

## Introduction

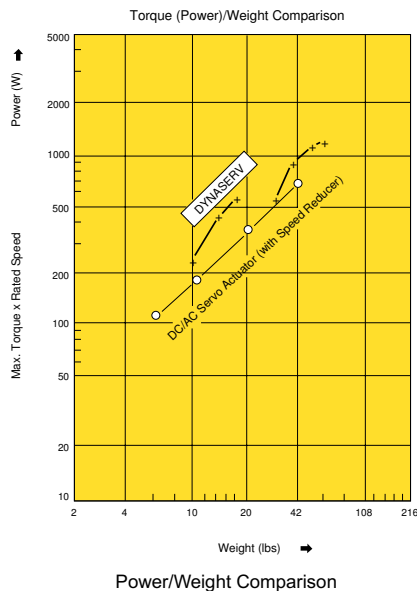
### The Dynaserv System Allows the User to Operate in One of Three Modes of Control:

- Position control – up to 4,096,000 steps/rev
- Speed control –  $\pm 10V$  Velocity command input
- Torque control – stable response at  $\pm 8V$  input

This type of flexibility combined with a high torque/weight ratio, high accuracy, faster settling times, high torque at high speed, smooth rotation, optimum tuning and clean operation all add up to cost effective high performance alternative to the traditional motor and speed reducer combinations.

### High Torque/Weight Ratio

The Dynaserv motors are designed with a permanent magnet constructed of rare-earth materials located at the center of the stator core.

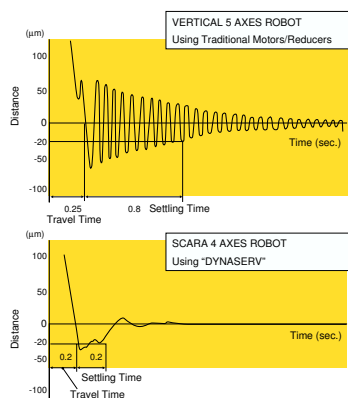


### High Precision

Dynaserv motors eliminate the backlash or hysteresis inevitable in using any speed reducer. Absolute positioning of 30 arc-sec is typical with a repeatability of  $\pm 1$  arc-sec.

### Faster Settling Time

The Dynaserv system reduces machine cycle times by decreasing settling times. This result is realized because of the "gearless" design and sophisticated "I-PD" control algorithm.



Settling Time comparison in Robot Application

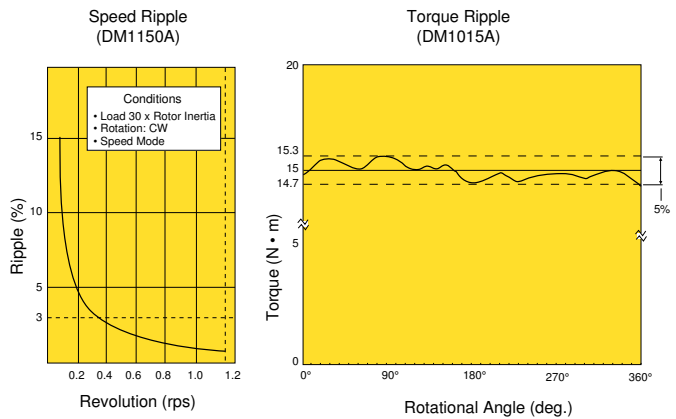
## DYNASERV

### High Torque at High Speed

The torque/speed curve of the various Dynaserv models is very flat. This results in high acceleration at high speeds (4.0 rps) with good controllability.

### Smooth Rotation

The very low velocity and torque ripple of the Dynaserv contribute to its excellent speed controllability.



Dynaserv Velocity/Torque Ripple

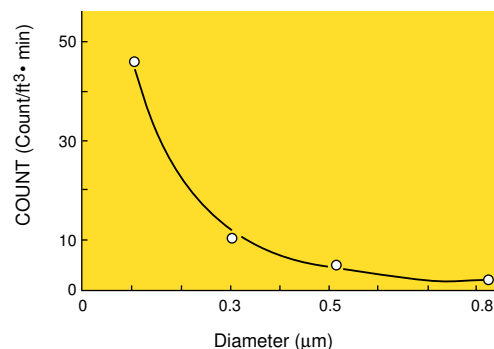
### Optimum Tuning

Dynaserv systems offer the user a tuning mode that simplifies the setting of optimum parameters for the actual load. Turning on the "test" switch on the front panel of the drive produces a test signal. Utilizing an oscilloscope the gain settings are quickly optimized by adjusting the digital switches and potentiometers on the front panel.

### Clean Operation

The Dynaserv system is brushless and gearless which results in a maintenance-free operation. With preparation, the DM Series can operate in Class 10 environments.

Measured by:	LPC-101 Particle Counter
Made by:	PMS Corp.
Source:	He-Ne Lazor Light
Min. Resolution:	0.1 micro meter (Particle Diameter)
Sampling:	0.1 Cubic feet/min.



Dust from Dynaserv (DM1045B)

## Introduction

### The Dynaserv has provided solutions to a variety of applications such as:

#### Assembly

- Base machine
- Pick and place
- Inserter/mounter

#### Robots

- Handling
- Clean room
- Universal

#### Transport

- Turn table
- Belt conveyor
- Three-dimensional warehouse

#### Inspection and Measuring

- Three dimensional measuring
- Goniometer
- Non-destructive x-ray

#### Work

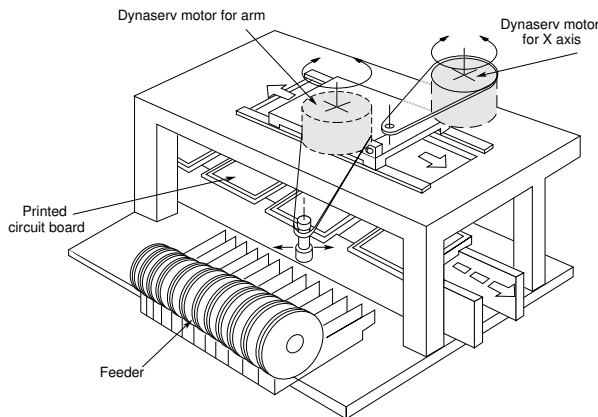
- Machining center work table
- Press roll feed
- Grinder table

#### Commercial

- Printing machines
- Medical equipment
- Follow-up equipment

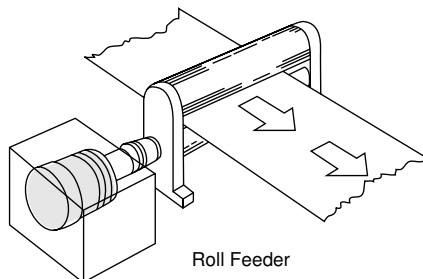
### Material Handling

By attaching a small arm or linkage to the Dynaserv, very high velocities can be attained. This type of design has been used on a wide variety of equipment, such as a chip mounting machine. On this machine accuracies of 30 arc-sec are maintained with very high arm speed.



### Feed-to-Length

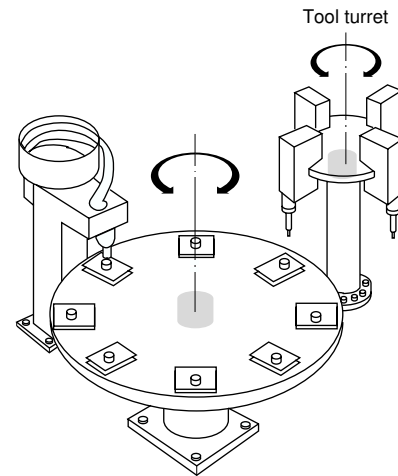
The Dynaserv system eliminates the need for gear reduction and allows for direct control of the nip roll in most feed-to-length applications. The ability to effectively control loads up to 100 times its own rotor inertia allows the Dynaserv to be applied in a variety of machines. The net result of specifying a Dynaserv system is increased repeatability of the feed material.



## DYNASERV

### Indexing/Rotary Positioning

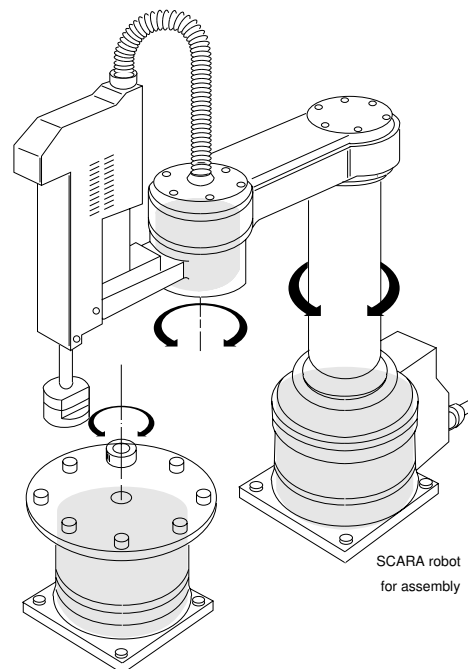
The Dynaserv has high accelerations lending itself to high speed point-to-point positioning applications requiring low cycle time. In scanning and inspection applications the outstanding low speed performance will be of merit.



Rotary table for assembly

### Robotics

Dynaserv direct drive motors were first developed to drive SCARA (Selective Compliance Assembly Robot Arm) in applications requiring repetitive and physically taxing operations.



SCARA robot for assembly

Peripherals for robot

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## Motor Construction and Operation

The torque is proportional to the square of the sum of the bias magnetic flux  $\Phi_m$ , due to the permanent magnet and the excitation magnetic flux of windings.

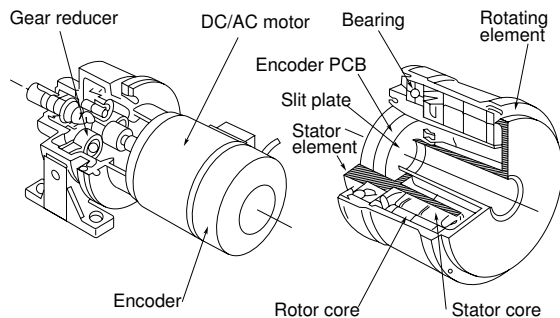
$$T \propto (\Phi_m + \Phi_c)^2$$

High torque is generated due to the following factors. First, the motor diameter is large. The tangential forces between rotor and stator act at a large radius, resulting in higher torque. Secondly, a large number of small rotor and stator teeth create many magnetic cycles per motor revolution. More working cycles means increased torque.

Direct drive systems couple the load of the system directly to the motor without the use of belts or gears. Most servo motors, brushed or brushless, often lack adequate torque or resolution to satisfy application needs. Therefore, mechanical means, such as gear reduction systems are implemented to meet system requirements. The Dynaserv can provide very high torque in a modest package size and solve many of the performance issues of the gear reducer. All this in a system that is as easy to use as a stepping motor.

The figure below shows the construction of the Dynaserv DM Series direct drive motor compared to a conventional motor with a gear reducer. As shown in the figure, the gear reducer relies on frictional contact to reduce the speed of the load. This gearing effectively increases torque and resolution but sacrifices speed and accuracy. The direct drive motor is brushless and gearless so it eliminates friction from its power transmission. Since the feedback element is coupled directly to the load, system accuracy and repeatability are greatly increased and backlash is eliminated.

### Conventional Motor/Gear Reducer vs. Dynaserv

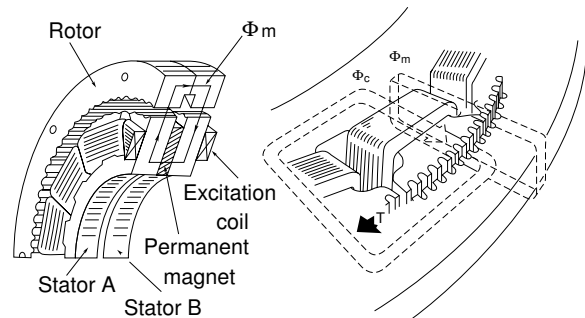


### DM Series

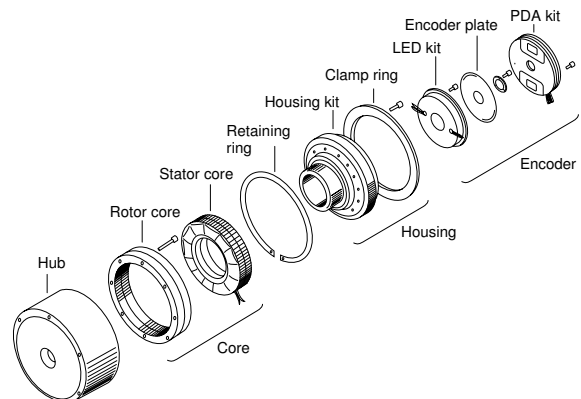
#### Gear Reducer System Limitations

- Backlash limits positional accuracy
- Gearing causes a trade-off between speed and resolution
- Inefficiently transfers torque

### Magnetic Circuit



### Exploded View of the Dynaserv Motor Model DM



- Friction introduces inaccuracies and non-linearities
- Gearing reduces stiffness at the load

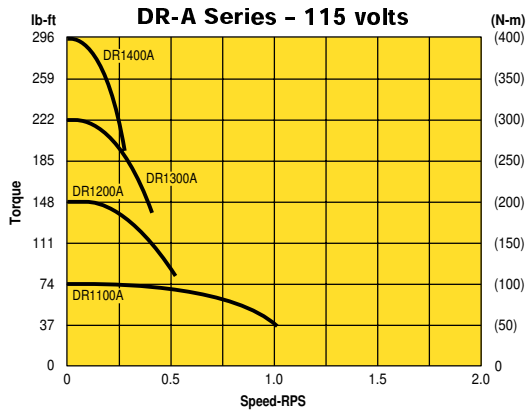
The motor contains precision bearings, magnetic components and integral feedback in a compact motor package. The motor is an outer rotor type, providing direct motion of the outside housing of the motor and thus the load. The cross roller bearings which support the rotor have high stiffness, to allow the motor to be connected directly to the load. In most cases it is not necessary to use additional bearings or connecting shafts.

# Selecting your Dynaserv

The normal principals of servo motor sizing apply to the Dynaserv, but there are a few special considerations to keep in mind.

## Peak Torque/Continuous Torque

The speed torque curves in this section represent the peak available torque. Continuous torques are approximately 2/3 of the peak value. Use one-half of peak torque for the DM1004.



## Inertia Matching

When selecting the right Dynaserv for your application, the inertia match between the motor and load is a critical factor. The specifications listed in this section are for a 30:1 load to rotor inertia ratio. The following table lists the recommended ratios for specific application types. Actual results will depend highly on the usage, so these values are just for reference purposes. It is always a good idea to add 30-50% safety margin in sizing calculations.

### Application Types and Ratios

Application Type	Max K Ratio ( $J_{load}/J_{motor}$ )
High throughput applications (printing machines, chip mounting)	5-10
General high speed applications (SCARA robot, transfer arms)	20-30
High speed but balanced load applications (Rotary Index, Rotary Tables)	50-100
High accuracy, slow speed applications (Measuring Equipment)	100-200

## Motor Types

When selecting the motor type, the decision comes down to a trade-off of resolution, accuracy, speed, and cost. Please use this table to match your specific application requirements to the correct direct drive motor. Keep in mind that these ratings are speculative and based only on the features of these three models. The lowest accuracy Dynaserv is still very accurate by normal motor standards.

### Motor Types

	DM Series	DR Series	DR5000 Series
Power	Lowest	Medium	Highest
Accuracy	Highest	Medium	Lowest
Motor Weight	Lowest	Medium	Highest
Resolution	Highest	Medium	Lowest
Cost	Medium	Lowest	Highest
Speed	Lowest	Medium	Highest

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# Application Considerations for using the Dynaserv Direct-Drive Brushless Servo Systems

## Sizing and Selection Considerations

- All Speed vs. Torque curves shown in Compumotor's Catalog and **Dynaserv User Guide** show peak torque. Use two-thirds of peak torque to calculate the available continuous torque. Use one-half for DM1004.
- If you require more than two-thirds of peak torque for short periods of time (low duty cycle applications), calculate RMS (root mean square) torque. make sure RMS torque is less than 2/3 of peak torque.
- Friction torque should not exceed 30% of a motor's peak torque.
- Dynaservs operate most efficiently with a balanced load. Overhung loads cannot exceed 148 ft-lbs for the DR-B and DM-B series motors. Overhung loads cannot exceed 15 ft-lbs for DR5000C series, 24 ft-lbs for the DM1004C and 20 ft-lbs for the DM1004B. These values should be derated by 33% for constant loads and 80–90% for intermittent loads (fatigue) to incorporate a safety margin.
- Always calculate the load-to-rotor inertia ratio before selecting a motor. The acceptable ratio is application- and motor-dependent. Applications requiring low cycle times and high accelerations need a lower ratio than slow-speed, continuous velocity applications. Refer to the acceptable inertia values for different application types on the previous page.

## Cabling Considerations

- The Dynaserv is not shipped with a power cable. This cable must be provided by the end user. The Dynaserv is shipped with a 50-pin Honda connector. Use this connector to construct a cable between the Indexer, Servo controller, or other input/output devices. Prefabricated cables for Compumotor indexers and servo controllers are available.
- The motor and feedback cables cannot exceed 30 meters in length.

## Mounting and Environmental Considerations

- Do not drill holes into the Dynaserv motor.
- The Dynaserv is an outer rotor motor. The rotating load must be mounted to the upper mounting surface (the rotor). The lower stator surface must be mounted to the rigid and stationary machine base.
- Install the motor in an appropriate location as the motor is not dust proof, watertight, or oil proof.

### Axial Compression and Tension Load Limits

	Compression	Tension
DR5000C	1124 lbs	674 lbs
DR-B Series	6744 lbs	2248 lbs
DR-E, DR-A	8992 lbs	4496 lbs
DM1004B	440 lbs	154 lbs
DM1004C	770 lbs	770 lbs
DM-B	6600 lbs	2200 lbs
DM-A	8800 lbs	4400 lbs

These limits should be derated to incorporate a safety margin. If the load is intermittent and repetitive, derate these values by 80–90%.

- If the motor is used with oscillating rotation movements with a small angle (50° or less), then perform a running-in operation with back-and-forth movements about 10 times, each move exceeding an angle of at least 90°. The running-in operation must be carried out every 10,000 times of back-and-forth oscillation movements in order to ensure proper lubrication of the bearings.