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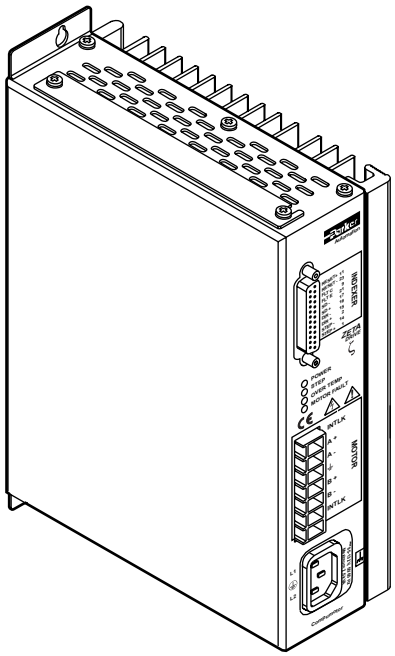
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Compumotor

ZETA8 and ZETA12 Drive
User Guide



Compumotor Division
Parker Hannifin Corporation
p/n 88-016888-01A June 1998

Parker

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IMPORTANT

User Information

To ensure that the equipment described in this user guide, as well as all the equipment connected to and used with it, operates satisfactorily and safely, all applicable local and national codes that apply to installing and operating the equipment must be followed. Since codes can vary geographically and can change with time, it is the user's responsibility to identify and comply with the applicable standards and codes. **WARNING:** ***Failure to comply with applicable codes and standards can result in damage to equipment and/or serious injury to personnel.***

Personnel who are to install and operate the equipment should study this user guide and all referenced documentation prior to installation and/or operation of the equipment.

In no event will the provider of the equipment be liable for any incidental, consequential, or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with the use of this user guide or the equipment.

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CE

Product Type: ZETA8 or ZETA12 Stepper Drive

The above product is in compliance with the requirements of directives

- 89/336/EEC Electromagnetic Compatibility Directive as amended by Directive 92/31/EEC

The product is intended for use in the Commercial, Light Industrial and Industrial Environments as defined in the relevant EMC standards.

This product is compliant with the Low Voltage Directive.

- 72/23/EEC Low Voltage Directive
- 93/68/EEC CE Marking Directive

The ZETA Drive, when installed according to the instructions in this user guide, and particularly in *Appendix B, LVD and EMC Installation Guide*, has been shown to comply with the Electromagnetic Compatibility Directive (EMC) and the Low Voltage Directive (LVD) of the European Community. If you do not follow these instructions, the operation and protection of the product may be impaired.

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CHAPTER ONE

1 Introduction

IN THIS CHAPTER

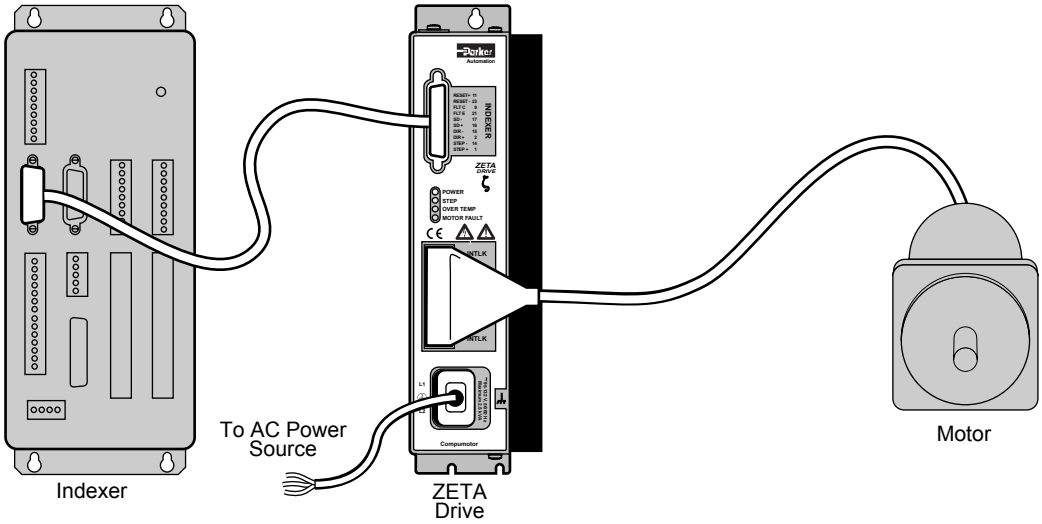
- ZETA Drive Description
- Anti-Resonance
- Active Damping
- Electronic Viscosity

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ZETA DRIVE – DESCRIPTION

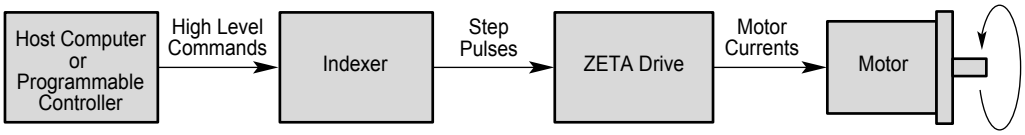
The ZETA Drive is a microstepping drive that runs two-phase step motors. It operates directly from 120VAC power; no separate DC power supply or transformer is required.

A typical system is shown below.



System Components

The indexer 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 ZETA System

The host computer or programmable controller may or may not be necessary, depending upon the indexer'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 on top of the ZETA Drive, behind a removable metal cover. During the installation procedure, the user sets these DIP switches to scale the drive for motor current, resolution, waveform, and other functions.

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INPUT & OUTPUT

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

- Step Input
- Direction Input
- Shutdown Input
- Fault Output
- Reset Input
- Clockwise/Counterclockwise Input

ROTARY SWITCHES

Two rotary switches are located on top of the ZETA Drive, next to the DIP switches. The rotary switches are used to adjust the drive's active damping and electronic viscosity circuits.

POTENTIOMETERS

Three potentiometers are located on top of the ZETA Drive, next to the rotary and DIP switches. The potentiometers are used to adjust the drive's electrical characteristics to match the motor's individual characteristics.

DAMPING TECHNOLOGIES IN THE ZETA DRIVE

All step motors are subject to resonance, and to ringing after quick transient moves. The ZETA Drive has three unique circuits that can damp resonance and ringing.

ANTI-RESONANCE

This is a general purpose damping circuit that provides aggressive and effective damping. The user sets DIP switches to choose one of two ranges, based upon system resonant frequency and inertia.

ACTIVE DAMPING

This is an extremely powerful damping circuit. The user sets seven DIP switches and one rotary switch on the drive, to optimize active damping for a specific motor and load.

Anti-resonance and active damping work at speeds greater than three revolutions per second.

ELECTRONIC VISCOSITY (EV)

This circuit provides damping at speeds from rest up to three revolutions per second. The user sets one rotary switch on the drive, to optimize EV for a particular application. EV can reduce settling time at the end of a move, which can lead to increased machine throughput.

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THE ZETA NAME

In the equation that describes the transfer function of a step motor, the Greek symbol ζ (zeta) is used to represent the damping ratio. Because our drive has such sophisticated and unique damping capabilities, we decided to name it the *ZETA Drive*.

R AND T SERIES MOTORS

R and T Series motors are available from Compumotor for use with the ZETA Drive. These motors are designed to match the drive's high performance capabilities.

COMPUMOTOR FAMILY OF PRODUCTS

The ZETA Drive is completely compatible with Compumotor's broad range of microstepper indexers (single-axis and multi-axis) and other motion control products.

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CHAPTER TWO

2 Installation

IN THIS CHAPTER

- Product Ship Kit List
- Motor Selection and Wiring
- Quick Test
- Drive Configuration – DIP Switches, I/O, Potentiometers
- Mounting the Drive and Motor; Attaching the Load
- Testing the Installation
- Active Damping and Electronic Viscosity – Configuration

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WHAT YOU SHOULD HAVE *(SHIP KIT)*

If you ordered a ZETA8 or ZETA12 Drive, you should have:

Part	Part Number
ZETA8 Drive or ZETA12 Drive	ZETA8 or ZETA12
Power Cable - 6.6 feet (2.0 m) in length	44-030083-01
Motor Connector – 7 pin, with jumper installed	71-016155-01
Boot for Motor Connector	58-016135-01
ZETA8 and ZETA12 Drive User Guide	88-016888-01

You may have ordered one of the following options:

Part	Part Number	
R Series Motor	RS31B-*nnnnn*	RS42B-*nnnnn*
	RS32B-*nnnnn*	RE42B-*nnnnn*
	RS33B-*nnnnn*	
T Series Motor	TS31B-*nnnnn*	TS41B-*nnnnn*
	TS32B-*nnnnn*	TS42B-*nnnnn*
	TS33B-*nnnnn*	TS43B-*nnnnn*
Cable Kit for LVD/EMC Installation	C10	
EMC Kit for LVD/EMC Installation	ZETA EMC SHIPKIT	

PRECAUTIONS

To prevent injuries to personnel and damage to equipment, observe the following guidelines.

- Never probe the drive. Hazardous voltages are present within the drive.
- Never open the drive. Opening the drive will void the warranty.
- Never increase the current setting to a value greater than that specified for the motor you are using. Excessive current may cause motor overheating and failure.

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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:

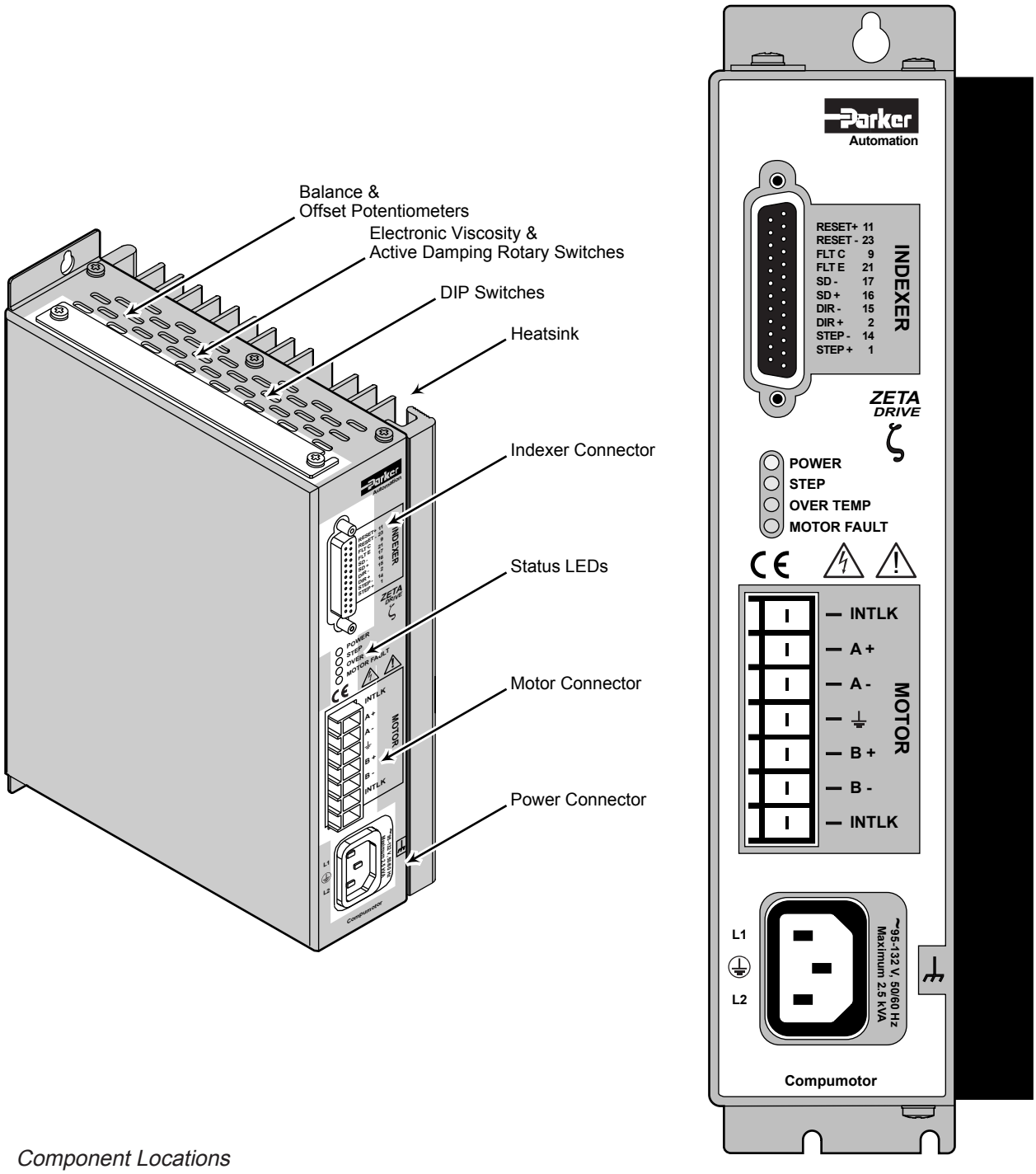
- Motor selection—specifications, speed/torque curves, and dimensions
- Motor wiring—series vs. parallel
- Quick Test
- DIP switch configuration
- Indexer connections and 25 pin D-connector input/output schematic
- Drive/Motor matching procedure
- Drive mounting
- Motor mounting
- Connecting the load
- Connecting AC power
- Testing the installation
- Resonance, ringing, and damping – discussion and theory
- Active Damping and Anti-Resonance configuration
- Electronic Viscosity configuration

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INSTALLATION PROCEDURE

In the following installation procedure, we assume you are using a Compumotor R or T Series motor and operating your ZETA Drive at 120VAC. If you do not use an R or T motor, consult *Appendix A, Using Non-Compumotor Motors*. For LVD/EMC, consult *Appendix B, LVD and EMC Installation Guide*.

The next drawing shows locations and names of the various components that you will encounter during the installation procedure.



Component Locations

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PRE-INSTALLATION

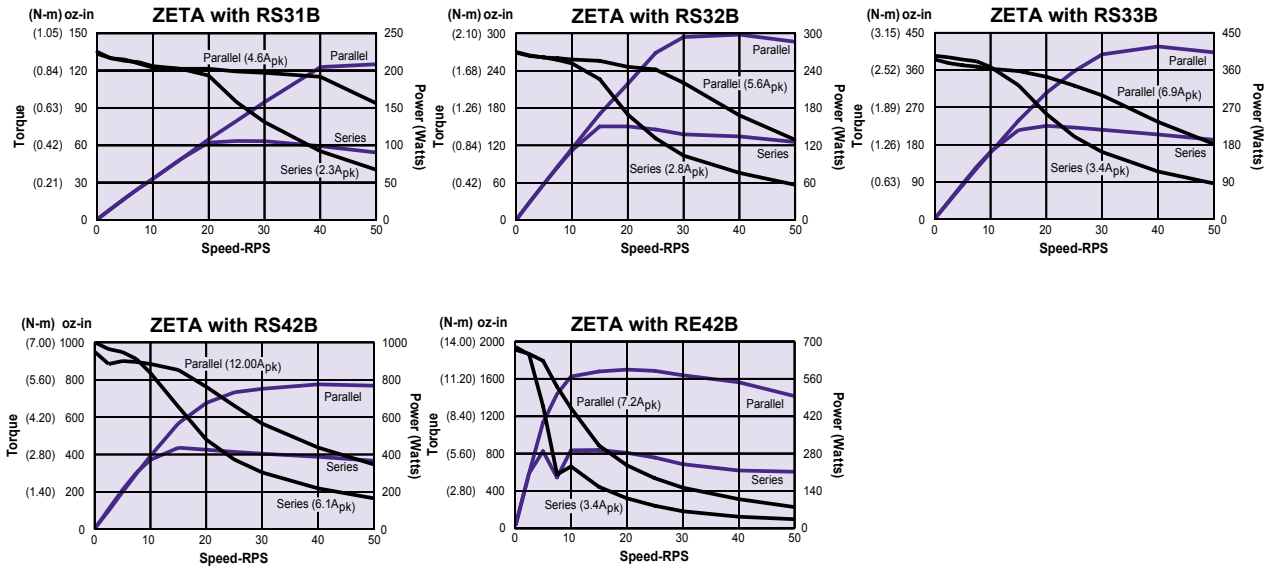
This section explains steps to take before you permanently install your system—selecting a motor, wiring it for series or parallel motor current, and performing a quick test.

1 – SELECT A MOTOR

We recommend that you use a Compumotor R Motor or T Motor with your ZETA Drive. Because the R or T Motor's materials, design, and construction are matched to the drive's high performance capabilities, it will operate more efficiently than other motors. Furthermore, the drive's special features—anti-resonance, active damping, and electronic viscosity—were optimized to work best with R or T Motors. These features will be most effective if you use an R or T Motor.

Speed/Torque curves, specifications, and motor dimensions for R or T Motors are shown below.

SPEED/TORQUE CURVES FOR R MOTORS WITH ZETA DRIVE



Note 1: Parallel connected motors are limited to 50% duty cycle when operated above 5 rps. For greater than 50% duty cycle above 5 rps, you must connect the motor in series. Fan cooling the motor will increase duty cycles above 5 rps.

Note 2: Viscous damper is not required to achieve speed torque curves.

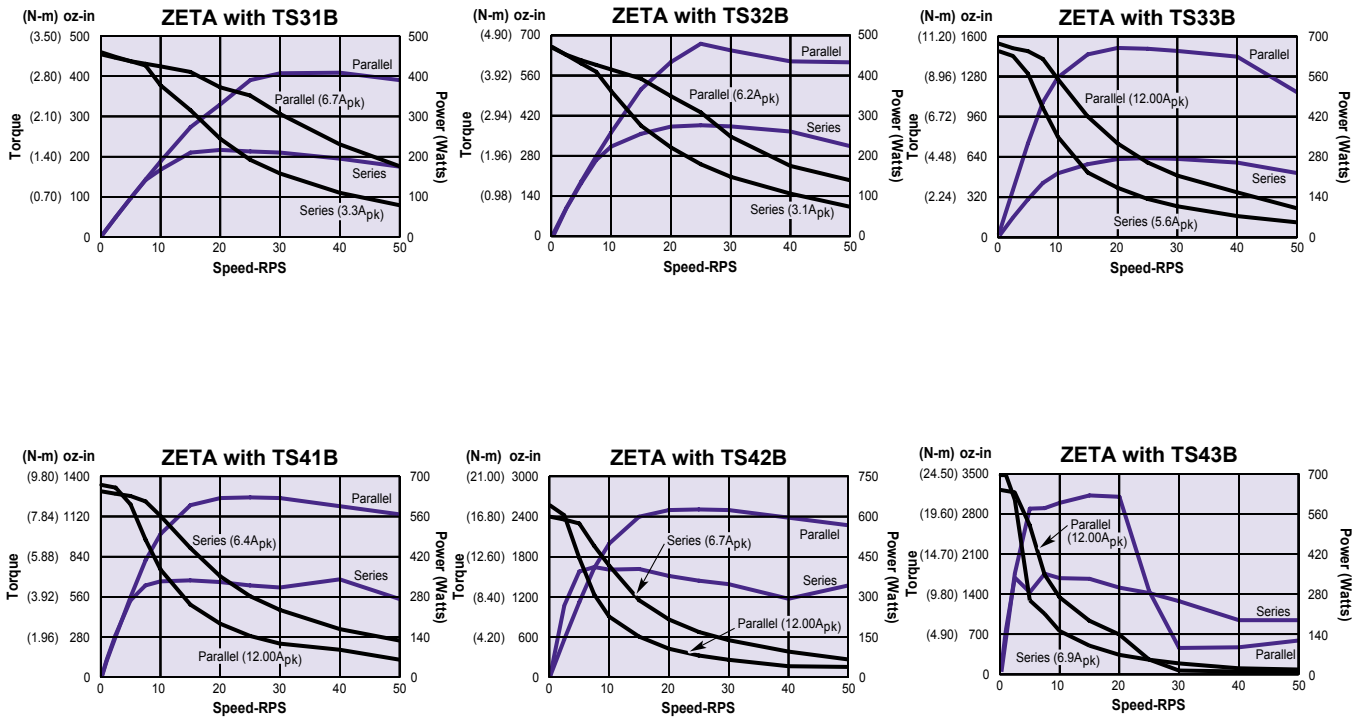
Note 3: ±10% torque variance due to motor tolerance .

Speed/Torque Curves for R Motors with ZETA Drive

Drive's Current Range	
ZETA8	0–8 A_{pk}
ZETA12	0–12 A_{pk}

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SPEED/TORQUE CURVES FOR T MOTORS WITH ZETA DRIVE



Note 1: Parallel connected motors are limited to 50% duty cycle when operated above 5 rps. For greater than 50% duty cycle above 5 rps, you must connect the motor in series. Fan cooling the motor will increase duty cycles above 5 rps.

Note 2: Viscous damper is not required to achieve speed torque curves.

Note 3: ±10% torque variance due to motor tolerance.

Speed/Torque Curves for T Motors with ZETA Drive

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R Series Motor Specifications

	Size 34			Size 42	
	RS31B	**RS32B**	**RS33B**	**RS42B**	**RE42B**
Static Torque**					
oz-in	133	267	392	985	1907
(N-m)	(0.93)	(1.87)	(2.74)	(6.90)	(13.35)
Rotor Inertia					
oz-in^2	3.02	6.56	9.65	61.76	61.76
(kg-cm^2)	(0.55)	(1.20)	(1.77)	(11.30)	(11.30)
Drive Current Apk (Arms)**					
Series	2.3 (1.6)	2.8 (2.0)	3.4 (2.4)	6.1 (4.3)	3.4 (2.4)
Parallel	4.6 (3.3)	5.6 (4.0)	6.9 (4.9)	12.0 (8.5)	7.2 (5.1)
Phase Inductance (mH)***					
Series	9.4	11.6	9.6	8.2	42.6
Parallel	2.4	2.9	2.4	2.1	10.7
Detent Torque					
oz-in	8.8	18	27	50	81
(N-m)	(0.06)	(0.13)	(0.19)	(0.35)	(0.57)
Bearings – Thrust load					
lb	180	180	180	400	400
(kg)	(81.6)	(81.6)	(81.6)	(182)	(182)
Bearings – Radial load					
lb	35	35	35	140	140
(kg)	(15.9)	(15.9)	(15.9)	(63.6)	(63.6)
Bearings – End play *(Reversing load Equal to 1 lb)*					
in	0.001	0.001	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Bearings – Radial play *(Per 0.5 lb load)*					
in	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)	(0.02)-				
		(0.02)	(0.02)	(0.02)	(0.02)
Motor Weight					
lb	3.2	5.3	7.6	18.2	18.2
(kg)	(1.5)	(2.4)	(3.5)	(8.3)	(8.3)
Certifications					
UL recognized	yes	yes	yes	yes	yes
CE (LVD)	yes	yes	yes	yes	yes
CE (EMC & LVD)	*	*	*	*	*

* EMC is achievable with C10 Cable Kit and EMC Kit.
** Values shown in speed-torque curves.
*** Small signal values.

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T Series Motor Specifications

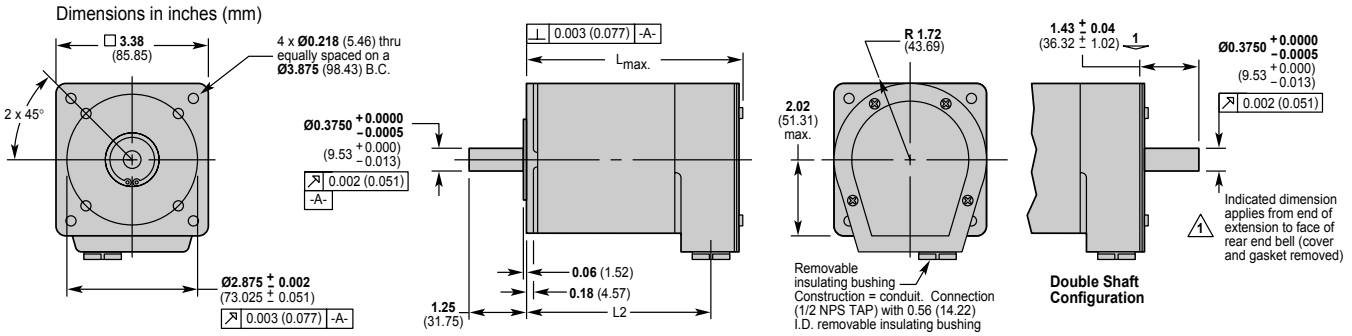
		Size 34			Size 42	
	TS31B	**TS32B**	**TS33B**	**TS41B**	**TS42B**	**TS43B**
Static Torque**						
oz-in	455	647	1525	1332	2515	3479
(N-m)	(3.19)	(4.53)	(10.68)	(9.32)	(17.61)	(24.35)
Rotor Inertia						
oz-in^2	7.80	14.67	21.89	30.22	59.68	88.51
(kg-cm^2)	(1.43)	(2.68)	(4.01)	(5.53)	(10.92)	(16.20)
Drive Current Apk (Arms)**						
Series	3.3 (2.3)	3.1 (2.2)	5.6 (4.0)	6.4 (4.5)	6.7 (4.7)	6.9 (4.9)
Parallel	6.7 (4.7)	6.2 (4.4)	12.0 (8.5)	12.0 (8.5)	12.00 (8.5)	12.0 (8.5)
Phase Inductance (mH)***						
Series	10.3	10.3	13.6	15.8	22.0	30.7
Parallel	2.6	2.6	3.4	3.9	5.5	7.7
Detent Torque						
oz-in	18	36	54	42	84	106
(N-m)	(0.13)	(0.25)	(0.38)	(0.30)	(0.59)	(0.75)
Bearings – Thrust load						
lb	305	305	305	404	404	404
(kg)	(139)	(139)	(139)	(184)	(184)	(184)
Bearings – Radial load						
lb	65	65	110	125	110	110
(kg)	(30)	(30)	(50)	(57)	(50)	(50)
Bearings – End play *(Reversing load Equal to 1 lb)*						
in	0.001	0.001	0.001	0.001	0.001	0.001
(mm)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Bearings – Radial play (*Per 0.5 lb load*)						
in	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
(mm)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Motor Weight						
lb	5.0	8.4	11.9	11.0	18.4	25.7
(kg)	(2.3)	(3.8)	(5.4)	(5.0)	(8.3)	(11.7)
Certifications						
UL Recognized	yes	yes	yes	yes	yes	yes
CE (LVD)	yes	yes	yes	yes	yes	yes
CE (EMC & LVD)	*	*	*	*	*	*

* EMC is achievable with C10 Cable Kit and EMC Kit.
** Values shown in speed-torque curves.
*** Small signal values.

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R Motor Dimensions

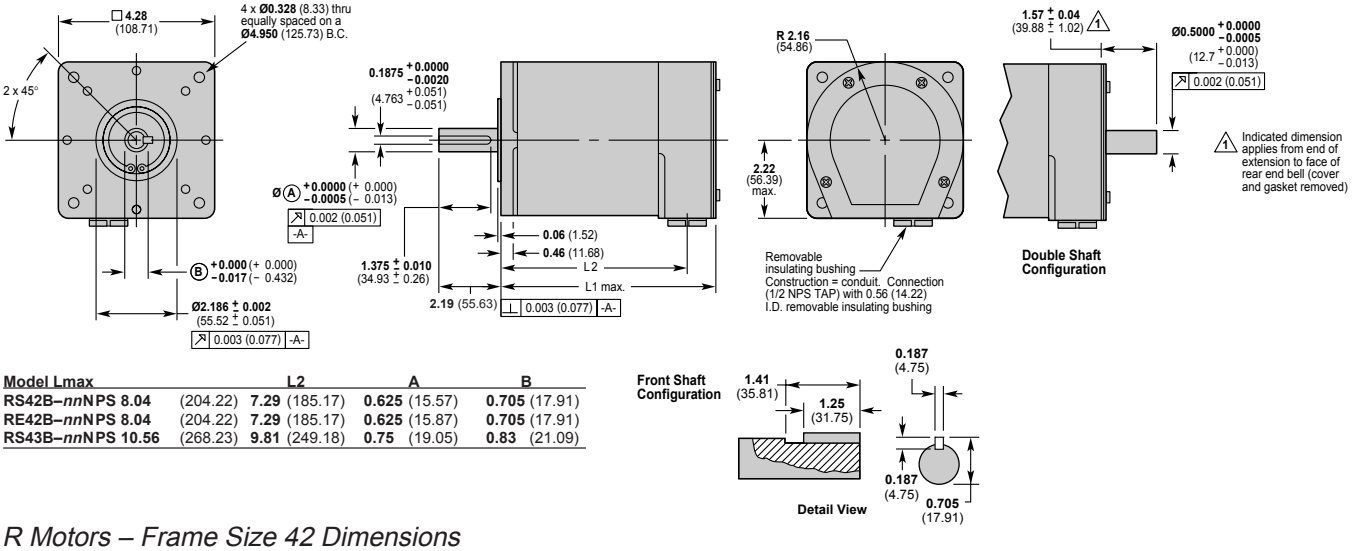
Dimensions in Inches (mm)



Model	Lmax		L2	
RS31B–*nn*NPS	**3.62**	(91.95)	**2.87**	(72.9)
RS32B–*nn*NPS	**4.77**	(121.16)	**4.02**	(102.11)
RS33B–*nn*NPS	**6.05**	(153.67)	**5.30**	(134.62)

R Motors – Frame Size 34 Dimensions

Dimensions in Inches (mm)



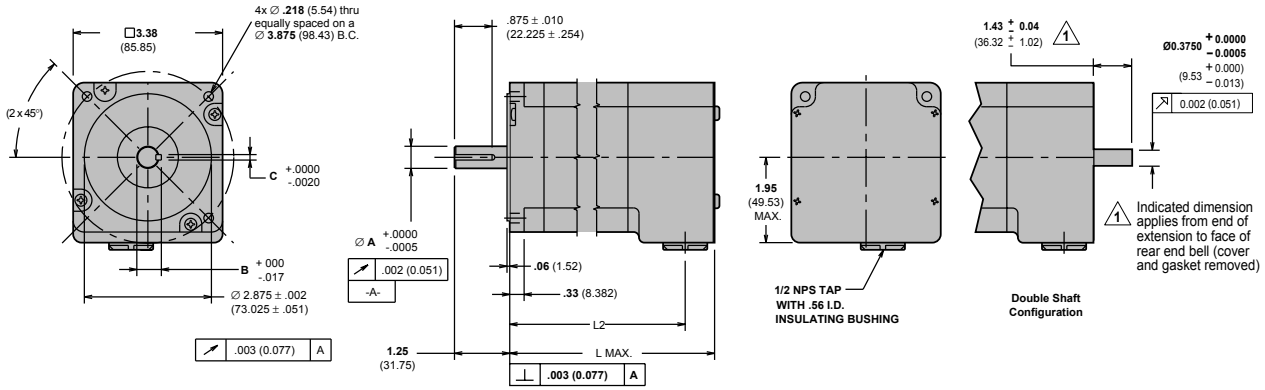
Model	Lmax		L2	A	B
RS42B–*nn*NPS	**8.04**	(204.22)	**7.29** (185.17)	**0.625** (15.57)	**0.705** (17.91)
RE42B–*nn*NPS	**8.04**	(204.22)	**7.29** (185.17)	**0.625** (15.87)	**0.705** (17.91)
RS43B–*nn*NPS	**10.56**	(268.23)	**9.81** (249.18)	**0.75** (19.05)	**0.83** (21.09)

R Motors – Frame Size 42 Dimensions

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T MOTOR DIMENSIONS

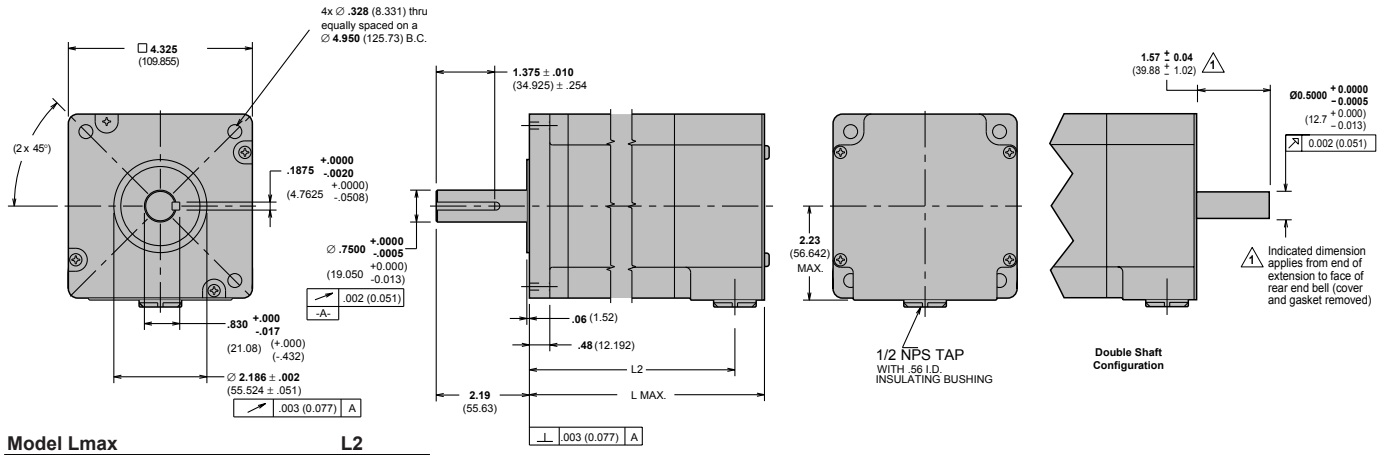
Dimensions in Inches (mm)



Model Lmax	L2	A	B	C
TS31B–nnNPS	**4.44** (112.78)	**3.70** (93.98)	**0.5000** (12.70)	**.555** (14.097)	**.1250** (3.175)
TS32B–nnNPS	**5.96** (151.38)	**5.22** (132.59)	**0.5000** (12.70)	**.555** (14.097)	**.1250** (3.175)
TS33B–nnNPS	**7.48** (189.99)	**6.74** (171.20)	**0.6250** (15.88)	**.705** (17.907)	**.1875** (4.763)

T Motors – Frame Size 34 Dimensions

Dimensions in Inches (mm)



Model Lmax	L2
TS41B–*nn*NPS 5.20 (132.08)	**4.46** (113.28)
TS42B–*nn*NPS 7.22 (183.39)	**6.48** (164.59)
TS43B–*nn*NPS 9.23 (234.44)	**8.49** (215.65)

T Motors – Frame Size 42 Dimensions

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2 – Choose Series or Parallel Motor Wiring

The R or T Motor's 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.

These two alternatives—series and parallel—produce different speed/torque characteristics, affect the motor's current rating, and alter the motor's operating temperature. They are explained below.

Interlock Terminals

The interlock terminals on the motor connector comprise a safety feature that protects the motor connector. The drive checks for continuity between the interlock terminals. A jumper on the connector provides this continuity; the jumper must be in place, or the drive will not operate. If the connector is removed when the drive is running, continuity between the interlock terminals is broken. The drive considers this a fault: it illuminates the `MOTOR FAULT` LED, and turns off power to the motor.

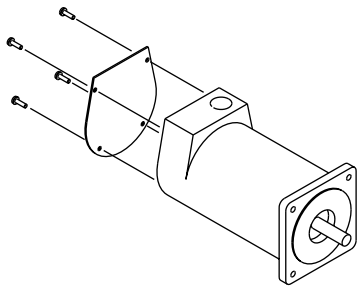
Do not extend the interlock jumper wire beyond the connector. The interlock circuit is designed to work with a *very short* jumper. Longer wires may change the electrical characteristics of the circuit, making it more susceptible to noise. Therefore, do not use a long jumper.

Ground the Motor Case

You must ground the motor case, for safety purposes. Connect a green/yellow wire from the motor's protective earth terminal to the drive's ground terminal on its motor connector. Inside the drive, this ground terminal connects directly to the ground pin on the AC power connector. (The C10 Cable Kit has a motor cable that contains a green/yellow wire.)

Wiring the R or T Motor

The R or T Motor are sold with and without a cable attached. A LVD/EMC cable kit is available from Compumotor (part number C10) that includes a motor cable and mounting hardware. To connect a motor cable, remove the end bell cover plate from the end of the motor, as shown below.



Removing Cover Plate

Make connections according to the following diagrams, which show typical series and parallel connections.

Cut individual wires to length, to avoid excess wire inside the end bell.

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Precautions

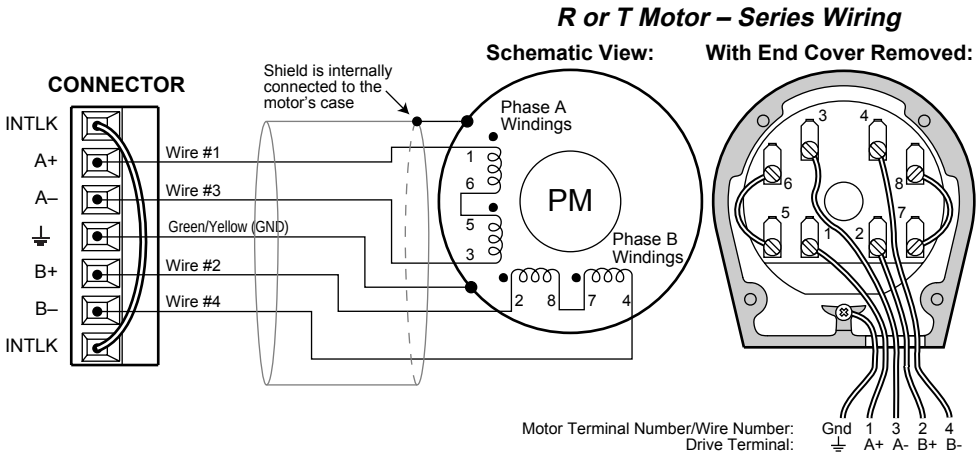
Follow these precautions when you wire the motor and connector.

1. Turn off power to the drive before connecting or disconnecting the motor connector.
2. Verify that no wire whiskers short out motor connections.
3. Do not apply power to the drive when the motor is not connected.
4. Never extend the interlock jumper beyond the motor connector.
5. Never connect anything other than the motor to the motor terminals.
6. When finished, perform the Automatic Test to verify proper connections.

Series Wiring

For series operation, make connections according to the next diagram.

Notice that you must use jumper wires to connect terminal #7 to #8, and to connect terminal #5 to #6. Use 18 AWG (0.75 mm) or larger diameter wire for the jumpers, with ring terminals attached to each end.



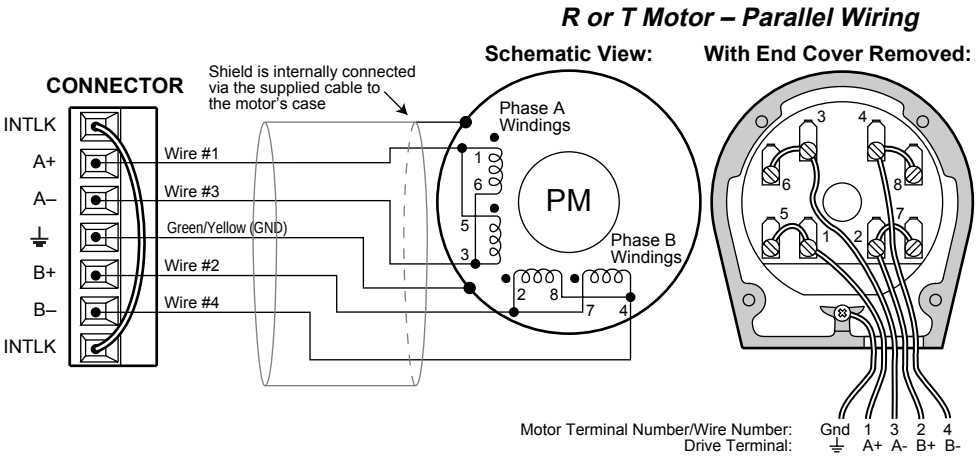
*Motor Connector – Wired for **SERIES** Motor Current*

The operating temperature of a motor connected in series will typically be lower than that of a motor connected in parallel. Therefore, you should operate your motor in series, if your application permits. Typically, series connections work well in high torque/low speed applications.

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PARALLEL WIRING

For parallel operation, make connections according to the next diagram.



*Motor Connector – Wired for **PARALLEL** Motor Current*

Use jumper wires to connect terminal #2 to #7, #4 to #8, #1 to #5, and #3 to #6. Use 18 AWG (0.75 mm) or larger diameter wire, with ring terminals.

At higher speeds, a motor connected in parallel will produce more torque than the same motor connected in series. However, the operating temperature of the motor in parallel will be much higher.

If you operate your motor in parallel, you must measure motor temperature under actual operating conditions. R and T Motors have maximum allowable temperatures of 100°C (212°F).

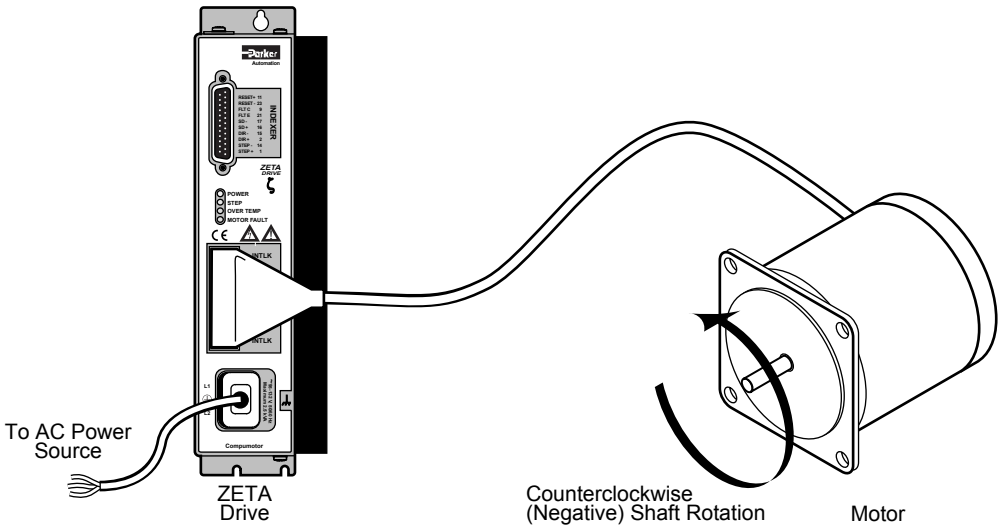
CAUTION

High current in parallel connected motors may cause motor overheating. If the motor exceeds its maximum case temperature, reduce the duty cycle to 50%, or use automatic standby, or use forced air cooling to decrease motor temperature.

3 – QUICK TEST

Follow this procedure to have your ZETA Drive perform its *automatic test* function. Once you set DIP switches, connect the motor, and connect AC power, the automatic test will begin—the motor shaft will turn in the counterclockwise direction until you remove power. This will verify that the drive, motor, and motor cable work properly as a system.

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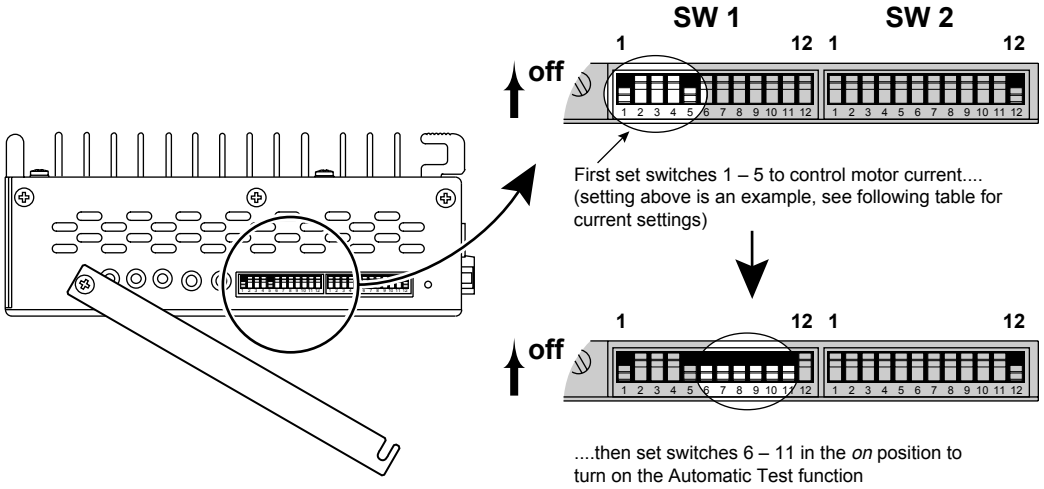


Quick Test Setup

This is a *bench top* procedure—as the drawing shows, you can perform it before you connect an indexer, mount the drive, or mount the motor. Full installation instructions follow this section.

1. Set DIP Switches for SERIES Motor current

Two 12-position DIP switches are located on top of the ZETA Drive, behind a cover. Move the cover to access the switches. Before you change them, make note of the DIP switch settings. You will restore the switches to their original settings at the end of this procedure.



DIP Switch Location

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Use the following table to set DIP switches SW1-#1 — SW1-#5 for *series* current for your R or T Motor.

ZETA8 Drive Current Settings for R & T Motors in Series

Motor Size	Current	SW1-#1	SW1-#2	SW1-#3	SW1-#4	SW1-#5
RS31B	2.32	off	on	off	off	on
RS32B	2.84	off	on	off	on	on
RS33B	3.61	off	on	on	on	off
RS42B	6.19	on	on	off	off	off
RE42B	3.61	off	on	on	on	off
TS31B	3.35	off	on	on	off	on
TS32B	3.10	off	on	on	off	off
TS33B	5.68	on	off	on	on	off
TS41B	6.45	on	on	off	off	on
TS42B	6.71	on	on	off	on	off
TS43B	6.97	on	on	off	on	on

ZETA12 Drive Current Settings for R & T Motors in Series

Motor Size	Current	SW1-#1	SW1-#2	SW1-#3	SW1-#4	SW1-#5
RS31B	2.32	off	off	on	on	off
RS32B	3.10	off	on	off	off	off
RS33B	3.48	off	on	off	off	on
RS42B	6.19	on	off	off	off	off
RE42B	3.48	off	on	off	off	on
TS31B	3.48	off	on	off	off	on
TS32B	3.10	off	on	off	off	off
TS33B	5.81	off	on	on	on	on
TS41B	6.58	on	off	off	off	on
TS42B	6.97	on	off	off	on	off
TS43B	6.97	on	off	off	on	on

Using a Non-Compumotor Motor?: see ***Appendix A*** at the end of this user guide

2. Set DIP Switches for the AUTOMATIC TEST Function

Set DIP switches SW1-#6 through SW1-#11 to the *on* position. This switch combination selects the automatic test function.

3. Connect the Motor

Plug your R or T Motor cable's 7-pin connector into the drive's MOTOR connector. For safety, always observe the following two warnings:

WARNING

POWER MUST BE OFF when you connect or disconnect the motor connector. Lethal voltages are present on the screw terminals!

WARNING

You must ground the motor case. Large potentials can develop at the motor case that can create a lethal shock hazard if the motor case is not grounded.

The case of an R or T Motor will automatically be grounded when you plug the cable's 7-pin connector into the ZETA Drive.

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4. Connect AC Power

The ZETA Drive does not have an *on*/*off* switch. When you connect power, the automatic test will begin—the drive will turn on and the motor will start turning. Therefore, before you apply power to the ZETA Drive:

- Properly secure the motor.
- Do not attach a load to the motor shaft.

To apply power, plug one end of the power cable into the drive. Plug the other end into a grounded 120VAC power source.

5. Observe the Automatic Test

Your ZETA Drive should now be running in automatic test mode:

- The motor shaft should rotate at approximately one revolution per second (1 rps) in the counterclockwise (negative) direction, until you remove power.
- LEDs on the front panel should operate as follows:

`POWER`	LED should illuminate
`STEP`	LED should alternately flash red and green
`OVER TEMP`	LED should not illuminate
`MOTOR FAULT`	LED should not illuminate

6. Stop the Automatic Test

Disconnect power to stop the motor. Set DIP switches 6 – 11 to *off*, or to their original settings. Return other DIP switches to their original settings.

Installation

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

1 – Set DIP Switches

Configure the ZETA Drive's DIP switches for your motor and application. The drive's 24 DIP switches are located behind the movable metal cover on top of the drive. Switch 1 (SW1) and Switch 2 (SW2) are each 12-position DIP switches. The next illustration summarizes switch settings for various current levels. Following this section, we provide a table showing the recommended current values for the R and T Series motors.

Default Settings

The factory default position is *off* for all switches.

Motor Current

Set DIP switches SW1-#1 — SW1-#5 for motor current. Verify that your motor wiring, connector wiring, and motor current rating match the series or parallel current that you set with these five switches.

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Drive Resolution

Set DIP switches SW1-#6 — SW1-#9 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.

Be sure to set your indexer to the same resolution as your ZETA Drive. If the indexer resolution and drive resolution do not match, commanded accelerations and velocities will not be properly scaled.

Waveform

Set SW1-#10 and SW1-#11 to select a current waveform. There are four choices: one is a pure sine wave; the others reduce the current waveform's 3rd harmonic by 4%, 6%, or 10%. In most applications, the default setting (*both switches off = -4% 3rd harmonic*) provides the best performance. For further information about selecting a waveform, see the section *Match the Drive to the Motor* later in this chapter.

NOTE: If you choose 200 steps/rev for resolution, do not select pure sine for a waveform. SW1-#6 — SW1-#11, when all *on*, do not select 200 steps/rev and pure sine—they select the automatic test (see below).

Automatic Test

DIP switches SW1-#6 — SW1-#11 have a double function. As mentioned earlier in *Quick Test*, they select the Automatic Test function when they are all *on*. For any other setting, they select resolution and waveform.

Step & Direction/CW & CCW

SW1-#12 should be *off* if you use a step & direction indexer. All Compumotor indexers are step and direction indexers.

If you use a clockwise/counterclockwise (CW & CCW) indexer, turn this switch *on*.

Automatic Standby

The *automatic standby* function allows the motor to cool when it is not moving. Automatic standby reduces motor current by 50% 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.

SW2-#1 should be *off* if you do not use automatic standby. Turn this switch *on* to use automatic standby. If you use position maintenance we recommend that you do not use automatic standby.

Anti-Resonance Disable

SW2-#2 should be *off* for the anti-resonance circuit to be enabled. Normally, you will want anti-resonance enabled; therefore, this switch should be *off*. If you must disable anti-resonance, turn SW2-#2 *on*.

NOTE: If active damping is enabled via the rotary switch on top of the drive, anti-resonance is automatically disabled, regardless of the setting of SW2-#2. See *Damping in the ZETA Drive* later in this chapter for an explanation.

Anti-Resonance Phase

This switch allows a broad range of motors to benefit from the anti-resonance damping technique. SW2-#3 should be *off* if your mechanical

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system's resonant frequency is 80 Hz or less. SW2-#3 should be *on* if your mechanical system's resonant frequency is greater than 80 Hz, if your motor drives an extremely low inertia load, or if your system has an extremely high torque to inertia ratio.

Anti-Resonance Gain

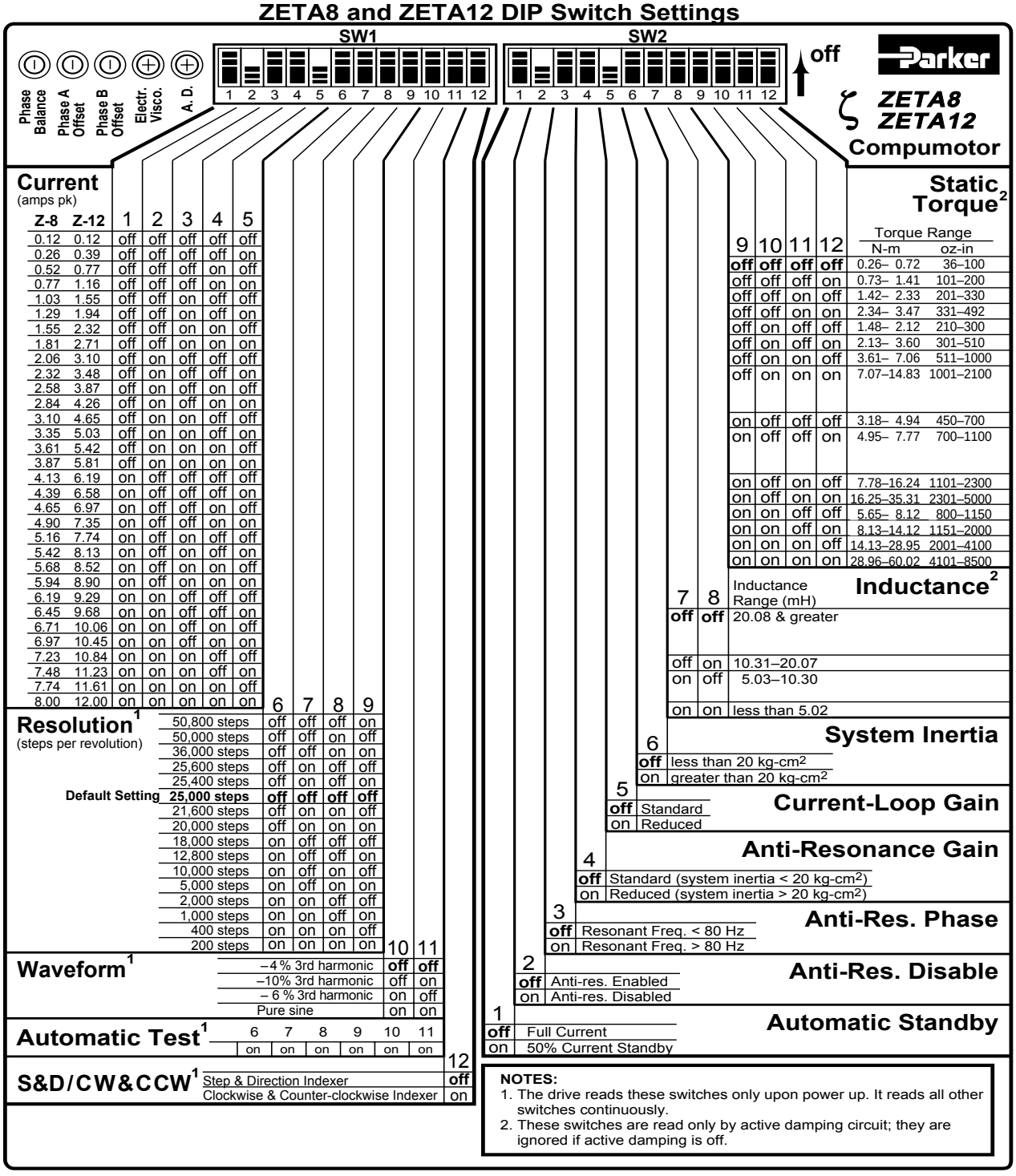
Large rotor motors, or motors driving large inertial loads, may require a reduction in anti-resonance gain. This will be evident if the load becomes too responsive and settles in an overly abrupt manner for your application. SW2-#4 should be *off* if system's inertia is 20 kg-cm^2 or less. SW2-#4 should be *on* if system's inertia is greater than 20 kg-cm^2

Current Loop Gain

SW2-#5 should be *off* for normal current-loop gain. You can reduce the responsiveness of the current control loop by setting SW2-#5 to the *on* position. This may be necessary when connecting a motor with an extremely low inductance value, on the order of 2 mH. If you hear a high pitched (10 kHz) oscillation from the motor, you can decrease or eliminate the oscillation by reducing loop gain. Excessive loop gain may cause motor faults at high loads; reduce loop gain to eliminate this problem.

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ZETA8 and ZETA12 DIP Switch Settings



Current (amps pk)

Z-8	Z-12	1	2	3	4	5
0.12	0.12	off	off	off	off	off
0.26	0.39	off	off	off	off	on
0.52	0.77	off	off	off	on	off
0.77	1.16	off	off	off	on	on
1.03	1.55	off	off	on	off	off
1.29	1.94	off	off	on	off	on
1.55	2.32	off	off	on	on	off
1.81	2.71	off	off	on	on	on
2.06	3.10	off	on	off	off	off
2.32	3.48	off	on	off	off	on
2.58	3.87	off	on	off	on	off
2.84	4.26	off	on	off	on	on
3.10	4.65	off	on	on	off	off
3.35	5.03	off	on	on	off	on
3.61	5.42	off	on	on	on	off
3.87	5.81	off	on	on	on	on
4.13	6.19	on	off	off	off	off
4.39	6.58	on	off	off	off	on
4.65	6.97	on	off	off	on	off
4.90	7.35	on	off	off	on	on
5.16	7.74	on	off	on	off	off
5.42	8.13	on	off	on	off	on
5.68	8.52	on	off	on	on	off
5.94	8.90	on	off	on	on	on
6.19	9.29	on	on	off	off	off
6.45	9.68	on	on	off	off	on
6.71	10.06	on	on	off	on	off
6.97	10.45	on	on	off	on	on
7.23	10.84	on	on	on	off	off
7.48	11.23	on	on	on	off	on
7.74	11.61	on	on	on	on	off
8.00	12.00	on	on	on	on	on

Resolution[1] (steps per revolution)

	6	7	8	9
50,800 steps	off	off	off	on
50,000 steps	off	off	on	off
36,000 steps	off	off	on	on
25,600 steps	off	on	off	off
25,400 steps	off	on	off	on
Default Setting 25,000 steps	**off**	**off**	**off**	**off**
21,600 steps	off	on	on	off
20,000 steps	off	on	on	on
18,000 steps	on	off	off	off
12,800 steps	on	off	off	on
10,000 steps	on	off	on	off
5,000 steps	on	off	on	on
2,000 steps	on	on	off	off
1,000 steps	on	on	off	on
400 steps	on	on	on	off
200 steps	on	on	on	on

Waveform[1]

	10	11
–4 % 3rd harmonic	**off**	**off**
–10% 3rd harmonic	off	on
– 6 % 3rd harmonic	on	off
Pure sine	on	on

Automatic Test[1]

6	7	8	9	10	11
on	on	on	on	on	on

S&D/CW&CCW[1]

	12
Step & Direction Indexer	**off**
Clockwise & Counter-clockwise Indexer	on

Static Torque[2]

9	10	11	12	Torque Range N-m	Torque Range oz-in
off	**off**	**off**	**off**	0.26– 0.72	36–100
off	off	off	on	0.73– 1.41	101–200
off	off	on	off	1.42– 2.33	201–330
off	off	on	on	2.34– 3.47	331–492
off	on	off	off	1.48– 2.12	210–300
off	on	off	on	2.13– 3.60	301–510
off	on	on	off	3.61– 7.06	511–1000
off	on	on	on	7.07–14.83	1001–2100
on	off	off	off	3.18– 4.94	450–700
on	off	off	on	4.95– 7.77	700–1100
on	off	on	off	7.78–16.24	1101–2300
on	off	on	on	16.25–35.31	2301–5000
on	on	off	off	5.65– 8.12	800–1150
on	on	off	on	8.13–14.12	1151–2000
on	on	on	off	14.13–28.95	2001–4100
on	on	on	on	28.96–60.02	4101–8500

Inductance[2]

7	8	Inductance Range (mH)
off	**off**	20.08 & greater
off	on	10.31–20.07
on	off	5.03–10.30
on	on	less than 5.02

System Inertia

6	
off	less than 20 kg-cm^2
on	greater than 20 kg-cm^2

Current-Loop Gain

5	
off	Standard
on	Reduced

Anti-Resonance Gain

4	
off	Standard (system inertia < 20 kg-cm^2)
on	Reduced (system inertia > 20 kg-cm^2)

Anti-Res. Phase

3	
off	Resonant Freq. < 80 Hz
on	Resonant Freq. > 80 Hz

Anti-Res. Disable

2	
off	Anti-res. Enabled
on	Anti-res. Disabled

Automatic Standby

1	
off	Full Current
on	50% Current Standby

NOTES:
1. The drive reads these switches only upon power up. It reads all other switches continuously.
2. These switches are read only by active damping circuit; they are ignored if active damping is off.

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System Inertia

This switch selects the low or high inertia range, which pre-scales the 16-position rotary switch used by the active damping circuit. (This is explained later in this chapter, in *12 – Configure Active Damping*.)

Inductance

The active damping circuit reads SW2-#7 and SW2-#8 to determine motor inductance. Set these switches according to your motor's *large-signal* inductance. The table shows the large-signal inductance range that corresponds to each of the four settings.

Large signal inductance is found by measuring the actual generator AC flux linkage and generator short circuit current under dynamic conditions. Small-signal inductance is the value read on an ordinary inductance bridge or meter. If you only have the small-signal inductance value available, use the formula below to approximate large-signal inductance:

$$\textit{small signal inductance} * 1.5 \approx \textit{large signal inductance}$$

NOTE: If active damping is *off*, switches SW2-#7 and SW2-#8 are ignored by the drive, and are inactive.

Static Torque

The active damping circuit reads SW2-#9 — SW2-#12 to determine the motor's static torque. Set these switches according to your motor; the table shows the range of static torque that corresponds to each of the four settings. NOTE: If active damping is *off*, switches SW2-#9 — SW2-#12 are ignored by the drive, and are inactive.

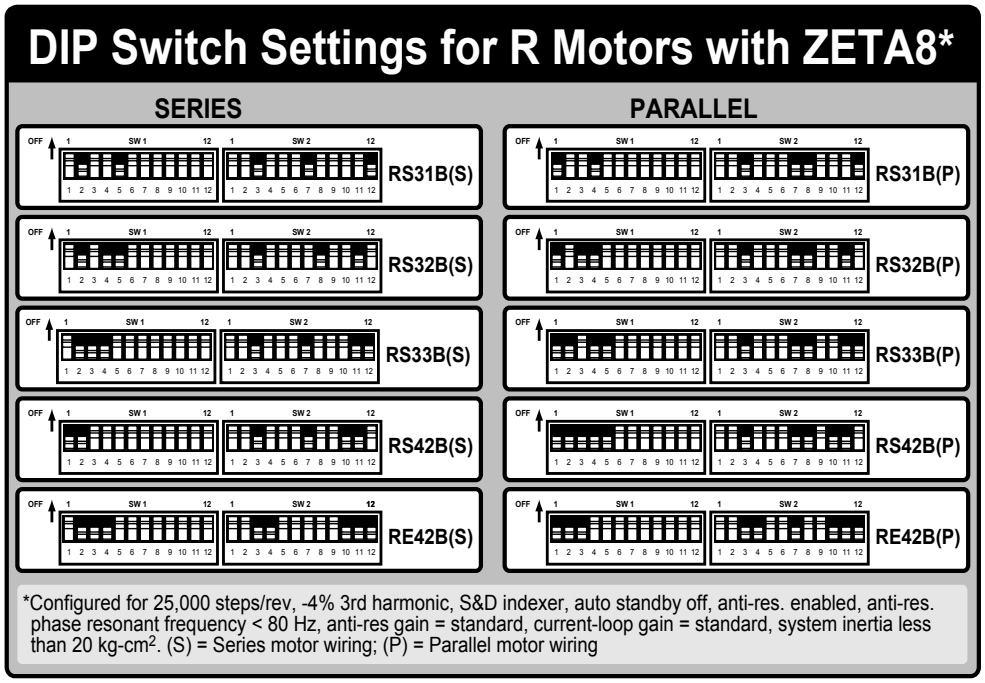
Replace Cover

Replace and secure the cover after you set the DIP switches.

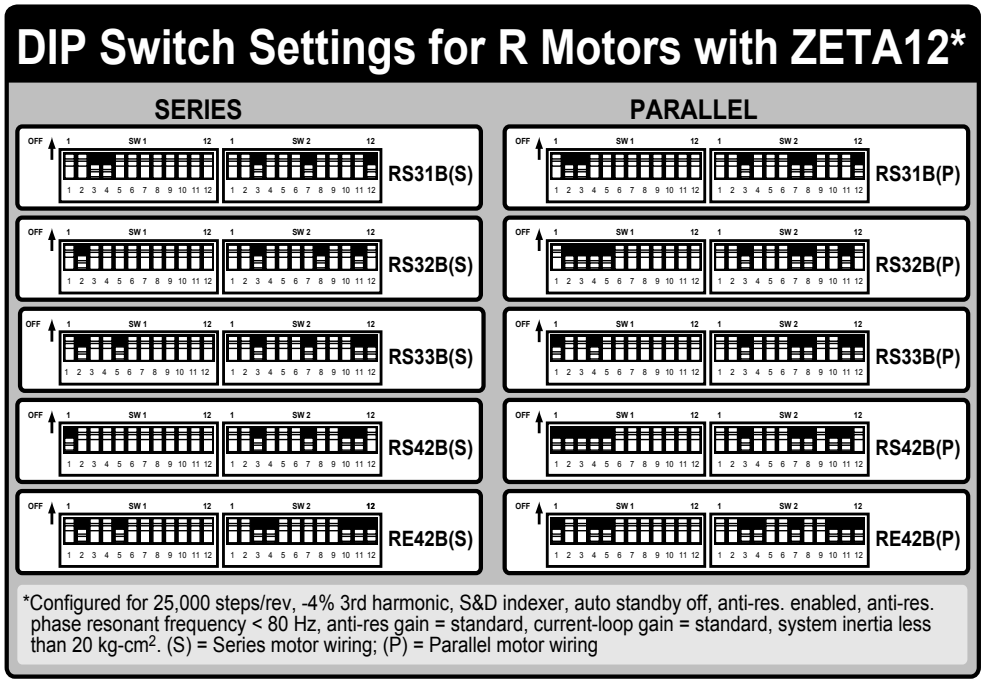
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DIP SWITCH SETTINGS FOR COMPUMOTOR ZETA MOTORS

The following illustrations summarizes the switch settings for Compumotor ZETA motors.

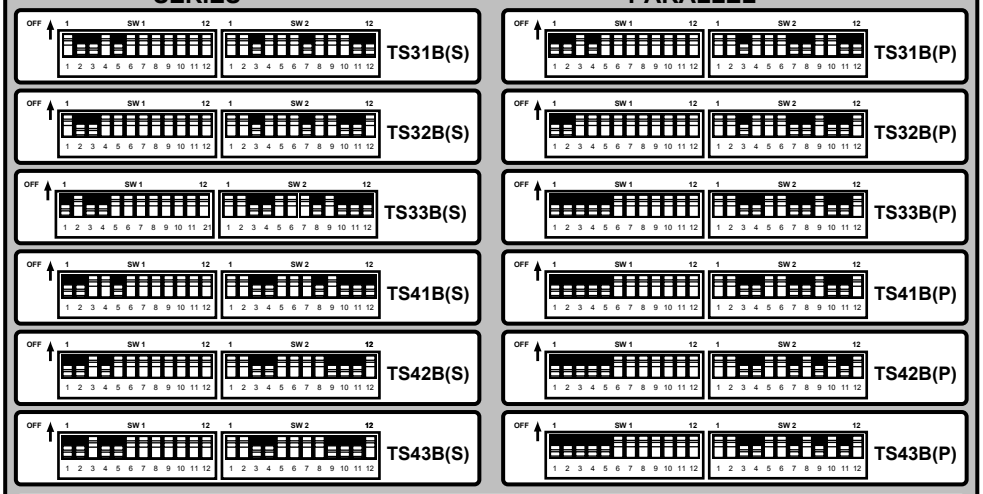


Note: N/A indictates not available at time of printing



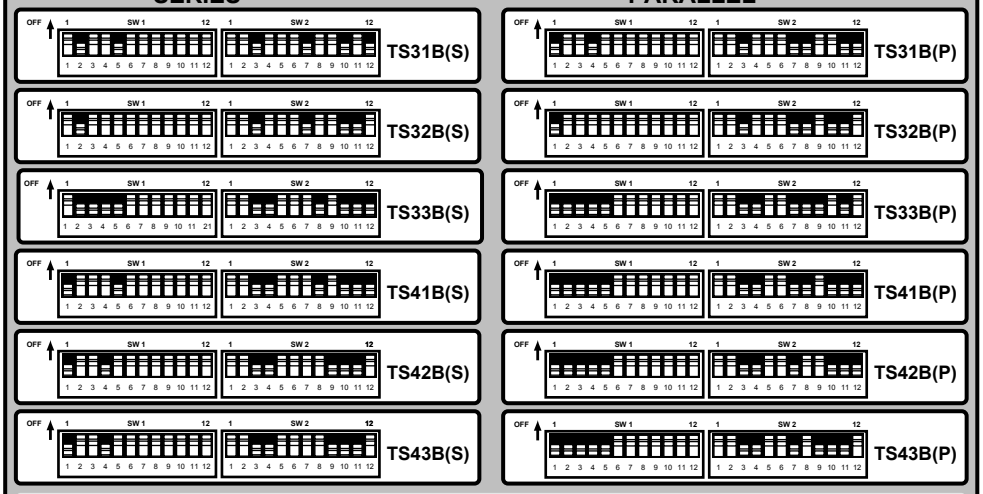
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DIP Switch Settings for T Motors with ZETA8*



*Configured for 25,000 steps/rev, -4% 3rd harmonic, S&D indexer, auto standby off, anti-res. enabled, anti-res. phase resonant frequency < 80 Hz, anti-res gain = standard or reduced, current-loop gain = standard, system inertia less than 20 kg-cm^2. (S) = Series motor wiring; (P) = Parallel motor wiring

DIP Switch Settings for T Motors with ZETA12*

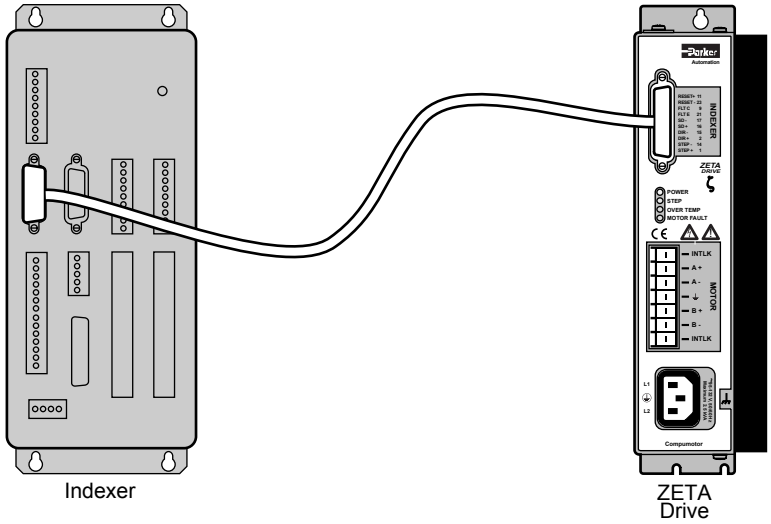


*Configured for 25,000 steps/rev, -4% 3rd harmonic, S&D indexer, auto standby off, anti-res. enabled, anti-res. phase resonant frequency < 80 Hz, anti-res gain = standard or reduced, current-loop gain = standard, system inertia less than 20 kg-cm^2. (S) = Series motor wiring; (P) = Parallel motor wiring

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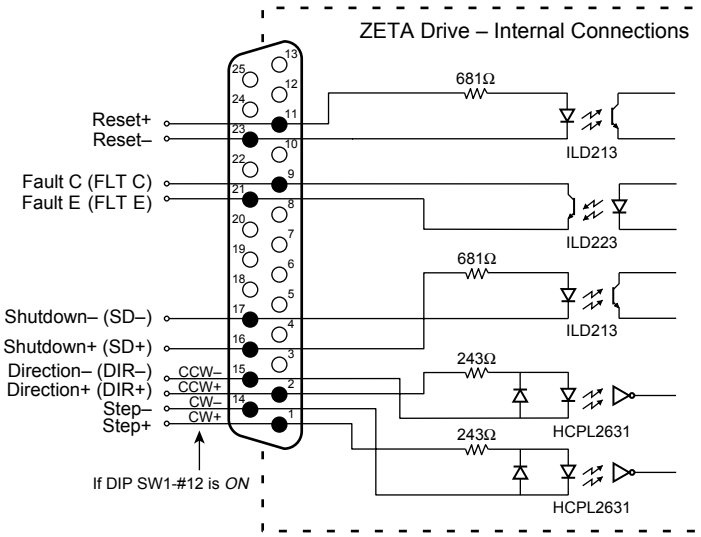
2 – CONNECT AN INDEXER – INPUTS & OUTPUTS

Connect your indexer cable to the ZETA Drive's **INDEXER** connector, a 25 pin D-connector on the front of the drive. The cable that comes with Compumotor indexers is pre-wired for compatibility with the ZETA Drive—you can plug the cable directly into the ZETA Drive's indexer connector. (See *Appendix B, LVD and EMC Installation Guide* for additional instructions regarding EMC, and Compumotor's optional EMC compliant cable.)



Connecting a Compumotor Indexer

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



25 Pin D-Connector

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.

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The input is optically isolated. It may also be differentially driven.

Step input specifications are:

Input Current:	6.5 mA	minimum	
	15 mA	maximum	
Input Voltage:	3.5V	minimum	(min. required for *on* or *high* signal)
	5.2V	maximum*	
Step Pulse:	200 nanosecond minimum pulse width		
	200 nanosecond minimum off time		
	2 MHz	maximum pulse rate	
Optically Isolated:	Yes		

*As a custom product, Compumotor can modify drive for higher input voltage

Direction Input (DIR+ & DIR-)

While a positive voltage is applied to **DIR+** with respect to **DIR–**, 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 **DIR+** with respect to **DIR–**, the drive will commutate the motor in the counterclockwise (negative) direction as it receives step pulses.

The input is optically isolated. It may also be differentially driven.

Direction input specifications are:

Input Current:	6.5 mA	minimum	
	15 mA	maximum	
Input Voltage:	3.5V	minimum	(min. required for *on* or *high* signal)
	5.2V	maximum*	
Optically Isolated:	Yes		
Direction Change:	Direction input may change polarity coincident with first step pulse.		

*As a custom product, Compumotor can modify drive for higher input voltage

Clockwise and Counterclockwise (CW & CCW)

You can convert the ZETA Drive's step and direction inputs to clockwise and counterclockwise inputs, for use with a CW/CCW indexer. To do so, set DIP SW1–#12 to the *on* position. These changes result:

Pin #	SW1–#12 *OFF*	SW1–#12 *ON*	
1	Step+	Clockwise+	(CW+)
14	Step–	Clockwise–	(CW–)
2	Direction+	Counterclockwise+	(CCW+)
15	Direction–	Counterclockwise–	(CCW–)

Input specifications are the same as those listed above under *Step Input* and *Direction Input*. Each positive voltage pulse applied to CW+ with respect to CW– causes the drive to commutate the motor and increment rotor position in the *clockwise* direction. Each positive voltage pulse applied to CCW+ with respect to CCW– causes the drive to commutate the motor and increment rotor position in the *negative* direction.

Shutdown Input (SD+ & SD-)

You can use the shutdown input to *shutdown*, or disable, the ZETA Drive. To activate shutdown, apply a positive voltage to **SD+** with respect to **SD–** when the motor is not moving. During shutdown, the drive turns off current to the motor. The current stays off as long as the voltage is maintained on the shutdown input.

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When you remove the voltage on the input, shutdown ends. The drive restores current to the motor, in the same phase relationship that existed before shutdown was invoked.

The shutdown input may also be differentially driven. Specifications are:

Input Current:	2.5 mA	minimum	
	30 mA	maximum	
Input Voltage:	3.5V	minimum	(min. required for *on* or *high* signal)
	13V	maximum	
	5V	maximum reverse voltage	
Active Level:	While voltage is applied, current to motor is shut down. When voltage is removed, normal operations resume.		
Time:	250 nanosecond minimum width.		
Optically Isolated:	Yes		

Fault Output (FLT C & FLT E)

The ZETA Drive can signal, through its fault output, that it has detected a fault. Internally, the terminals **FLT C** and **FLT E** connect to the open collector and open emitter, respectively, of an optically isolated transistor. The transistor acts like a switch: it conducts when the drive is functioning normally; it does not conduct when any of the following conditions exist.

- No power is applied to the drive.
- AC line voltage is too low (less than 95VAC).
- Drive temperature is higher than 55°C (131°F).
- Drive detects a short circuit in motor or motor cable.
- Motor is not connected.
- Continuity between interlock terminals is broken.
- Shutdown input is active.

Fault output specifications are:

V_{CE}:	30VDC
V_{CESAT}:	1 VDC
Collector Current:	80 mA minimum
Dissipation:	80 mW maximum
Optically Isolated:	Yes

Reset Input

The reset input provides a means for you to reset the ZETA Drive, without actually cycling power. To activate the reset input, apply a positive voltage to **RESET+** with respect to **RESET–** when the motor is not moving. The reset will not be complete until 0.7 seconds after the voltage is removed. A reset has the same effect on the drive as cycling power:

- DIP switch settings are loaded into the drive for configuration.
- Existing faults are cleared.
- Current to the motor is turned off while voltage is applied to the reset input.
- After voltage is removed from the reset input, the drive's soft start procedure will ramp current up to the start-up state. The motor will move to the nearest pole position.
- After voltage is removed from the reset input, there will be a 0.7 second delay before reset is complete, and normal operations can continue.

Reset input specifications are:

Input Current:	2.5 mA	minimum	
	30 mA	maximum	
Input Voltage:	3.5V	minimum	(min. required for *on* or *high* signal)
	13V	maximum	
	5V	maximum reverse voltage	

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Reset Voltage Pulse: 250 nanosecond minimum pulse width.
Active Level: While voltage is applied, reset occurs.
When voltage is removed, normal operations resume.

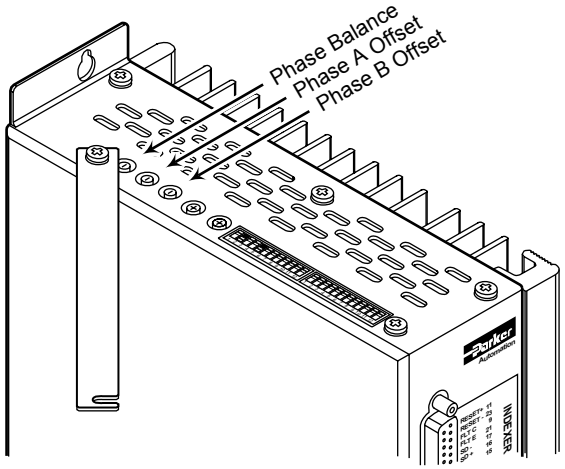
Reset Delay: 0.7 second delay until reset is complete, after voltage is removed from input.

Optically Isolated: Yes

3 – Match the Drive to the Motor

Due to slight manufacturing variations, each motor has its own particular characteristics. In the procedure below, you will adjust three potentiometers, to match your ZETA Drive to your specific motor. You will also select the best current waveform to use with your motor.

The ZETA Drive's potentiometers are located behind the removable metal cover on top of the drive.



Potentiometer Locations

The single turn potentiometers control the following functions:

- Phase B Offset: Controls the DC offset of Phase B motor current
- Phase A Offset: Controls the DC offset of Phase A motor current
- Phase Balance: Adjusts the magnitude of Phase B with respect to Phase A

The procedure below is a *bench top* procedure—the drive, motor, and indexer should be temporarily connected together, but not yet permanently mounted. Apply AC power when necessary to perform the steps below.

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Properly secure the motor. This procedure will be easier to perform if you do not attach the load to the motor shaft. The load is not required, because the characteristics you are matching are those only of the drive/motor combination.

Matching Procedure

1. **Apply power to the drive**
   Allow the drive to reach a stable operating temperature. This will take at least two minutes, and may take up to 30 minutes. For optimum results, perform the matching procedure at the same ambient temperature at which your application will operate.

2. **Consult Table for Operating Speeds**
   For each of the adjustments that follow, consult the next table to find the speed at which to run the motor. These are speeds that cause *resonance* in the unloaded motor. When the motor is running at a resonant speed, you will notice increased noise and vibration. To make resonance the most noticeable, you may need to vary the speed around the value given below for your motor. You can find the resonant speed by touching the motor lightly with your fingertips as you vary the speed. When you feel the strongest vibrations, the motor is running at resonant speed.

Motor	**Offset Adjust** (rps)	**Balance Adjust** (rps)	**Waveform Adjust** (rps)
RS31B (S)	2.58	1.29	0.65
RS31B (P)	2.58	1.29	0.65
RS32B (S)	2.48	1.24	0.62
RS32B (P)	2.48	1.24	0.62
RS33B (S)	2.63	1.32	0.66
RS33B (P)	2.63	1.32	0.66
RS42B (S)	1.72	0.86	0.43
RS42B (P)*	1.68 / 1.46	0.84 / 0.73	0.42 / 0.37
RE42B (S)	2.58	1.29	0.65
RE42B (P)	2.58	1.29	0.65
TS31B (S)	3.11	1.56	0.78
TS31B (P)	3.11	1.56	0.78
TS32B (S)	2.72	1.36	0.68
TS32B (P)	2.72	1.36	0.68
TS33B (S)	3.36	1.68	0.84
TS33B (P)*	3.40 / 2.92	1.70 / 1.46	0.85 / 0.73
TS41B (S)	2.82	1.41	0.71
TS41B (P)*	2.78 / 2.50	1.39 / 1.25	0.70 / 0.63
TS42B (S)	2.94	1.47	0.74
TS42B (P)*	2.57 / 2.35	1.29 / 1.18	0.64 / 0.59
TS43B (S)	2.74	1.37	0.69
TS43B (P)*	2.56 / 2.21	1.28 / 1.11	0.64 / 0.55

*Note: Use secondary value (after slash) when being run with ZETA8 (only 8 amps)

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3. **Run Motor at *Offset Adjust* Resonant Speed**
   Run your motor at the resonant speed listed in the *Offset Adjust* column. Vary the speed slightly until you find the resonance point.

4. **Adjust Phase A Offset and Phase B Offset**
   Adjust the offset potentiometers for minimum motor vibration and smoothest operation. Alternate between Phase A and Phase B to find the minimum vibration point.

5. **Run Motor at *Balance Adjust* Resonant Speed**
   Run your motor at the resonant speed listed in the *Balance Adjust* column. Vary the speed slightly until you find the resonance point.

6. **Adjust Phase Balance**
   Adjust the Phase Balance potentiometer until you find the setting that provides minimum motor vibration and smoothest operation.

7. **Repeat steps 3 – 6**

8. **Run Motor at *Waveform Adjust* Resonant Speed**
   Run the motor at the resonant speed listed in the *Waveform Adjust* column. Vary the speed slightly until you find the resonance point.

9. **Choose Waveform for Smoothest Operation**
   Choose the current waveform that provides minimum motor vibrations and smoothest operation at the speed you selected in step 8. To find the best waveform, compare motor performance as you select different waveforms using DIP switches SW1-#10 and SW1-#11.

Waveform	SW1-#10	SW1-#11	Note
-4% 3rd harmonic	off	off	Default from factory
-10% 3rd harmonic	off	on	Recommended for all TS motor sizes for optimal smoothness in most applications.
-6% 3rd harmonic	on	off	
Pure sine	on	on	Do not use with 200 step/rev resolution

   Note: We recommend the -10% 3rd harmonic setting for use with all TS motor sizes. This will provide the optimal smoothness in most applications.

   The drive reads these DIP switches only upon power up or reset. Therefore, you must cycle power or reset the drive each time you change the DIP switch settings.

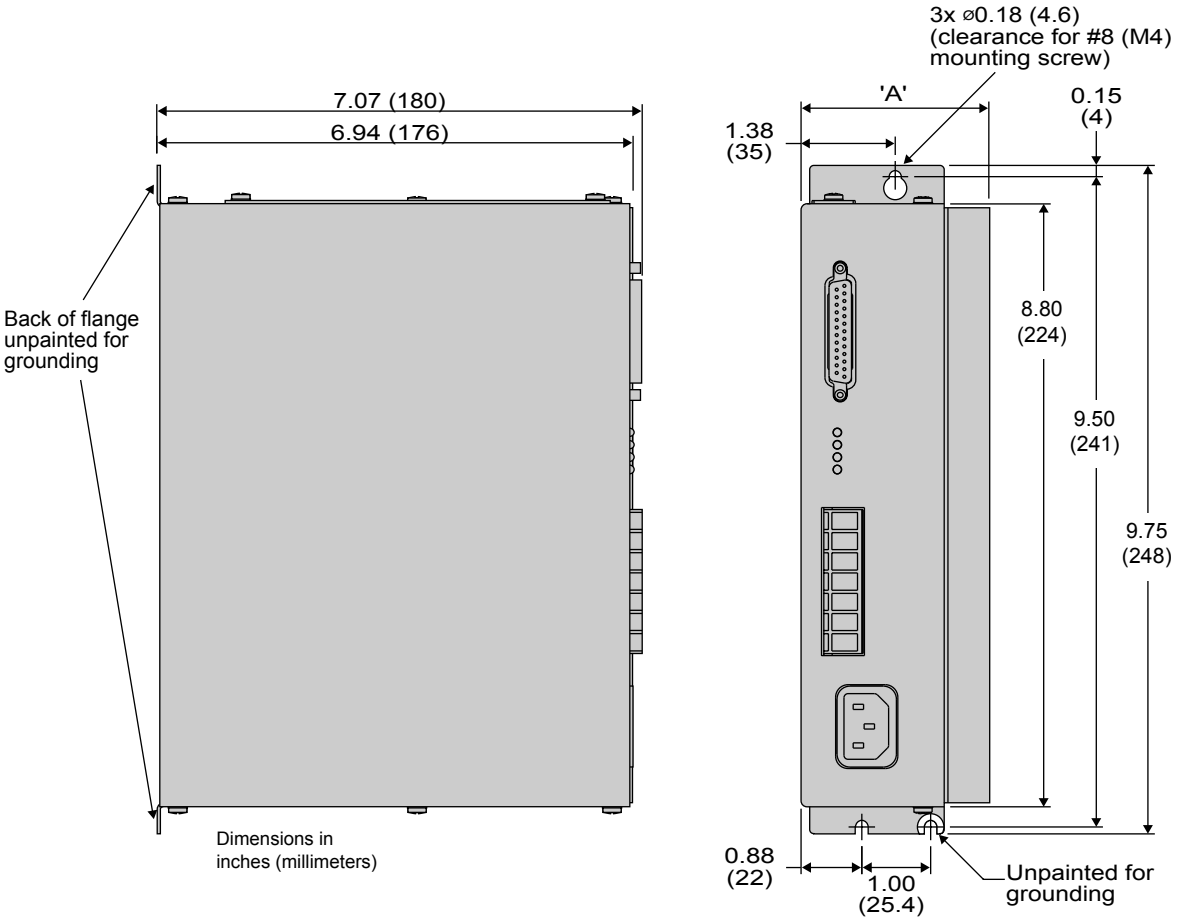
10. **Disconnect Power**
    Disconnect AC power to turn off the drive. Replace the cover over the potentiometers and DIP switches. This completes the matching procedure.

Proceed to the next section to mount the drive and motor.

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4 – MOUNT THE DRIVE

Dimensions of the ZETA Drive are shown below.



	A' Dimensions
ZETA8	2.75 (70)
ZETA12	3.75 (96)

ZETA Drive Dimensions

ENVIRONMENTAL CONSIDERATIONS

TEMPERATURE SPECIFICATIONS

Maximum Ambient Temperature: 50°C (122°F)
Minimum Ambient Temperature: 0°C (32°F)
Overtemperature Shutdown Fault: 55°C (131°F)

The ZETA Drive has an internal temperature sensor, located near the heatsink. If the sensor reaches 55°C (131°F), it will trigger an overtemperature fault, and the drive will shut down.

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Fan Cooling

Operating the ZETA Drive in high ambient temperatures may require fan cooling to keep the drive from shutting down due to an overtemperature fault.

Humidity

Keep the relative humidity below 95%, non-condensing.

Liquids

Do not allow liquids or fluids to come into contact with the ZETA Drive or its cables.

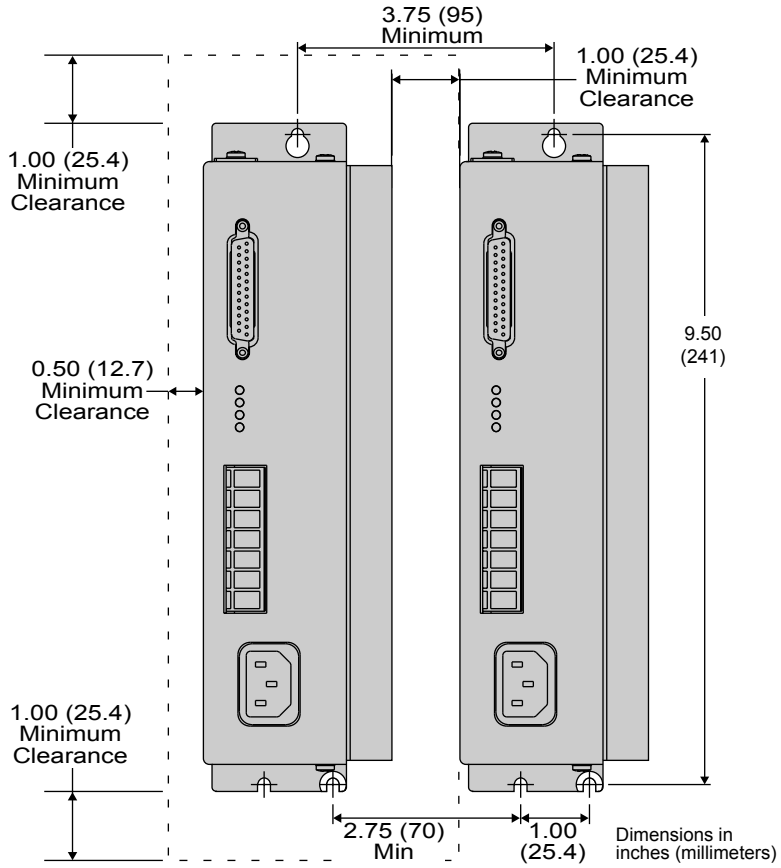
Airborne Contaminants

Particulate contaminants, especially electrically conductive material such as metal shavings or grinding dust, can damage the ZETA Drive and motor. Do not allow contaminants to come into contact with the drive or motor.

Note: To satisfy UL requirements, the drive should be mounted in an appropriate manner per the UL508C safety standards covering Industrial Control Equipment.

Panel Layout

Follow these minimum spacing and clearance requirements when you mount multiple ZETA Drives.



ZETA8 Panel Layout Dimensions (ZETA12 is 1 inch wider)

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5 – MOUNT THE MOTOR

Use flange bolts 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.

Motors used with the ZETA Drive can produce very high torque and acceleration. 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 safety of personnel, and compromise system performance.

For Compumotor R or T Series 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 *heatsink*. 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. You can also use a fan to blow air across the motor for increased cooling, if conduction through the flange does not provide enough 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.

EXTENDING MOTOR CABLES

If you need to extend R or T Motor cables beyond the standard 10 feet (3 m), consult the table below for recommended wire sizes. Cables longer than 50 feet (15 m) may degrade system performance. Do not extend cables beyond 200 feet (61 m). LVD and EMC installations require special cables, which are not included in the table on the next page see *Appendix B, LVD and EMC Installation Guide* for additional instructions for LVD/EMC cables.

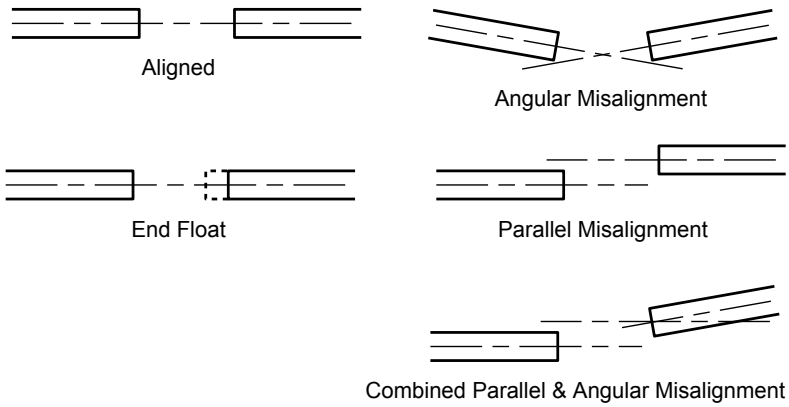
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Motor Type	Max. Current (amps)*	Less than 100 ft. (30 m) Size: AWG	mm²	100 – 200 ft. (30 – 60 m) AWG	mm²
RS31B (S)	2.32	20	0.50	18	0.75
RS31B (P)	4.65	18	0.75	16	1.50
RS32B (S)	3.10	20	0.50	18	0.75
RS32B (P)	5.81	18	0.75	14	2.50
RS33B (S)	3.48	18	0.75	16	1.50
RS33B (P)	6.97	16	1.50	14	2.50
RS42B (S)	6.19	16	1.50	14	2.50
RS42B (P)	12.00	14	2.50	12	4.00
RE42B (S)	3.48	18	0.75	16	1.50
RE42B (P)	7.35	16	1.50	14	2.50
TS31B (S)	3.48	18	0.75	16	1.50
TS31B (P)	6.97	16	1.50	14	2.50
TS32B (S)	3.10	20	0.50	18	0.75
TS32B (P)	6.19	16	1.50	14	2.50
TS33B (S)	5.81	18	0.75	14	2.50
TS33B (P)	12.00	14	2.50	12	4.00
TS41B (S)	6.58	16	1.50	14	2.50
TS41B (P)	12.00	14	2.50	12	4.00
TS42B (S)	6.97	16	1.50	14	2.50
TS42B (P)	12.00	14	2.50	12	4.00
TS43B (S)	6.97	16	1.50	14	2.50
TS43B (P)	12.00	14	2.50	12	4.00

(S) = Series Configuration (P) = Parallel Configuration
Rated current in wire sizes shown may result in a maximum temperature rise of 10°C (18°F) above ambient.
*Current value shown are for use with ZETA12 Drive (also applies when used with ZETA8)

6 – 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. Three misalignment conditions, which can exist in any combination, are illustrated and described below.



Misalignment Conditions

- 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.

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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. Box1460
San Rafael, CA 94903	Huntington Beach, CA 92649	Santa Maria, CA 93456
(415) 492-0278	(714) 891-9922	(805) 928-3851

7 – Connect AC Power

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

The ZETA Drive does not have an *on/off* switch. When you plug the power cord into the drive, the system will turn on. Therefore, before you apply power to the ZETA Drive, verify the following:

- Motor should be properly secured
- Motor cable should be connected to drive
- Drive should be properly mounted
- Indexer cable should be connected to drive
- Indexer cable should not be in close physical proximity to motor cable
- Active Damping rotary switch should be set to zero
- Electronic Viscosity rotary switch should be set to zero

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Apply Power

Apply power to the ZETA Drive by plugging one end of the molded power cord into the drive's AC power connector. The cord is 6.6 feet (2 m) long. Plug the other end of the power cord into a 120 VAC power source that meets the following specifications:

Specifications – AC Power Input

Input Power:	120VAC nominal 95VAC minimum 132VAC maximum 50 – 60 Hz
Inrush Current:	25 amps maximum
Fuses:	No user serviceable fuses
Grounding:	You must provide a proper AC power ground
Transformer:	Not required for 120VAC operation; to size stepdown transformer, use Volt-Amp rating *(see below)*

WARNING

The motor case and drive are grounded through the AC power connector ground pin. You must provide a proper AC power ground for safety purposes.

Peak Power Ratings

The amount of power the ZETA Drive requires from your AC power source depends upon the motor you use, whether it is wired in series or parallel, and upon your specific application. The next table shows *peak* power requirements. Power required for your application may be less.

Motor Type	Current (Amps)	Volt-Amp Rating (VA)	Motor Type	Current (Amps)	Volt-Amp Rating (VA)
RS31B (S)	2.32	440	TS31B (S)	3.48	630
RS31B (P)	4.65	830	TS31B (P)	6.97	1220
RS32B (S)	3.10	570	TS32B (S)	3.10	570
RS32B (P)	5.81	1030	TS32B (P)	6.19	1090
RS33B (S)	3.48	630	TS33B (S)	5.81	1030
RS33B (P)	6.97	1220	TS33B (P)	12.00	2080
RS42B (S)	6.19	1090	TS41B (S)	6.58	1160
RS42B (P)	12.00	2080	TS41B (P)	12.00	2080
RE42B (S)	3.48	630	TS42B (S)	6.97	1220
RE42B (P)	7.35	1290	TS42B (P)	12.00	2080
			TS43B (S)	6.97	1220
			TS43B (P)	12.00	2080

(S) = Series Configuration (P) = Parallel Configuration

Note: Values shown for ZETA12 drive. Zeta8 drive values are equal or less than what is shown here.

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8 – Test the Installation

System installation should be complete at this point. Perform the test procedure below to verify that your system is functioning properly. (Procedures to configure the drive's damping features follow this test.)

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 power**
   The green LED labeled POWER should illuminate.
2. **Command a slow move of one revolution in the clockwise direction**
   Verify that the motor turns as commanded. The bicolor LED labeled STEP should be illuminated green while the move is in progress.
3. **Command a slow move of one rev in the counterclockwise direction**
   Verify that the motor turns as commanded. The bicolor LED labeled STEP should be illuminated green while the move is in progress.
4. **Test the shutdown input**
   With the motor stopped, activate the shutdown input. The motor will have no torque when shutdown is activated. You should be able to turn the motor manually (if your mechanics permit).

Successful completion of this procedure will verify that your indexer and motor are correctly connected to the ZETA Drive, and that the drive is functioning properly. Proceed to the following sections to configure the ZETA Drive's damping features.

If the test was unsuccessful, observe the LEDs on the front panel of the ZETA Drive while you try the test procedure—they may indicate the cause of the problem. (*Chapter 3, Troubleshooting* has a complete description of LED functions.) Review earlier sections of this user guide, verify that you have completed each step, and try the test procedure again.

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

9 – Resonance, Ringing and Damping – Discussion and Theory

In this section we will discuss resonance and ringing in step motors. This information will help you configure the ZETA Drive's damping features—anti-resonance, active damping, and electronic viscosity.

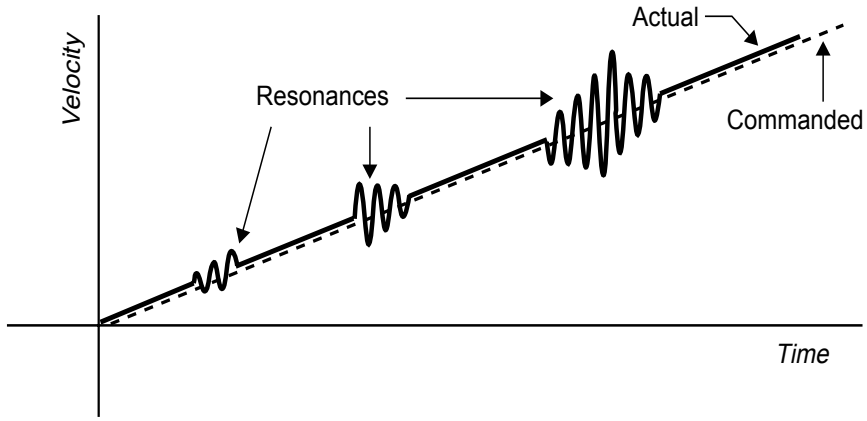
All step motors have natural resonant frequencies, due to the nature of their mechanical construction. Internally, the rotor acts very similarly to a mass suspended on a spring—it can oscillate about its commanded position. Externally, the machine, mounting structure, and drive electronics can also be resonant, and interact with the motor. During a move, two types of problems can arise from these causes: resonance and ringing transients.

Resonance (Steady State Response)

Resonance is a *steady state* phenomenon—it occurs when the motor's natural resonant frequencies are excited at particular velocities. It is not

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caused by transient commands that we give the motor. If you slowly increase your motor's speed from zero to 20 rps, for example, you may notice "rough" spots at certain speeds. The roughness is resonance; it is depicted in the next drawing.



Resonance

Instead of moving at the commanded velocity, the motor is oscillating between speeds faster and slower than commanded. This causes *error in rotor position*.

Resonance points can differ in intensity. The drawing shows a typical case—as motor speed increases, resonances of varying levels occur. Usually, the motor can accelerate through the resonance point, and run smoothly at a higher speed. However, if the resonance is extreme, the rotor can be so far out of position that it causes the motor to stall.

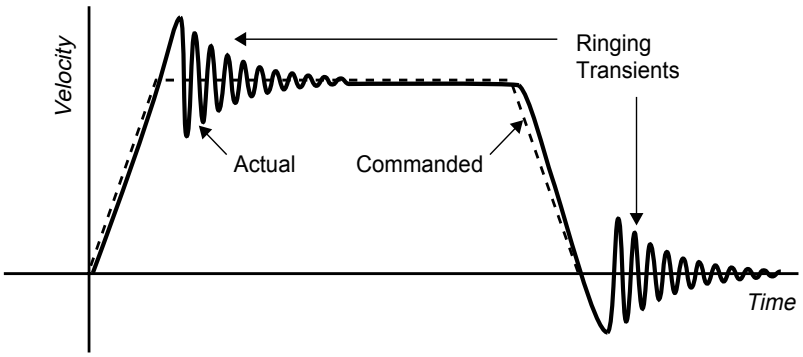
Resonance is affected by the load. Some loads are resonant, and can make motor resonance worse. Other loads can damp motor resonance. To solve resonance problems, system designers will sometimes attach a damping load, such as an inertial damper, to the back of the motor. However, such a load has the unwanted effect of decreasing overall performance, and increasing system cost.

The ZETA Drive has internal electronics that can damp resonance, and *increase* system performance. No external devices are necessary.

Ringing (Transient Response)

Inside a step motor, the rotor behaves like a mass on a spring, as mentioned above. When commanded to quickly accelerate to a given velocity, the rotor will "ring" about that velocity, oscillating back and forth. As shown in the next drawing, the ringing *decays*—grows smaller over time—and the rotor eventually settles at the commanded velocity.

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Ringing Transients

Notice that ringing can be caused both by accelerating (or decelerating) to a commanded velocity, and decelerating to a stop. In all of these cases, ringing causes *error in rotor position*.

Ringing is a *transient* phenomenon (unlike resonance, which occurs during steady state operations). It is a response to a sudden change that we impose on the system, such as “Accelerate to Velocity” or “Stop.”

Several problems are associated with ringing. It can cause audible noise; the motor must have a margin of extra torque to overcome the ringing; and longer settling times can decrease throughput.

To eliminate these problems, system designers use damping to force the ringing to decay quickly. Inertial dampers have been used as components in passive damping methods. Accelerometers, encoders, and tachometers have been used as components in active damping methods. These devices can have the unwanted effect of limiting performance, adding complexity, and increasing cost.

The ZETA Drive has internal electronics that damp ringing transients, causing them to decay quickly. No external devices are necessary.

10 – Damping in the ZETA Drive

The ZETA Drive has three different circuits that can damp resonance and ringing.

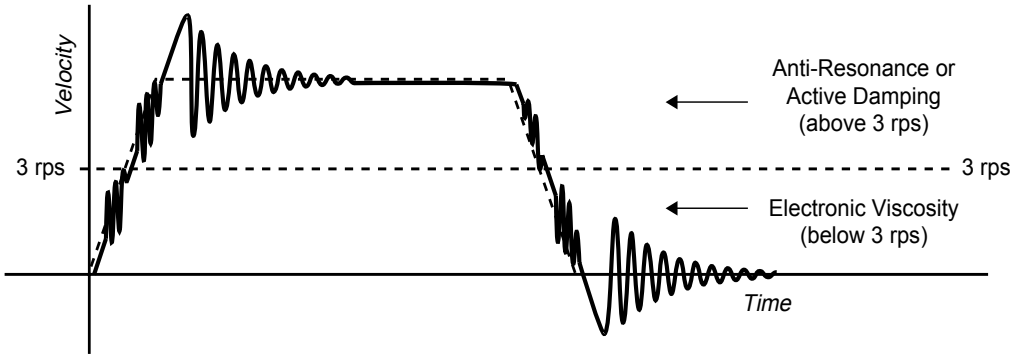
Anti-Resonance – General-purpose damping circuit. The drive ships from the factory with anti-resonance enabled. You can optimize its performance by setting two DIP switches. Anti-resonance provides aggressive and effective damping.

Active Damping – Extremely powerful damping circuit. The drive ships from the factory with active damping disabled. You must set seven DIP switches (SW2-#6 – SW2-#12) and a rotary switch to enable active damping, and optimize it for a specific motor size and load.

Electronic Viscosity – Provides damping at lower speeds. The drive ships with electronic viscosity disabled. You must set a rotary switch to enable electronic viscosity, and optimize it for the specific application.

The first two damping circuits—anti-resonance and active damping—work at speeds greater than three revolutions per second (rps). Electronic viscosity works at speeds from rest up to three rps. The drive will automatically switch between the damping circuits, based upon the motor’s speed. The next drawing shows the effective range of each circuit.

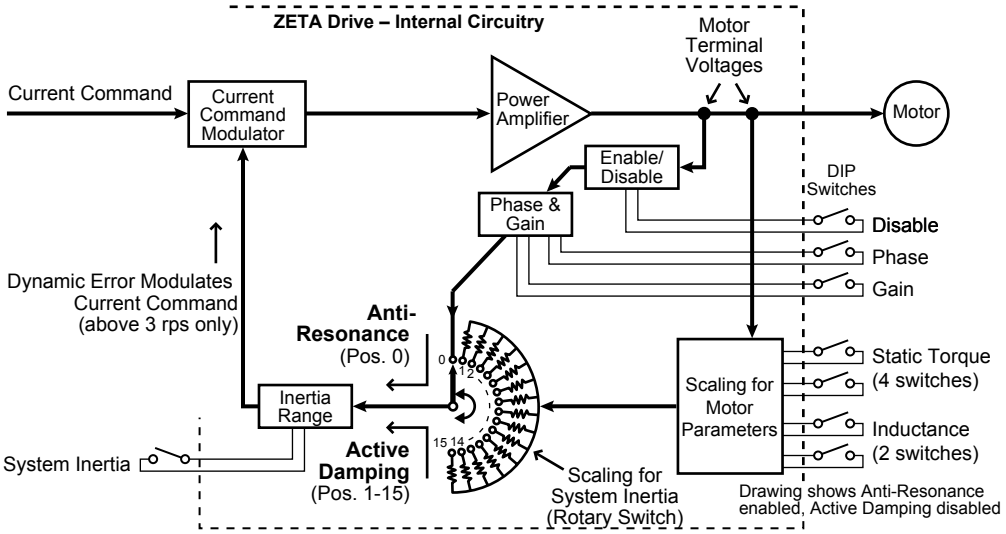
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Resonances, Ringing Transients, and Effective Range of Damping Circuits

Above 3 rps, the drive automatically enables anti-resonance or active damping—but not both at the same time. They are mutually exclusive.

If the rotary switch for active damping is set to the zero position, the drive enables anti-resonance. If the rotary switch is set to any position other than zero, the drive enables active damping. This relationship is shown in the next drawing. Notice that anti-resonance can also be disabled with a DIP switch.



Anti-Resonance and Active Damping – Block Diagram

Differences between anti-resonance and active damping are described next; refer to the block diagram above.

ANTI-RESONANCE

Anti-resonance monitors the drive's motor terminals, and looks at power exchange between the drive and motor. From this, it extracts information about error in rotor position caused by resonance or ringing. It modifies the internal motor current command to correct for the error.

Anti-resonance is a general-purpose circuit. It corrects rotor position error, without knowledge about the system—whether the motor is large or small, or the system inertia is high or low. You can optimize the circuit by setting two DIP switches. One selects a range for the circuit's phase; the other selects a range for the circuit's gain.

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Active Damping

Active damping monitors the motor terminals and, like anti-resonance, uses the same current command modulator to modify motor current.

Active damping uses a different method to extract information about rotor position error, however. The circuit's gains are adjustable—you can configure it for your particular system. DIP switches scale the circuit for motor inductance, static torque and inertia range. A 16-position rotary switch scales the circuit for system inertia.

The active damping circuit uses this information for two purposes:

1. It determines error in rotor position *very* accurately.
2. It adjusts the gains of its feedback loop, based upon how much inertia the system has, and how much torque the motor can produce.

If the rotor rings or vibrates, the active damping circuit will detect the corresponding error in rotor position. It will then modify the motor current command to damp the ringing.

DIP switches on top of the drive set the amount of motor current during normal operations; this current is constant. To damp ringing, the active damping circuit can cause the drive to produce up to twice as much current as is set by the DIP switches. The extra current is only applied while the circuit damps oscillations, and lasts a very brief time.

Electronic Viscosity (EV)

The ZETA Drive uses closed loop current control to develop and maintain precise currents in the motor phases. When EV is off, the current loops have a bandwidth of approximately 1000 Hz. Because this bandwidth is well beyond the knee of step motor speed-torque curves, the current loop dynamics do not limit the response of the motor.

EV monitors motor velocity, and turns on below 3 rps. It "detunes" the current loop compensation values and brings the bandwidth down to 150 Hz. With this lower bandwidth, the drive electronics become "sluggish." Ordinarily, when the rotor oscillates, it generates current in the motor's coils; but with EV's lower bandwidth, the drive's electronics impede the flow of current caused by oscillations.

The effect on the motor is as if there were a viscous drag on the rotor. At the end of a move, oscillations are damped, and the rotor quickly comes to rest. After accelerating or decelerating to velocities below 3 rps, the rotor quickly settles at the commanded velocity. EV significantly reduces low speed velocity ripple during moves below 3 rps.

EV is a "passive" circuit. It imposes viscosity on the system, but has no feedback loop to monitor the effect of the viscosity. EV keeps the amount of viscosity the same, regardless of the response of the system.

You can adjust the amount of viscosity by setting the rotary switch. This allows you to tailor the circuit for different motor sizes and system inertias, and adapt it to your application.

What's Next?

We recommend that you complete the next sections, and configure active damping and electronic viscosity. Even if you believe resonance and ringing will not cause problems in your system, you may find that the ZETA Drive's damping circuits provide increased smoothness, reduced audible noise, and better performance.

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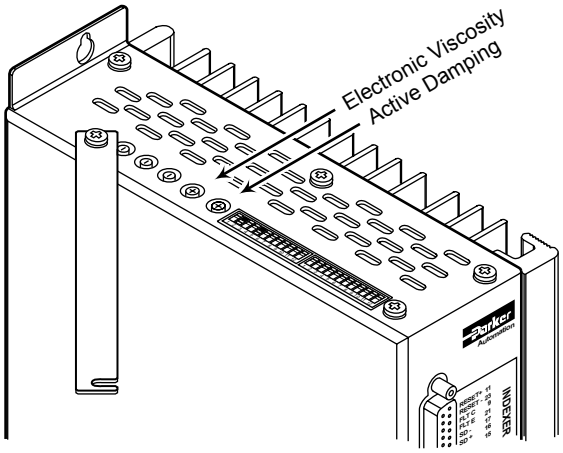
If you choose not to use active damping and electronic viscosity, at least use anti-resonance. Verify that anti-resonance is enabled (DIP SW2-#2 off), and that the rotary switches on the front of the drive, for active damping and electronic viscosity, are set to zero.

11 – Set Rotary Switches To Zero

The ZETA Drive has two rotary switches located behind the movable cover plate on top of the drive:

10–Position Switch:	for Electronic Viscosity (positions 0 – 7 are active)
16–Position Switch:	for Active Damping

Set each switch to zero. A setting of zero disables electronic viscosity and active damping. In the steps below, you will determine new switch settings to activate these two functions.



Rotary Switch Location

12 – Configure Active Damping

Follow these steps to configure the active damping circuit.

1. **Verify Correct Drive/Motor Matching**
   See *Match the Drive to the Motor* earlier in this chapter. To be fully effective, the active damping circuit requires proper matching. If you are replacing a component (new drive or motor in an existing application), you must re-match your system.

2. **Verify Correct DIP Switch Settings**

Anti-Resonance	SW2-#2	switch in *OFF* position
Inductance	SW2-#7 – #8	set for your motor
Static Torque	SW2-#9 – #12	set for your motor

3. **Verify that the Active Damping Rotary Switch is at Zero**

4. **Calculate the Maximum Rotary Switch Setting**
   To do this, first calculate your system inertia. Be sure to include the motor's rotor inertia. Then consult the table of inertia ranges below. Find the switch setting that corresponds to your system inertia.

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DIP SW2–#6 in *OFF* Position (Low Inertia Range)

Switch Position	Total Inertia ($kg\text{-}cm^2$)	Total Inertia ($kg\text{-}m^2 \times 10^{-6}$)	Total Inertia ($oz\text{-}in^2$)
15	0.088 – 0.205	8.8 – 20.5	0.481 – 1.121
14	0.205 – 0.572	20.5 – 57.2	1.121 – 3.127
13	0.572 – 1.069	57.2 – 106.9	3.127 – 5.845
12	1.069 – 1.754	106.9 – 175.4	5.845 – 9.590
11	1.754 – 2.727	175.4 – 272.7	9.590 – 14.910
10	2.727 – 3.715	272.7 – 371.5	14.910 – 20.312
9	3.715 – 5.020	371.5 – 502.0	20.312 – 27.447
8	5.020 – 6.275	502.0 – 627.5	27.447 – 34.308
7	6.275 – 8.045	627.5 – 804.5	34.308 – 43.986
6	8.045 – 9.595	804.5 – 959.5	43.986 – 52.460
5	9.595 – 11.760	959.5 – 1176.0	52.460 – 64.297
4	11.760 – 14.245	1176.0 – 1424.5	64.297 – 77.884
3	14.245 – 15.895	1424.5 – 1589.5	77.884 – 86.905
2	15.895 – 17.765	1589.5 – 1776.5	86.905 – 97.130
1	17.765 – 20.570	1776.5 – 2057.0	97.130 – 112.466
0	Active Damping Disabled		

DIP SW2–#6 in *ON* Position (High Inertia Range)

Switch Position	Total Inertia ($kg\text{-}cm^2$)	Total Inertia ($kg\text{-}m^2 \times 10^{-6}$)	Total Inertia ($oz\text{-}in^2$)
15	13 – 31	1324 – 3084	75 – 169
14	31 – 86	3084 – 8606	169 – 471
13	86 – 161	8606 – 16084	471 – 879
12	161 – 264	16084 – 26390	879 – 1443
11	264 – 410	26390 – 41029	1443 – 2243
10	410 – 559	41029 – 55894	2243 – 3056
9	559 – 755	55894 – 75528	3056 – 4129
8	755 – 944	75528 – 94411	4129 – 5162
7	944 – 1210	94411 – 121041	5162 – 6618
6	1210 – 1444	121041 – 144362	6618 – 7893
5	1444 – 1769	144362 – 176935	7893 – 9674
4	1769 – 2143	176935 – 214323	9674 – 11718
3	2143 – 2391	214323 – 239148	11718 – 13075
2	2391 – 2673	239148 – 267283	13075 – 14614
1	2673 – 3095	267283 – 309486	14614 – 16921
0	Active Damping Disabled		

Active Damping Rotary Switch Settings & Corresponding Inertia Ranges

This is your *maximum* switch setting. If you are on the boundary between two switch settings, pick the lower of the two numbers. In the rest of this procedure, ***never set the switch higher than this maximum setting***.

5. Make a Move With Active Damping Turned *Off*

(Rotary switch should be in the zero position.) This is your baseline move. Notice the sound, amount of motor vibration, etc. This move shows how your system operates with anti-resonance enabled, and active damping disabled. Each time you adjust this switch, you will compare results with this baseline move.

The move should be representative of your application, with similar velocity and acceleration. The speed must be faster than 3 rps, in order for the drive to activate anti-resonance or active damping.

6. Turn On Active Damping

Turn the active damping rotary switch to position 1. This turns on active damping at its lowest setting, and disables anti-resonance.

You can change the rotary switch setting “on the fly.” You do not have to cycle power each time you change the switch setting. During a repetitive move, you can change the switch setting while the move is in progress. This allows you to immediately compare two different switch settings.

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7. **Make a Move With Active Damping Turned *On***
   Compare the sound and vibration to the baseline move.

8. **Increase the Switch Setting**
   Turn the rotary switch to position 2 (unless position 1 is your calculated maximum). Make the move again. Compare the sound and vibration to the levels obtained at the lower setting.

9. **Find the Ideal Switch Setting**
   Continue to increase the switch setting by single increments. Each time you increase the setting, compare the results with the lower setting. Increase the setting until you obtain optimum results for your move. This will be the setting that yields the lowest audible noise and smoothest motor operation.

Never exceed your maximum switch setting. For many applications, you will not need to go as high as the maximum setting. If you do not see perceptible improvement from one switch setting to the next, use the lower switch setting.

Higher switch settings result in higher dynamic motor current during transients, which can cause increased motor heating. Higher current also increases motor torque, resulting in sharper accelerations that can jerk or stress the mechanics in your system. If you ramp up through each intermediate switch position, you can evaluate the effects on your mechanics as you gradually increase damping.

13 – Configure Electronic Viscosity (EV)

If you configured active damping in the previous step, you can leave the active damping rotary switch set at the value you chose. You do not need to set active damping at zero while you configure EV.

1. **Verify that the EV Rotary Switch is Set at Zero**
   EV is *off* when the switch is in the zero position.

2. **Make a Move With EV Turned *Off***
   Notice the sound, amount of motor vibration, perceptible ringing, etc. This is your baseline move. It shows how your system operates with EV off. Each time you adjust this switch, you will compare results with this baseline move.

   Remember, EV only works below 3 rps. Select a move that is representative of your application, with similar velocity and acceleration.

3. **Turn On EV**
   Turn the rotary switch to position 1. This turns on EV.

   You can change the switch setting “on the fly,” while the move is in progress. You do not need to cycle power each time you change the switch setting. For repetitive moves, you can change the switch setting while the move is in progress. This allows you to immediately evaluate the results, and compare two different settings.

4. **Make a Move With EV Turned *On***
   Compare results to the baseline move.

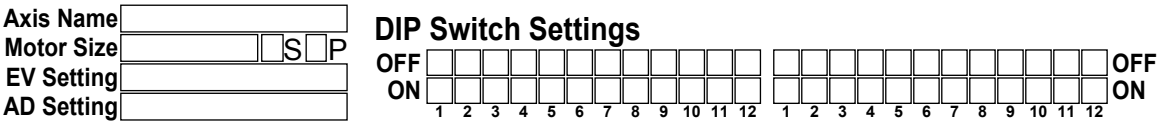
5. **Increase the Switch Setting**
   Turn the switch to the next higher position. Make the move. Notice the results, and compare them to earlier settings.

6. **Find the Ideal Switch Setting**
   Repeat *Step 5* until you find the setting that gives the best performance. You can try all seven switch settings. Incorrect switch settings will not cause damage.

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14 – Record Your System's Configuration Information

This completes the installation procedure. You may wish to record your configuration information in the chart below.



Configuration Information

This chart is repeated, along with other facts, on the information label located on the side of the ZETA Drive. This is a *magnetic* label. You can leave it on the drive; or, you can remove it and place it in a convenient location near the drive (on an equipment cabinet door, for example).

Use a marker or pen to write configuration information in the spaces at the bottom of the label. If you have multiple drives, you can remove the labels and stack them on top of each other, with the bottom edge of each visible. This shows information about all axes at a glance.

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CHAPTER THREE

3 Troubleshooting

IN THIS CHAPTER

- Troubleshooting Basics
- Diagnostic LEDs
- Protective Circuits
- Automatic Test
- Anti-Resonance Disable
- 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. If the problem persists, contact your local technical support resource.

DIAGNOSTIC LEDS

The ZETA Drive has four LEDs on its front panel. The following summary of LED functions may help you isolate problems.

LED Name	Color	Function
POWER	Green	Illuminates when AC power is applied Off if AC power is under voltage (<95VAC)
STEP	Green Red/Green	Illuminates with each applied step pulse Alternates red & green during Auto Test
OVER TEMP	Red	Indicates drive has exceeded temperature limit
MOTOR FAULT	Red	Indicates short circuit in motor or cabling Indicates open interlock

PROTECTIVE CIRCUITS

The ZETA Drive has several protective circuits, some of which can indicate fault conditions by illuminating one of the above LEDs.

OVERTEMPERATURE PROTECTION

To protect against damage from high temperatures, the ZETA Drive has an internal temperature sensor. If the sensor reaches 55°C (131°F) it will trigger an overtemperature fault. The red OVER TEMP LED will illuminate, and the drive will shut down. This is a latched fault. To restart the drive, first allow it to cool, then cycle power or toggle the reset input.

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Short Circuit Protection

The ZETA Drive has short circuit protection. When the drive detects a short circuit in the motor or motor cabling, it illuminates the MOTOR FAULT LED, and stops producing motor current. This is a latched condition. To restart the drive, first fix the short in the motor or cable, then cycle power.

Regeneration

The ZETA Drive has an internal regeneration resistor. If the motor *regenerates*—produces excess energy during deceleration—the drive will automatically dissipate the excess energy in its regeneration resistor. If the motor regenerates an excess amount of energy on a continuous basis, the drive's internal temperature may rise and trigger an overtemperature fault (see above).

Automatic Test

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

You can then configure the drive to run its automatic test. See instructions near the beginning of *Chapter 2 Installation*, under *Quick Test*. If the motor turns as expected—counterclockwise at approximately one rps—then the drive, motor, and cables are probably not the cause of the problem. The cause may lie with the indexer, limit switches, mechanics, etc.

Anti-Resonance Disable

If your mechanical system is highly resonant at precisely the *wrong* frequency, anti-resonance might interpret the mechanical vibrations as rotor position error. You would notice greater torque ripple, increased audible noise, and possibly even stalling. To solve these problems, try adjusting the anti-resonance phase and gain (SW2-#3 & #4), or try disabling anti-resonance (SW2-#2 on), and see if the problems improve.

You can also turn on and use active damping. The drive automatically disables anti-resonance when active damping is turned on.

Technical Support

If you cannot solve your system problems using this user guide, 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, from 6:00 AM to 5:00 PM Pacific time.

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PRODUCT RETURN PROCEDURE

If you must return your ZETA 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 ZETA 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, user guide)?
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 the UK, call Parker Digiplan for a GRA (Goods Returned Authorization) number. Returned products cannot be accepted without a GRA number. The phone number for Parker Digiplan Repair Department is 0202-690911. The phone number for Parker Digiplan Service/Applications Department is 0202-699000.

   Ship the unit to:
   Parker Digiplan Ltd.,
   21, Balena Close,
   Poole, Dorset,
   England. BH17 7DX
5. Elsewhere: Contact the distributor who supplied the equipment.

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APPENDIX A

Using Non-Compumotor Motors

IN THIS APPENDIX

- Wiring Configurations: 4-, 6- and 8-lead motors
- Terminal Connections: 4-, 6- and 8-lead motors
- Setting Motor Current: Series or Parallel
  Unipolar or Bipolar

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USING NON-COMPUMOTOR MOTORS

When the ZETA Drive operates from a nominal 120VAC input, its rectified output is approximately 170VDC. We recommend you use Compumotor R or T Series motors, which are designed to operate at 170VDC. If you use a non-R or non-T Series motor, it must meet the following specifications:

- Motor must be able to withstand 170VDC input voltage.
- Motor must have a minimum 500VDC high-pot insulation rating from phase-to-phase and phase-to-ground.
- Motor must have a minimum inductance of 2 mH, series or parallel. (Compumotor recommends a minimum inductance of 5 mH.)
- Motor must be designed for use with a bipolar drive (no common center tap).
- Motor must not have riveted rotors or stators.
- Do not use solid rotor motors.
- Test all motors carefully. Verify that the motor temperature in your application is within the system limitations. *The motor manufacturer's maximum allowable motor case temperature must not be exceeded.* You should test the motor over a 2-to-3 hour period. Motors tend to have a long thermal time constant, but can still overheat, which results in motor damage.

CAUTION

Consult your motor vendor to verify that your motor meets the above specifications. Consult your Automation Technology Center (ATC) if you have questions regarding the use of a non-Compumotor motor with Compumotor equipment.

WIRING CONFIGURATIONS

Refer to the manufacturer's motor specification document to determine the motor's wiring configuration. You can also determine the wiring configuration with an ohmmeter using the procedures below (*4-Lead Motor, 6-Lead Motor, 8-Lead Motor*). Once you determine the correct motor wiring configuration, use the terminal connection diagram, shown at the end of this section, that applies to your configuration.

4-LEAD MOTOR

1. Label one motor lead **A+**.
2. Connect one lead of an ohmmeter to the **A+** lead and touch the other lead of the ohmmeter to the three remaining motor leads until you find the lead that creates continuity. Label this lead **A–**.
3. Label the two remaining leads **B+** and **B–.** *Verify that there is continuity between the* **B+** *and* **B–** *leads.*
4. Proceed to the *Terminal Connections* section below.

6-LEAD MOTOR

1. Determine, with an ohmmeter, which three of the six motor leads are common (one phase).
2. Label each one of these three motor leads **A**.
3. Using the ohmmeter, verify that the remaining three leads are common.
4. Label the remaining three leads **B**.
5. Set the ohmmeter range to the 100 ohm scale (approximately).
6. Connect the ohmmeter's negative lead to one of the motor leads labeled **A**. Alternately measure the resistance to the two remaining motor leads also labeled **A**. The measurements will reflect one of the following two scenarios.

   Scenario #1 — The resistance measurements to the two remaining motor leads are virtually identical. Label the two remaining motor leads **A+** and **A–**. Label the motor lead connected to the negative lead of the ohmmeter **A-CT** (this is the *center tap*, or common lead for Phase A of the motor).

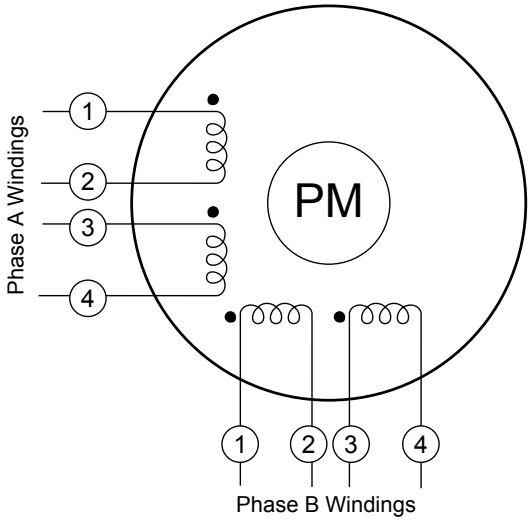
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Scenario #2 — The resistance measurement to the second of the three motor leads measures 50% of the resistance measurement to the third of the three motor leads. Label the second motor lead **A-CT** (this is the *center tap*, or common lead for Phase A of the motor). Label the third motor lead **A-**. Label the motor lead connected to the ohmmeter **A+.**

7. Repeat the procedure as outlined in step 6 for the three leads labeled **B** (**B-CT** is the *center tap*, or common lead for Phase B of the motor).
8. Proceed to the *Terminal Connections* section below.

8-Lead Motor

Because of the complexity involved in phasing an 8-lead motor, you must refer to the manufacturer's motor specification document. Using the manufacturer's specifications, label the motor leads as shown in the next drawing.



8-Lead Motor – Labeling the Leads

You can configure the 8-lead motor in series or parallel.

Series Configuration Use the following procedure for series configurations.

1. Connect A2 & A3 together and relabel this common point **A-CT.**
2. Connect B2 & B3 together and relabel this common point **B-CT.**
3. Relabel the A1 lead **A+**.
4. Relabel the A4 lead **A–**.
5. Relabel the B1 lead **B+**.
6. Relabel the B4 lead **B–**.
7. Proceed to the *Terminal Connections* section below.

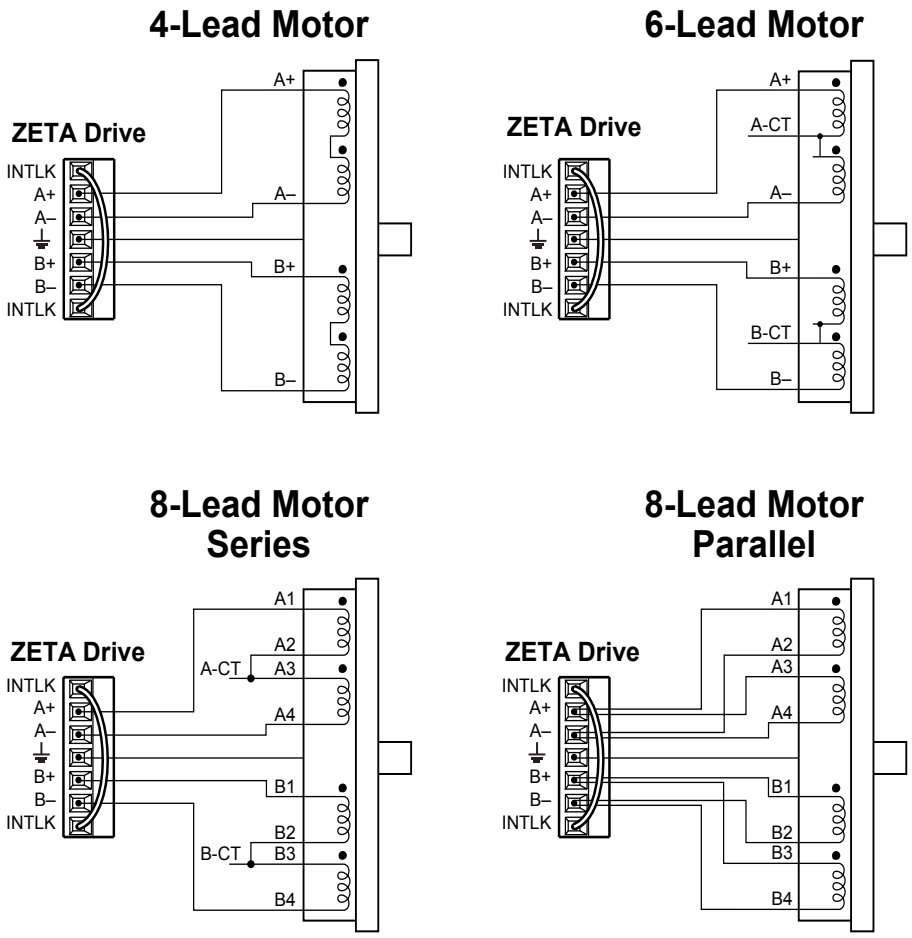
Parallel Configuration Use the following procedure for parallel configurations.

1. Connect motor leads A1 & A3 together and relabel this common point **A+**.
2. Connect motor leads A2 & A4 together and relabel this common point **A–**.
3. Connect motor leads B1 & B3 together and relabel this common point **B+**.
4. Connect motor leads B2 & B4 together and relabel this common point **B–**.
5. Proceed to the *Terminal Connections* section below.

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TERMINAL CONNECTIONS

After you determine the motor's wiring configuration, connect the motor leads to the ZETA Drive's 7-pin **MOTOR** connector according to the following figure.



Non-Compumotor Motor Connections

DIRECTION OF MOTOR ROTATION

The procedures above do not determine the direction of motor shaft rotation. To find out which direction the shaft turns, you must power up your system and command motion. If the shaft turns in the opposite direction than you want, exchange the motor leads connected to **A+** and **A–** to reverse the direction of rotation.

WARNING

Motor shaft rotation may be opposite than you expect. Do not connect a load to the shaft until you first determine the direction of shaft rotation.

The *Automatic Test*, described near the beginning of *Chapter 2, Installation*, provides a simple method of determining motor shaft rotation. The test causes the shaft to rotate in the counterclockwise (negative) direction, if the motor wires are properly connected. No indexer is required to perform the automatic test.

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SETTING MOTOR CURRENT – NON-COMPUMOTOR MOTORS

To set motor current for a non-Compumotor motor, refer to the formulas below that correspond to your motor (4-lead, 6-lead, 8-lead) and use the current settings shown in the DIP switch table (in *Chapter 2, Installation*) to set the motor's current.

WARNING

Do not connect or disconnect the motor with the power on. Doing so will damage the contacts of the motor connector and may cause injury to personnel.

4-LEAD MOTORS

If you use a 4-lead motor, the manufacturer's current specification will translate directly to the values shown for current in the DIP switch table.

6-LEAD MOTORS

Manufacturers generally use either a bipolar rating or a unipolar rating for motor current in 6-lead motors.

Bipolar Rating: If the manufacturer specifies the motor current as a bipolar rating, you can use the DIP switch table's current settings directly to set motor current—no conversion is required.

Unipolar Rating: If the manufacturer specifies the motor current as a unipolar rating:

- Use the following formula to convert the unipolar current rating to the correct bipolar rating:

  Unipolar Current * 0.707 = Bipolar Current

- Use the converted value and the DIP switch table's current settings to set the motor current.

8-LEAD MOTORS

Manufacturers generally use either a bipolar rating or a unipolar rating for motor current in 8-lead motors.

Bipolar Rating: If the manufacturer specifies the motor current as a bipolar series rating:

- If you wire the motor in **series**, use the DIP switch table's current settings directly.
- If you wire the motor in **parallel**, you must double the manufacturer's rating and then use the DIP switch table's current settings to set the motor current.

Unipolar Rating: If the manufacturer specifies the motor current as a unipolar rating:

- Use the following formula to convert the unipolar current rating to the correct bipolar rating:

  Unipolar Current * 0.707 = Bipolar Current

- If you wire the motor in **series**, use the converted value and the DIP switch table's current settings to set the motor current.
- If you wire the motor in **parallel**, you must **double** the converted value and use the DIP switch table's current settings to set the motor current.

If you have questions about setting motor current, call Compumotor's Applications Engineering Department at (800) 358-9070.

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APPENDIX B

LVD and EMC Installation Guide

IN THIS APPENDIX

- LVD Installation Instructions
- EMC Installation Instructions

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General Instructions

When installed according to the instructions in this user guide and this appendix, the ZETA Drive will comply with requirements set forth by the European Union with regard to product safety (Low Voltage Directive, 73/23/EEC) and electromagnetic compatibility (EMC, 89/336/EEC).

Two kits are available from Compumotor to facilitate installation:

- **C10 Cable Kit** – Includes motor cable and associated hardware. Allows the use of CE marked (LVD) step motors with 1/2" NPT or PG11 cable entry with the ZETA Drive
- **EMC Kit** – Includes mains (AC line) filter and EMC indexer-to-drive cable (Compumotor standard pinout 15M-to-25M pin D-shell)

In this appendix, we assume you are using a Compumotor R or T Series motor, C10 Cable Kit, and EMC Kit. When installed with these options, the ZETA Drive has been demonstrated to meet Electromagnetic Compatibility Standard and the Low Voltage Directive requirements.

When properly installed, the ZETA Drive is *not required* to be mounted within a screened enclosure (cabinet) to achieve compliance. The ultimate responsibility for ensuring that the EMC requirements are met rests with the systems builder.

If you use non-Compumotor equipment, see Compumotor's *EMC Installation Guide* for additional instructions on meeting EMC requirements.

Low Voltage Directive (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 ZETA Drive is designed for pollution degree 2.

Installation Category

The ZETA Drive is designed for installation category II.

Electrical

Connecting and Disconnecting Power

The ZETA Drive accepts mains input voltage from 95 – 132VAC, at 47-63 Hz. Maximum power consumption is shown in *Chapter 2, Installation*, under *Connect AC Power*.

The ZETA Drive ships with a molded 3-conductor power cable. Install this cable in accordance with local regulations.

The ZETA Drive's protective earth connection is provided through its AC power connector. You must reliably earth the ZETA Drive's protective earth connection.

The ZETA Drive's supply voltage is limited to 132VAC.

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Connecting the Protective Conductor Terminal to Earth

You must provide a connection from the ZETA Drive's protective conductor terminal to a reliable system earth point.

The protective conductor terminal is marked with a label on the product bearing the following symbol:



Protective Conductor Terminal Marking

Follow these steps to connect the protective conductor terminal to earth:

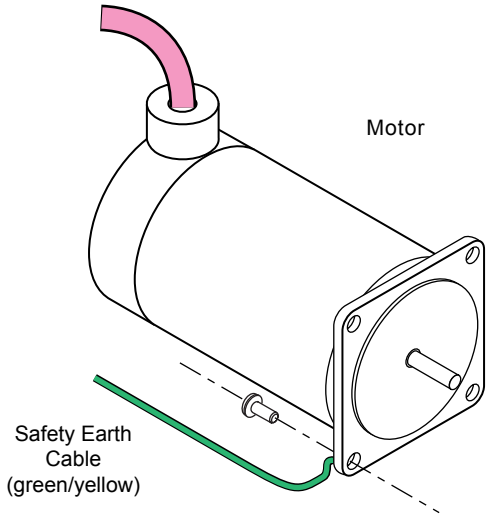
1. For compliance with LVD, you must use a VDE approved green/yellow protective conductor terminal wire to reliably earth the protective conductor terminal. Wire gauge must be no thinner than the current-carrying wire in the product's mains supply.
3. Resistance between the protective conductor terminal and earth must be no greater than 0.1 ohms. Use thicker gauge wire if the resistance is too high.

Providing a Protective Earth Connection for Motors

You must provide a connection from the motor to a reliable protective earth. This connection provides a protective earth for the motor contact point. The motor's protective earth connection is important for safety reasons, and *must not be omitted*.

Compumotor's R and T Series motors with the C10 Cable option have a protective conductor in the removable cable. The ZETA Drive grounds the motor through its motor connector.

If you use a motor without a protective conductor, make connections according to the following instructions and diagram:



Motor – Earth Connection

1. Use a ring terminal with a star washer and mounting bolt to make good contact with the bare metal surface of the motor's mounting flange.
2. Use a VDE approved green/yellow protective conductor terminal wire to make the connection between the motor and earth. Wire gauge must be no thinner than the current carrying wire in the motor's power cable.
3. Resistance between the motor and earth must be no greater than 0.1 ohms. Use thicker gauge wire if the resistance is too high.

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Extending Motor Cables

Compumotor's C10 Motor Cable is 10 feet (3 m) long. Longer cable lengths are not available from Compumotor. If you extend the motor cable, follow the appropriate guidelines in the LVD regulations published by the EEC.

Maximum DC resistance between the ZETA Drive's "earth" terminal (protective conductor terminal) and motor body must not exceed 0.1 ohm. Consider this requirement when sizing wire cross section (gauge) for extended cable lengths.

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.

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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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EMC Installation Instructions

General Product Philosophy

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

For specific installations, the full protection requirements of the EMC Directive 89/336/EEC must 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.

It is important to follow ***all*** the installation instructions to achieve an adequate level of compliance.

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 EN60204. Safety must never be compromised for the purpose of achieving EMC compliance. In the event of a conflict occurring between the safety regulations and the following recommendations, ***the safety regulations always take precedence.***

ZETA Drive Instructions

We assume you are using:

- Compumotor R or T Series Motor
- C10 Cable Kit (provides motor cable, gland, R-clamp with screw)
- EMC Kit (provides AC mains filter, EMC indexer cable)

If you use non-Compumotor parts for your installation, see Compumotor's *EMC Installation Guide* for additional instructions on meeting EMC requirements.

Mounting

The ZETA Drive must be mounted to a conductive, earthed panel. Before mounting the drive, ensure that the mounting location is flat and free from paint or other nonconductive surface coatings. If necessary, remove paint from the mounting surface. This should guarantee a good high-frequency connection between the drive case and the mounting surface. After mounting the unit use petroleum jelly on the exposed metal to minimize the risk of future corrosion.

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Filtering the AC Mains

In most installations, the AC mains will require fitting of a mains filter.

Recommended AC Input Filter for use with the Zeta Drive:

CORCOM part number 10EP1	SCHAFFNER part number FN2070-10-06
Corcom World Headquarters	Schaffner EMC Inc.
Phone: 847-680-7400	Phone: 201-379-7778
Fax: 847-680-8169	Fax: 201-379-1151

For applications requiring the full 12 amps of current from the ZETA12, we recommend the SCHAFFNER part number, **FN2070-12-06**. There is no comparable CORCOM 12 amp filter.

You will need one of these filters for each drive. Compumotor's EMC Kit includes a suitable AC mains filter.

Mount the filter as close as possible to the drive's AC input connector (see the figure *EMC Compliant Installation* at the end of this section). Ensure that there is no paint on the mounting panel under the filter—a large-area conductive contact between the filter and the panel is vital.

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.

Route these wires away from motor cables and other high current cabling, while keeping their length as short as possible.

Motor Connections – R or T Series Motor with C10 Option

The C10 option for Compumotor's R or T Series motors includes a removable braided cable and all necessary hardware for making an EMC compliant installation. Instructions for attaching the cable follow.

The C10 Motor Cable is 10 feet (3 m) long. Longer cable lengths are not available from Compumotor. If you extend the motor cable, follow the appropriate guidelines in the LVD regulations published by the EEC.

CAUTION

At no time during the following procedure should the motor cable be allowed to twist within the gland assembly. This can damage the cable and greatly reduce its life.

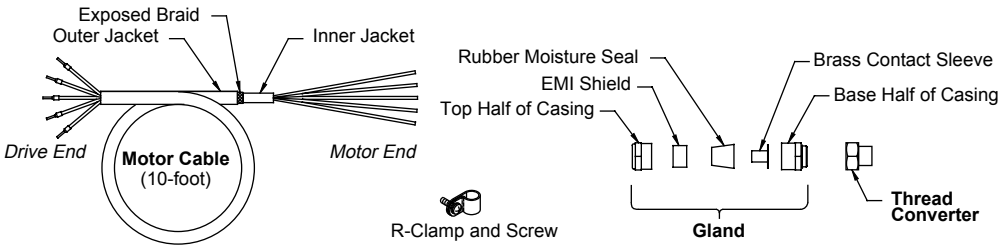
Procedure for Attaching C10 Cable to R or T Series Motor and ZETA Drive

1. **Inventory** (ship kit contents are listed below and shown in next drawing)
   - Thread converter
   - Gland assembly (5 pieces)
   - Motor cable, 10 ft. (3 m)
   - R-Clamp with 6-32 x 1/2 inch screw

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Required Assembly Hardware:

- Phillips screwdriver #2
- Wire strippers
- Standard slotted screwdriver, approximately 0.25 in (6 mm)
- Crimp-on ring terminals sized for 18AWG (0.75 mm) wire:
  - 9 required for series wiring
  - 13 required for parallel wiring
- 18AWG (0.75 mm) wire jumpers 4 in (100 mm) long:
  - 2 required for series wiring
  - 4 required for parallel wiring
- Crimp tool
- Open end 15/16-inch wrench



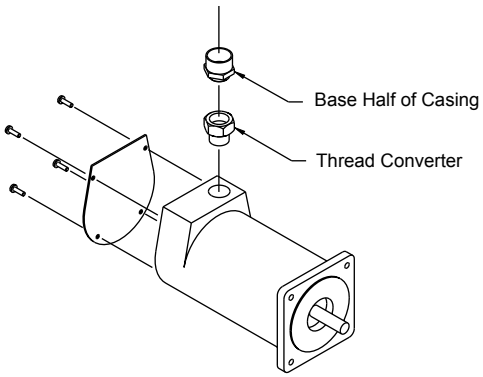
2. Install Thread Converter and Casing Base

A. Remove and discard the motor's plastic thread insert (CCW rotation)

B. Remove endbell cover plate from the rear of the motor.

C. Insert the thread converter into the motor rear endbell, and tighten. The NPT thread is designed for compression fit into the motor body and therefore will not bottom out.

D. Insert the base half of the outer casing into the thread converter and tighten securely.



3. Arrange Components on Cable

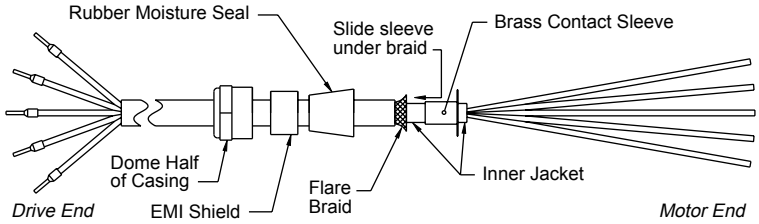
A. From the motor end of the cable, first slide on the dome casing half, then the EMI shield, and finally the rubber moisture seal. The EMI shield is installed blunt end first. The tapered end of the EMI shield fits over the tapered end of the rubber moisture seal.

B. **The next step is critical and if not done properly will impair the EMC performance of the system:**

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With a finger tip, flare the braid away from the inner jacket of the cable (all the way around). This will allow the braid to relax, and eases insertion of the brass sleeve.

C. Carefully slide the brass sleeve as far under the exposed braid as possible. The sleeve must not cause the braid to bunch up or slide up under the outer jacket. The sleeve flange should butt up against the inner jacket of the cable.

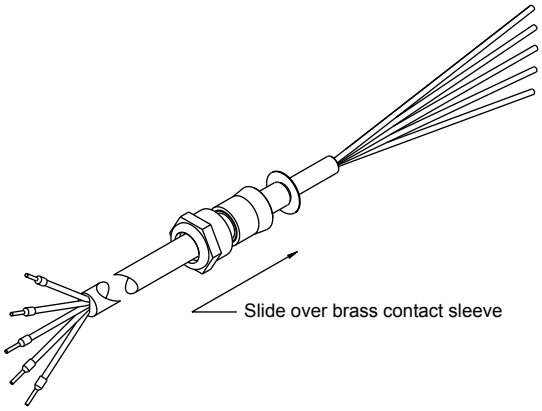


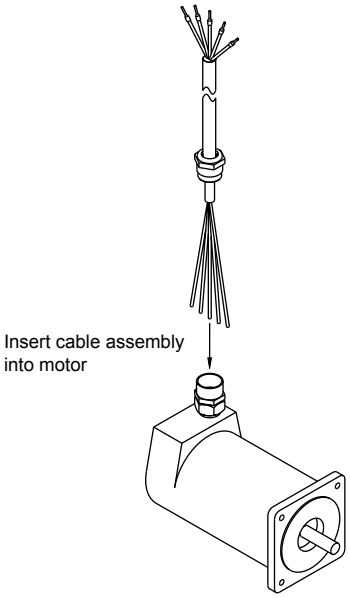
4. Assemble Components on Cable

A. Slide the rubber moisture seal up to the flange of the brass sleeve.

B. Slide the EMI shield onto the rubber moisture seal.

C. Slide the dome half of the outer casing over the EMI shield





5. Insert Cable Assembly into Motor

Insert the assembly into the prepared motor and screw the dome half to the base half of the outer casing until snug. **Do not twist the cable**.

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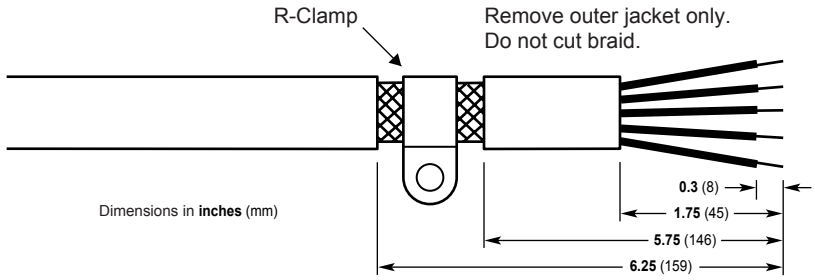
6. **Wire Motor for Series or Parallel Operation.**

   Wire the motor as instructed in *Chapter 2*, in the section *Choose Series or Parallel Motor Wiring*. Install the end bell cover plate onto the rear of the motor.

7. **Connect the Cable to the ZETA Drive**

   At the drive end of the motor cable, expose a short length of braiding and anchor the cable to the ZETA Drive with the R-clamp and screw included in the C10 Cable Kit. Avoid looping the motor cable. The motor cable should be kept away from I/O cables carrying control signals.

   The next figure shows dimensions for your cable preparation.



R-Clamp Installation

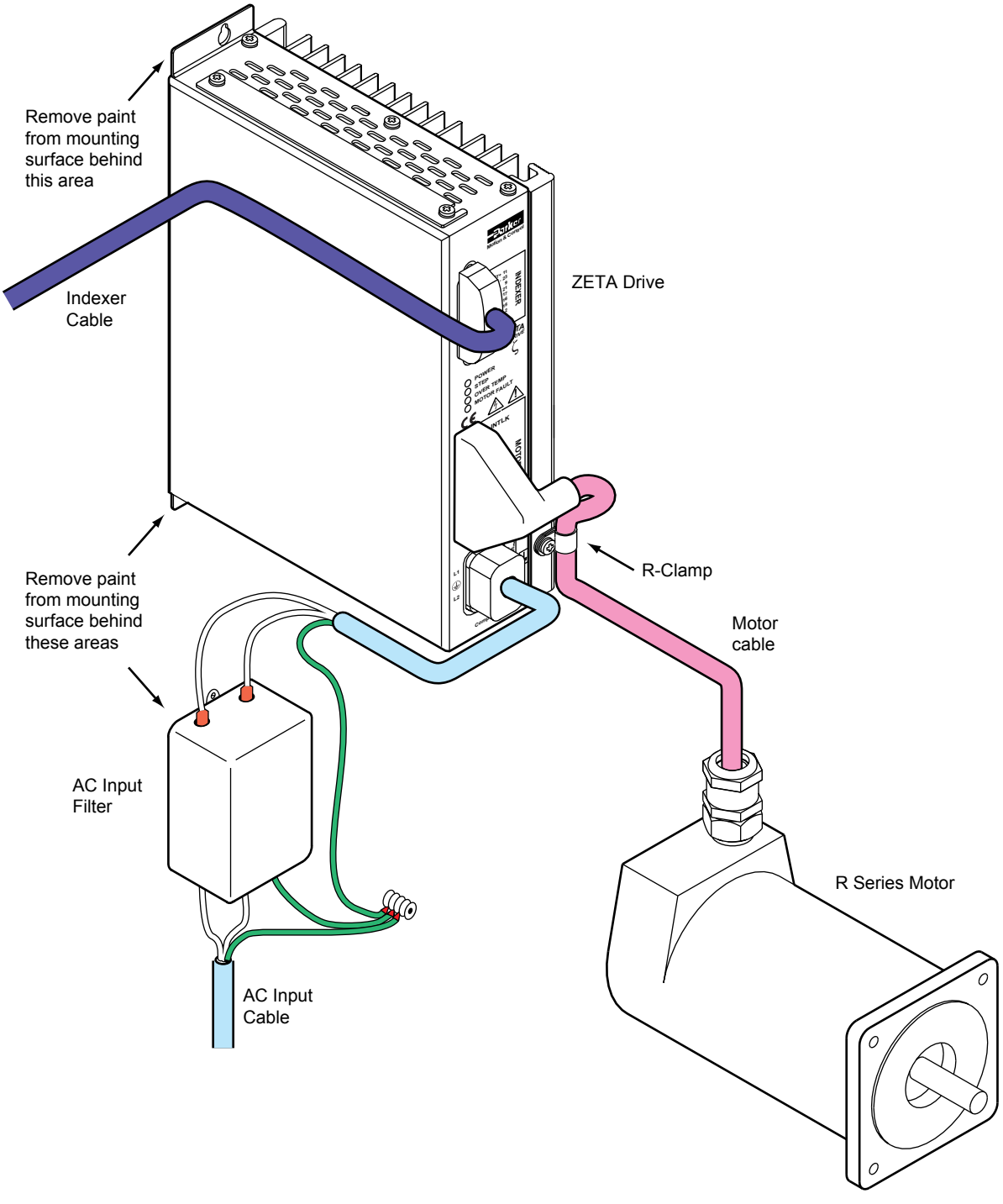
Indexer Connections

Compumotor's EMC Kit includes an EMC version of the indexer-to-drive cable, with Compumotor's standard 15M-to-25M pin D-shell connectors. This cable has a 360° braided shield, and twisted pair wires. Plug the cable into the ZETA Drive and your Compumotor indexer.

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Installation Drawing

The next drawing shows a typical EMC compliant installation.



EMC Compliant Installation

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EMC Considerations – Motors with Non-Removable Cables

Except for the C10 cabling option used with R or T Series motors, Compumotor motors do not incorporate braided screen cables. This is true of O and R Series motors with the L10 option. To improve *electromagnetic compatibility* (EMC) performance, follow the suggestions below. In addition, review *Appendix B, LVD and EMC Installation Guide*.

If motor cabling is not confined within earthed conduit, 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 braided screen cable to the motor. We recommend using a terminal block or other hardware, as in-line splicing on high power cables is not allowed.

Terminate the braided shield at the motor by using a clamp that provides a 360° bond to the motor body. R-clamp the braid to the rear end bell of the motor housing; this not only provides 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. The motor cable should be kept away from I/O cables carrying control signals.

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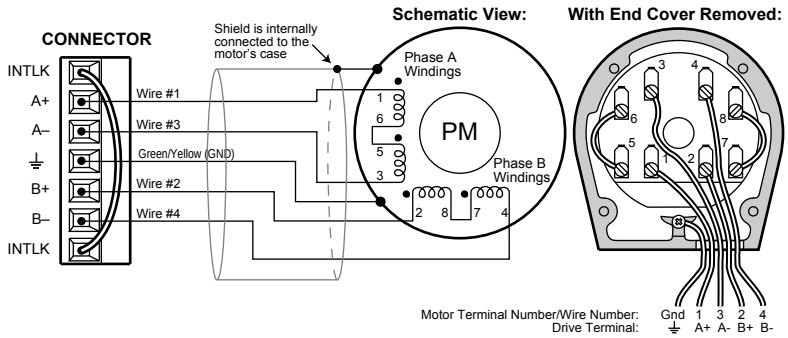
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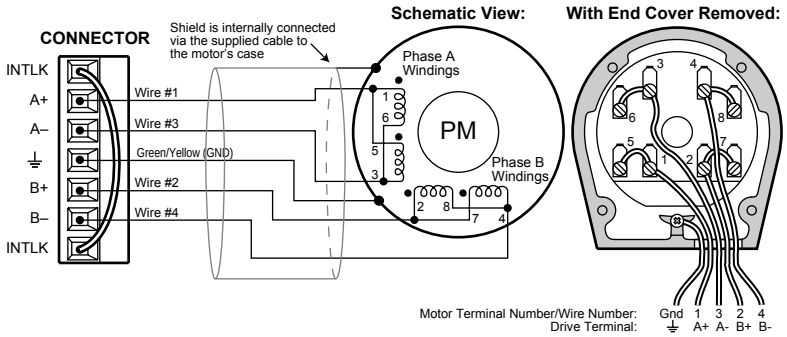
ZETA Drive
Compumotor

R or T Motor – Series Wiring

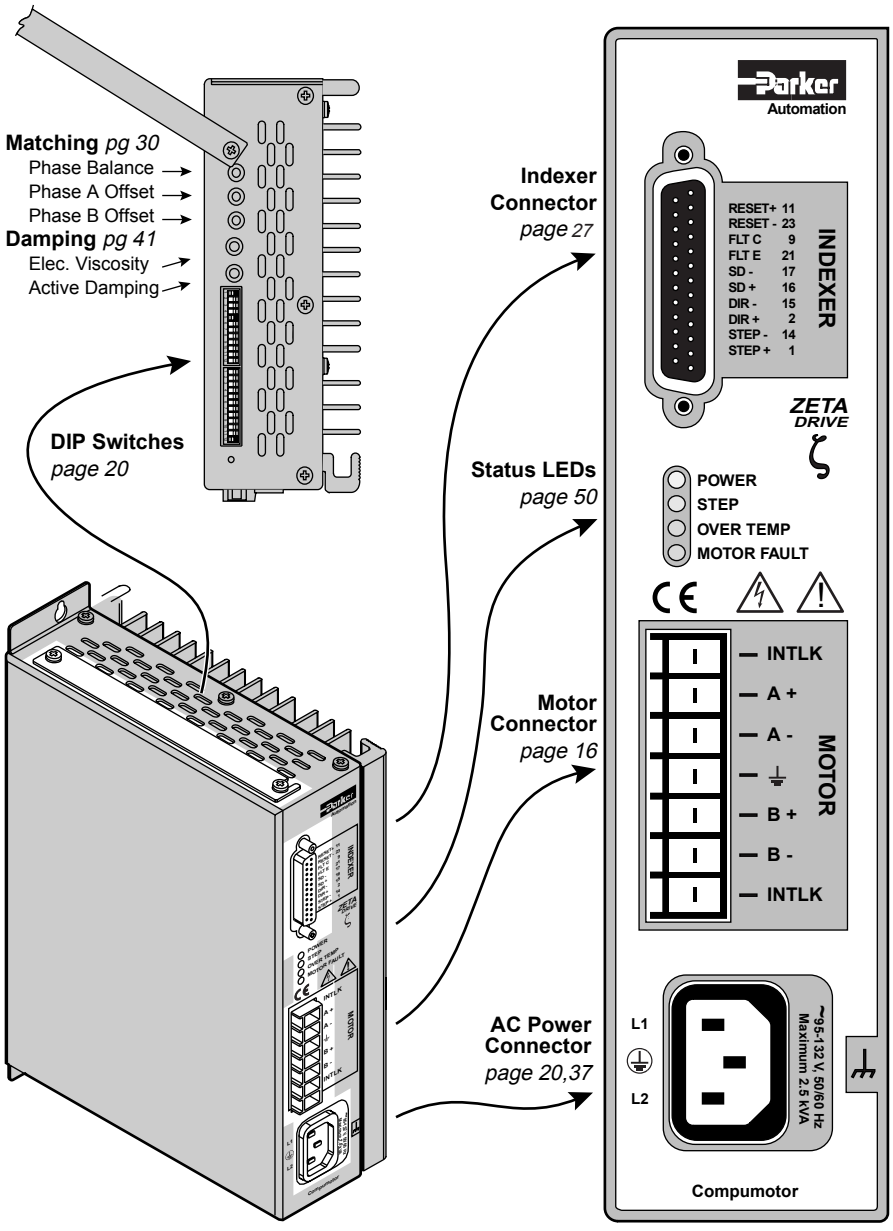


Motor Wiring—Series *pg 16*

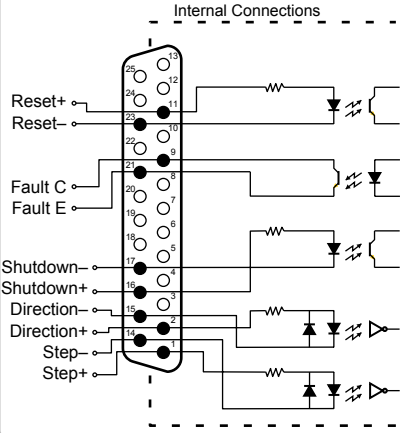
R or T Motor – Parallel Wiring



Motor Wiring—Parallel *pg 17*



Inputs & Outputs *see page 27*



Status LEDs *see page 50*

POWER	Green when power is on
STEP	Green when drive receives step Flashes Red/Green in auto test
OVER TEMP	Red indicates over temp fault
MOTOR FAULT	Red when drive detects short circuit in motor or motor cable; Red if interlock is open

Damping in the ZETA Drive

Anti-Resonance *pg 42*	Works at speeds > 3 rps. DIP SW2-#2 must be off.
Electronic Viscosity *pg 43*	Works from zero to 3 rps. Adjust with rotary switch. Disabled if switch is at 0.
Active Damping *pg 43*	Works at speeds > 3 rps. Adjust with 7 DIPs and 16-position rotary switch. Disabled if rot. sw. at 0. Switch setting based on total system inertia.

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