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Compumotor

Dynaserv
DM & DR
Direct Drive Servos
User Guide

Compumotor Division
Parker Hannifin Corporation
p/n 88-013940-01 B **March 1995**

Parker
Motion & Control

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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.*

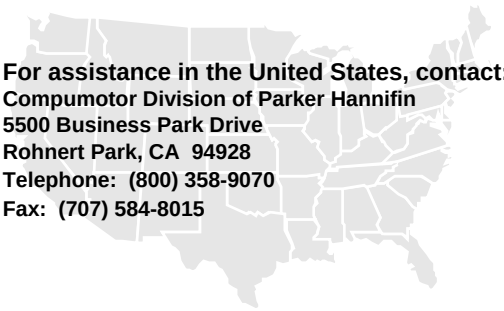
Personnel who are to install and operate the equipment should study this user guide and all referenced documentation prior to installation and/or operation of the equipment.

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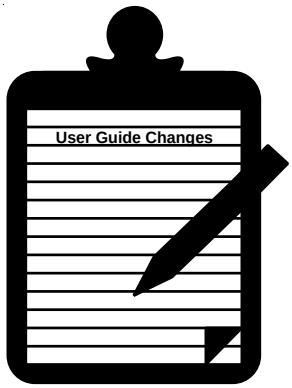


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CHANGE SUMMARY



The original version of this user guide was designed by Yokogawa Precision Corporation in Japan. ***This user guide has been completely revised***. This user guide, version 88-013940-01**B**, supersedes version 88-013940-01**A**.

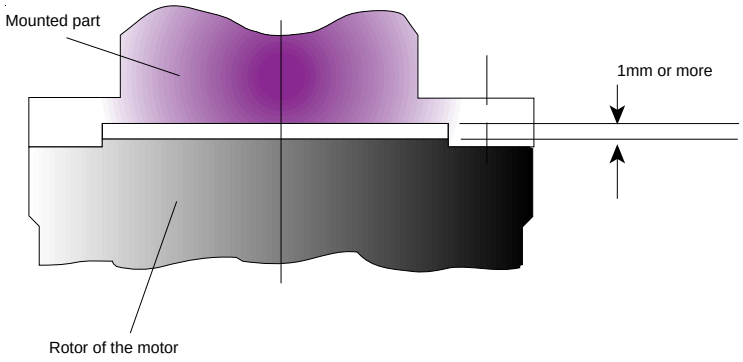
Much of the information from the original user guide has been incorporated in this document. All instructions, procedures, graphics, and technical tables have been written, drawn and tested by Parker Hannifin Corporation's Compumotor Division in Rohnert Park, CA (USA). The text has been reorganized, and edited for clarity and all graphics have been redrawn to better support steps and procedures provided in the user guide.

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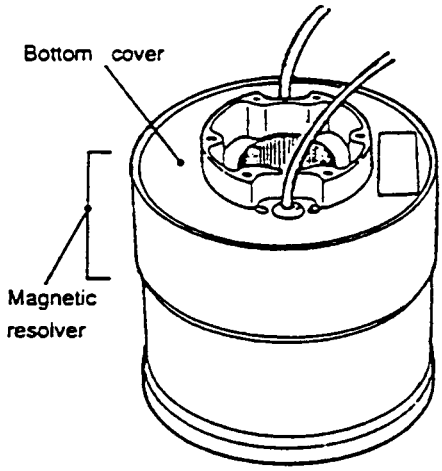
Installation and Operation Precautions

1. Never install the motor with the rotor fixed and the stator set free for rotation.
2. Ensure that the power is switched off when removing the side panel of the driver for jumper setting, etc. Dangerously high voltage is present inside the unit.
3. The motor rotates at high speed with high torque. Beware of the rotating radius of the load when operating the motor with the load installed.
4. When installing a load to the rotor of the motor, allow a space of 1, or more between the top surface of the motor and the surface of the load in order to maintain the proper alignment of the surfaces. Never apply any force or press fit any materials into the center hole. (See the figure below.)

5. Because a magnetic resolver is incorporated in the motor part shown in figure on the right, avoid shock, mechanical pressure, or strong magnetic field.



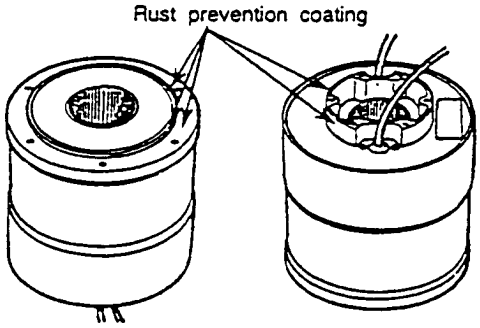
6. Use only such screws which shall not exceed the effective screw depth of the motor part in order to fix the load. The use of long screws may cause damage to the motor.
7. If the motor is used with oscillating rotation movements with a small angle (59° or less), carry out a running-in operation with back-and-forth movement about 10 times, each move exceeding an angle of 90° at least. The running-in operation must be carried out every 10,000 times of back and forth oscillation movement in order to ensure proper lubrication of the bearings.



8. Materials easily affected by magnetism must never be brought close to the motor as the surface of the motor is magnetized.
9. Install the motor in an appropriate location as the motor is not dust proof, watertight, or oil proof.
10. Compatibility of the motor with the driver or vice versa of same model is possible only when they are of the same type. (i.e., When the motor code is DR1❑❑❑❑60*1 and the driver code is SR1❑❑❑❑60, the ❑❑❑❑ of the motor and driver shall be the same.)
11. Never disassemble or modify the motor or the driver. When such disassembling or modification is required, consult Compumotor. Compumotor accepts no responsibility for disassembled or modified motor and driver.

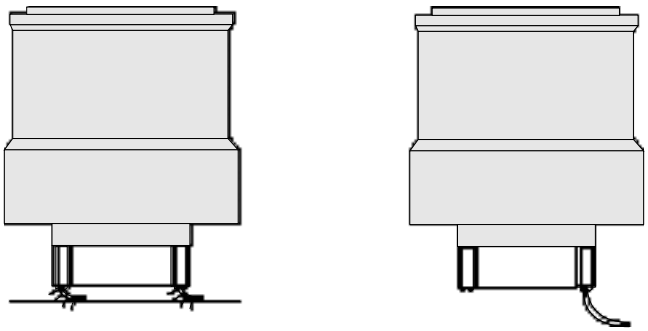
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12. With the motors of the Dynaserv DR series, rust prevention coatings are applied to the loadmount part at the top and also to the fixed part at the bottom of the motor. Before assembling the motor, completely remove this coating using a cloth or paper dipped in petroleum solvent or chlorine solvent. The presence of the coating may lead to severe mechanical inaccuracies of the assembled system.



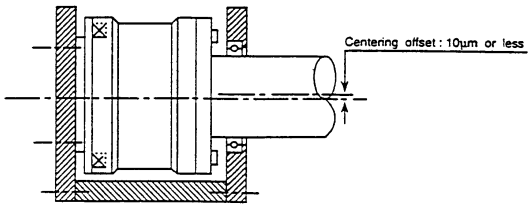
13. If the motor is placed on the floor or a table as shown below when carrying or installing the Dynaserv, the cable is bent by the weight of the motor and this bending may cut the conductor wire. When placing the motor, be sure to use the supporting base which protects the cable from being bent.

    The minimum bending radius shall be 50mm or more when installing the motor with the cable being bent. Do not apply bending force repeatedly to the cable when it is used. The cable specifications do not include application with a robot.



14. Never carry out a withstanding voltage test. Carrying out this test even accidentally may damage the circuits.

15. Appropriate centering and alignment must be carried out when connecting the motor to a load. The shaft metal of the motor may get damaged if the centering offset remains 10µm or more.



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O V E R V I E W

How To Use This User Guide

This user guide is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section should help you find and use the information in this user guide.

Assumptions

This user guide assumes that the user has a fundamental understanding of computers, basic electrical concepts, basic motion control concepts, and basic serial communication (RS-232C) concepts.

User Guide Contents

This user guide contains the following information.

Chapter ① Introduction

This chapter provides a description of the product's basic functions, features, and theory of operation.

Chapter ② Getting Started

This chapter lists items you should have received with your shipment. A basic checkout procedure is provided.

Chapter ③ Installation

This chapter contains system mounting and wiring instructions. Upon completion of this chapter, your system should be completely installed and ready to perform basic operations.

Chapter ④ Control Mode & Adjustment

This chapter provides additional information that will help you customize the system to meet your application's needs. Important application considerations are discussed. Sample applications are provided.

Chapter ⑤ Hardware Reference

This chapter contains system performance specifications (torque/speed curves) and motor dimension specifications.

Chapter ⑥ Maintenance & Troubleshooting

This chapter describes system maintenance procedures. Methods for isolating and resolving problems are provided. Diagnostic error codes are listed.

Installation Process Overview

To ensure trouble-free operation, you should follow the installation procedures outlined in this user guide. Pay special attention to the environment in which the Dynaserv will operate, the layout and mounting, and the wiring and grounding practices used.

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Developing Your Application

Before you develop and implement your application, there are several issues that you should consider.

① Clarify the requirements of your application. Clearly define what you expect the system to do.

② Assess your resources and limitations. This will help you find the most efficient and effective means of developing and implementing your application.

③ Follow the guidelines and instructions outlined in this user guide. Proper installation and implementation can only be ensured if all procedures are completed in the proper sequence.

Installation Preparation

Before you attempt to install this product, you should complete the following steps. Successful completion of these steps should prevent subsequent performance problems and allow you to resolve any potential system difficulties before they affect your system's operation.

① Become familiar with the user guide's contents so that you can find information that you need quickly.

② Develop a basic understanding of all system components, their functions, and interrelationships.

③ Complete the basic system configuration and wiring instructions (in a simulated environment, not a permanent installation) provided in *Chapter ② Getting Started*.

④ Perform as many basic moves and functions as you can with the preliminary configuration. Try to simulate (with no load attached) the task(s) that you expect to perform when you permanently install your system.

⑤ After you have familiarized yourself with and/or tested the system's functions and features, carefully read *Chapter ③ Installation*.

⑥ Begin the installation process. Do not deviate from the sequence or installation methods provided.

⑦ Before you begin to customize your system, check the system functions and features to ensure that you have completed the installation process correctly.

Related Publication

For more information on motion control concepts and Compumotor's complete product line and product capabilities, refer to the current *Parker Compumotor Motion Control Catalog*

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CHAPTER ①

Introduction

The information in this chapter will enable you to:

- ❑ Understand the product's basic functions and features

Product Description

The Dynaserv is a high-torque, low-speed, highly accurate, outer-rotor type servo actuator that can be used in various applications related to factory automation, including industrial robots, rotary indexes, etc.

The Dynaserv system's primary function is to seek and maintain a position command from an indexer or a velocity or torque command from a servo controller. Digital electronics simplify the position loop and enable precise positioning. The analog velocity loop provides high stiffness and controllability.

DM & DR Series Motors

The Dynaserv's DD motors meet the needs of the advanced motion control environment. Two motor versions are available—DR and DM Series. The DR Series includes:

- ❑ A high-speed motor option (up to 4.0 rps)
- ❑ Brushless resolver feedback
- ❑ 9 models (50 to 500 Nm) of the A type with an outer diameter of 264 mm (10")
- ❑ 5 models (70 to 220 Nm) of the E type with an outer diameter of 205 mm (8")
- ❑ 8 models (8 to 60 Nm) of the B type with an outer diameter of 150 mm (6")
- ❑ 2 models (10 to 15 Nm) of the C type with an outer diameter of 106 mm (4")

The DM Series includes:

- ❑ Incremental encoder feedback
- ❑ 6 models (50 to 200 Nm) of the A type with an outer diameter of 264 mm (10")
- ❑ 5 models (15 to 75 Nm) of the B type with an outer diameter of 150 mm (6")

SR & SD Series Driver

Although the system is defined by the motor number, the drive will have its own part number on the serial tag. When using the DR series, the corresponding drive is the **SR** series and the DM series uses the **SD** drive series. Both drives are available as 115VAC or 230VAC. Some of the high-performance drives require 200VAC. Verify the drive type prior to set-up.

Product Features

- ❑ Brushless Direct Drive Motor
- ❑ Encoder Feedback - DM Series

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- ❑ Resolver Feedback - DR Series
- ❑ Compression loads up to 8900 lbs
- ❑ Overhung loads up to 296 ft-lbs
- ❑ Speeds: up to 2.0 rps (standard version), 4.0 rps (high-speed version)
- ❑ Torques to 370 ft-lbs
- ❑ Resolutions up to 1,024,000 steps/rev
- ❑ Analog Velocity Loop
- ❑ Digital Position Loop
- ❑ 10 KHz PWM Switching Frequency
- ❑ Accepts Digital Step and Direction for Position Control
- ❑ Accepts ±10V for Torque or Velocity Control
- ❑ Monitor output representing velocity or torque
- ❑ Quadrature encoder output to interface with servo controllers or digital counter
- ❑ Built-in Test mode to simplify tuning

Interface Options

The Dynaserv can be operated in Position, Velocity, or Torque mode. In *Position mode*, the Dynaserv is compatible with all Compumotor Indexers. In Position mode, the Dynaserv moves one motor increment for each pulse received over the **STEP** input. In *Velocity mode* or *Torque mode*, the Dynaserv accepts a ±10V analog signal representing a velocity or torque command. In torque mode ±8.5V represents the torque command. To make the Dynaserv fully compatible with a servo controller, you can use the encoder output signal to close the position loop to your servo controller.

Theory of Operation

Direct-drive systems couple the load of the system directly to the motor without gears or pulleys. Most servo motors do not have the torque or resolution required to satisfy many application needs. Therefore, mechanical methods, such as speed reducers, are implemented to meet system requirements. Speed reducers, however, have inherent problems. Friction introduces inacuracies and backlash in the gears limits positional accuracy. Gearing also ultimately limits the top speed of the system due to the large reduction. The Dynaserv system consists of three major components:

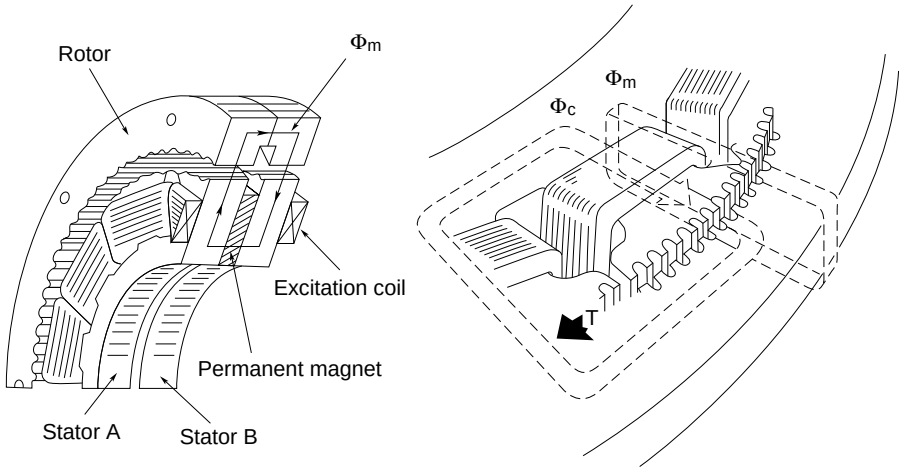
① Direct drive motor

② Drive

③ Feedback device

The direct-drive motor is the heart of the Dynaserv system. The motor provides very high torques in a modest package size. The figure on the following page shows that torque is proportional to the square of the sum of the magnetic flux, (Øm) of the permanent magnet and the magnetic flux, (Øc) of the stator windings. Two factors help the Dynaserv to generate high torque. First, since the radius of the motor is large, the tangential forces between rotor and stator work at a greater distance—producing additional torque. Second, many small rotor and stator teeth create many magnetic cycles per motor revolution. More flux contributing cycles create increased torque.

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The motor contains precision ball bearings, magnetic components, and integral feedback in a compact motor package. The motor is outer—rotor, providing direct motion of the outside housing and thus the load. The cross roller bearings allow the motor to take very large compressing loads.

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CHAPTER ②

Getting Started

The information in this chapter will enable you to:

- ❑ Verify that each component of your system has been delivered safely
- ❑ Become familiar with the system components and their interrelationships
- ❑ Ensure that each component functions properly by bench testing

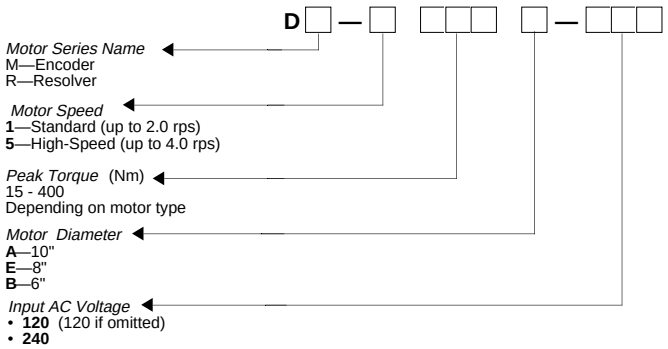
What You Should Have

Inspect your Dynaserv shipment upon receipt for any shipping damage. Report any damage to the shipping company. Compumotor cannot be held responsible for any damage incurred in shipping. You should have received the following items in the Dynaserv ship kit:

Part Number	Quantity	Remarks
Motor	1	Standard motor has10-ft. motor and feedback cables (except DR5000"A" 18-in)
Drive	1	Drive is matched to specific motor
Connector for CN1	1	MR-50LM Honda Tsushin Kogyo
Connector for CN2	1	MR-8LM (DR) Honda Tsushin Kogyo MR-16LM (DM) Honda Tsushin Kogyo
Fuse	2	6 x 32 mm, 15A
User Guide	1	DM & DR Direct Drive Servos Part # 88-013940-01
Optional Equipment		
71-011858-01	1	Dynaserv-Indexer Adapter—Step, Direction, and Shutdown only
71-012985-10	1	Dynaserv-Indexer—10ft cable, complete I/O Interface

Drive/Motor Configuration

Dynaserv systems are pre-configured and sold as motor/drives. A motor part number is included on the drive serial tag. The motor part number must match the drive's part number. The part numbers are based on the motor torque output and motor size. System nomenclature is as follows:



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Check-Out Procedure

This section provides a basic bench test of the Dynaserv drive. Compumotor recommends that you complete these steps before you install the system permanently.

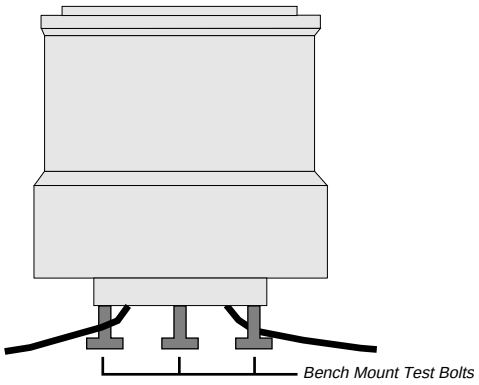
Bench Test

This bench test is designed to test the motor's basic functionality. During the bench test, only Test Mode motion is possible. For further motor operation, the motor should be permanently mounted. Refer to ***Chapter ③ Installation***. For the bench test, the following items are required:

- ❑ A 5VDC power supply with jumper leads
- ❑ An AC power cord
- ❑ Two (2) 2" jumper wires
- ❑ A Honda connector from ship kit

Step ①

Bench mount the Dynaserv motor. Three bolts can be used to elevate the motor for the bench test. When the motor is bench mounted, it may be operated upright to allow for proper cable routing without restricting the rotation of the outside motor housing.

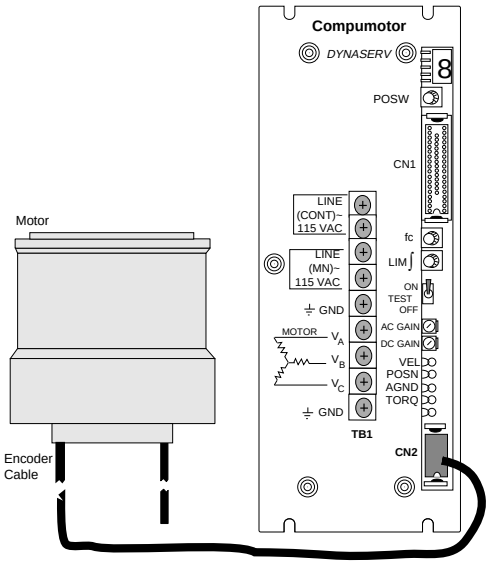


CAUTION

① ***Never operate the motor upside down with the rotor stationary. This will cause cable wind-up and possible sytem damage.***

② ***Never attach a load to the drive during the bench test procedure. This mounting configuration is for bench test only. For permanent installation, refer to Chapter ③ Installation.***

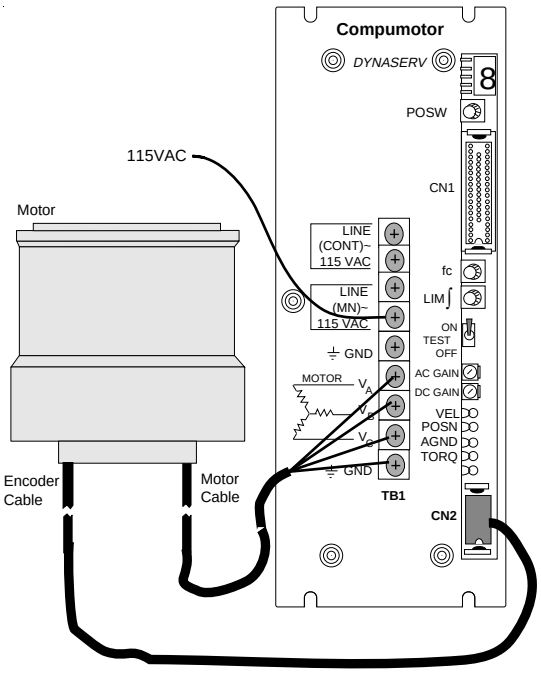
Step ②



Connect the feedback cable. On the DR Series, an *8-pin Honda connector is provided. A 16-pin Honda connector is used with the DM Series.* **These cables are pre-wired**.

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Step ③

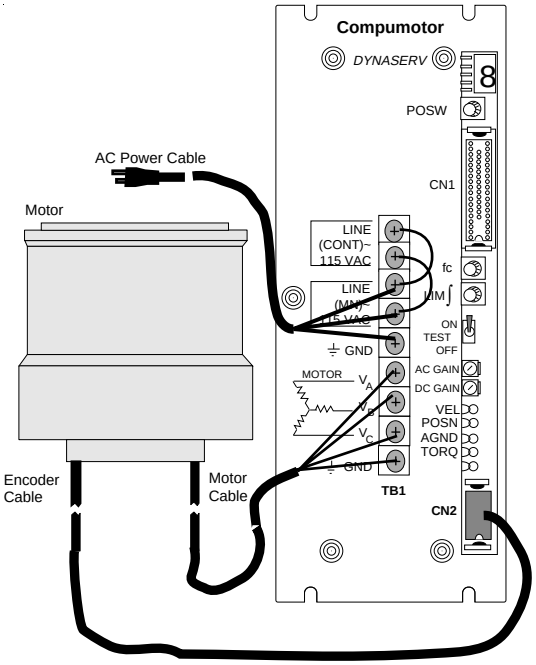


Connect the motor cable between the motor and drive. Match the correct phase as specified on the terminal leads (check color codes).

CAUTION

Never connect motor cables when power is connected to the drive—this may damage motor connector contacts.

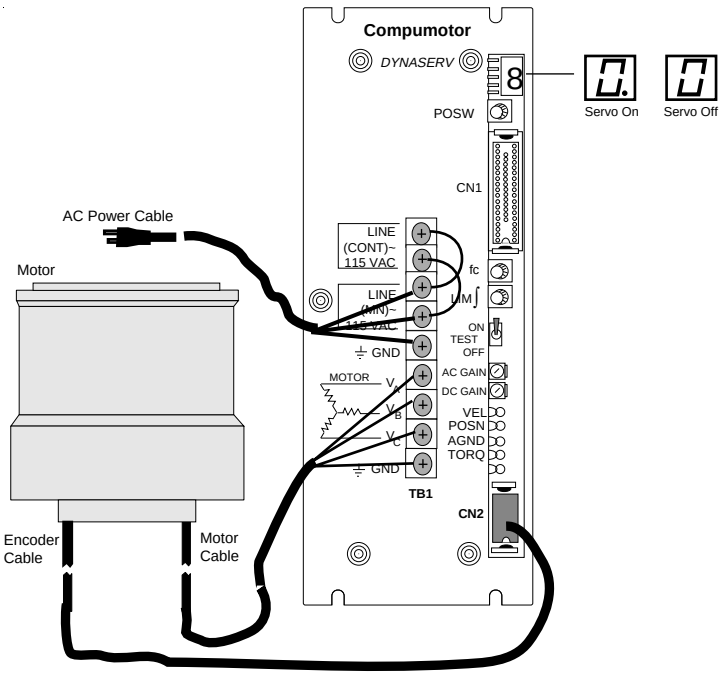
Step ④



Measure and verify incoming power. The Dynaserv has separate power inputs for the control and main power supplies. These inputs can be jumpered together. This configuration is valid for both 115VAC and 230VAC models. The 200VAC version requires three-phase power. Connect, ***but do not energize the power input***.

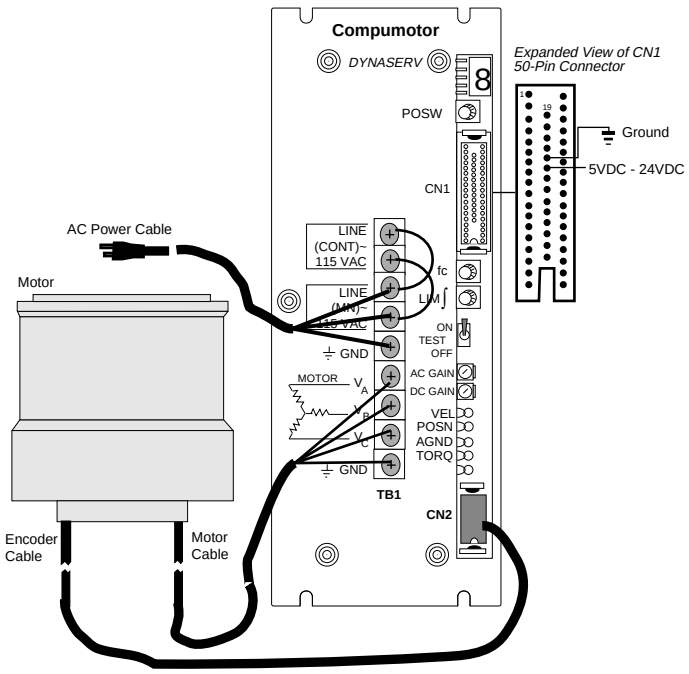
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Step ⑤



Check the cable connections and apply power to the drive. The drive is always energized in a ***servo off*** state. ***Servo on*** and ***servo off*** are indicated by the presence (on) or absence (off) of a lit decimal ***after*** the LED character.

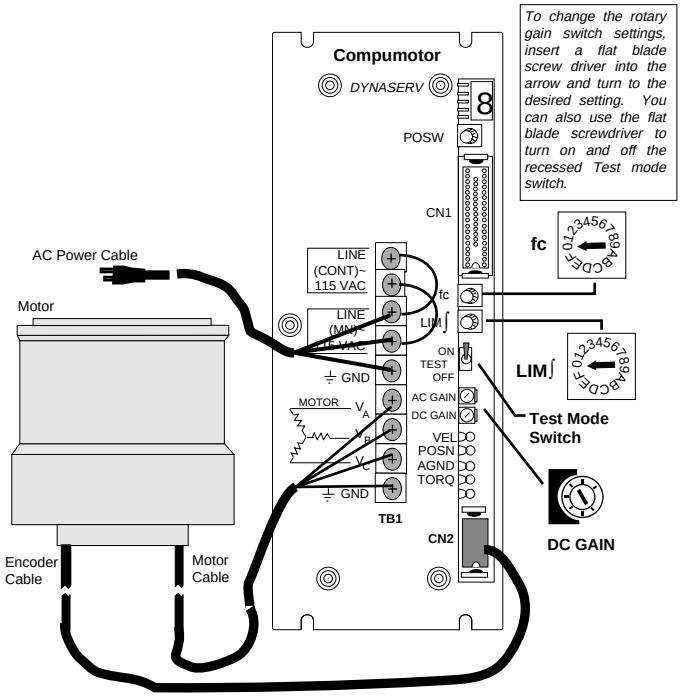
Step ⑥ A-



To enable the servo, apply 5V to pin 24 and GND pin 23 (**CN1** 50-pin connector). This activates the ***servo on*** state. Confirm that the display now reads **Ø.** If the display does not show **Ø.**, consult *Chapter ⑥ Maintenance & Troubleshooting*.

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Step ⑥ B



When the motor is enabled, current flows to the motor. When shipped from the factory, the system gains are set to minimum values, so it is normal for the motor to have little torque. Adjust the gain settings to the recommended values listed in the table.

Condition	fc	LIM*f*	DC Gain
Unloaded Motor	A	4	Mid-range

Step ⑥ C

To complete the bench test, turn on the Test mode switch (see previous figure). The switch is recessed in the drive. When you turn the switch on, the motor will rotate back and forth at a rate of 2.5 Hz. If the motor rotates as described, the motor is operational and you may proceed. *To stop the motor, turn the Test mode switch off.*

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CHAPTER ③

Installation

The information in this chapter will enable you to:

- ❑ Ensure that the complete system is installed correctly
- ❑ Mount all system components properly

Environmental Considerations

You must consider the environment in which your system will be operating. Proper mounting, wiring, and grounding will ensure trouble-free operation.

WARNING *The Dynaserv motor is not dust-proof, water-proof, or oil-proof and measures must be taken if the system will be operating in such environments.*

Compumotor recommends that you operate and store the Dynaserv in the following conditions:

- ❑ ***Storage Temperature*: -4°F to 185°F (-20°C to 85°C)**
- ❑ ***Operating Temperature*: 32°F to 122°F (0°C to 50°C)**

Complete System Configuration

Safety is the primary concern when installing any motion control system. This chapter provides guidelines that you should use to ensure the safety of the operator and equipment. Install all Compumotor hardware in conformity with local and national electrical and safety codes.

Once the system has been properly installed and adjustments are made, minimal adjustment should be required to maintain normal operation. Each Dynaserv motor/drive system is adjusted as a pair. ***Do not change the motor/driver combination*. Serial numbers on the motor and drive must match. Unpredictable motion can result with unmatched motors/drives causing personal injury or system damage.** Consult the Compumotor Applications Department before interchanging systems.

Drive Mounting

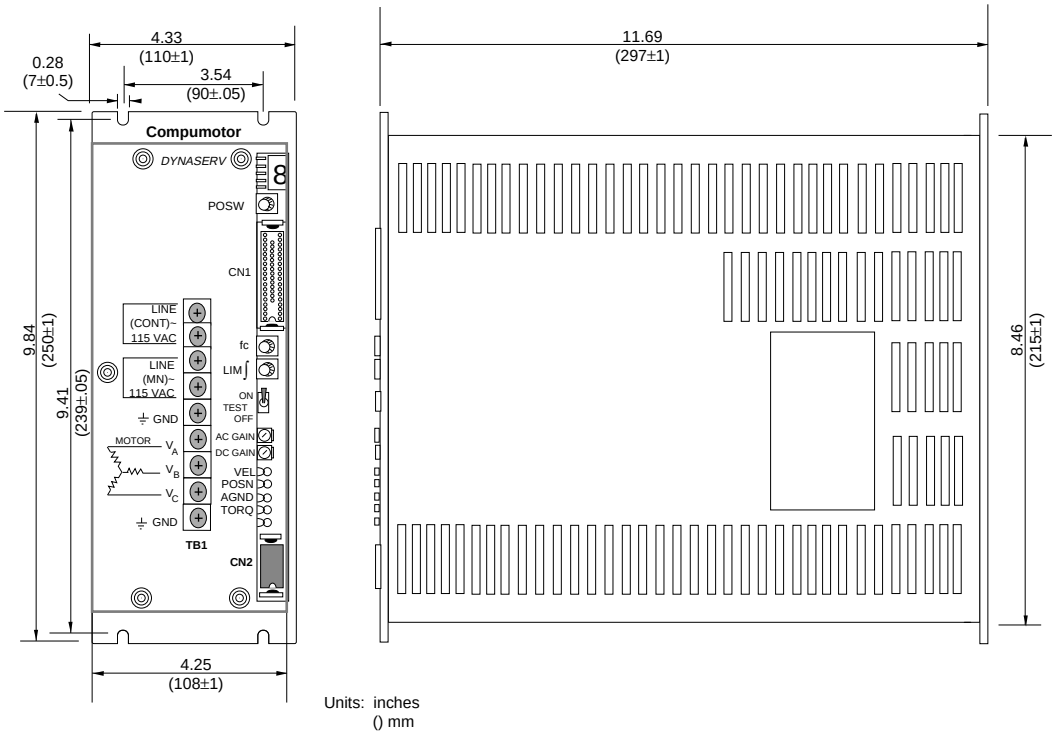
The Dynaserv should be installed in an enclosure that will protect it from atmospheric contaminants (oil, metal flakes, moisture, and dirt). The National Electrical Manufacturers Association (NEMA) has established standards that define the

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degree of protection that electrical enclosures provide. Industrial environments may contain airborne contaminants. The enclosure should conform to an enclosure *NEMA TYPE 12 standard* (minimum).

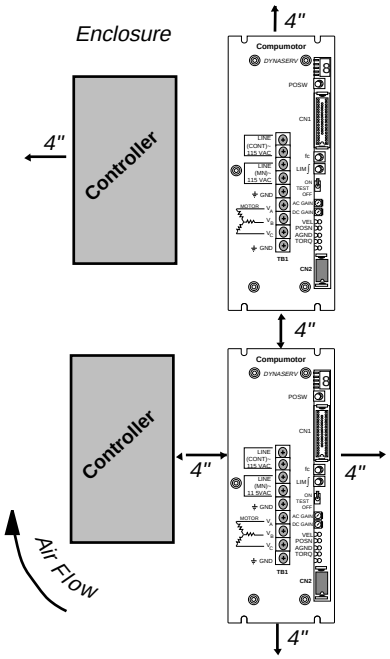
You can mount the Dynaserv drive in a panel or rack configuration. For ***panel mounting***, the Dynaserv has open-end slots for flat panel mounting. Refer to the figure below for dimensions and slot locations. You should use 10-32 or 1/4 x 20 screws into captured nuts to mount the Dynaserv in a panel mount configuration. Use locking type fasteners to prevent the drive from coming loose due to vibration. *When there is a vibration source near the drive, mount the drive to the panel with vibration insulators.*

The Dynaserv has open-end slots for ***rack mounting***. Refer to the figure below for dimensions and slot locations. To simplify rack mounting, the panel mount tabs at the rear of the Dynaserv are removable. Use 10-32 or 1/4 x 20 screws into captured nuts to mount the Dynaserv in a rack mount configuration. Use locking type fasteners to prevent the drive from coming loose due to vibration.



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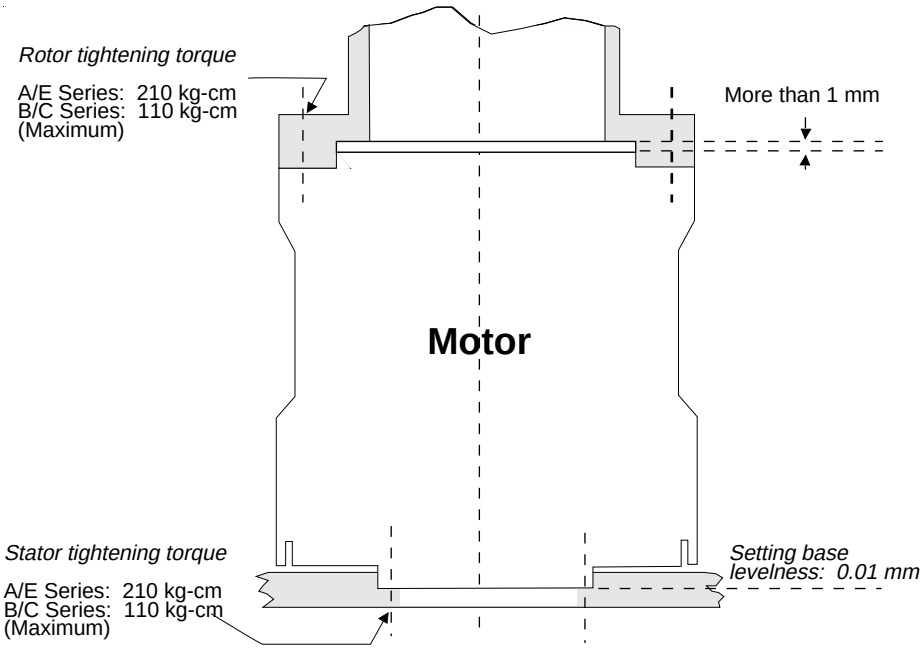
Panel Layout



Proper panel layout prevents equipment in the enclosure from overheating. Each drive must have an unrestricted air flow. The figure below shows the recommended panel layout configuration. *Mount the drive **vertically**. If it is mounted **horizontally**, heat will not be vented adequately and the drive will overheat.*

DR/DM Motor Mounting

The motor can be mounted vertically or horizontally. Incorrect mounting or an unsuitable mounting location may shorten the motor's life.



Mechanical Coupling

To couple a load with the motor rotor section, use the following guidelines.

- ❑ When coupling the load to the motor rotor, keep a clearance of more than 1 mm between the load and the motor's upper surface to maintain surface accuracy.
- ❑ Base levelness should be less than 0.01 mm.

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- When tightening the screws, always apply LOCKTITE 601 or its equivalent to these screws to lock them.

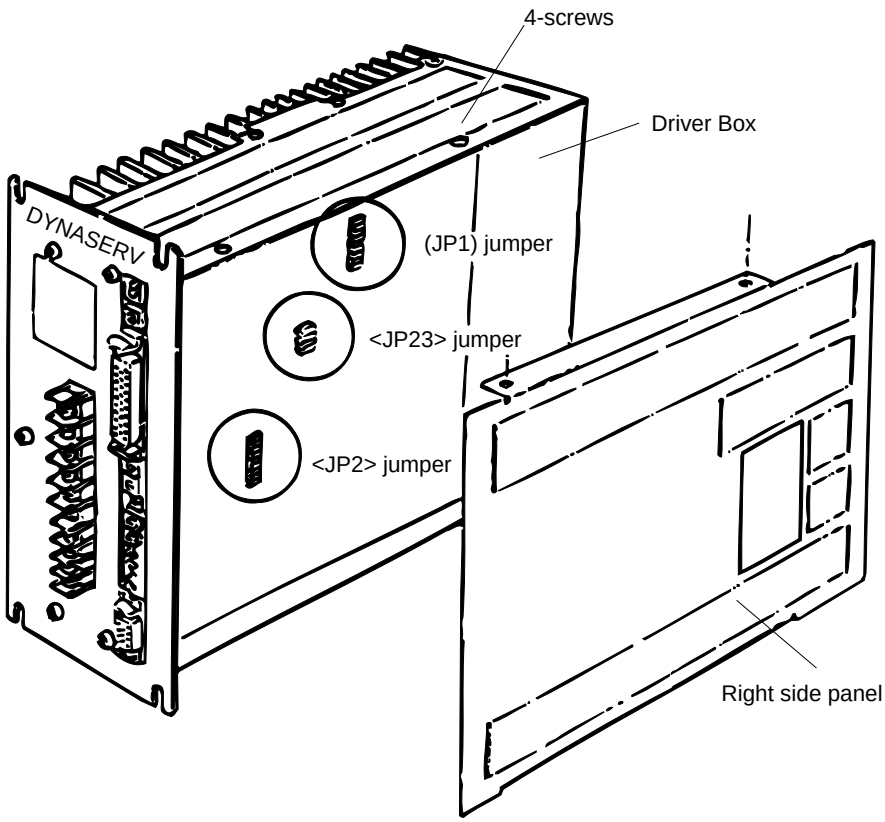
Operation Cautions

- The driver is adjusted with the matched motor. Do not change the motor/driver combination.
- This motor rotates at high speed and high torque. ***To prevent accidents, do not touch the rotating radius when operating with a load connected to the motor***.
- The motor is not dust-proof, water-proof, or oil-proof. Care must be taken to shield the motor from these contaminants.
- The magnetic resolver is built into the motor. Do not apply a strong force, shock, or magnetic field to the motor (***applicable to DR Motors only***).
- Since the motor surface is magnetically charged, do not put any magnetized objects or substances near the surface.
- Never disassemble or modify the motor or driver. If they need to be modified, contact Compumotor. ***Compumotor is not responsible for the products' operation after they have been disassembled or modified without our permission***.

Preparation for Operation

You may need to reset some jumpers, switches, and variable resistors within the driver box to meet your application's requirements. The jumpers, variable resistors, and switches are on a board inside the Dynaserv. The factory settings (*how they are set when you receive the Dynaserv*) are set as shown in subsequent figures and tables.

Prior to opening the drive, always turn power **OFF**. Remove the side plate of the driver box. *Never touch the high-voltage generation section, even with power turned **OFF**. Never touch switches and variable resistors other than those specified.*



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<JP1> Jumper

MODE	:See following table
CALIB	:See following table
RATE#1	:Position command pulse multiplying factor setting
RATE#2	:Position command pulse multiplying factor setting
UD/AB	:With jumper/A/B-phase, Without jumper/Up/Down pulse
VFFH	:Velocity feed forward amount setting (Note 1)
VFFM	:Velocity feed forward amount setting (Note 1)
VFFL	:Velocity feed forward amount setting (Note 1)
GAIN H	:DC gain magnification setting (Note 2)

<JP2> Jumper

I	:Velocity I type control
P	:Velocity P type control
100	:Velocity detection filter (Hz) selection (Open when a mechanical resonance filter is installed)
200	:Velocity detection filter (Hz) selection (Open when a mechanical resonance filter is installed)
PV	:Mode selection
VEL	:Velocity input
TORQ	:Torque input
TLIM	:Open for standard models

Indicates setting prior to shipment.

Note (1)

VFFH	VFFM	VFFL	Velocity feed forward amount (1%)
Shorted	Shorted	Shorted	100
Shorted	Shorted	Open	95
Shorted	Open	Shorted	90
Shorted	Open	Open	85
Open	Shorted	Shorted	80
Open	Shorted	Open	75
Open	Open	Shorted	70
Open	Open	Open	65

Note (2)

Type	Gain Magnification
With Jumper	DC Gain X13
Without Jumper	DC Gain X1

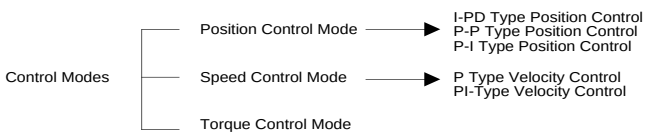
Switch, Volume Settings Done Prior to Shipment

The table below shows the default values of the rotary switches and variable resistors. For safety, they are set to their minimum values.

Switch Name/Volume	Setting Status
DC Gain	Minimum position
AC Gain	Minimum position
POSW	8
fc	0
I.LIM	0
TEST	OFF

Control Mode Jumper settings

The following 6 control modes are available for the Dynaserv DR/SR Series.



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The following table shows the validity or invalidity of the switches and variable resistors related to the control mode and the jumper pin settings for each control mode.

	Jumper Name	Position Control			Velocity Control		Torque Mode
Section	Switch Name	I-PD Mode	P-P Mode	P-I Mode	P Mode	PI Mode	Control Mode
JP1	MODE	Shorted	Shorted	Shorted	Open	Open	Open
	CALIB	Open	Open	Open	Open	Open	Open
	RATE #1	①	①	①	①	①	①
	RATE #2	①	①	①	①	①	①
	UD/AB	①	①	①	①	①	①
	VFFH	①	①	①	②	②	②
	VFFM	①	①	①	②	②	②
	VFFL	①	①	①	②	②	②
	GAIN H	①	①	①	①	①	②
JP2	I	Open	Open	Shorted	Open	Shorted	Open
	P	Shorted	Shorted	Open	Shorted	Open	Open
	100	①	①	①	①	①	①
	200	①	①	①	①	①	①
	PV	Shorted	Shorted	Shorted	Shorted	Shorted	Open
	VE;	Open	Open	Open	Shorted	Shorted	Open
	TPRQ	Open	Open	Open	Open	Open	Shorted
V1	DC GAIN	①	①	①	①	①	②
	AC GAIN	②	②	①	②	①	②
S1	POSW	①	①	①	②	②	②
S2	fc	①	①	①	②	②	②
	I.LIM	①	②	②	②	②	②
	TEST	①	①	①	①	①	②

① VALID: Affects motor performance

② INVALID: Does not affect motor performance

Velocity Signal Filter Setting/JP1

In addition to changing operating modes, you can use the **JP1** jumpers from the Control Board to select velocity signal filter cut-off frequency. The cut-off frequency is set to 100 Hz with 100 shorted, and it is set to 200 Hz with 200 shorted. For initial set-up, leave the jumper at the default 200 Hz. Leave three jumpers open, when using the low-pass filters and the notch filters. ***Chapter ⑥ Maintenance & Troubleshooting*** contains instructions on using the low-pass filter and the notch filter.

Feedback & Position Pulse Resolution Settings/JP1

The servo driver receives a signal from the feedback integral to the motor, then outputs an A/B phase or UP/DOWN pulse signal to a higher-level controller. Jumper pins related to the feedback pulse signal are **RATE#1**, **RATE#2**, and **UD/AB**. The position command pulse signal multiplication factor is determined by setting jumpers **RATE#1** and **RATE#2** on **JP1**. Adjusting these jumpers changes the position command pulse signal by 1 to 1/8 times (table below). However, changes in the multiplication factor also change the resolution. *When operating the Dynaserv with lower pulse frequency controllers, it may be necessary to reduce the resolution to realize full motor speed.*

Motor Type	Rate #1	*Rate #2*	*Multiplication Factor*	*Resolution*
DR-B	Shorted	Shorted	1	507,904
	Open	Shorted	1/2	253,952
	Shorted	Open	1/4	126,976
	Open	Open	1/8	63,488
DR-E	Shorted	Shorted	1	614,400
	❍	S	1/2	307,200
	S	❍	1/4	153,600
	❍	❍	1/8	76,800

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DR-A	Shorted	Shorted	1	819,200
	❍	S	1/2	409,600
	S	❍	1/4	204,800
	❍	❍	1/8	102,400
DR5000B	Shorted	Shorted	1	278,528
Series	❍	S	1/2	139,264
	S	❍	1/4	69,632
	❍	❍	1/8	34,814
DR5000A	Shorted	Shorted	1	425,984
Series	❍	S	1/2	212,992
	S	❍	1/4	106,496
	❍	❍	1/8	53,248
DR5000C	Shorted	Shorted	1	212,992
Series	❍	S	1/2	106,496
	S	❍	1/4	53,248
	❍	❍	1/8	26,624
DM-B	Shorted	Shorted	1	655,360
Series	❍	S	1/2	327,680
	S	❍	1/4	163,840
	❍	❍	1/8	81,920

UD/AB Jumpers

The **UD/AB** jumpers allow you to select the A/B and UP/DOWN phases. The *shorted jumper* activates the A/B phase. The *open jumper* activates the UP/DOWN phase.

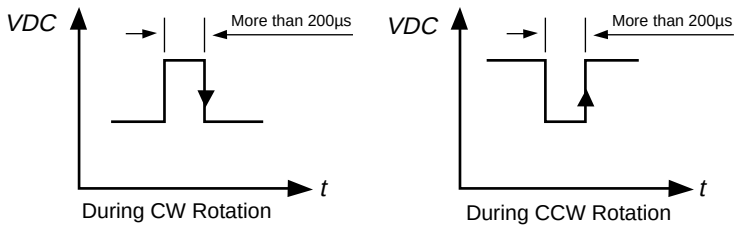
Velocity Loop Gain

The **AC GAIN** and **DC GAIN** rotary switches, allow you to adjust the servo parameters and are accessible from the front panel of the drive.

Origin (2-Channel) Pulse Output Signal Setting/JP23

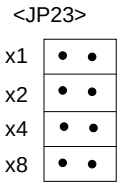
The point at which H changes to L (CW direction), or L changes to H (CCW direction), corresponds to the original position. (The CW and CCW directions are direction of movement when the motor is viewed from the load side.)

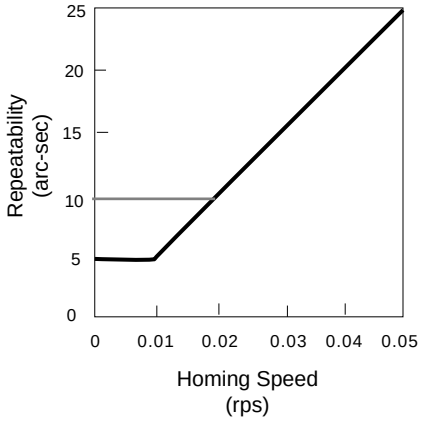
Origin (2-channel) repeatability depends on the homing speed (RPS). The following figure shows the characteristics. The number of origins per revolution can be selected by setting jumper <JP23>.



	A Type	B Type	E Type	A Type	B Type	C Type
x1 shorted with others open	200	124	150	104	68	52
x2 shorted with others open	400	248	300	208	136	104
x4 shorted with others open	800	496	600	416	272	208
x8 shorted with others open	1600	992	1200	832	544	416

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This function is only available in the DR series. In the DM series, the number of Z channels is not selectable. The number of Z channels is as follows:

- ❏ A Type: 100
- ❏ B Type: 60

Positioning Completion Width Setting/S1

When positioning in the Position Control mode is completed, the CN1 connector COIN signal is set to ON. This positioning completion width can be selected by the POSW switch on the front panel.

The following table shows the relationship between POSW switches with <POSW 0, 1> signal of the CN1 connector set to H and the positioning completion width.

At the same time, when setting the position completion width using <POSW 0,1> signal, set the POSW switch in 4 steps as shown in the following table. With a combination of H and L of the <POSW> signals, the same selection as the POSW switch can be obtained.

POSW Set Value	Position Completion Width (Unit: Pulse)*	POSW 1	POSW 0	POSW Switch
0	1	H	H	
1	5	H	L	0
2	20	L	H	
3	100	L	L	
4	2	H	H	
5	10	H	L	4
6	40	L	H	
7	200	L	L	
8	4	H	H	
9	20	H	L	8
A	80	L	H	
B	400	L	L	
C	8	H	H	
D	40	H	L	C
E	160	L	H	
F	800	L	L	

*:1 pulse =1/max. resolution

Notch Filter Board

Each Dynaserv comes with a Notch Filter Board to help combat mechanical resonance in the system. For more information on the Notch Filter Board refer to ***Chapter ⑥ Maintenance & Troubleshooting***.

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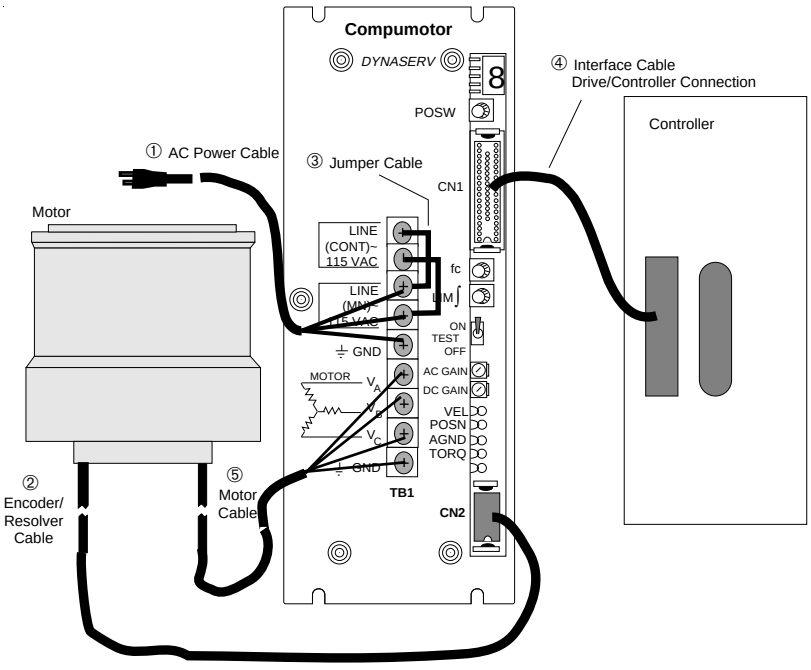
Wiring Cables

This table contains the Dynaserv cable sizes and their rated currents. The cables are cross-referenced in the subsequent figure.

			A Type	B Type	E Type
Input	① AC Power Cable	Current (A)	20	15	20
		Conductor Size	HIV*: More than 2.0 mm²cross sectional area (14AWG) Length: Within 30mm		
	② Feedback Cable	Current (A)	150mA DC•Maximum		
		Conductor Size	HIV*: More than 0.2 mm²cross sectional area (24AWG) Twisted pair collectively shielded wire length: within 30m		
	③ Jumper Cable	Current (A)	20	15	20
		Conductor Size	HIV*: More than 2.0 mm²cross sectional area (14AWG)		
Output	④ Interface Cable	Current (A)	100 mA DC•Maximum		
		Conductor Size	HIV*: More than 0.2 mm²cross sectional area (24AWG) Twisted pair collectively shielded wire length: within 30m		
	③ Jumper Cable	Current (A)	20	15	20
		Conductor Size	HIV*: More than 2.0 mm²cross sectional area (14AWG)		

** HIV: Special heat-insulation wire*

- Current values: rms of rated currents
- Outer sizes of **CN1** and **CN2** cables: Less than 14 mm or 9 mm, respectively
- Cable size is obtained under the condition that ambient temperature is 40°C and the rated current flows through three bundled leadwires
- HIV: Special heat-insulation wire—allowable conductor temperature of 75°C



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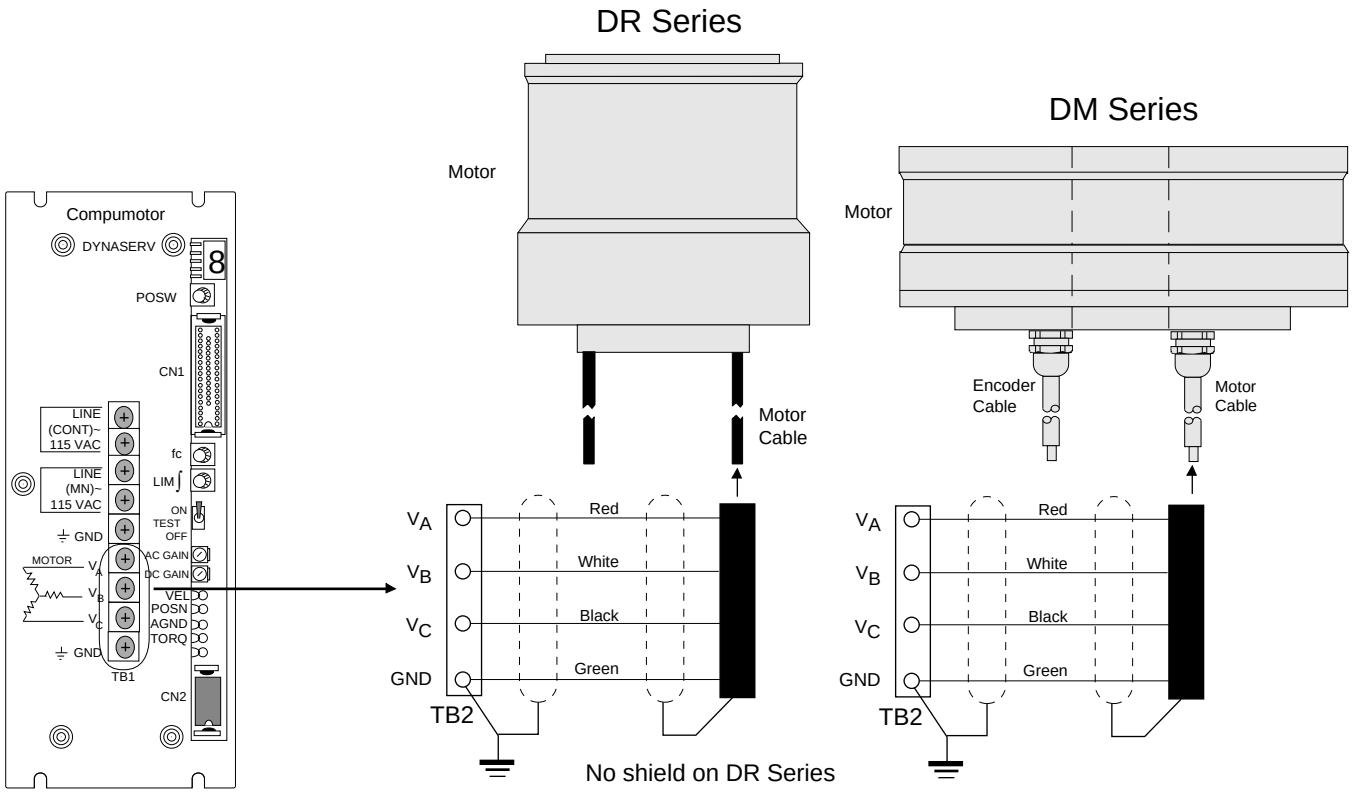
Wiring Cautions

- ❑ Use specified multi-core twisted pair cables with collective shielding for interface and feedback cables. Conduct shield end treatment correctly.
- ❑ Use thick conductors as grounding cables. Ground the Dynaserv through a resistance of less than 100Ω.
- ❑ Since high-voltage current flows through motor and AC power cables, make sure that their wirings are correct.

Motor/Drive Connection

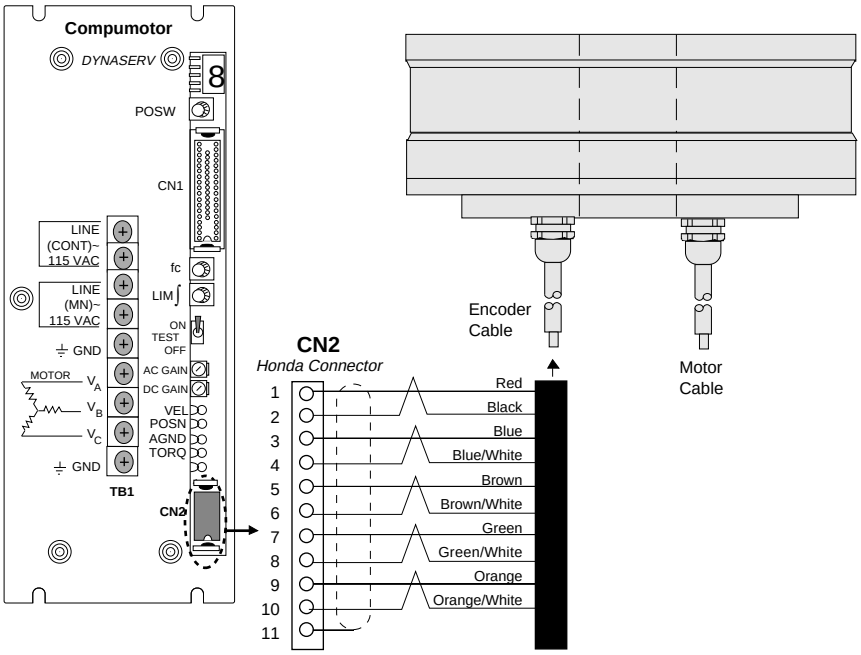
The motor and encoder cables provided with the Dynaserv are pre-wired. If you need to re-wire these cables, use the following color codes and function descriptions.

Motor Cable Codes (DM & DR Series)

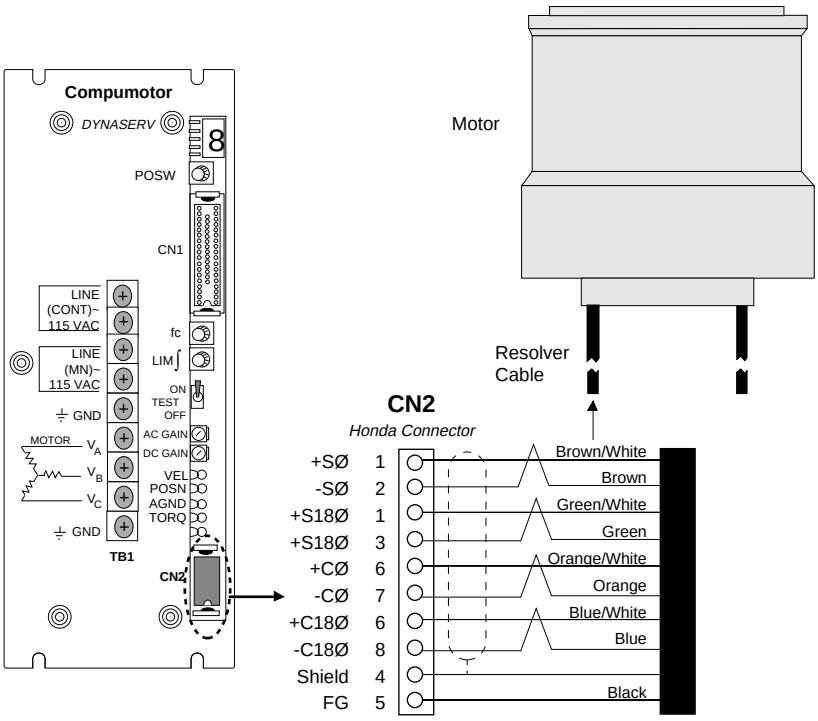


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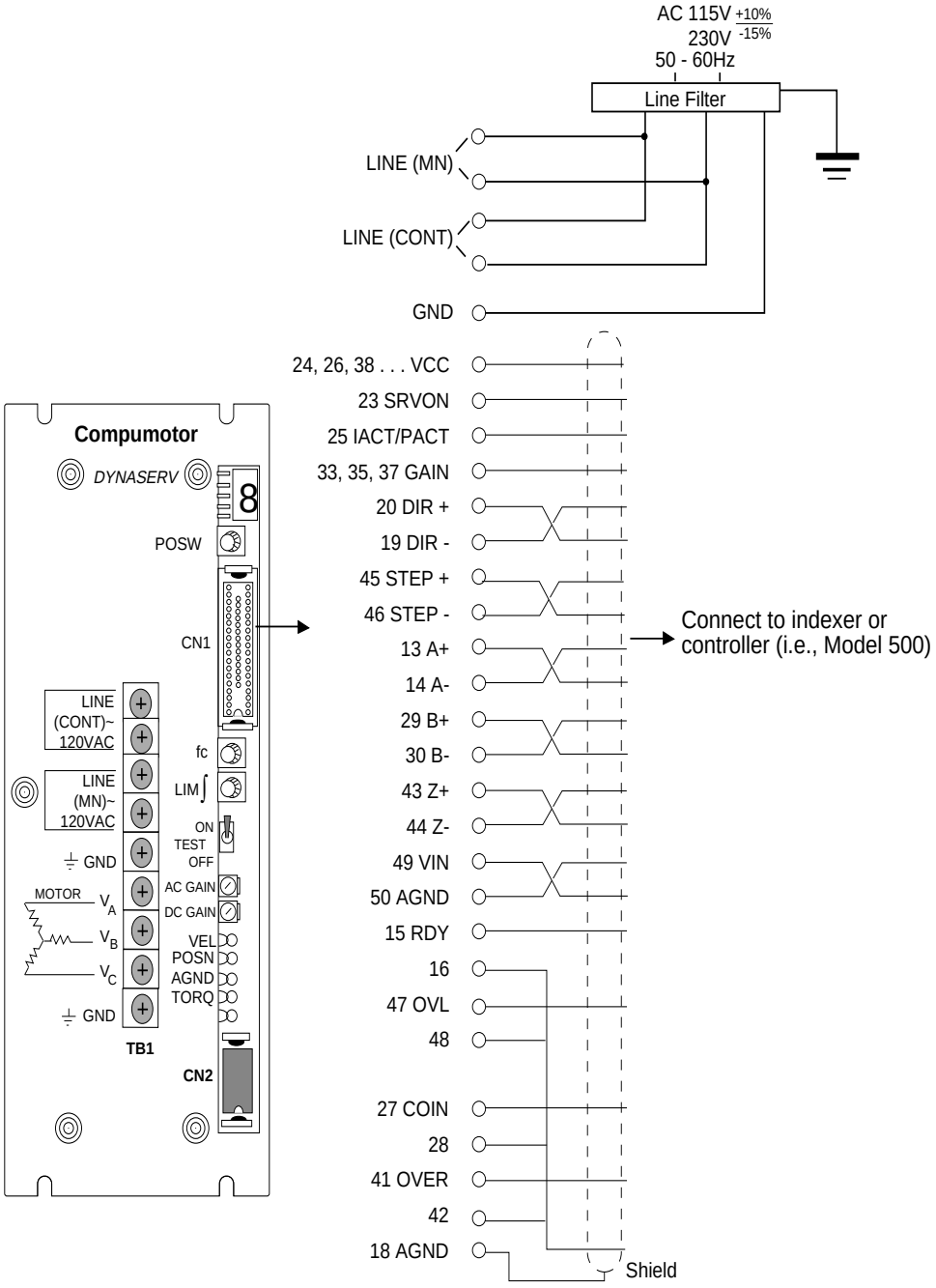
Encoder Cable Codes (DM Series)



Resolver Cable Codes (DR Series)

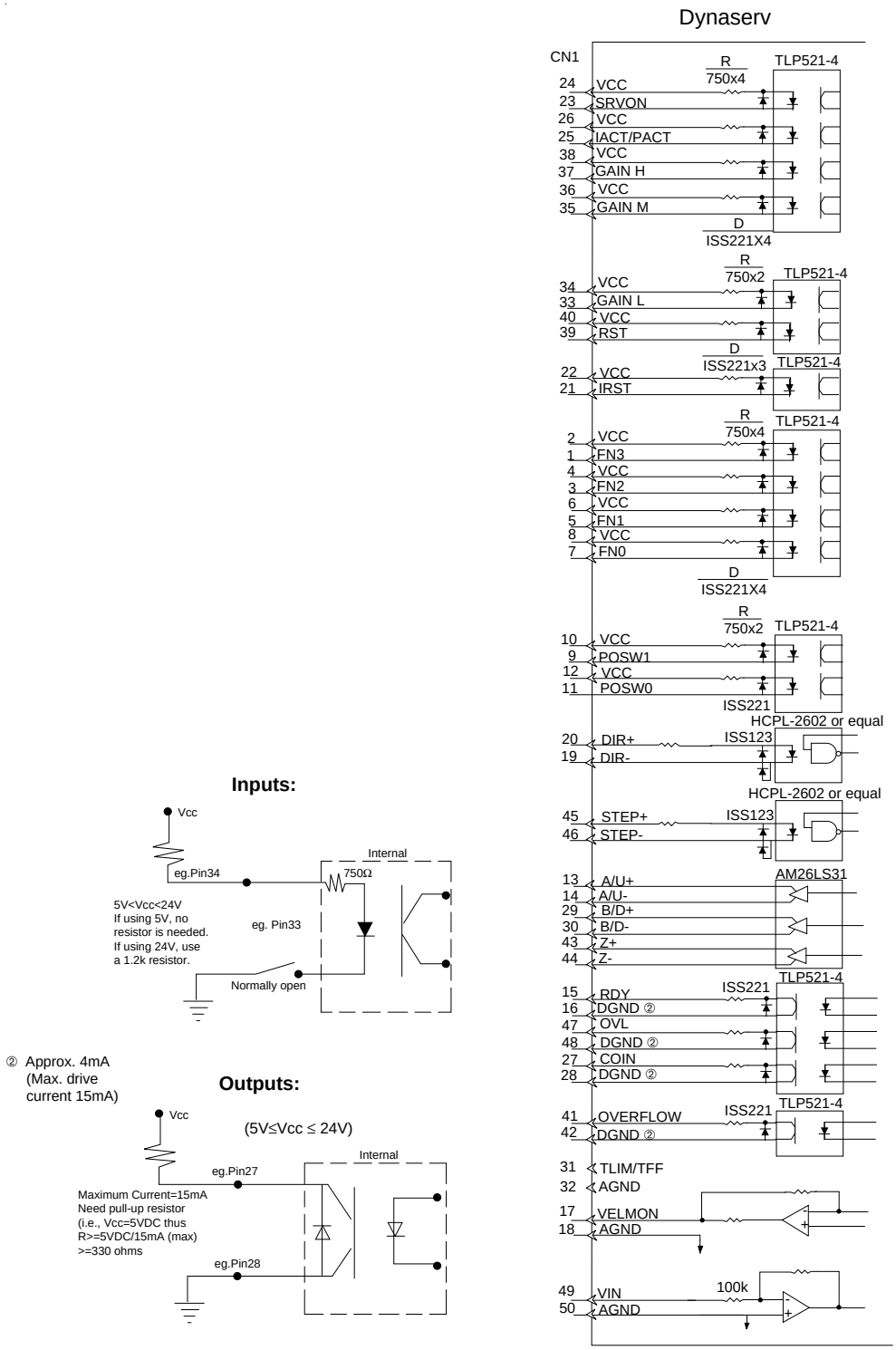


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Indexer/Drive Connection



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The following table describes CN1 inputs' functions and characteristics.

Signal Name	Pin No.*	Function	Description
FN3FN2FN1FNØ	1 (2)3 (4)5 (6)7 (8)	Compliance Setting	The signal for setting the fc switch on an interface is a 4-bit (Servo Stiffness Setting) positive logic binary number that can be set in 16 steps of fc = 1 to 16 Hz.
POSW 1POSW Ø	9 (10)11 (12)	Positioning Completion	This signal sets a deviation counting value to output Pulse-Width End positioning completion pulses. A four-step setting can be made in ranges of 1 to 100, 2 to 200, 4 to 400, or 8 to 800 together with POSW switch setting.
DIR+DIR-	2019	Rotating Direction Command	The motor rotates CW with this signal set to H and CCW with it set to L (When viewed from the load side, it is the same hereafter).
IRST	21 (22)	Integral Capacitor Reset	The integral capacitor in the velocity loop is shorted.
SRVON	23 (24)	Servo On	The motor is set to the servo ON status 0.2 seconds after this signal is set to L to set the driver to the command wait status.
IACT/PACT	25 (26)	Integral/Proportional Action Selection	Integral action is selected when this signal is set to H and proportional action selection is selected when this signal is set to L in Position Control mode.
GAIN H GAIN M GAIN L	37 (38)35 (36)33 (34)	Gain Selection	Signal to select the variable DC gain range. DC gain can be varied in the range of 0.5 to 110 times. Set by the variable resistor.
RST	39 (40)	CPU Reset	The driver control section is initialized when this signal is set to L for more than 50 seconds.
STEP+STEP-	45 46	Position Command Pulse	Driver position command pulse signal pulse
VIN	49	Velocity Command Input Torque Command Input	Use the following voltages to perform various functions. • Set to maximum number of revolutions input: +10V • CW: +10V • CCW: -10V • Torque command: ±8V
AGND	50	Analog Input GND	Velocity/Torque input analog GND

* ( ) Indicates Vcc signal power input.

FN Ø to 3 and POSW Ø to 1 are wired-ORed with the rotary switch on the interface card.

The following table describes the **CN1** outputs' functions and characteristics.

Signal Name	Pin No.*	Function	Description
A+/U+ A-/U- B+/D+ D-/D-30	13 14 29	Position Feedback Pulse Signal	Pulse signal to indicate the motor rotatin position. Either A/B or UP/DOWN phase pulse can be selected by the jumper on the board
RDY	(15) 16	Servo Ready	This signal is set to the H level about 3 seconds after driver power is ON
VELMON	(17) 18	Velocity Monitoring	Signal for monitoring the motor revolutions to output positive voltage for CW rotation and negative voltage for CCW rotation. Velocity detection sensitivity is not guaranteed for motor revolutions exceeding ±7.5V
COIN	(27) 28	Positioning Completion Signal	This signal is set to L when the deviation counter value is the POSW switch set-value.
OVERFLOW	(41) 42	Deviation Counter Overflow or Overspeed (Excess Position Error)	Deviation counter overflow signal is output only in Position Control mode. This signal is set to L when the deviation counter value is 32767. The overspeed signal is set to L when feedback pulse output frequency is 3 MHz. It is set to L if the number of motor revolutions exceeds ±7.5V in the Position Control or Velocity Control modes.
Z+ Z-	43	Origin Pulse	Signal for detecting the original positions obtained by equally dividing motor 1 revolution (200 for the A series, 150 for the E series, and 124 for the B series), and changes from H to L (CW) and from L to H (CCW).
OVL	47	Overload	Set to H during overload, it simultaneously reduces motor current automatically to 1/3.

* ( ) Indicates Vcc signal power output.

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Input and Output Signals

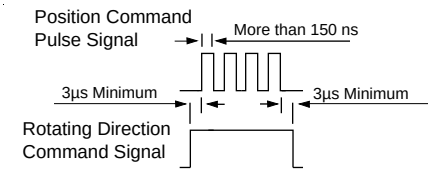
The step, direction, and velocity inputs and the velocity monitoring, and pulse output signals employ a different circuit design than the inputs and outputs previously defined.

Step Input Signal

The step input is a drive position command pulse signal. The pulse signal is in positive logic and its minimum pulse width is 150 ns.

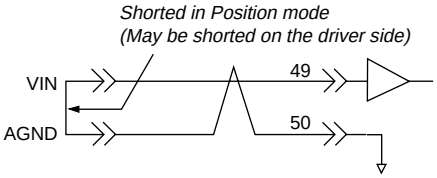
Direction Input Signal

This direction input signal sets the direction that the motor rotates. The motor rotates CW when this signal is set to **H** and CCW with it is set to **L**.



Velocity Command Input (VIN)

This analog input signal gives the motor rotating velocity command value. The maximum rated CW velocity is +10V. The maximum rated CCW velocity is -10V (in the ±10V input range, input impedance is 100 kΩ). This input is only valid in Torque mode or Velocity mode.

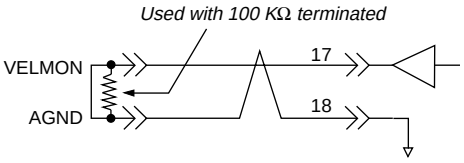


Velocity Monitoring Output (VELMON)

Motor analog velocity monitoring output voltage:

- ❑ At maximum velocity +5 V (CW)
- ❑ At maximum velocity -5 V (CCW)
- ❑ (Output impedance: 1 kΩ)

The analog velocity monitoring output circuit is shown below.



The table below describes Dynaserv's velocity detection capabilities.

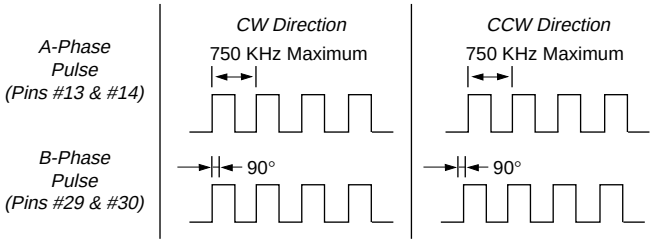
Model	Model Velocity Detection Sensitivity (V/rps)	# of Detection Limit Revs (rps)
DR1015B - DR1060B, DR1070E, DR1100E	5.0/2.0	3.0
DR1050A	5.0/1.5	2.3
DR1130E - DR1250E, DR1100A - DR1400A	5.0/1.5	1.5
DM-B	5.0/2.0	2.4
DM-A	5.0/1.0	1.2
DR5015C - DR5030B - DR5070B	5.0/4.0	5.0
DR5300A - DR5500A	5.0/2.0	3.0

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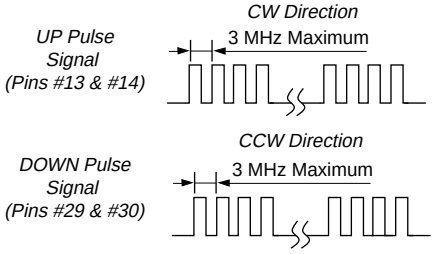
A/B Phase, UP/DOWN Pulse Output Signals (A/U, B/D)

Pulse signals indicate the motor's position. You can select the states of two pulse outputs with Control Board jumpers (see JP11H3).

- **A/B Phase Output Pulse**: The following pulse signal is output with the jumper UD/AB on the controller board shorted. This output is very similar to a standard incremental encoder.



- **UP/DOWN Phase Output Pulse**: The following pulse signal is output with the jumper UD/AB on the controller board opened. This output is appropriate for use with a simple counter.



Compliance Control Gain Setting

You can set fc or corner frequency with the front panel rotary switch or with input signals FNØ - FN3. The following table shows the corner frequency values and corresponding switch positions.

FN3	FN2	FN1	FNØ	fc Switch Position	fc (Hz)
H	H	H	H	Ø	1
H	H	H	L	1	2
H	H	L	H	2	3
H	H	L	L	3	4
H	L	H	H	4	5
H	L	H	L	5	6
H	L	L	H	6	7
H	L	L	L	7	8
L	H	H	H	8	9
L	H	H	L	9	1Ø
L	H	L	H	A	11
L	H	L	L	B	12
L	L	H	H	C	13
L	L	H	L	D	14
L	L	L	H	E	15
L	L	L	L	F	16

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DC Gain Scaling Setting

The following table shows **DC GAIN** scaling settings.

GH	GM	GL	Gain*
H	H	H	1
H	H	L	4
H	L	H	7
H	L	L	10
L	H	H	13
L	H	L	16
L	L	H	19
L	L	L	22

*The product of the gain scale factor and **DC GAIN** variable resistor setting is the total gain.

Power ON/OFF

Note the following conditions when power is ON.

① When turning ON the main and control circuit power supplies, turn them ON simultaneously or turn ON the control circuit power first.

② When turning them OFF, turn them OFF simultaneously (including after instantaneous power failure), or turn OFF the main circuit power first.

③ Rush current in both the main and control power circuits is about 25A (peak).

④ The motor is enabled (servo on) about 200 ms after SRVON is set to L.

⑤ When the main power circuit is active, RDY = H indicates driver trouble. Use a sequence circuit to turn OFF the main power circuit when RDY = H. However, after the control and main circuit power supplies are turned ON, the RDY = H condition is maintained for up to 3 seconds. Therefore, hold the power-ON signal for more than 3 seconds.

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CHAPTER ④

Control Mode & Adjustment

The information in this chapter will enable you to:

- ❑ Effectively use the operating modes and adjust the system to meet your application's needs
- ❑ Recognize and understand important considerations that must be addressed before you implement your application
- ❑ Understand the system's capabilities

Position Control Mode Adjustment

In the Position Control mode, motor positioning control is performed according to the command position sent from the higher-level controller. Two control methods are available in the Position Control mode: the I-PD type control system is selected with the CN1 connector IACT/PACT signal set to H, and the P type control system, with the same signal set to L. Usually, the I-PD type control system is selected in the Positioning mode.

I-PD Type Position Control

This method uses position integral feedback and is suitable for applications that require highy accurate positioning. A stable control characteristic is achieved even under load variation. In this mode, adjustments of **fc switch**, **LIM∫ switch** and **DC Gain** variable resistor are necessary.

fc Switch

The fc switch, which controls the *characteristic frequency*, is a 16-position rotary switch. The switch's values represent frequencies of 1-16Hz. The fc value can be set remotely with pins 1-8 on the CN1 connector (**FNØ - FN3**). When using the rotary switch,, **FNØ - FN3** must all be set to **H** (no connection). The value is a logical **AND** between the rotary switch and **FNØ - FN3**, ***Chapter ③ Installation*** *(Compliance Control Gain Setting* section), discusses the relationship between the switch and the inputs.

LIM Switch

This switch prevents the wind-up phenomenon by limiting the output of the digital integrator during software servo computation. The larger the switch number, the larger the limit value. The smaller the limited value, the smaller the wind-up and

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the shorter the setting time. However, if the limited value becomes too small, the motor output torque is limited. Therefore, it is better to make the switch value large within the no wind-up range. Wind-up is not always evident in Test mode, so final adjustment is performed during normal operation.

DC Gain Variable Resistor

The **DC Gain** variable resistor set the overall velocity loop gain. The **DC Gain** variable resistor is a single turn pot that carries a non-dimensional value of 0.5 to 5. **DC Gain** should be set as high as possible without the system vibrating, since this will result in the most responsive system. As a rule of thumb, the **DC Gain** needs to increase as the inertia is increased.

The combination of driver **CN1** connector signals **GAIN H** to **L** and the **DC Gain** variable resistor results in an adjustment range of from **0.5** to **110** times. When large inertias are present, it will be necessary to use the scale factors (**Gain H** to**L**) to access adequate **DC GAIN**. When there is an inertial change, adjust the gain so that it becomes optimum at the maximum load.

P Type Position Control

Positioning accuracy is not high because proportional control is used for positioning feedback. This position control can be set for P and I types. Refer to *Control mode, Jumper settings*.

With the P type position control (P-P type), a torque output which is proportional to the positioning error is obtained, and compliance control is possible. In this control mode, only fc switch and DC gain control are adjusted.

With the I type position control, a high tact positioning can be achieved. In this control mode, the amount of velocity feed-forward is adjusted with a jumper in addition to DC switch, DC gain control, and AC gain control.

Position Control System Adjustment Procedure

The position control system can be adjusted in the test mode. Turning ON the test switch at the front of the driver generates a 2.4Hz square-wave position command signal inside the driver to output the motor position to the POSN signal terminals. At this time, ensure that the motor exhibits reciprocal action at very small rotating angles.

The adjustment procedure for I-PD type position control in the test mode is as follows:

Step ① **Connect an oscilloscope to the POSN signal terminals**

Step ② **Set the CN1 connector SERVO signal to L. Set the TEST switch to OFF.**

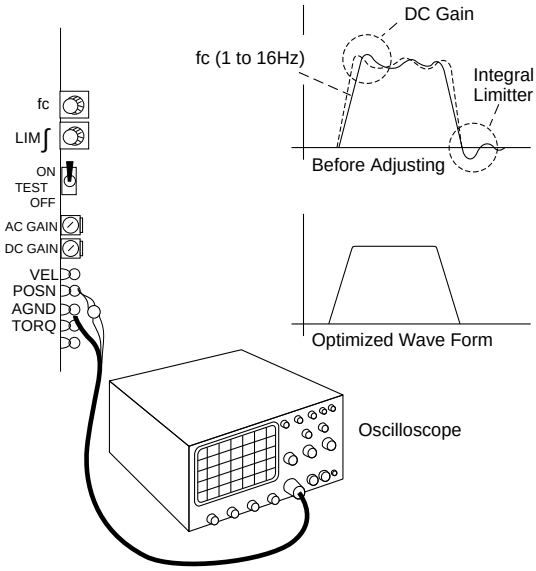
Step ③ **Set the TEST switch on the front of the driver to ON.**

Step ④ **Adjust the fc switch. Its variable range is from 1 to 16Hz and it should be set to about 10Hz scale graduation: 9) under normal load conditions. Set the I.LIM switch to a large value within the range where there is no hunting. Select the I.LIM switch GAIN H to L signal so they match the load condition. Fine adjustment is done using the DC gain adjustments so the POSN signal becomes a square wave.**

Step ⑤ **Set the TEST switch on the front of the driver to OFF.**

Step ⑥ **Set the CN1 connector SERVO signal to H.**

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The adjustment procedure for P-I type position control in the Test mode is as follows

Step ① **Connect an oscilloscope to the POSN signal terminals**

Step ② **Set the CN1 connector SERVO signal to L. Set the TEST switch to OFF.**

Step ③ **Set the TEST switch on the front of the driver to ON.**

Step ④ **Adjust the fc switch. Its variable range is from 1 to 16Hz and it should be set around the center position under normal load conditions.**

Set the AC gain control to a large value within the range in which there is no hunting.

Fine adjustment is done using the DC gain control.

Perform the above adjustments so the POSN signal becomes a square wave.

Step ⑤ **Set the TEST switch on the front of the driver to OFF.**

Step ⑥ **Set the CN1 connector SERVO signal to H.**

Procedure for Adjustment without Measuring Instruments

The preceding section demonstrates the procedure for performing adjustments while monitoring the waveform; this section demonstrates an adjustment procedure that does not use any measuring instruments. These adjustment methods are valid only in the case of the Position Control mode (P-ID type, factory default setting).

① Calculate or otherwise verify the load inertia. In order to make use of this adjustment method, the load inertia must be known accurately. At this time, calculate the load multiple (K) by dividing the load inertia (J_L: kg•m^2 units) by the motor (Dynaserv) rotor inertia (J_M).

② Set the TEST switch on the front panel to ON.

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③ Take the computed load multiple and refer to the following tables. For example, suppose the K is [15] for a DR1200A; the 5 range applies for this case.

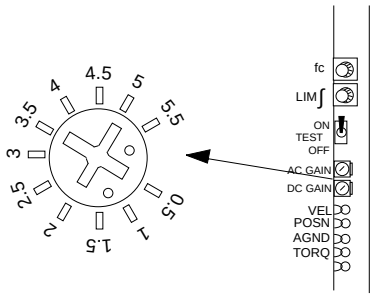
④ The value in DC gain (column 1) is 25, set the control to 25.

When the value for either A or B series is within range 1 or 2 (DC gain is 5 or less), change the DC gain switching signal to H before carrying out the setting.

⑤ Similarly, take the Column 1 values for fc and LIM∫ in the same row, and set their respective controls to those values.

⑥ When the above settings have been completed, set the TEST switch to [OFF] to complete the adjustments.

Note: The GAIN value for signal selection shown below is multiplied by the DC GAIN level value to obtain the total gain.



Setting The Dynaserv Controls

Approximate tuning parameters per inertia ratio (Load to rotor; K)

DR-A Series

	K			Set-Up Value		
Range	DR5500A	DR5400A	DR5300A	DC Gain	fc	LIM¶
1	No load	No Load	No Load	3	E	6
2	—0.4	—0.3	—0.1	4	D	6
3	0.4 —1.7	0.3—1.5	0.1—1.2	8	C	4
4	1.7—4	1.5—3.6	1.2—3.1	13	B	3
5	4—8.6	3.6—7.8	3.1—6.8	25	A	3
6	8.6—22	7.8—20	6.8—18	50	9	1
7	22—31	20—29	18—25	65	8	2
8	31—45	29—41	25—36	80	7	1
9	45—88	41—82	36—55	100	5	2
10	88—136	82—125	55—110	110	2	4

Range	DR1400A	DR1300A	DR1200A	DR1150A	DR1100A	DC Gain	fc	LIM¶
1	-1.2	-0.9	-0.5	-1.4	-0.1	3	E	5
2	1.2-2.3	0.9-1.9	0.5-1.3	0.4-1.2	0.1-0.6	4	D	3
3	2.3-5.6	1.9-4.8	1.3-3.6	1.2-3.3	0.6-2.3	8	C	2
4	5.6-11	4.8-9.7	3.6-7.5	3.3-6.9	2.3-5.1	13	B	2
5	11-22	9.7-19	7.5-15	6.9-14	5.1-11	25	A	2
6	22-55	19-49	15-38	14-36	11-27	50	9	2
7	55-77	49-68	38-54	36-50	27-38	65	8	2
8	77-110	68-97	54-77	50-72	38-55	80	7	2
9	110-166	97-146	77-116	72-108	55-82	100	5	3
10	166-331	146-292	116-232	108-215	82-165	110	2	6

Range	DR1050A	DC Gain	fc	LIM¶
1				
2				
3	-0.2	8	C	3
4	0.2-1.2	13	B	3
5	1.2-3.3	25	A	3
6	3.3-9.4	50	9	2
7	9.7-13	85	8	2
8	13-20	80	7	2
9	20-30	100	5	3
10	30-60	110	2	5

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DR-E Series

Range	DR1250E	DR1220E	DR1180E	DR1130E	DC Gain	fc	LIM¶
1	-1.4	-1.3	-1	-0.8	3	E	4
2	1.4-2.6	1.3-2.4	1-2	0.9-1.7	4	D	3
3	2.6-6.2	2.4-5.9	2-5	1.7-4.4	8	C	3
4	6.2-12	5.9-12	5-10	4.4-8.8	13	B	3
5	12-24	12-23	10-20	8.8-18	25	A	2
6	24-60	23-57	20-50	18-44	50	9	1
7	60-85	57-80	50-70	44-62	65	8	1
8	85-121	80-115	70-99	62-89	80	7	1
9	121-181	115-172	99-149	89-134	100	5	1
10	181-362	172-344	149-298	134-267	110	2	5

Range	DR1100E	DR1070E	DC Gain	fc	LIM¶
1					
2	-0.3		4	D	5
3	0.3-1.5	-1	8	C	5
4	1.5-3.6	1-2.6	13	B	4
5	3.6-7.8	2.6-5.9	25	A	3
6	7.8-20	5.9-16	50	9	3
7	20-29	16-22	65	8	3
8	29-41	22-32	80	7	2
9	41-62	32-49	100	5	2
10	62-125	49-98	110	2	5

DR-B Series

Range	DR5070B	DR5050B	DR5030B	DC Gain	fc	LIM¶
1						
2	No Load	No Load	No Load	4	D	6
3	—0.7	—0.5	—0.4	8	C	4
4	0.7—2.0	0.5—1.7	0.4—1.5	13	B	3
5	2.0—4.8	1.7—4.0	1.5—3.8	25	A	3
6	4.8—13	4.0—11	3.8—11	50	9	1
7	13—19	11—16	11—15	65	8	2
8	19—27	16—23	15—22	80	7	1
9	27—41	23—36	22—34	100	5	2
10	42—82	36—72	34—68	110	2	4

Range	DR1060B	DR1045B	DR1030B	DR1015B	DR1008B	DC Gain	fc	LIM¶
1	-1.1	-1	-0.1			3	E	6
2	1.1-2.2	1-2	0.4-1.2	-0.2		4	D	6
3	2.2-5.3	2-5	1.2-3.3	0.2-1.5	-0	8	C	4
4	5.3-11	5-10	3.3-7	1.5-3.5	1-2.8	13	B	3
5	11-21	10-20	7-14	3.5-7.7	2.8-6.1	25	A	3
6	21-53	20-50	14-36	7.7-20	6.1-16	50	9	1
7	53-74	50-70	36-50	20-28	16-23	65	8	2
8	74-105	70-100	50-72	28-41	23-33	80	7	1
9	105-158	100-150	72-108	41-61	33-50	100	5	2
10	158-315	150-300	108-217	61-123	50-102	100	2	45

DM-A Series

Range	DM1200A	DM1150A	DM1100A	DM1050A	DC Gain	fc	LIM¶
1	—1.1	—0.9	—0.5	No Load	3	E	6
2	1.1—2.2	1.9—1.8	0.5—1.2	—0.4	4	D	6
3	2.2—5.4	1.8—4.6	1.2—3.5	0.4—1.8	8	C	4
4	5.4—11	4.6—9.3	3.5—7.2	1.8—4.1	13	B	3
5	11—21	9.3—19	7.2—15	4.1—8.7	25	A	3
6	21—53	19—47	15—37	8.7—23	50	9	1
7	53—75	47—66	37—52	12—32	65	8	2
8	75—107	66—94	52—75	32—46	80	7	1
9	107—180	94—141	75—112	46—69	100	5	2
10	180—320	141—282	112—224	69—138	110	2	4

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Range	DM1075B	DM1060B	DM1045B	DM1030B	DM1015B	DC Gain	fc	LIM¶
1	-2.1	-1.9	-1.6	-1.2	-0.4	3	E	6
2	2.1-3.7	1.9-3.4	1.6-3.0	1.2-2.4	0.4-101	4	D	6
3	3.7-8.3	3.3-7.7	3.0-6.9	2.4-5.7	1.1-3.2	8	C	4
4	8.3-16	7.7-15	6.9-14	5.7-11	3.2-67	13	B	3
5	16-32	15-30	14-27	11-22	6.7-14	25	A	3
6	32-78	30-73	27-67	22-56	14-35	50	9	1
7	78-109	73-103	67-93	56-78	35-49	65	8	2
8	109-156	103-146	93-133	78-112	49-70	80	7	1
9	156-233	146-219	133-199	112-168	70-105	100	5	2
10	233-466	219-438	199-398	168-336	105-209	110	2	4

Velocity Control Mode Adjustment

In the Velocity Control mode, the motor rotating angle is controlled so it corresponds to the velocity command voltage (±10V) from the higher-level controller. The two control methods can be selected in the Velocity Control mode (PI type and P type).

The following table shows the relationship between velocity command voltage and motor velocity.

Model	Velocity/Input Voltage (rps/V)
DR1008A to 1060B, DR1070E, DR1100E	2/10
DR1050A	1.5/10
DR1130E to 1250E, DR1100A to 1400A	1/10
DR5030B to 5070B	1/1

PI Type Velocity Control

The use of integral/proportional action in velocity control achieves smooth, disturbance-resistant control. This is the same control mode used in the conventional DC/AC servo motor control. In this control mode, only the two DC GAIN and AC GAIN adjustment controls are adjusted.

a. DC GAIN

   The combination of the driver CN1 connector GAIN multiplier signals results in an adjustment range of from 0.5 to 120 times

b. AC GAIN

   Velocity loop band damping is adjusted.

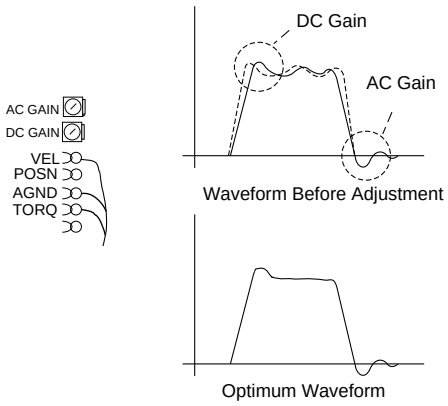
P Type Velocity Control

Since velocity control is effective only in proportional action, response is fast but is strongly influenced by disturbances in the controlled motor. In this Control mode, only the DC GAIN variable resistor at the front of the driver is adjusted. While in this velocity mode, the test switch becomes invalid.

Adjustment of Velocity Control System

Adjustment of velocity control system can be carried out in the Test mode. By turning the test switch on the front panel to ON, apply a 2.5Hz square waveform signal to the speed input in the driver, and the motor starts back and forth movements, repeatedly, at a small rotating angle. Under this condition observe the VEL Signal at the front panel on an oscilloscope, and adjust DC GAIN and AC GAIN so that VEL Signal becomes an optimum waveform as shown in the figure below.

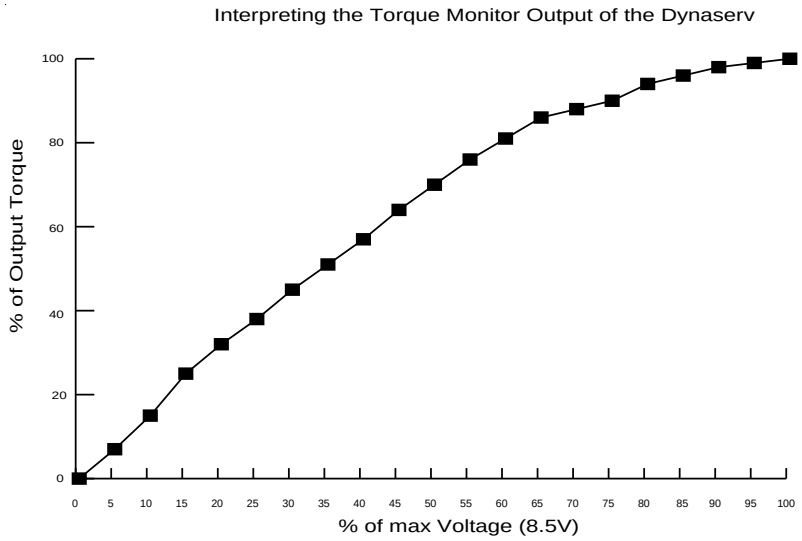
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Torque Control Mode Adjustment

In the torque control mode, current flows through the motor corresponding to the current command voltage (±8V) from the higher-level controller. Motor output torque depends on the current. Therefore, torque is 0 at 0V of command voltage, and the maximum torque is produced at 8.5V.

When using the torque control mode, carefully plan and design the velocity & position control loops and a proper interlocking system, will assure the final control system meets the exact specifications of the application.



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CHAPTER 5

Hardware Reference

The information in this chapter will enable you to:

- ❑ Find system specifications (dimensions and performance) quickly
- ❑ Find system settings (DIP switches) and configuration data (wiring) quickly

General Specifications

DR Series

Parameter	Value	
Performance		
Repeatability	±5 arc-sec (0.00139°)	
Accuracy	±30 arc-sec (0.0083°)DRA Series	
	±45 arc-sec (0.0125°) DRB, DRE Series	
Max stepping rate	1,600,000 steps/sec	
Power		
Volts	115VAC 1-phase, or 230 VAC 1-phase	
Range	+10% to -15%	
	50/60 Hz	
Current	20 amps max	
Inputs		
Command Interface		
Step input	Low going, low pulse, 150 nanoseconds minimum pulse width	
Direction	Logic high = CW rotation	
	Logic low = CCW rotation	
Analog input	±10V command signal	
Outputs		
Encoder output	A/B encoder output 750 kHz max	
Environmental		
	Driver	Motor
Weight	13.2 lb (6 kg)	See Table
Operating	32° to 122°F (0° to 50·°C)	32° to 113°F (0° to 45·°C)
Storage	-4° to 185° F (-20° to 85°C)	-4° to 185° F (-20° to 85°C)
Humidity	20 to 90% noncondensing	20 to 85% noncondensing

No corrosive gasses. Dust free atmosphere. The Dynaserv is not waterproof, oil proof, or dust proof.

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DR5000 Series

Parameter	Value	
Performance		
	DR5000 "A" (10")	**DR5000 "B" (6")**
Repeatability	±5 arc-sec (0.00139°)	±10 arc-sec
Accuracy	±45 arc-sec (0.0125°)	±90 arc-sec
Max stepping rate	1,600,000 steps/sec	1,400,000 steps/sec
Power		
Volts	200VAC 3-phase	230 VAC 1-phase
Range	+10% to -15%	+5 to - 15%
	50/60 Hz	50/60 Hz
Current	20 amps max	20 amps
Inputs (All Models)		
Command Interface	Step and direction—Position control ±10V DC—Velocity control	
Step input	low going pulse, 150 nanosecond minimum pulse width	
Direction	Logic high = CW rotation Logic low = CCW rotation	
Analog input	±10V DC max	
Other inputs (gain selection, servo on, etc.)	5 to 25 volts pullup	
Outputs (all Models)		
Encoder output	A, B Quadrature signal (400 KHz max) Z Channel—"A": 104 pulses/rev—"B": 68 pulses/rev	
Other outputs (in position, alarm, etc.)	TTL	
Environmental		
	Driver	Motor
Weight	24 lb (11 kg)	See Table
Operating	32° to 122°F (0° to 50·°C)	32° to 113°F (0° to 45·°C)
Storage	-4° to 185° F (-20° to 85°C)	-4° to 185° F (-20° to 85°C)
Humidity	20 to 90% noncondensing	20 to 85% noncondensing
No corrosive gasses. Dust free atmosphere. The Dynaserv is not waterproof, oil proof, or dust proof.		

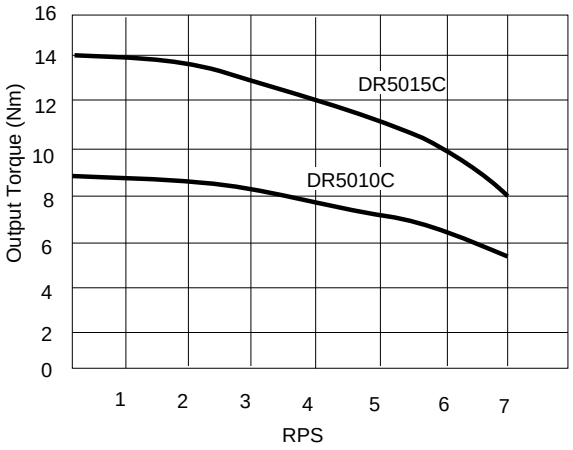
DM Series

Parameter	Value	
Performance		
Repeatability	±2 arc-sec (0.00056°)	
Accuracy	±25 arc-sec (0.0069°)	
Max stepping rate	1,600,000 steps/sec	
Power		
Volts	115VAC 1-phase, or 230 VAC 1-phase	
Range	+10% to -15%	
	50/60 Hz	
Current	20 amps max	
Inputs		
Command Interface		
Step input	Low going, low pulse, 150 nanoseconds minimum pulse width	
Direction	Logic high = CW rotation Logic low = CCW rotation	
Analog input	±10V command signal	
Outputs		
Encoder output	A/B encoder output 393 kHz max	
Environmental		
	Driver	Motor
Weight	13.2 lb (6 kg)	See Table
Operating	32° to 122°F (0° to 50·°C)	32° to 113°F (0° to 45·°C)
Storage	-4° to 185° F (-20° to 85°C)	-4° to 185° F (-20° to 85°C)
Humidity	20 to 90% noncondensing	20 to 85% noncondensing
No corrosive gasses. Dust free atmosphere. The Dynaserv is not waterproof, oil proof, or dust proof.		

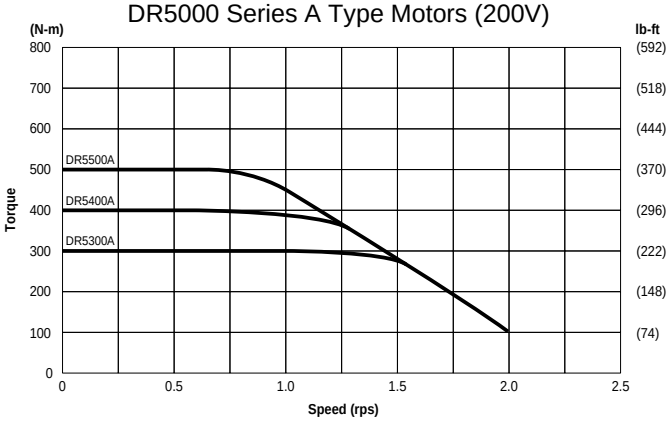
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DR5000 Motor Performance

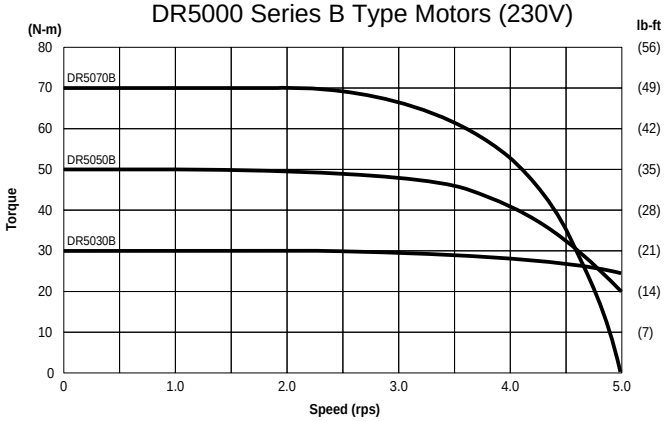
The torque/speed curves represent the available peak torque. Continuous torques are approximately 2/3 of the peak value.



DR5000 Series A Type Motors (200V)

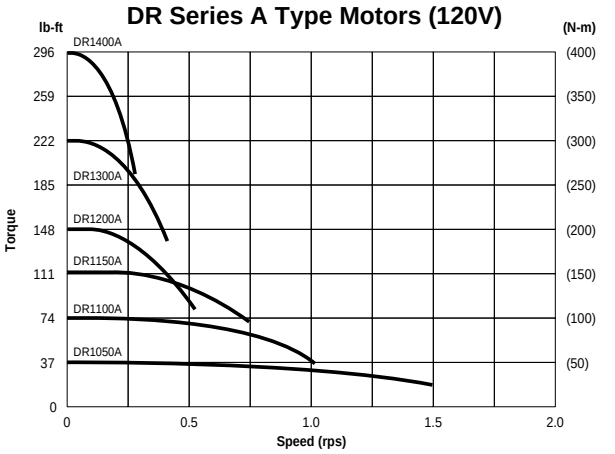


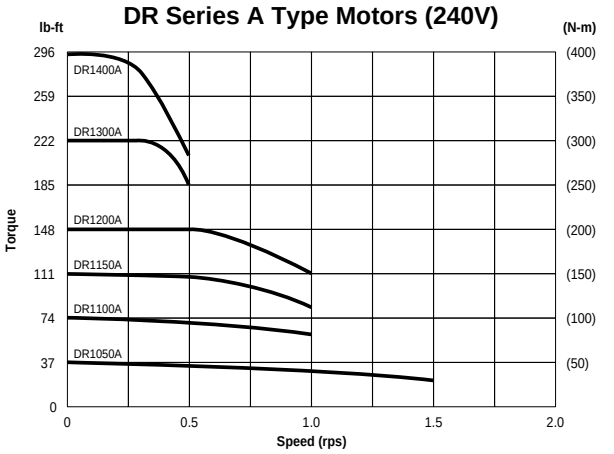
DR5000 Series B Type Motors (230V)

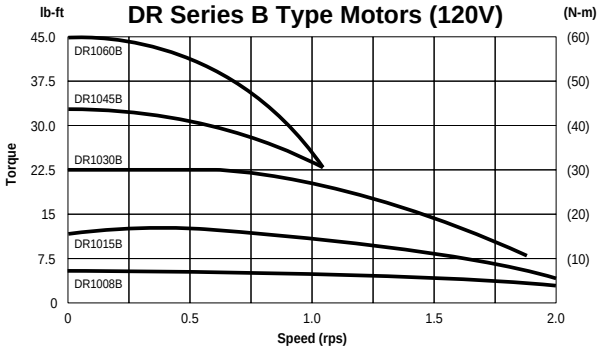


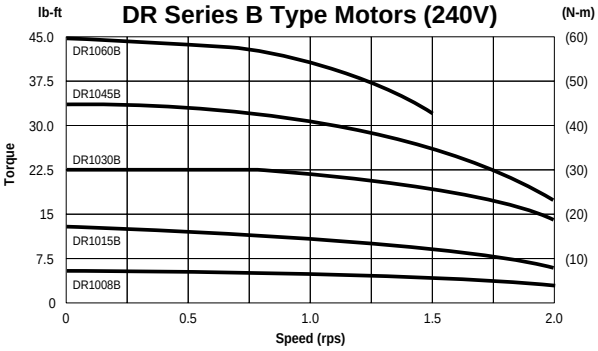
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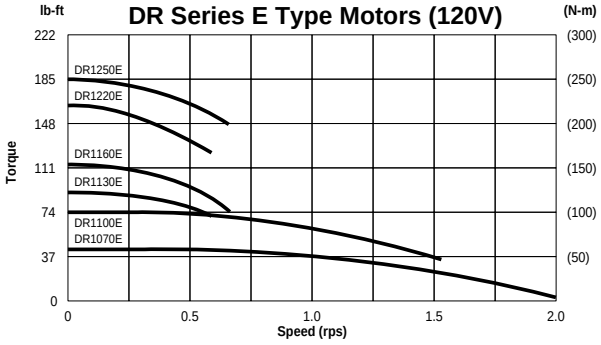
DR Motor Performance

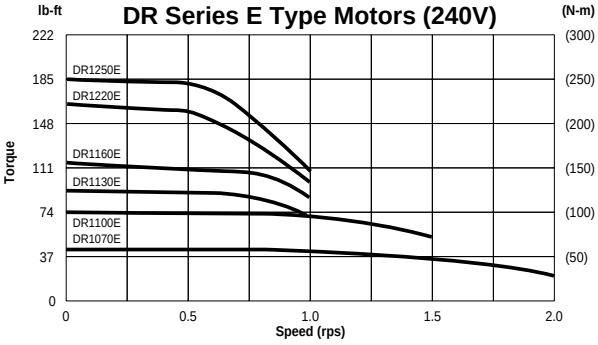












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DR Series—Motor Data

		Model 1008B	Model 1015B	Model 1030B	Model 1045B	Model 1060B	Model 1070E	Model 1100E	Model 1130E	Model 1160E
Peak torque	ft-lbs	6	11	22	33	44	52	74	96	118
	(Nm)	(8)	(15)	(30)	(45)	(60)	(70)	(100)	(130)	(160)
Rated speed 115/230VAC	rps	2.0/2.0	2.0/2.0	1.5/2.0	1.0/2.0	1.0/1.5	1.5/2.0	1.0/1.5	0.5/1.0	0.5/1.0
Maximum power 115/230VAC consumption	KVA	0.4/0.8	0.6/1.2	1.0/2.0	1.0/2.0	1.0/2.0	1.2/2.4	1.3/2.6	1.4/2.8	1.6/3.2
Rotor inertia										
	oz-in^{2}x10^2	7.9	11	13	14	18	46	55	68	77
	(kgm^{2}x10^{-3})	(15)	(21)	(24)	(26)	(33)	(85)	(100)	(125)	(140)
Max resolution		507,904	507,904	507,904	507,904	507,904	614,400	614,400	614,400	614,400
Motor weight*	lbs	13	20	24	29	35	49	57	70	79
	(kg)	(6)	(9)	(11)	(13)	(16)	(22)	(26)	(32)	(36)
Maximum axial load**										
Compression	lbs	6,744	6,744	6,744	6,744	6,744	8,992	8,992	8,992	8,992
Tension	lbs	2,248	2,248	2,248	2,248	2,248	4,496	4,496	4,496	4,496
Maximum overhung load **	ft-lb	148	148	148	148	148	295	295	295	295

*Drive weight is 13.2 lbs (6 kgs)

** For alternating loads, multiply these values by 0.3

		Model 1100A	Model 1200A	Model 1300A	Model 1400A	Model 5015C	Model 5030B	Model 5070B	Model 5300A	Model 5500A
Peak torque	ft-lbs	74	148	221	295	10.3	22	51	221	370
	(Nm)	(500)	(100)	(300)	(400)	(14)	(14)	(70)	(300)	(500)
Rated speed	rps	1.0/1.0	0.5/1.0	0.25/0.5	0.25/0.5	4	4	4	1.5	1.5
Rotor inertia	oz-in^{2}x10^2	109	156	186	219	4.38	14.2	19.7	186.0	251.6
	(kgm^{2}x10^{-3})	(200)	(285)	(340)	(400)	(8)	(8)	(36)	(340)	(460)
Resolution	Steps/rev	819,200	819,200	819,200	819,200	212,992	278,528	278,528	425,984	425,984
Motor weight*	lbs	68	101	125	15	15.4	28.9	38.9	122.2	166.7
	(kg)	(31)	(46)	(57)	(68)	(7)	(7)	(17.5)	(55)	(75)
Maximum axial load**										
Compression	lbs	8,992	8,992	8,992	8,992	1,100	6,600	6,600	8,800	8,800
Tension	lbs	4,496	4,496	4,496	4,496	660	2,200	2,200	4,400	4,400
Maximum overhung load**	ft-lb	295	295	295	295	15	148	148	296	296
Maximum power consumption	KVA	1.4/2.9	1.7/3.5	1.8/3.7	1.8/3.7	—	3.6	3.6	5.5	7.5

*Drive weight is 24lbs (11kgs)

**For alternating loads, multiply these values by 0.3

*Drive weight is 13.2 lbs (6 kgs)

** For alternating loads, multiply these values by 0.3

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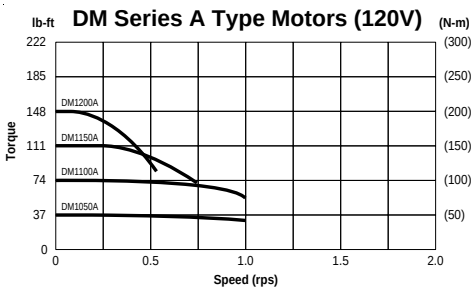
DM Series Motor Performance

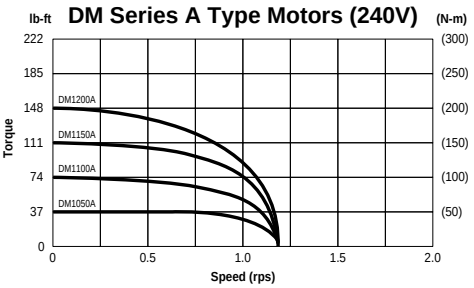
		Model 1015B	Model 1030B	Model 1045B	Model 1050A	Model 1100A	Model 1150A	Model 1200A
Peak torque	ft-lbs	11	22	33	37	74	111	148
(Nm)	(8)	(15)	(30)	(45)	(50)	(100)	(150)	(200)
Rated speed	115VAC	2.0	2.0	1.0	1.0	1.0	0.5	0.5
rps	230VAC	2.0	2.0	2.0	1.0	1.0	1.0	1.0
Power Consumption load								
Max 115/230VAC	KVA	0.9/1.8	1.2/2.3	1.2/2.3	1.4/2.8	1.6/3.1	1.7/3.5	1.7/3.5
Rotor inertia	oz-in^{2}x10^2	6.6	8.2	10.4	52.5	65.1	77.6	91.3
	(kgm^{2}x10^{-3})	(12)	(15)	(19)	(96)	(119)	(142)	(167)
Max resolution	lbs	655,360	655,360	655,360	1,024,000	1,024,000	1,024,000	
Motor weight*	lbs	12	17	21	32	42	53	64
	(kg)	(5.5)	(7.5)	(9.5)	(14.5)	(19)	(24)	(29)
Maximum axial load**								
Compression	lbs	6,600	6,600	6,600	8,800	8,800	8,800	8,800
Tension	lbs	2,200	2,200	2,200	4,400	4,400	4,400	4,400
Maximum overhung load**	ft-lb	148	148	148	296	296	296	296

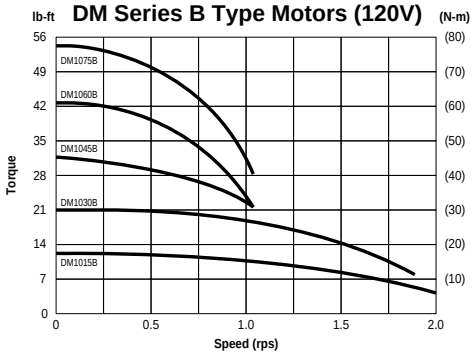
*Drive weight is 13.2

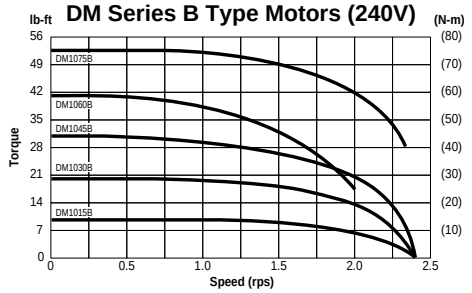
**For alternating loads, multiply these values by 0.3

DM Series Motor Performance







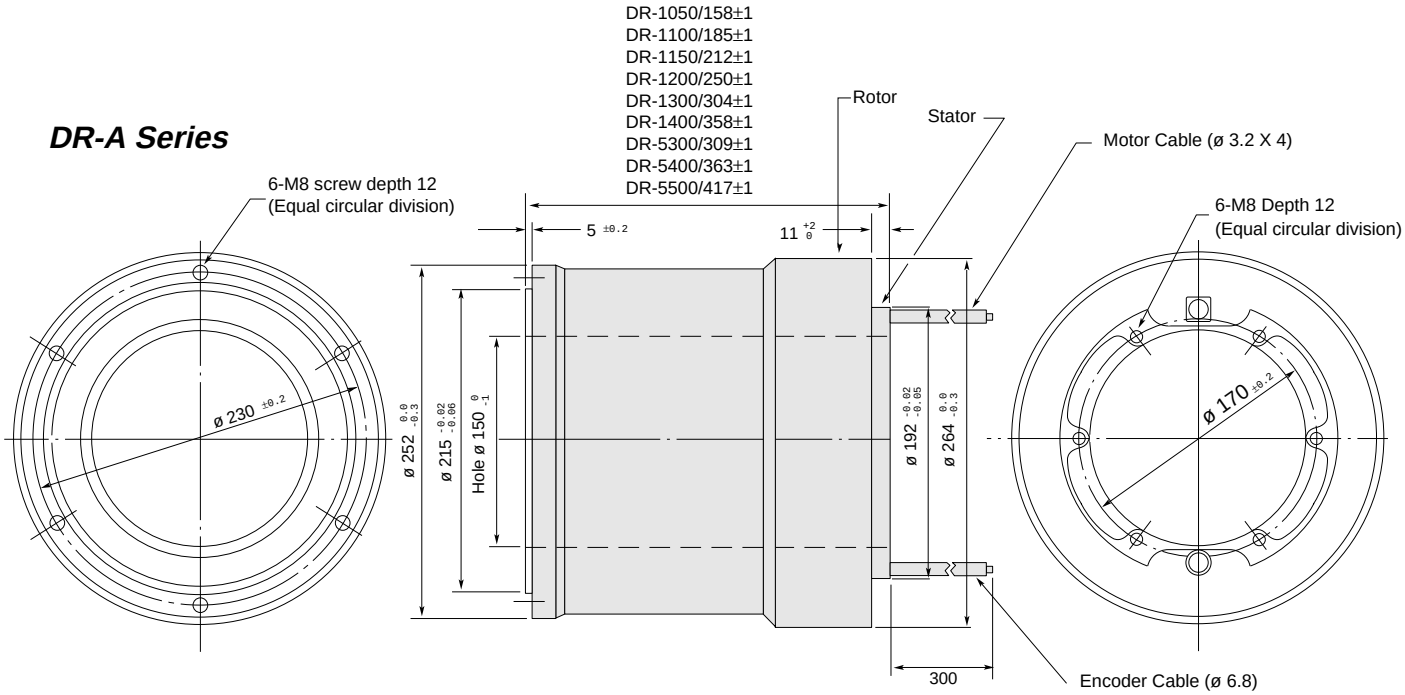


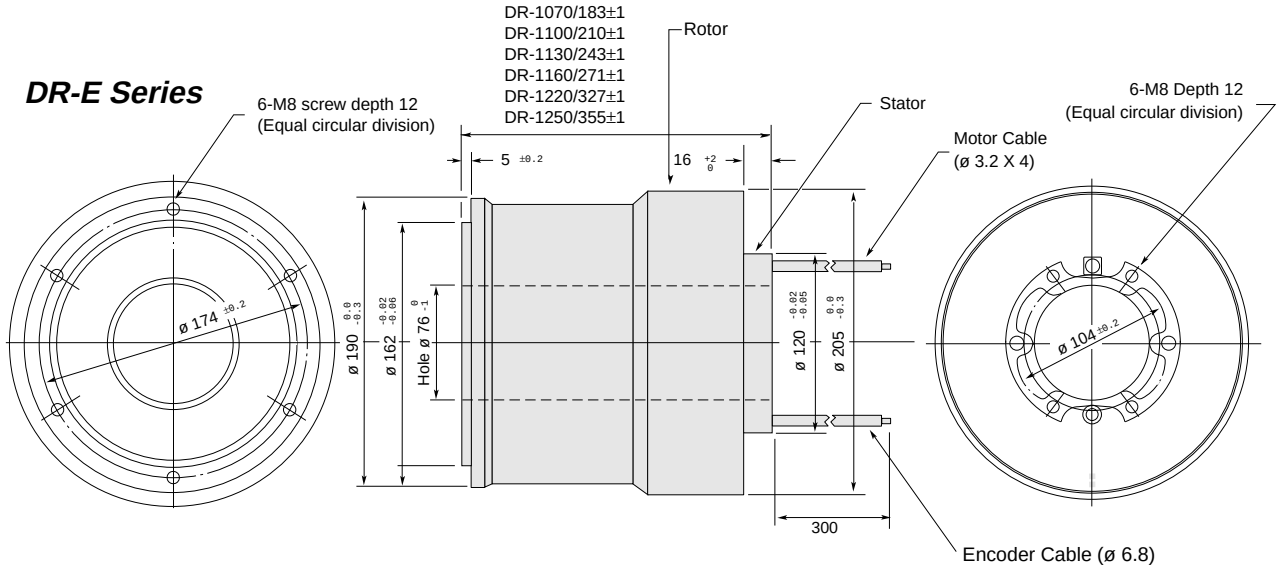
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Dimensional Specifications

This section contains dimensional specifications of Dynaserv motors. The dimensions are presented in millimeters (mm).

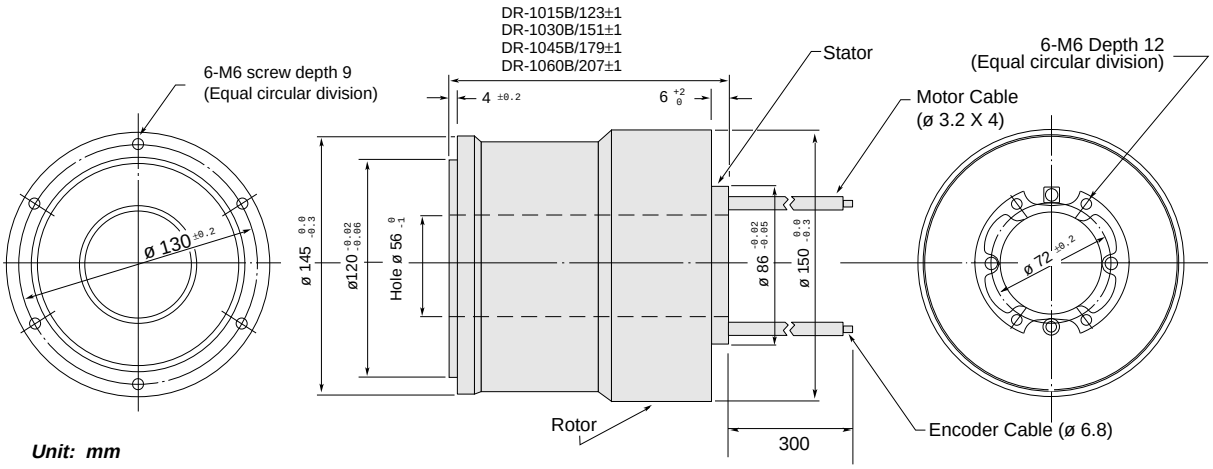
Motor Dimensions (Types A and E)





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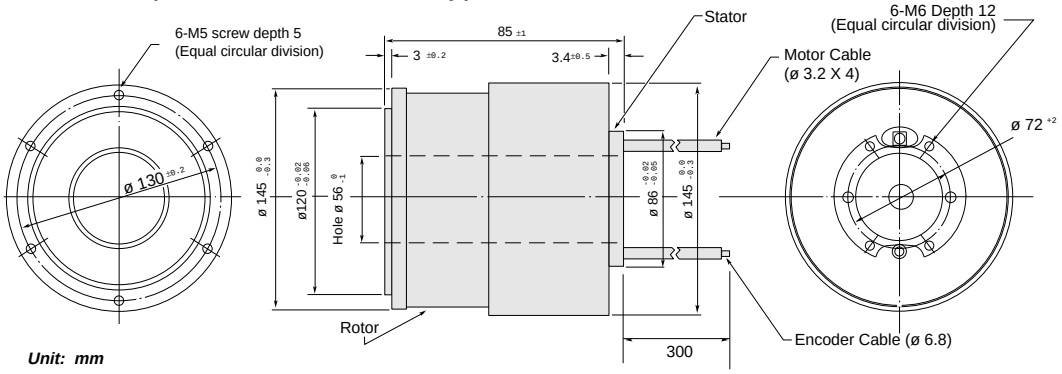
DR-B Series



Unit: mm

DR-B Series (for the DR1008B only)

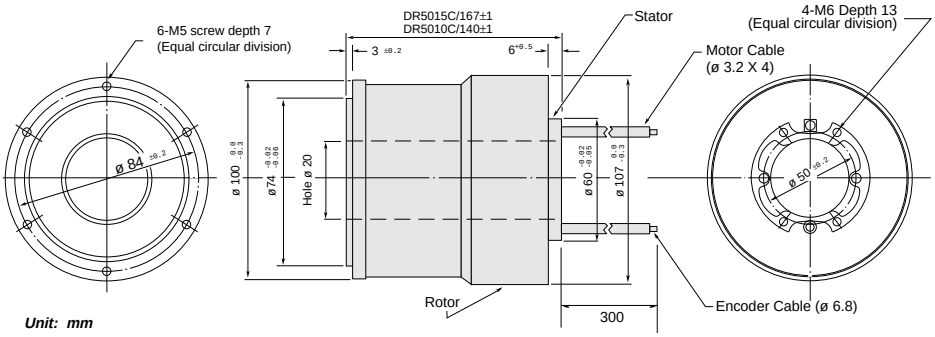
DR-B Series (for the DR1008B only)



Unit: mm

DRC Series

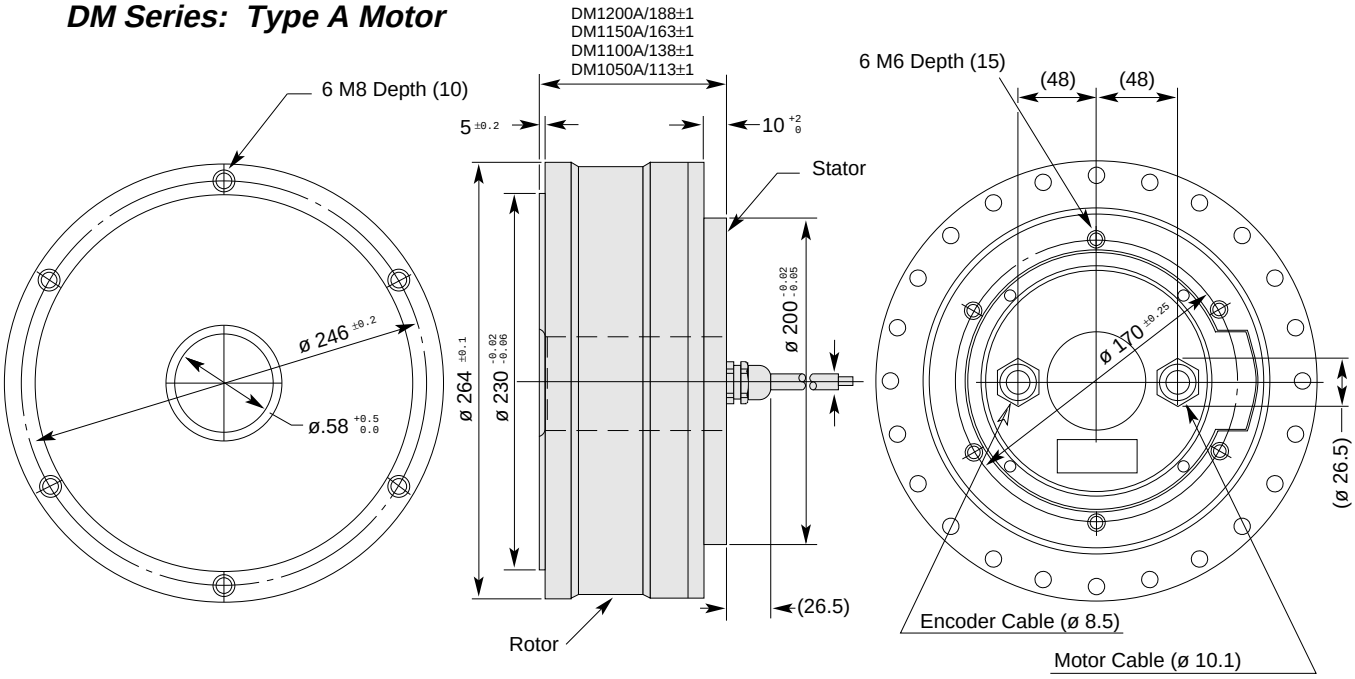
DRC Series



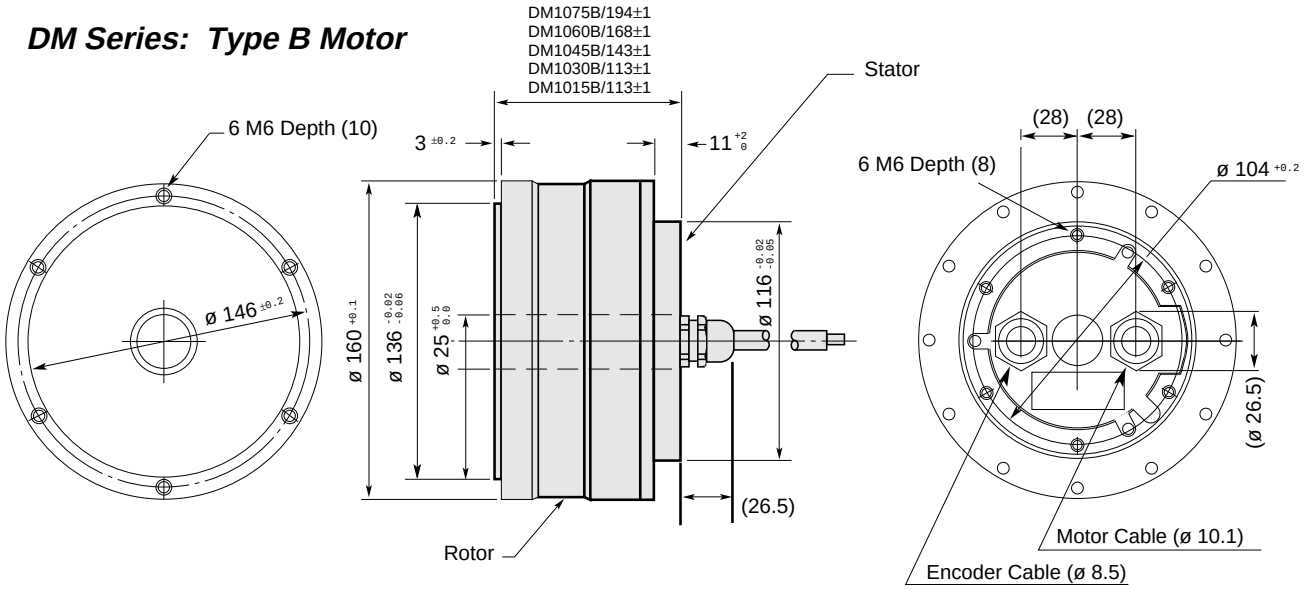
Unit: mm

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DM Series: Type A Motor



DM Series: Type B Motor



Unit: mm

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I/O Signals Between Motor and Driver

TB1 Connection Signal

Signal Name	Meaning
LINE (MN)	AC input for motor/drive power
115VAC or 230VAC	AC input for motor/drive power
LINE (CONT)	AC input for control circuit power
115VAC or 230VAC	AC input for control circuit power
GND	Frame ground

TB2 Connection Signal

Signal Name	Meaning
LINE (MN)	AC input for motor/drive power
115VAC or 230VAC	AC input for motor/drive power
LINE (CONT)	AC input for control circuit power
115VAC or 230VAC	AC input for control circuit power
GND	Frame ground

CN2 Connection Signal (DR Series)

Signal Name	Connector Pin #	Meaning
+S0	1	Excitation Signal Output (Sine phase)
+S180	1	
-S0	2	Detection Signal Input (Sine 0°)
-S180	3	Detection Signal Input (Sine 180°)
SHIELD	4	Shield
FG	5	Frame ground
+C0	6	Excitation Signal Output (Cosine phase)
+C180	6	
-C0	7	Detection Signal Input (Cosine 0°)
-C180	8	Detection Signal Input (Cosine 180°)

CN2 Connection Signal (DM Series)

Signal Name	Connector Pin #	Meaning
+V	1	Encoder Power Supply
GND	2	Above Signal Ground
O Signal	3	Encoder Phase 1 Signal
GND	4	Above Signal Ground
O Signal	5	Encoder Phase 1 Signal
GND	6	Above Signal Ground
ZERO	7	Detection Signal Input (Cosine 0°)
GND	8	Above Signal Ground
CLK+	9	Encoder Sample Clock
CLK-	10	Above Signal Ground
FG	11	Frame ground
	12 - 16	No Connection

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CHAPTER ⑥

Maintenance & Troubleshooting

The information in this chapter will enable you to:

- ❑ Maintain the system's components to ensure smooth, efficient operation
- ❑ Isolate and resolve system hardware problems

Problem Isolation

If your system does not function as you expect it to operate, you must identify and isolate the problem. When you accomplish this, you can effectively begin to resolve and eradicate 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 use them to replace 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 re-create the problem? Do not make quick rationalizations about the problems. Random events may appear to be related, but they may not be contributing factors to your problem. Carefully investigate and decipher the events that occur before the subsequent system problem.

You may be experiencing more than one problem. You must solve one problem at a time. 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 the problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If your system's problem persists, call Compumotor at 800-358-9070.

Motor Maintenance and Inspection

Since this motor does not use wear-prone parts, the following daily inspection is sufficient. Each inspection period varies with the environment and operating conditions. Furthermore, some parts that have been used for 20,000 hours or 5 years may need to be replaced, requiring an overhaul if there are many of them. When an overhaul or motor disassembly is required, call Compumotor (800-358-9068).

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Inspection Item	Period	Inspection Details	Evaluation
Sound and Vibration check	Daily	Widen the motor rotating range as much as possible when the motor is checked audibly and by touching.	No change is found under daily inspection.
Insulation Resistance Measurement	Once a year	Separate the coupling from the driver, then measure the insulation resistance between the coil terminal and stator housing with an ohmmeter.	If it is more than 10 , it is OK. If it is less than 10 , consult Compumotor .

Resolving Motor Trouble

If motor trouble occurs, take the appropriate measures in accordance with the information in the following table. If the problem persists after corrective measures have been taken, stop the operation immediately and contact Compumotor. The table shows possible motor problems, their causes, what to inspect, and how to resolve the problem.

Trouble	Possible Cause(s)	Item to Inspect	How to Resolve
No motor torque	• No AC power is applied. • The fuse has burned out. • The servo on (SRVON) terminal is set to **H**. • The CPU reset (RST) terminal. is set to L • The integral capacitor reset (IRST) terminal is set to L • Fc, ILIM, DC gain is small	• Wiring inspection • Fuse inspection • Inspection • Inspection • Inspection • Inspection	• Apply the specified AC power • Fuse replacement • Set to L • Set to H • Set to H • Adjusted to an appropriate value
The motor does not move	• Under overload (error c.) • Incorrect external wiring	• Under no load • Inspect the wiring diagram in this manual).	• Reduce the load or use a larger motor • Rewire unit correctly (use connection
Motor rotation is unstable	• Wrong connection • The motor and driver combination is wrong	• Check Phase A, B, C, and GND connections • Check the numbers on the	• Rewire unit correctly (use connection diagram in this manual). • Match product(s) with appropriate component(s). Consult Compumotor.
The motor overheats	• Ambient temperatire is high • The motor is overloaded	• Check temperature (should be below 45°C) • Run the motor without its load	• Reduce the temperature (below 45°C). • When you start the motor, lighten the load, or replace existing motor with a large motor.
An abnormal sound is produced	• The unit is mounted incorrectly • The bearings are worn or damaged • The mounting base is vibrating	• The set screws are loose • Check for sound and vibration near the bearing • Check the mounting base	• Tighten the screws. • Replace the motor (contact Compumotor). • Reinforce the mounting base.
The position is dislocated	• The A/B Phase and U/D pulse jumper selections are wrong	• Inspect the A/B Phase and U/D pulse jumper selections.	
rate	• The command pulse rate and width are not specified	• Check the feedback pulse rate (3 MHz maximum) and the circuit response	
	• Both ends of the feedback pulse transmission cable are not wired to the earth connector	• If the ends are not connected, connect the driver to **AGND** and the controller to **SG**.	

Driver Maintenance and Inspection

Although the servo driver does not require daily maintenance and inspection, it is advisable to clean it and check for loose screws periodically. Overhaul the driver in the same way as the motor (i.e., after 20,000 hours or 5 years).

LED Displays

A 7-segment LED is mounted on the front panel of the driver to display the motor and driver's status. Display details are shown below.

LED Display	Display Details	Cause/Measures
0 0.	• Servo OFF, normal status • Servo ON, normal status	
1 1.	• Servo OFF status after overspeed occurrence • Servo ON status after overspeed occurrence	• Encoder malfunctions • Command input trouble—check command input
2	• RAM error occurrence	• Control board trouble—requires repair
3	• Encoder error occurrence	• Encoder malfunction encoder cable wiring check • Connector trouble—check encoder cable connector • 0000 Open circuit (SIGØ,SIG1 stop) • 0001 Open circuit (SIG1 stop) • 0002 Open circuit (SIGØ stop) • 0006 Abnormal frequency (Smoother error)

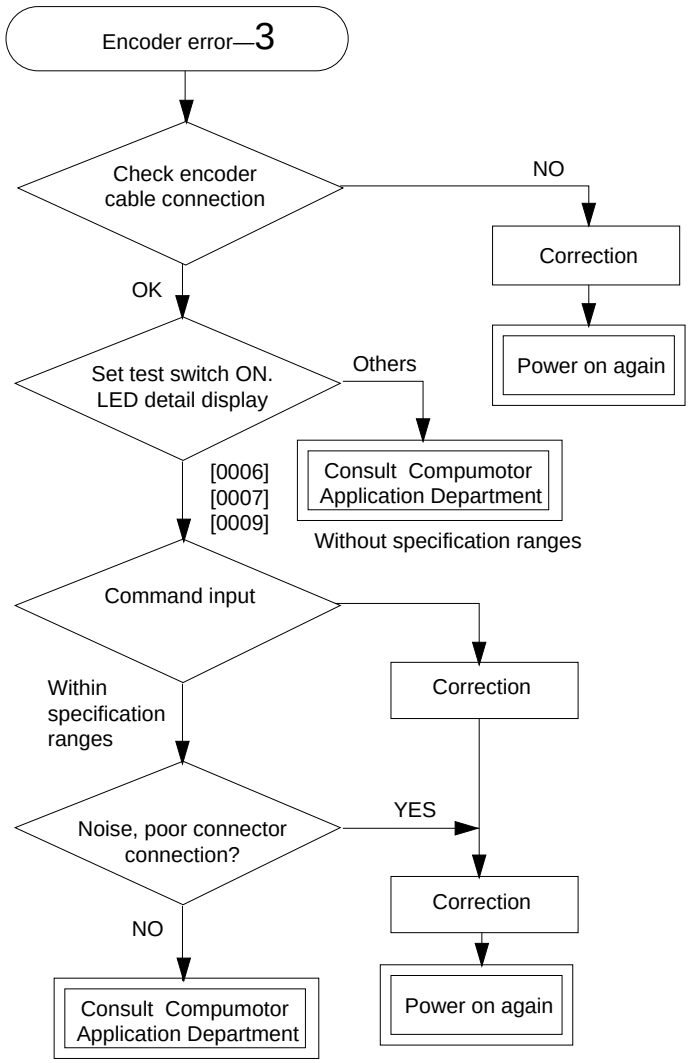
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		• 0007 Abnormal frequency (Incorrect interruption detected) • 0009 Abnormal frequency (Divided error)
5	• Power supply error	• Control power supply voltage trouble • Connector trouble—requires repair
6	• Counter overflow	• High acceleration/deceleration • High revolution—check command input
7	• ROM error occurrence	• Control board trouble requires repair
8	• Main power supply trouble	• Decrease in main power supply voltage • Fuse burnt out/replace the fuse
8.	• CPU stop	• Control borad trouble/requirement for repair • **Driver reset status**
9	• WDT error, Illegal interrupt, compulation overflow	• Control board trouble/encoder cable wiring check
A	• Power amplifier error	• High main power supply voltage • Bad connector contact—requires repair • Power board trouble—requires repair • 0001 Overvoltage (OOV) signal ON) • 0003 Over current (FAULT) signal ON
c.	• Overload occurrence (Servo ON status)	• Heavy load—review operation procedure • Motor locked status—locked status release
c	• Overload occurrence (Servo OFF status)	• Ambient temperature too high—reduce environmental temperature
OTHER	• Trouble of elements relating to LED output	• Control board trouble—requires repair

For engineering assistance, call Compumotor at 800-358-9070. For repairs, see below.

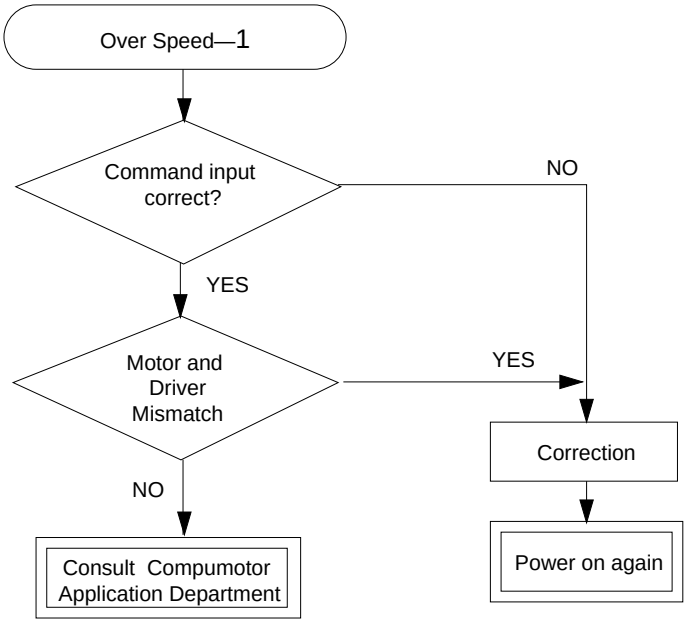
Procedure for Error Correction

(1) Encoder Error

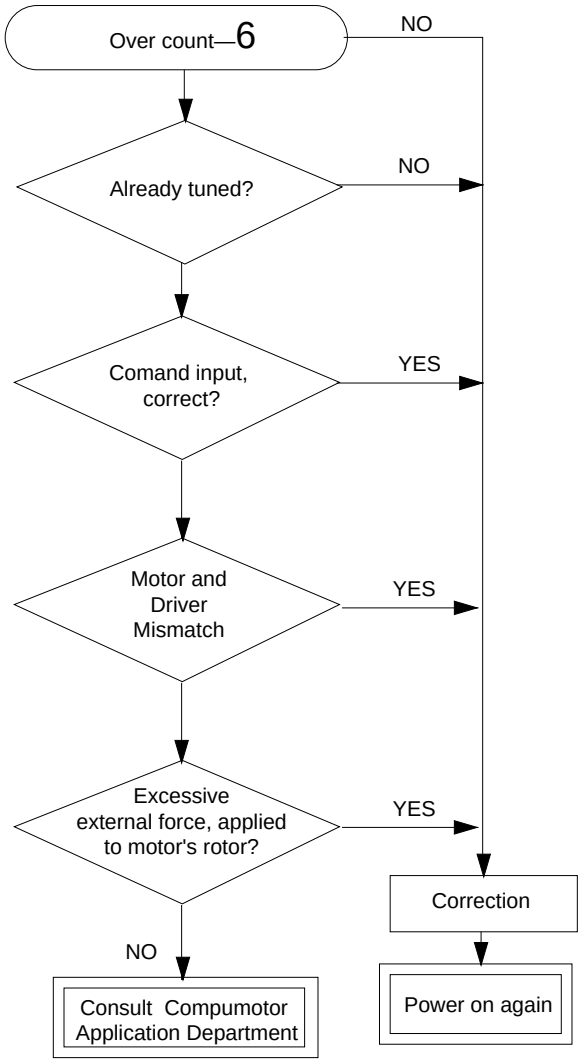


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(2) Over Speed

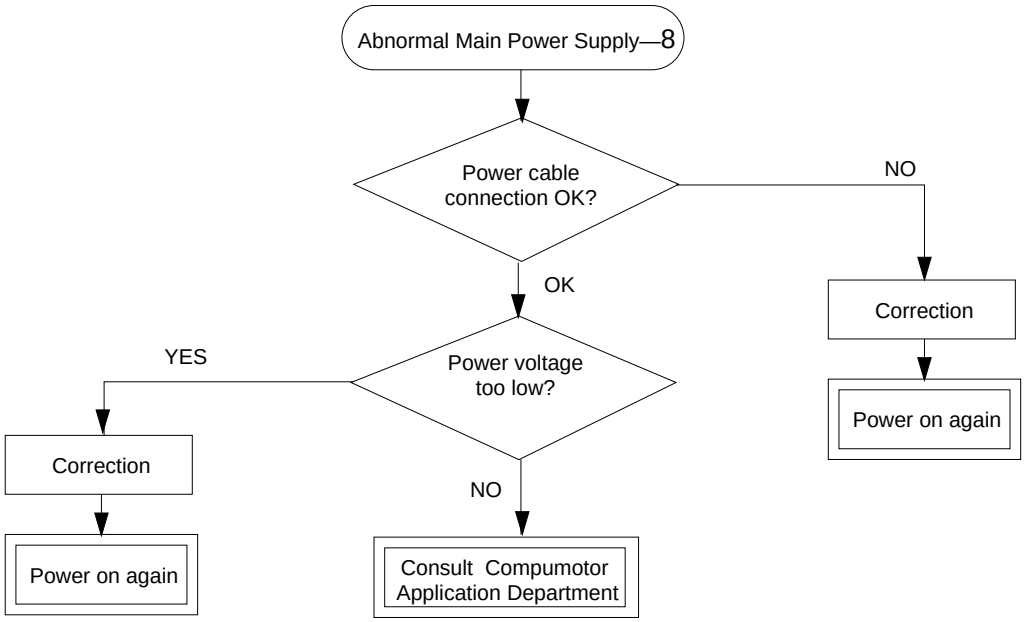


(3) Over Count

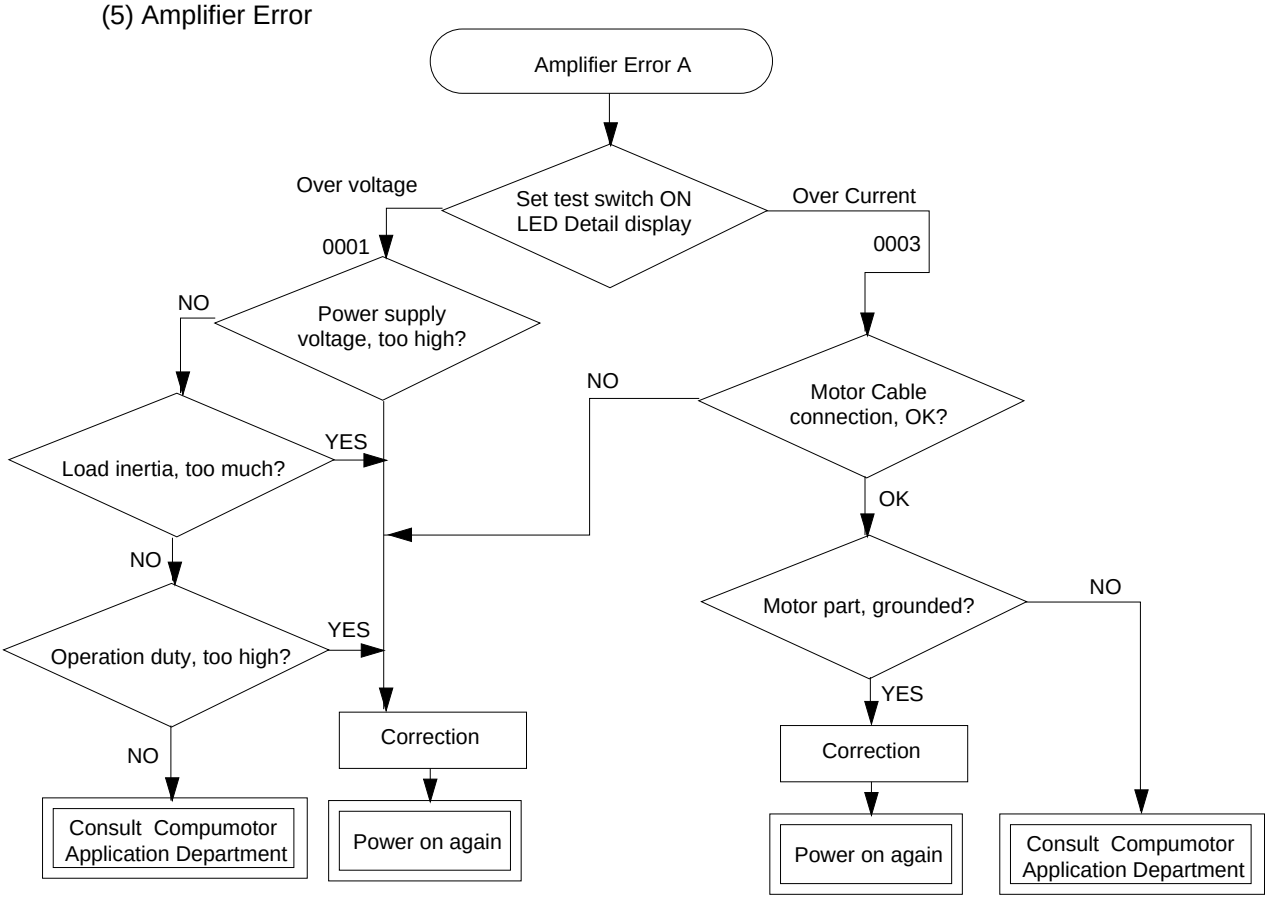


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(4) Abnormal Main Power Supply

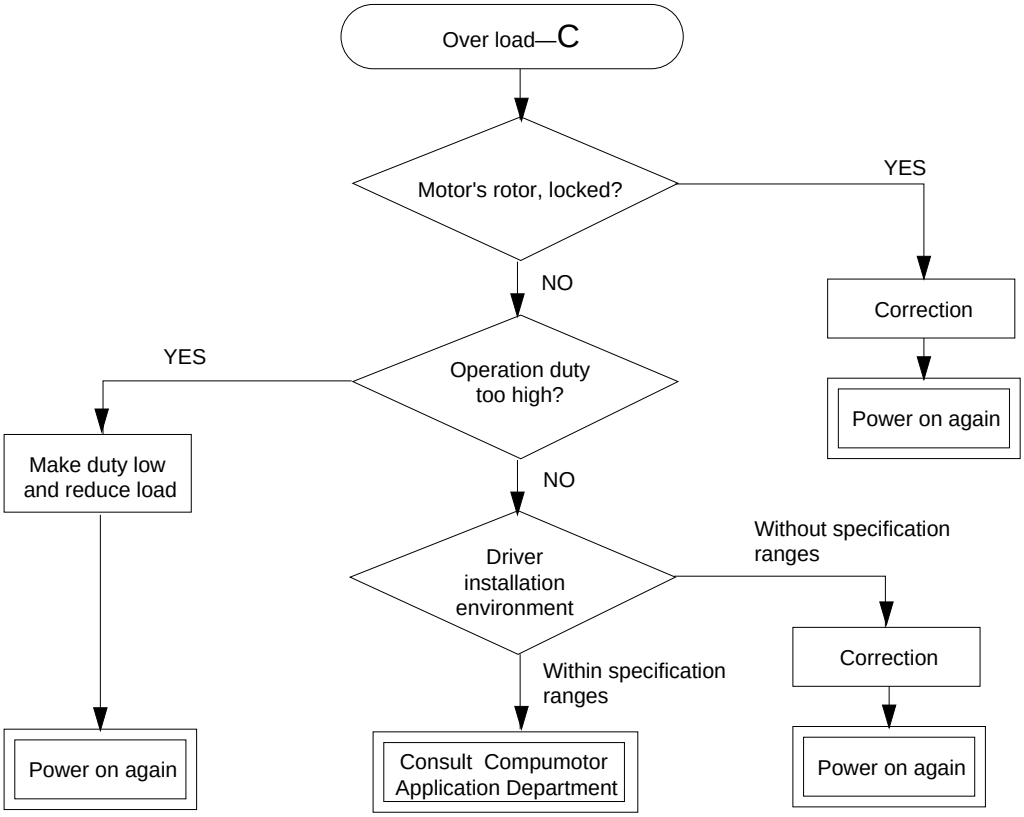


(5) Amplifier Error



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(6) Over load



Returning the System

If your Dynaserv is faulty, you must return the drive and motor for replacement or repair. A failed drive can damage motors. If you must return your Dynaserv to effect repairs or upgrades, use the following steps:

Step ①

Get the serial number and the model number of the defective unit(s), and a purchase order number to cover repair costs in the event the unit is determined by Parker Compumotor to be out of warranty.

Step ②

Before you ship the drive to Parker Compumotor, have someone from your organization with a technical understanding of the Dynaserv and its application include answers to the following questions:

- ❑ What is the extent of the failure/reason for return?
- ❑ How long did it operate?
- ❑ How many units are still working?
- ❑ How many units failed?
- ❑ What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- ❑ How was the product 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 sizing (speed, acceleration, duty cycle, inertia, torque, friction, etc.)?
- ❑ What was the system environment (temperature, enclosure, spacing, unit orientation,

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contaminants, etc.)?

❑ What upgrades, if any, are required (hardware, software, user guide)?

Step ③

Call Parker Compumotor's Applications Engineering Department [(800) 358-9070] for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number.

Step ④

Ship the unit to: Parker Compumotor Corporation
5500 Business Park Drive, Suite D
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

Reducing Electrical Noise

For detailed information on reducing electrical noise in your system, refer to the current Compumotor Catalog.

Direct Drive Motors & Resonance

The major feature of the direct drive motor is its lack of a speed reducer. It therefore is fast, highly precise, and compact. On the other hand, because it is directly coupled to the load, it is easy for the load's mechanical resonance characteristics to find their way into the velocity control loop, causing oscillations in the velocity control system.

These oscillations may consist both of relatively low-frequency (several Hz) hunting and windup phenomena, and relatively high-frequency phase shift oscillations and mechanical resonances.

Although most low-frequency oscillations can be cured by driver adjustments, high-frequency oscillations require countermeasures such as improving mechanical rigidity, adding mechanical damping, and/or inserting compensation filters. With high-frequency oscillations in particular, it is usual for there to be multiple resonance peaks, and to implement optimal countermeasures requires accurate location of the resonance frequencies by appropriate measurement methods.

The following table is a summary of the characteristics of the low-frequency oscillation phenomena (*referred to as oscillation or resonance*).

Oscillation Symptoms	Oscillation: Reasons/Conditions	Countermeasures
① Hunting	❑ Reason: Poor adjustment ❑ Frequency: Several Hz ❑ Conditions: f*p* fv Where f*p*: Position loop response frequency [Hz] fv: Speed loop response frequency [Hz] fc: Natural oscillation frequency [Hz] J: Load inertia [kg/m2] G: DC gain [multiplier] K: Constant (see attached table)	❑ Make f*p* < 2.5 fv
② Windup	Reason: Poor adjustment procedure). ❑ Frequency: Several Hz ❑ Conditions: May occur when load is great (load inertia <JL> is 10 times or more motor's rotor inertia <JM> and integral limiter <LIM> or <fc> is large, and large deviation is imposed by a step input, etc. *Since windup may sometimes not appear in Test mode, if <JL> is 10 or more times <JM>, you should impose a large deviation —10° or more—by external force or other means to check for it.*	❑ Reduce <LIM > (see adjustment ❑ Load inertia is too great. [Load multiple <K> guidelines] DM: 50 to 150 DR: 70 to 500
③ Phase Shift Oscillation	❑ Reason: Phase shift due to filter insertion. ❑ Conditions: Letting f*p* be the frequency at which the actual motor velocity is 180° phase-shifted relative to velocity command, oscillation occurs at f*p* if f*p* < fv.	❑ Insert compensating shift insertion phase-advancing filter into velocity loop to lower f*p*. *A compensation filter should not be inserted if fv > 40 —instead, lower the DC GAIN.*

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② Resonance	❑ Reason: Due to mechanical resonance. ❑ Frequency: 100 Hz to 2 kHz ❑ Conditions: Load mechanical resonance characteristics enter into velocity control loop, and velocity control system oscillates. Multiple resonance points are frequent.	❑ Increase mechanical rigidity to lower resonance peak valueS. ❑ Fit mechanical dampers to lower resonance peak values ❑ Add resonance compensation filters to lower resonance peak values.

Resonance Measurement Methods

Measurements of oscillatory phenomena are performed by measuring the transfer function for speed control in the Velocity P Control mode using a signal analyzer (FFT analyzer). When these measurements are performed, either a random waveform or sine wave signal can be input as the **VIN** signal.

If an FFT analyzer is not available, the resonance points can be found by applying the output of a sine wave generator to the analog velocity input, and monitoring the velocity signal (**VEL**) on an oscilloscope while varying the generator frequency.

Resonance Counter Measures

There are three counter measures for the resonance phenomena generally referred to as *mechanical resonance* (items ③ and ④ in the previous table).

① Increase machine rigidity to reduce resonance peak values.

② Fit dampers in the mechanical systems to reduce resonance peak values.

③ Insert machine resonance compensation filters to reduce resonance peak values.

These measures should be implemented in the order listed.

Mechanical Rigidity

Increasing the mechanical rigidity requires increasing the structural rigidity of the device. You should begin by minimizing play and looseness at all connections to raise the overall rigidity of the machine as a whole. In addition, you should also increase the rigidity of the individual structural components, posts and arms. An arm using a honeycomb or ribbed structure, for example, is more effective from a rigidity standpoint than a hollow construction. Although increasing the rigidity may give rise to new resonances at higher frequencies, such cases can be dealt with by the measures described in the sections that follow.

Dampers

A damper is a mechanical means for absorbing and attenuating resonant energy. Dampers generally consist of a rubber pad and deadweight. A damper's resonance frequency can be varied by changing the thickness and material properties of the rubber pad, and the weight of the deadweight. The following rules should be observed.

Damper resonance frequency = Equipment resonance frequency

Although the heavier the deadweight, the greater the energy absorption, the lowest limit is established by the following condition:

Deadweight weight > 1 kg

The damper mounting location should meet the following specification:

Directly above (or below) the individual axis motor

Resonance Compensation Filters

Generally, the term *compensation filter* refers to a filter of circuit configuration that compensates for resonance characteristics.

❑ First-order lag filter

❑ Notch filter

First-Order Lag Filter

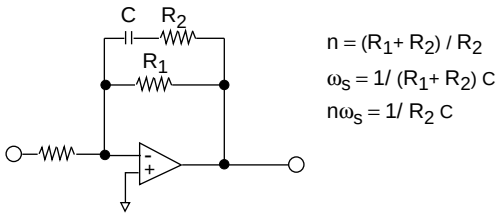
This filter can reduce a resonance peak within the velocity band, due to its small phase lag. The transfer function and circuit are shown in the figure below. As can

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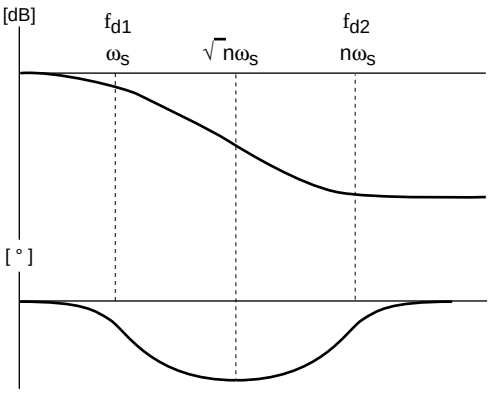
be seen from the characteristics for various values of frequency ratio, increasing n too greatly reduces the phase margin, so fd1 cannot be set very small.

In the actual circuit, n can be set to about 4, and fd1 and fd2, respectively, can be set to 20/80 Hz, 30/120 Hz, or 40/160 Hz by selection with jumpers provided; in addition, separate terminals are provided so that any desired values for C and R2 can be
soldered in.

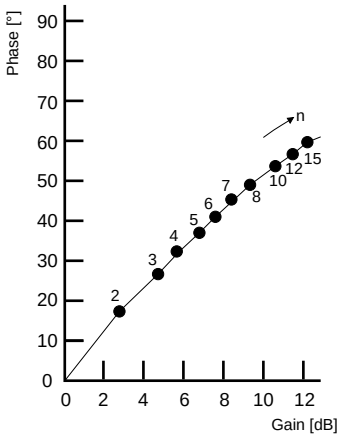
In general, the first-order lag filter is an effective countermeasure for resonances around 100 Hz; its circuitry is built into the same board as the notch filter.



First Order Lag Filter Circuit



First Order Lag Filter Transfer Function



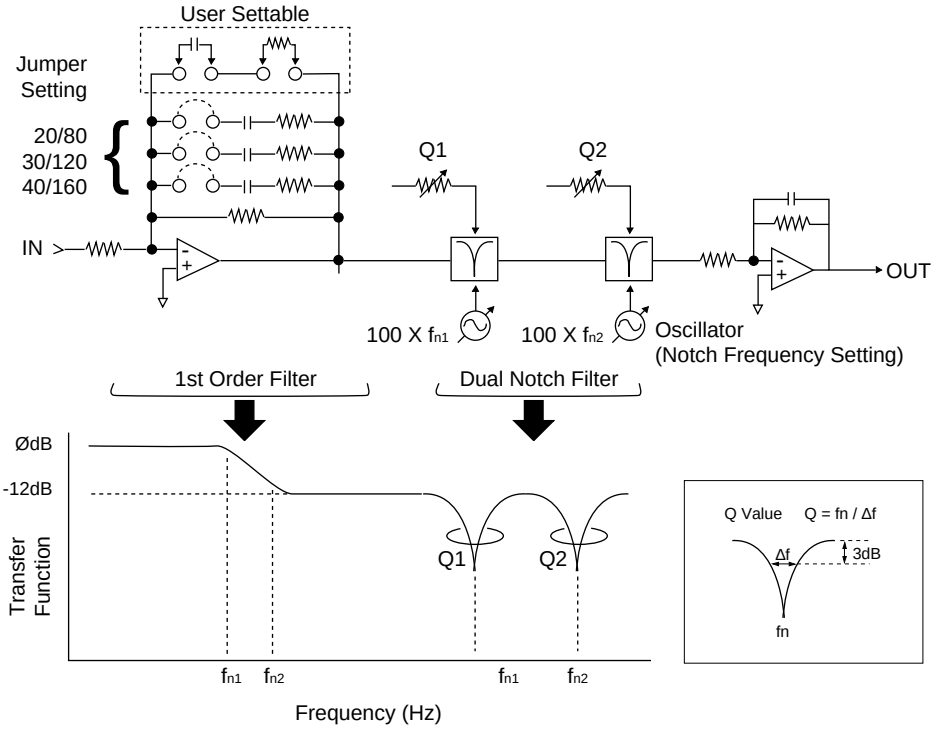
Relationship of Frequency Ratio n, Phase, and Gain

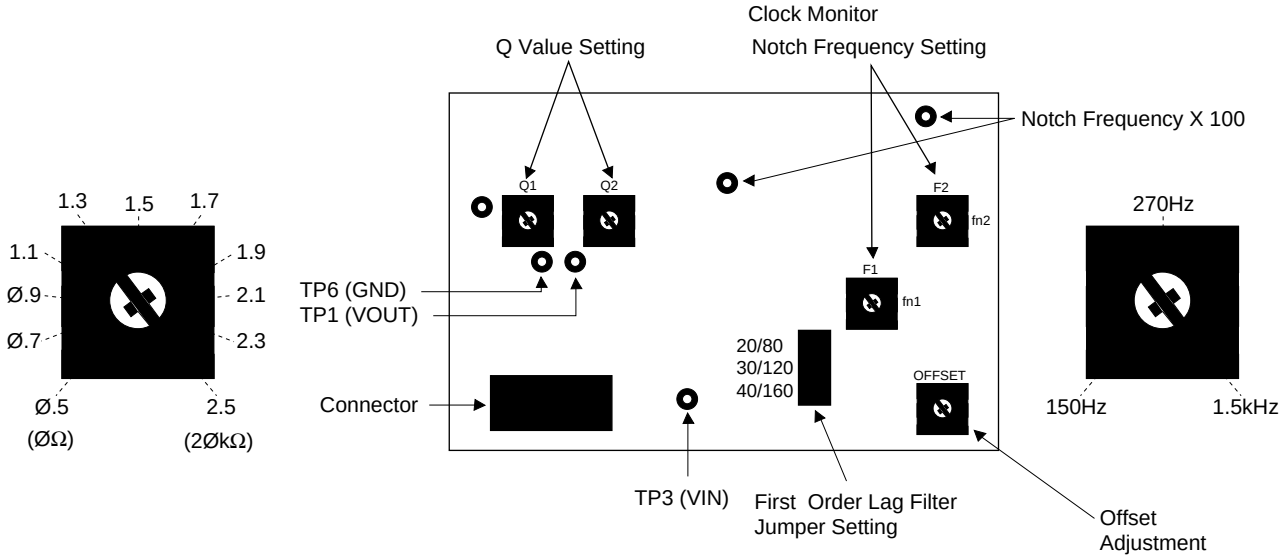
Notch Filter

The notch filter circuit configuration is shown in the next figure. The notch filter board is shown in the subsequent figure. This filter is effective for suppression of high-Q resonances at 100 Hz and above. A switched capacitor filter is used for the circuit, and the notch frequency and Q values can be set within a predetermined range.

From a circuit configuration standpoint, dual types providing two stages for notch frequency are typical, and in this case the first-order lag filter section is built into this construction.

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Adjustment Procedures

Since the offset voltage will change when the settings of pots Q1 and Q2 are changed, you should adjust the offset adjustment pot (**VR1**) so that the voltage difference between TP1 (**VOUT**) and TP3 (**VIN**) does not exceed 50mV. When taking signals from
TP1, TP3, and TP6, be careful not to touch any other pins or parts of the pattern.

General Filter Specifications

Item	**Specification**
System	Dual switched-capacitor notch filter+ first-order lag filter
Dimensions(mm)	$75 ~ 40 (board size)
Interface	DM series: Directly installed on control board DR series: Connected by 10-pin connector to control board
Power Supply	±15V, 50 mA

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Input Voltage Range	±10V
Output Offset Voltage	±100 m max (0 to 50°)

Notch and First-Order Filter Specifications

Notch Filter Section

Item	Specifications
Notch Frequency Setting Range	150 to 1.5 kHz
Q Value Setting Range	0.5 to 2.5
Notch Frequency Monitoring Terminal	**TP 4:** Stage 1 Frequency X 100 (TTL level) **TP 5:** Stage 2 Frequency X 100 (TTL level)

First-Order Lag Filter Section

Item	Specifications
Jumper Pin Setting	20/80 Hz 30/120 Hz 40/160 Hz
Setting via user-added resistor capacitor	Solder in locations: • C (C18) • R (R21)

Resonance Analysis Example

Oscillation in a servo system may not be due to a resonance peak. Oscillatory limits are also determined by phase margin and gain margin. Therefore, when resonance compensation filters (first-order lag and notch) are used, attention must be given to amplitude *and* phase margin. Particularly in robots, this may vary according to the arm posture. The worst case considered when designing the system.

Eliminating Resonance

The following table summarizes the sources of vibration and the ways that you might eliminate resonance from your system.

Vibration Location	Resonance Frequency	Problem	Counter Measure
Base	39 Hz	Servo rigidity reduction due to absorption	❑ Increase base rigidity ❑ First-order lead filter
Bearings motor)	79 Hz	Has resonance peak	❑ Mechanical damper (on
		(bearing section Moment mode)	❑ First-order lag filter
Arm filter	134 Hz	Has resonance peak	❑ Increase arm rigidity Notch
	276 Hz		

Resonance Tuning

The following is a procedure of suppressing resonance (vibration) in a Dynaserv application without the use of FFT Analyzer or Oscilloscope. The purpose is to adjust the Dynaserv for optimum tuning (high gain, stiffness, responsiveness) with no resonance.

1. This procedure is done in the Position mode.
2. Set the Fc and I.lim to 3.
3. Set Test Switch to ON (up position).
4. On the Notch Filter board set Q1 and Q2 to 1.5 (mid position).
5. Increase the DC Gain until resonance occurs.
6. On the Notch Filter board adjust F1 to null (tune-out) the resonance. If resonance is very close to the same frequency as the first, tune it out with the same pot (F1). If not use F2 pot.
7. Repeat steps 5 and 6 until the DC Gain can no longer be increased without resonance.
8. Repeat steps 5, 6, and 7 adjusting F2 on the Notch Filter board.
9. Depending on the mechanical conditions of the application additional filtering may be necessary. If resonance persists use the 1st Order Lag Filter (20/80, 30/120, 40/160) jumpers. Use one of these jumpers to minimize resonance then repeat steps 5 - 8. (Go to step 11).
10. Increase the DC Gain until resonance occurs, then try nulling it out with the 1st Order

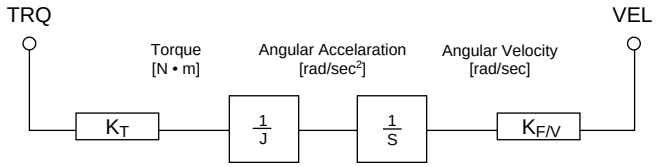
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Lag Filters (jimpers 20/80, 30/120. 40/160) on the Notch Filter board. Repeat steps 5 - 8 until

maximum gain is obtained without resonance.

11. Optimize the system tuning by increasing Fc and ILim.

Torque Constant and F/V Gain



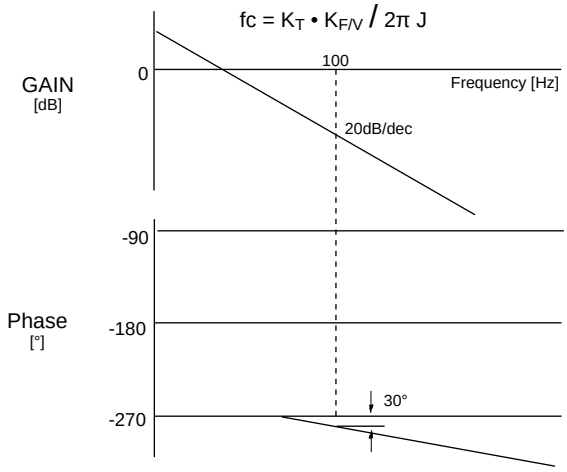
K_T: Torque Constant [N • m/V]

$K_{F/V}$: F/V GAIN [V/rad/sec]

J: Inertia [kg-m^2]

S: Angular Velocity [rad/sec]

The above figure illustrates the transfer function between torque (**TRQ**) and velocity (**VEL**) when no resonance is present.



The following tables contain the $K_{F/V}$ and K_T values for DM and DR Series motors respectively.

Motor Type:	DM Series	KF/V **[V/RAD/S]**	KT **[Nm/V]**
	DM1050A	0.796 (5V/2)	3.92
A Type	DM1100A		7.85
	DM1150A		11.77
	DM1200A		15.7
	DM1015B	0.398 (5V/2 • 2)	1.97
B Type	DM1030B		3.94
	DM1045B		5.91
	DM1060B		7.88

Motor Type:	**DR Series**	**KF/V [V/RAD/S]**	**KT [Nm/V]**A
Type	DR1050A	0.53 (5V/2 • 1.5)	4.86
	DR1100A	0.796 (5V/2)	9.72
	DR1150A		14.58
	DR1200A		19.44
	DR1300A		29.17
	DR1400A		38.89

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E Type	DR1070E	0.398 (5V/2 • 2)	4.91
	DR1100E		7.37
	DR1130E	0.796 (5V/2)	9.83
	DR1160E		12.28
	DR1220E		17.19
	DR1250E		19.65
B Type	DR1008N	0.398 (5V/2 • 2)	1.202
	DR1015B		2.04
	DR1030B		4.08
	DR1045B		6.11
	DR1060B		8.15

Motor Type:	**DR Series**	**KF/V [V/RAD/S]**	**KT [Nm/V]**A
Type	DR5030B	.159	3.52
	DR5050B	.159	4.69
	DR5070B	.159	5.87

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