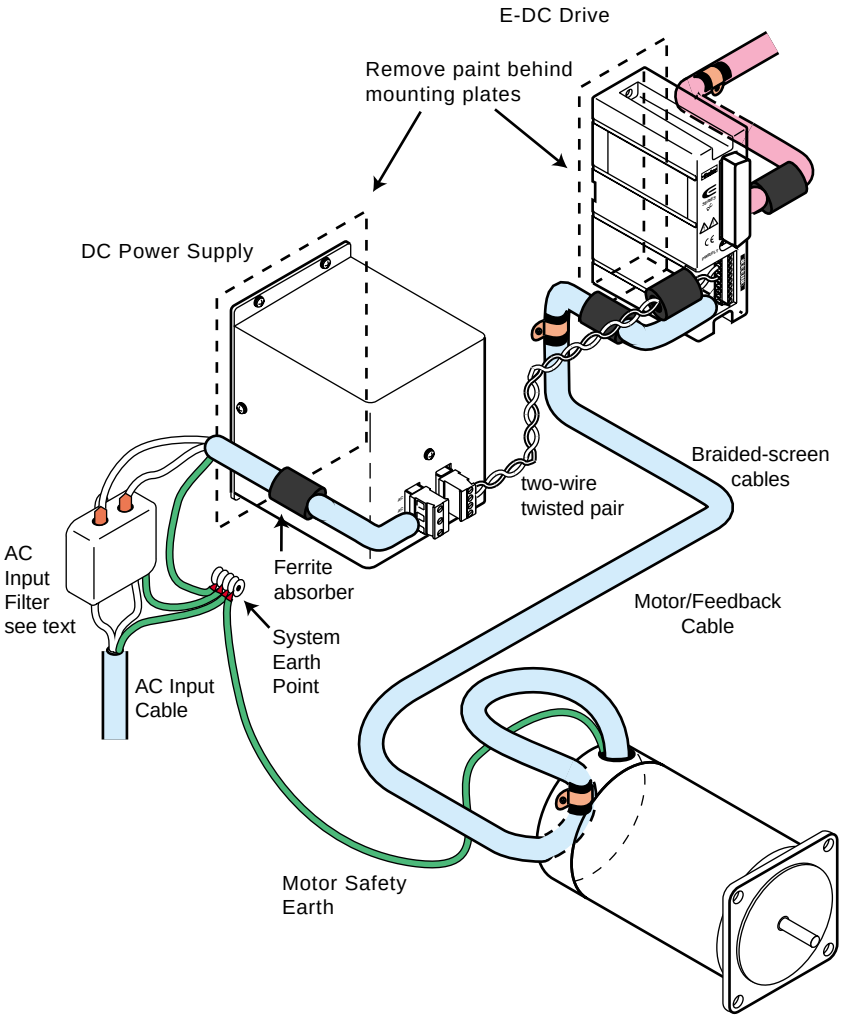
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Compumotor Motors, and other Motors With Non-Removable Cabling

When motor cabling is not confined within earthed conduit, it is necessary to shield the exposed length of cable and properly bond it to earth. In installations where the motor cable is within earthed conduit for the entire length of travel, the standard motor cable can be used.

To extend motor cables, cut off cable in excess of approximately 4 inches (10 cm). Configure the motor for series or parallel operation and attach the braided screen cable to the motor. The use of a terminal block or other hardware is recommended, as inline splicing on high power cables is not allowed.

Termination of the braid shield at the motor must be made using a 360° bond to the motor body. This may be achieved by using a suitable clamp. R-clamp the braid (see previous figure) to the rear end bell of the motor housing, shown in the next figure. This will not only provide a good high frequency bond, but strain relief as well.



Motor with Non-Removable Cabling

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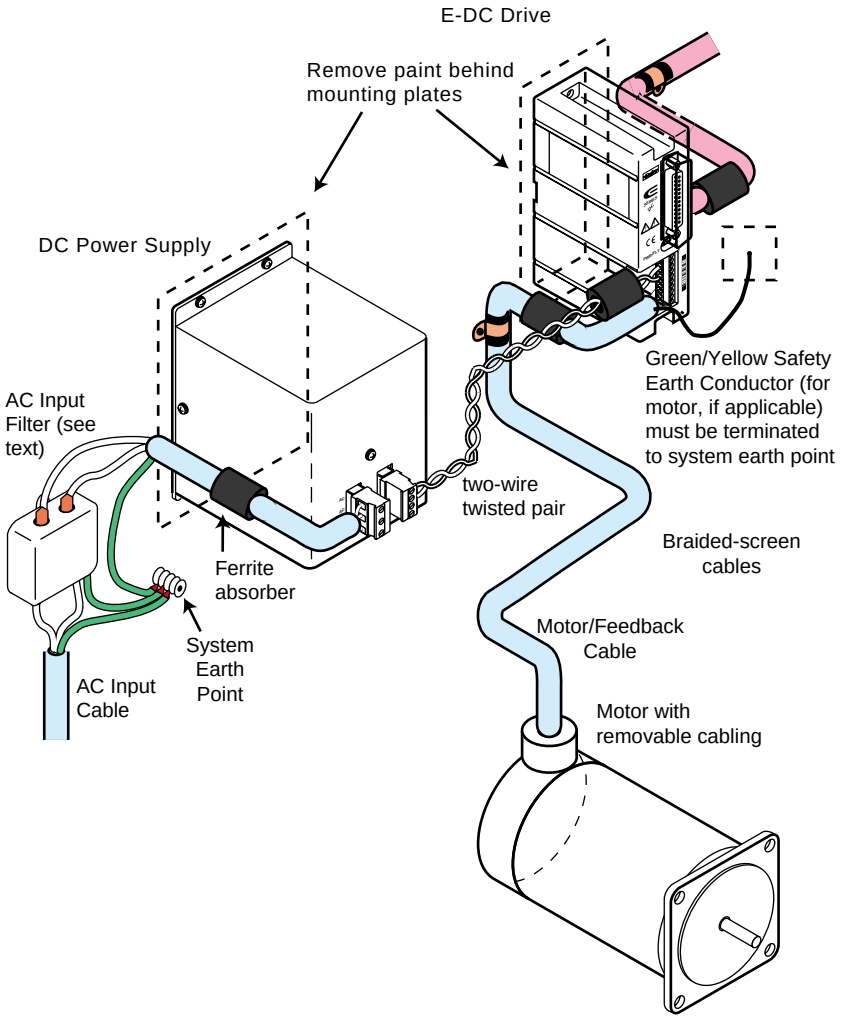
At the drive end of the motor cable, fit a ferrite absorber over the cable before wiring to the motor connector. Locate the absorber as close as possible to the connector using heat-shrink sleeving. Expose a short length of braiding and anchor to the panel with an R-clamp. Note that the motor cable should be kept away from I/O cables carrying control signals.

Other Motors with Removable Cabling

Remove the motor cable from the standard motor, and replace with a suitable cable described in *Motor Cables* following this section.

Termination of the braid shield at the motor must be made using a 360° bond to the motor body. This may be achieved with use of an appropriate threaded insert, or a suitable clamp. For the latter, R-clamp the braid to the rear end bell of the motor housing, as shown in the previous figure. This will not only provide a good high frequency bond, but strain relief as well.

At the drive end of the motor cable, fit a ferrite absorber over the cable before wiring to the motor connector. Locate the absorber as close as possible to the connector using heat-shrink sleeving. Expose a short length of braiding and anchor to the panel with an R-clamp. Note that the motor cable should be kept away from I/O cables carrying control signals.



Motor with Removable Cabling

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Motor Cables

Use 4-core 1.5mm^2 (AWG 14) (SWG 16) cable for the E-DC Drive.

All aftermarket motor connections must be made using a high quality braided-screen cable. Cables using a metallized plastic foil for an earth screen are unsuitable and in fact provide very little screening. Terminating to the screen in a mechanically stable manner is difficult because the screen itself is comparatively fragile—bending it in a tight radius can seriously affect the screening performance.

There must be no break in the 360° coverage that the screen provides around the cable conductors. If a connector must be used it should retain the 360° coverage, possibly by the use of an additional metallic casing where it passes through the bulkhead of the enclosure. The cable screen must *not* be connected to the cabinet at the point of entry. Its function is to return high-frequency chopping current back to the drive or controller. This may require mounting the connector on a sub-panel insulated from the main cabinet, or using a connector having an internal screen which is insulated from the connector housing.

Within the cabinet itself, all the motor cables should lie in the same trunking as far as possible. They must be kept separate from any low-level control signal cables. This applies particularly where the control cables are unscreened and run close to the drive or other sources of electrical noise.

Motor Feedback Cables

Feedback devices such as encoders and tachometers also require the use of high-quality braided screen cable. If it is necessary to replace the standard feedback cable, select a braided screen cable that matches the gage of the device's original cable and attach as close to the transducer as possible. Avoid complex and bulky connections that can cause degradation in feedback signal quality. If possible, use inline cable splicing techniques, and cover the splice point with heat-shrink tubing. Remove a section of the braided shield cable's insulation to expose the braid, and tie the braid to earth using the same R-clamp 360° bond as shown in the previous figure. Differential signals should use twisted pair cable to minimize magnetic coupling. At the receiving end, R-clamp the braid to a suitable ground (metal backplane of drive mounting panel, or earth point of device that receives the feedback).

Motors

It is preferable to use motors with screw terminations whenever possible. If flying-lead motors are used, it is important that the unscreened leads are converted into a braided-screen cable within 4 inches (100 mm) of the motor body. A separate terminal box may be used for this purpose but the braided cable screen must be properly strapped to the motor body. Motors fitted with terminal boxes also allow local selection of series or parallel connection, reducing the cost of the cable running back to the drive. For safety reasons, the motor case must be grounded, either through the grounded machine mounting interface or with the addition of a safety ground wire (green and yellow striped wire).

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Control Signal Wiring

High-quality braided screen cable should be used for control connections. In the case of the E-DC Drive, which has differential step/direction inputs, it is preferable to use cable with twisted pairs to minimize magnetic coupling. I/O lines require that separate grounds be individually run for each I/O point. In the case of limits and other I/O that must reside external to the mounting cabinet, braided screen cable must also be used. Bond the braid to the machine frame earth ground at the sensor end. No connection is made to the cable screen at the drive itself. Fit a ferrite absorber close to the I/O connector and run the cable to the mounting panel as shown in the previous figures. Expose a short length of the braided screen and anchor to the panel with an R-clamp.

The level at which the I/O operates means that the signals are unlikely to meet EMC immunity requirements if taken outside the enclosure without proper screening.

Communications

In applications that require serial communications with the E-DC Drive, special care must be taken in assuring proper wiring practices are utilized. Good quality braided screen cable should be used for the communications cabling. No connection is made to the cable screen at the drive itself. Fit a ferrite absorber close to the communications connector and run the cable to the mounting panel as shown in the previous figures. Expose a short length of the braided screen and anchor to the panel with an R-clamp. Avoid routing communication cables near high power lines, and sources of high energy impulses.

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