Bell Everman

Embedded Motion Systems

Rotary Positioning

ServoBelt Rotary, Direct Drive Theta and Custom Rotary Stages

Bell Everman

Embedded Motion Systems

ServoBelt Rotary Stages

Precision rotary motion in an easy-to-integrate package.

Room in the Middle. ServoBelt Rotary stages offer two different through hole configurations. Available with 50-, 100- or 200-mm center openings, our large through hole stages accommodate large bundles of power, signal and pneumatic conductors. They also make it easy to integrate laser and optical systems. Standard-sized models with 16- or 25-mm through holes offer a more economical choice when fewer utilities need to pass through the center of the stage.

Direct Drive Performance. Designed for NEMA 23 and 34 motors, ServoBelt Rotary stages offer speeds up to 1,000 rpm, continuous torque to 6.6 N-m and resolution down to 0.16 arc-sec with Renishaw ring encoders or tape scales for partial rotation.

Application Flexibility. ServoBelt Rotary stages support both continuous rotation and variable indexing applications.

Robust, Lubed-for-Life Bearings. ServoBelt Rotary stages incorporate large full duplex, angular contact bearings, imparting moment and load capacities far in excess of their usual application requirements. This excess load capacity translates into virtually limitless bearing life.

Cost-Effective. ServoBelt Rotary stages offer an economical solution for a variety of medium-duty rotary motion jobs, such as driving carousel tables on packaging and assembly machines and providing fourth-axis rotary motion for laser cutting and mini CNC machines.

Configure Stages Online
www.bell-everman.com/servobelt-rotary

Technical Specifications

	SBR-16-31	SBR-50-31	SBR-25-51	SBR-10
Type	NEMA 23 3:1 Belt Drive Rotary		NEMA 23 5:1 Belt Drive Rotary	
Bearing Type	Preloaded duplex angular contact		Preloaded duplex angular contac	
Stage Diameter/Height (mm)	100/50	100/54	165/54	165/6
Through Hole	16.0 mm (0.63 in.)	50.8 mm (2.00 in.)	25.4 mm (1.00 in.)	101.6 mm (
Accuracy (±arc-sec) Deviation from commanded angle.	16KCPR: 90 Ring: 36		16KCPR: 75 Ring: 48	
Kinematic Wobble (±arc-sec) Tilt of rotary axis irrespective of table flatness or physical runout of table top.	8		16	
Kinematic Radial Runout (µm TIR) In-plane wander of rotational centerline irrespective of table roundness or physical runout of table top OD.	13		20	
Table Top Parallelism to Base (µm TIR) Total indicated worst-case parallelism top to bottom.	80		80	
Bi-Directional Repeatability (±arc-sec) With motor encoder versions only, assumes 0.2 degrees lost motion at pinion, divided by ratio.	16KCPR: 120 Ring: Control Dependent, 1 count possible		16KCPR: 40 Ring: Control Dependent, 1 count po	
Uni-Directional Repeatability (±arc-sec) Angular conversion of 10µm at bull gear radius.	16KCPR: 30 Ring: Control Dependent, 1 count possible		16KCPR: 12 Ring: Control Dependent, 1 count po	
Resolution Choices	16KCPR: 16k @ motor Ring: 1µm, 0.5µm, 0.2µm, 0.1µm (100mm ring)		16KCPR: 16k @ motor Ring: 1µm, 0.5µm, 0.2µm, 0.1µm (150	
Table Resolution (KCPR) Measured in thousands of pulses per revolution of the table (KCPR).	16KCPR: 48 Ring: 314.9, 629.8, 1574, 3149		16KCPR: 80 Ring: 472, 944, 236, 4720	
Speed Limit (rpm) Note that maximum speed for ring encoder units decreases as resolution increases.	16KCPR: 1300 Ring: 1300-134		16KCPR: 800 Ring: 764-66	
Continuous Torque, N-m (motor) RMS torque allowed at table. Assume peak torque to be 3 times RMS torque for no longer than 3 seconds.	1.3(-1), 2.4(-2), 3.0(-3), 4.0(-4)		2.1(-1), 4.1(-2), 5.4(-3), 6.6(-4	
Load Capacity Axial/Radial (kN) Load capacity are for L10 rating life of 1 million table revolutions. Load capacity is not equivalent to payload. The ability to servo control a given payload is dependent on inertia, motion profile, duty cycle and control architecture.	14.0 / 26.0	7.0 / 4.0	48.0 / 39.0	14.0 /
Max. Moment (N-m) Moment loads are for L10 rating life of 1 million table revolutions.	480	120	1150	434
Rotational Inertia (kg-m^2) Rotational inertia of table.	16KCPR: 0.00048 Ring: 0.00093	16KCPR: 0.00051 Ring: 0.00096	16KCPR: 0.0033 Ring: 0.0050	16KCPR: (Ring: 0.(
Stage Weight (kg, less motor)	1.55	1.32	3.2	2.8
Recommended Payload Maximum (kg) Bearing capacity is far in excess of these numbers for enhanced bearing life. Ability to control recommended payloads entirely dependent on move profile and moment of inertia.	10		25	

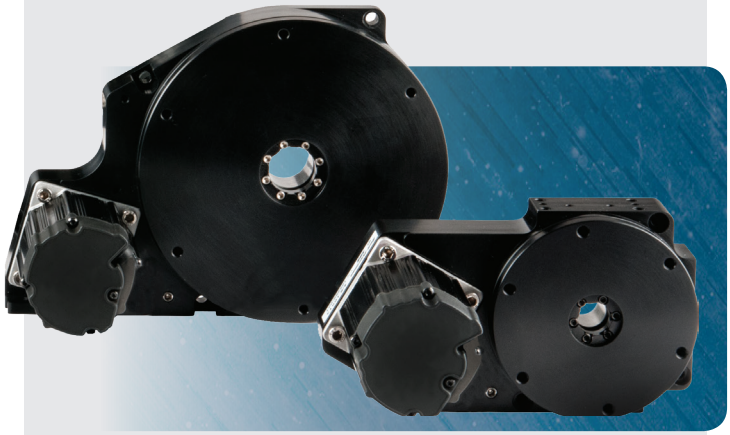
0-51	SBR-200
y	NEMA 23 or 34 11:1 Belt Drive Rotary
ct	Preloaded duplex angular contact
0.6	275 / 69.2
4.00 in.)	203.2 mm (8.00 in.)
	16KCPR: 60
	Ring: 66
	10
	30
	125
	16KCPR: 100
ssible	Ring: Control Dependent, 1 count possible
	16KCPR: 15
ssible	Ring: Control Dependent, 1 count possible
	16KCPR: 16k @ motor
mm ring)	Ring: 1µm, 0.5µm, 0.2µm, 0.1µm (225mm ring)
	16KCPR: 176
	Ring: 800, 1600, 4000, 8000
	16KCPR: 360
	Ring: 374-52
)	NEMA 23: 9.0(-2), 11.9(-3), 14.5(-4) NEMA 34: 20.0(-2), 30.0(-3), 38.0(-4)
8.0	21.0 / 12.0
4	1050
0.0060	16KCPR: 0.037
0070	Ring: 0.046
	7.5
	100

ServoBelt
Rotary Stages

Choose the best drive system.

LARGE THROUGH HOLES FOR EASY INTEGRATION

Many of our SBR Rotary stages feature an extra-large through hole, making it easy to pass power, signal, pneumatic, optical and other connections through the center of the stage. The large through hole also allows a tight integration between the positioning stage and related inspection, laser or robotic systems.



STANDARD THROUGH HOLES FOR COST SAVINGS

SBR Rotary stages with standard-sized through holes offer a more economical choice when fewer utilities need to pass through the center of the stage.

Configure and request a quote online at
www.bell-everman.com/servobelt-rotary

Direct Drive Theta

Low-profile stages for precision positioning and metrology.

Low Profile, Large Through Holes. DDT units are available in two sizes, both with ample space in the middle to bring power and utilities to the top of the stage. The DDT 100 offers a 15-mm through hole, and the DDT 200 has a 50-mm through hole. Both units are less than 50-mm tall.

Precise Angular Alignment. DDT Rotary stages provide superb angular alignment capabilities. The DDT 100 model has an accuracy of ±12 arc-sec, while the DDT 200 model has an accuracy of ±6 arc-sec. Both units have a bi-directional repeatability of ±1 encoder count.

Consistent Motor Tuning. DDT units have been engineered with extremely fine preload adjustments, which allow users to maintain consistent motor tuning.

Ease of Integration. DDT models install with just a four-bolt connection. Top plates can be configured to user specifications. The DDT 200 additionally offers three-point adjustable leveling mounts with a mechanism for tip, tilt and elevation adjustments.

Rugged. DDT features anodized aluminum construction with stainless steel hardware.

Configure Stages Online
www.bell-everman.com/direct-drive-theta

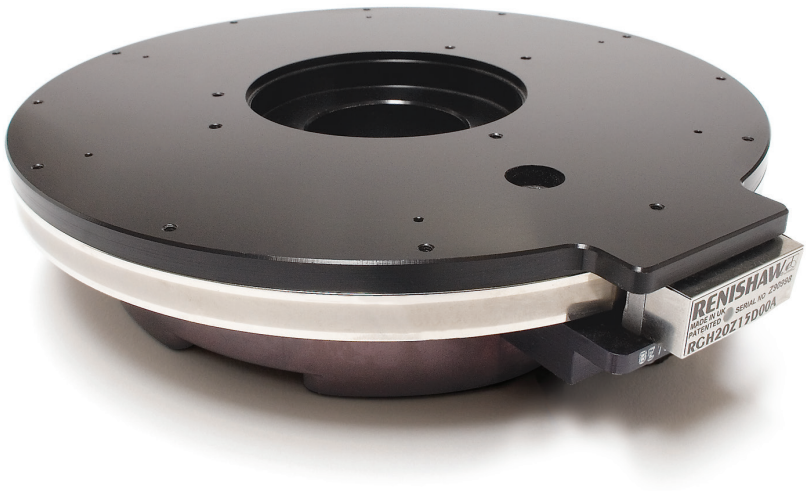
Technical Specifications	DDT-100	DDT-200
Type	Direct Drive Rotary	Direct Drive Rotary
Bearing Type	Preloaded duplex angular contact	Kingpost style angular contact
Motor Type	3-phase brushless	3-phase brushless
Through Hole	15 mm (0.59 in.)	50 mm (1.97 in.)
Accuracy (±arc-sec) Deviation from commanded angle.	12	6
Kinematic Wobble (±arc-sec) Tilt of rotary axis irrespective of table flatness or physical runout of table top.	15	12
Kinematic Radial Runout (µm TIR) In-plane wander of rotational centerline irrespective of table roundness or physical runout of table top OD.	8	8
Table Top Parallelism to Base (µm TIR) Total indicated worst-case parallelism top to bottom.	25	25
Table Top Physical Runout (µm TIR) Total indicated runout of the top of the rotating table under stationary indicator at the table's outer edge.	20	20
Repeatability	Control dependent ±1 count possible	Control dependent ±1 count possible
Resolution Choices (includes index pulse)	1µm, 0.5µm, 0.2µm, 0.1µm (75-mm ring)	1µm, 0.5µm, 0.2µm, 0.1µm (200-mm r
Table Resolution (KCPR) Measured in thousands of pulses per revolution of the table (KCPR).	236.8, 473.6, 1184, 2368	629.8, 1260, 3149, 6298
Speed Limit (rpm) Note that maximum speed for ring encoder units decreases as resolution increases.	178-1273	66-477
Continuous Torque, N-m (motor) RMS torque allowed at table. Assume peak torque to be 3 times RMS torque for no longer than 3 seconds.	0.74	1.07
Load Capacity Axial/Radial (kN) Load capacities are for L10 rating life of 1 million table revolutions. Load capacity is not equivalent to payload. The ability to servo control a given payload is dependent on inertia, motion profile, duty cycle and control architecture.	6.5/2.6	20.8/7.2
Max. Moment (N-m) Moment loads are for L10 rating life of 1 million table revolutions.	100	460
Rotational Inertia (kg-m^2) Rotational inertia of table.	0.0005	0.0052
Stage Weight (kg, less motor)	1.5	3.6

Direct Drive Theta

Rotary Stages

Choose the best drive system.

	DDT-200MT
	Direct Drive Rotary
	Kingpost style angular contact
	3-phase brushless
	50 mm (1.97 in.)
	6
	10
	8
	25
	5
e	Control dependent ±1 count possible
ring)	1µm, 0.5µm, 0.2µm, 0.1µm (200-mm ring)
	629.8, 1260, 3149, 6298
	66-477
	1.07
	20.8/7.2
	460
	0.0051
	4.5



Configure and request a quote online at
www.bell-everman.com/direct-drive-theta

Custom Rotary Stages

ServoBelt Rotary and Direct Drive Theta modifications.

While off-the-shelf rotary stages will do the job in most cases, sometimes your application requirements call for a customized stage. It may be something as simple as a special bolt-hole pattern on the top of the stage. Or you may need a way to secure a workpiece in the stage's center opening. Or you may need to squeeze a rotary positioning device into a tight space.

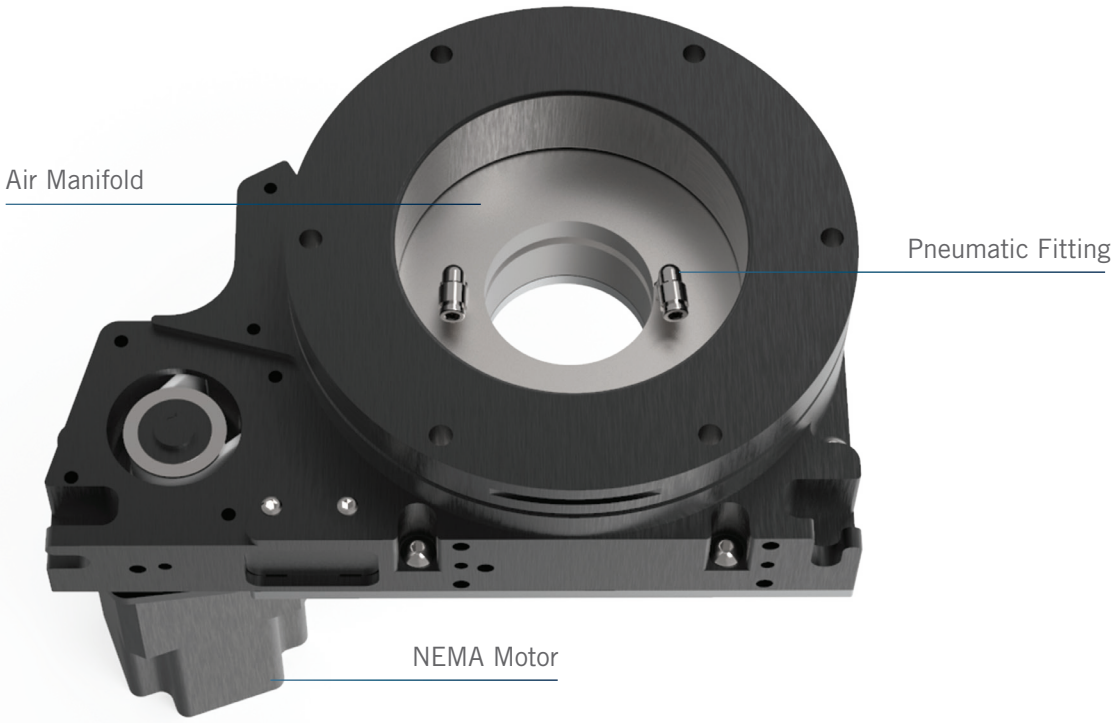
Whatever your requirements, we can help. We've introduced accessories and modular design features that make it easy to customize our standard ServoBelt (SBR) and Direct Drive Theta (DDT) Rotary stages. And in cases where our standard rotary platforms can't be modified to fit your requirements, we can often design and build one-of-a-kind rotary motion systems to your specifications.

Request A Custom Configuration
www.bell-everman.com/custom-rotary-stages

Three-Jaw Chuck

ServoBelt Rotary with Integrated Pneumatics

This custom version of a ServoBelt Rotary incorporates a rotating pneumatic system that fits almost entirely within the stage's large through hole.



Harsh Environment Rotary

This sealed wafer-chuck rotator provides precision motion within a harsh chemical and thermal environment.

Rotary Stage Customizations. Our customizations, many of which add no lead time to the stage, fall into six broad categories:

Mounting Flexibility. Custom bolt-hole patterns and other machined mounting features are the simplest and most common stage customizations. We can modify the tops and mounting surfaces of all our SBR and DDT models.

Workholding Solutions. Often, the most difficult part of using a rotary stage is securing devices to the stage top for tasks such as inspection, laser marking or CNC cutting. We've introduced a new and growing line of workholding accessories that mount seamlessly onto our rotary stages. These include air-actuated collet closers and three-jaw chucks to secure a variety of items.

Optimized Form Factor. Our standard stages are compact—both in profile and footprint. But sometimes you need a rotary positioning stage that has to fit in tight or oddly-shaped spaces. Our custom rotary positioning devices have met difficult space constraints on a variety of semiconductor, military and medical machines.

Challenging Environments. From vacuum systems to less-than-clean manufacturing processes, our rotary stages can be hardened and sealed to run reliably in environments that would shorten the life of an unprotected stage.

Drive Options. All of our stages can be set up with third-party motors and controls of your choosing. Assistance with motor sizing is always available from our engineering team.

Extra Precision and Accuracy. For applications with the most stringent run-out and parallelism requirements, we can precision-machine tops of fully assembled stages. We often go through this extra manufacturing step for stages used in metrology or semiconductor manufacturing.

Enclosed and Sealed Rotary Stage

Designed for a laser marking process, this custom rotary stage features integrated seals and a fully enclosed drive to keep contaminants from reducing positioning performance or lifecycle.

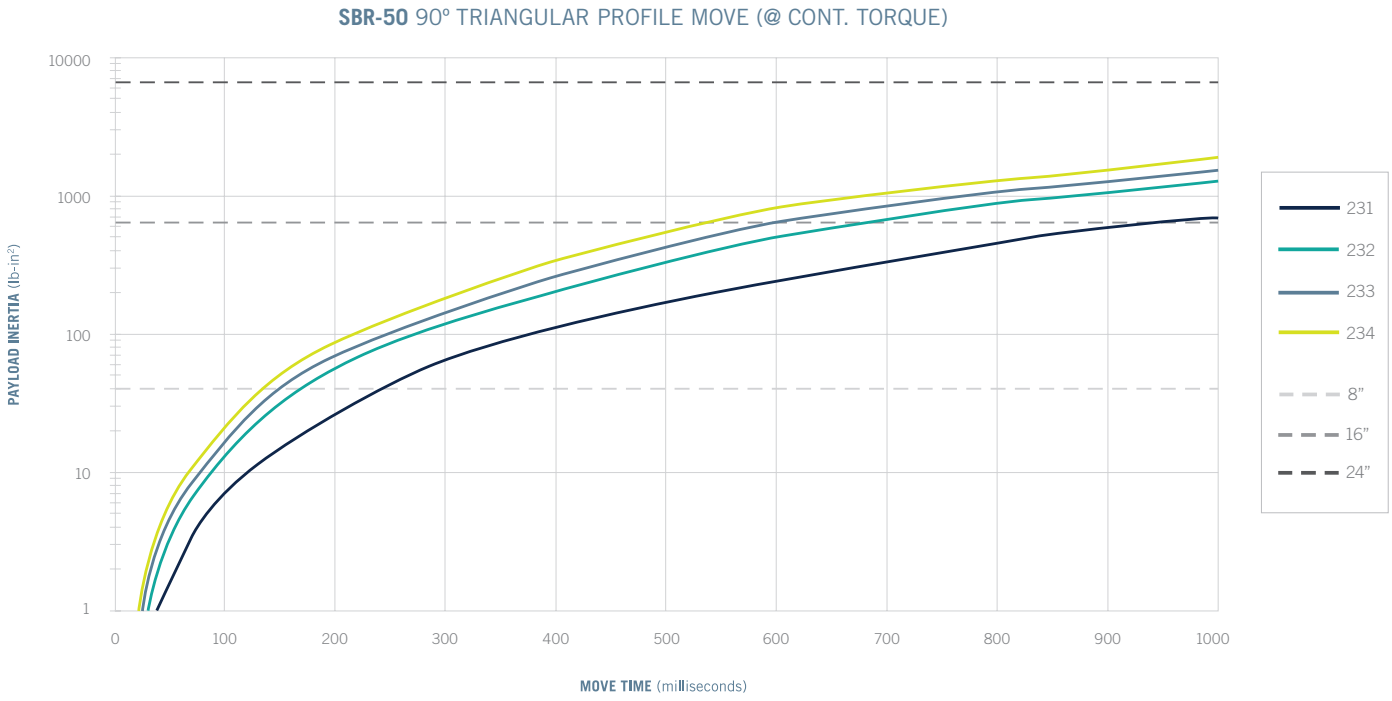
Request A Custom Configuration
www.bell-everman.com/custom-rotary-stages

Inertia Considerations
When Sizing Bell-Everman Rotary Stages

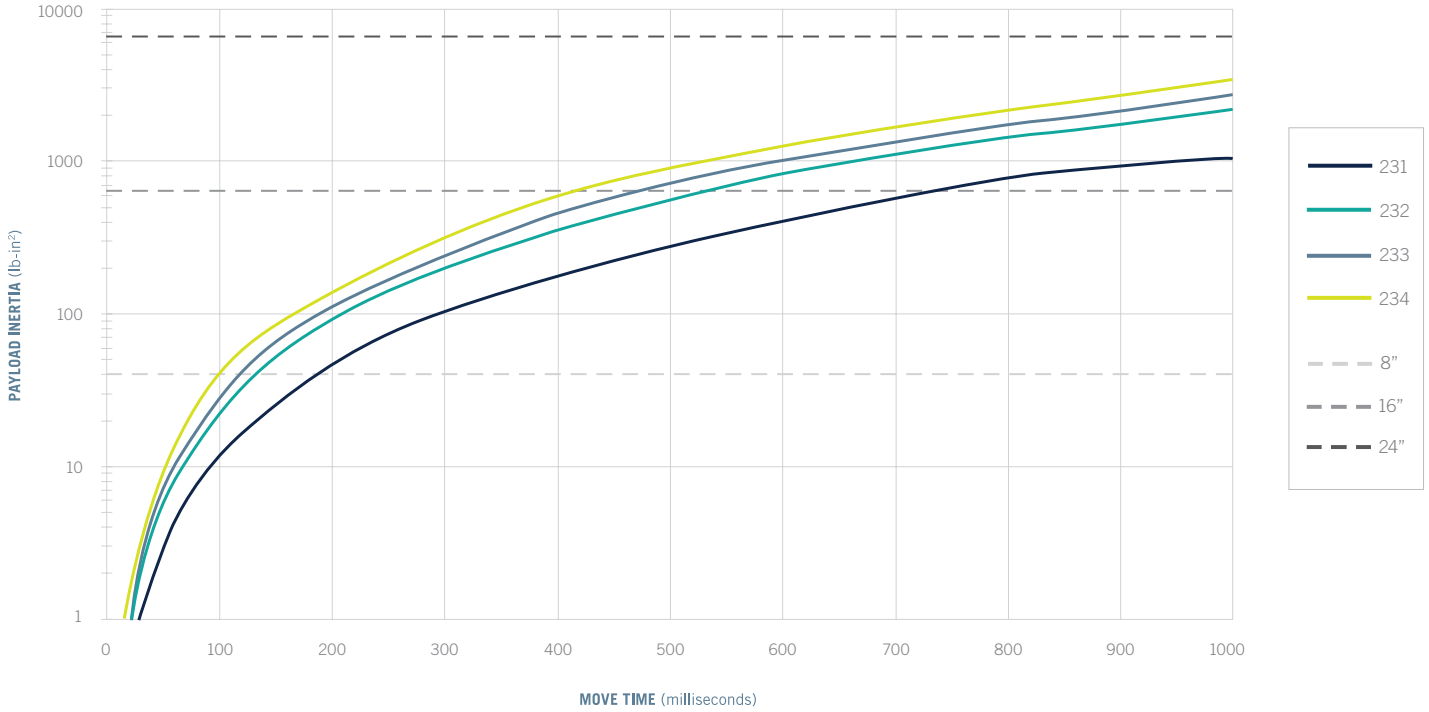
When specifying rotary stages, engineers understandably tend to focus on allowable payload. However, the actual mass of the payload on a ServoBelt Rotary (SBR) stage doesn't come into play because we use extremely robust duplex pair bearings that handle hundreds of pounds both statically and dynamically in the axial and radial directions without reducing service life. When sizing SBR stages, it's more important to pay attention to the payload's rotational inertia—also known as the polar or mass moment of inertia. The rotational inertia of the payload affects stage sizing because it **determines torque requirements** and **affects servo authority**.

Determines Torque Requirements
Continuous Torque Examples

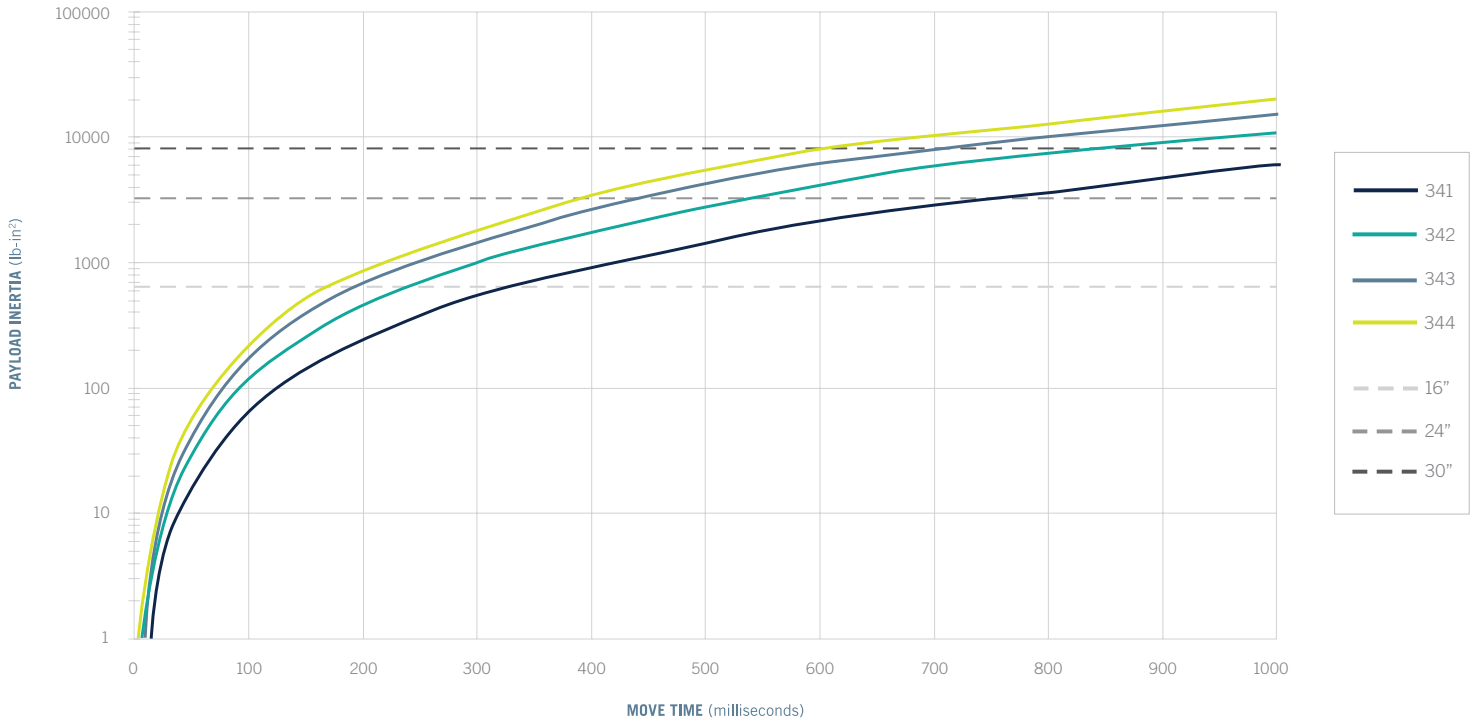
The rotational inertia of the payload determines the amount of torque the stage will need to provide to accelerate and decelerate the payload according to the desired motion profile and duty cycle. The following charts illustrate SBR's continuous torque capabilities. Horizontal dashed lines represent payloads that are one-inch thick circular aluminum plates of varying diameters. The motor designations indicate the NEMA size in the first two digits and the stack length in the last digit. Performance values are for Bell-Everman house motors.



SBR-100 90° TRIANGULAR PROFILE MOVE (@ CONT. TORQUE)



SBR-200 90° TRIANGULAR PROFILE MOVE (@ CONT. TORQUE)

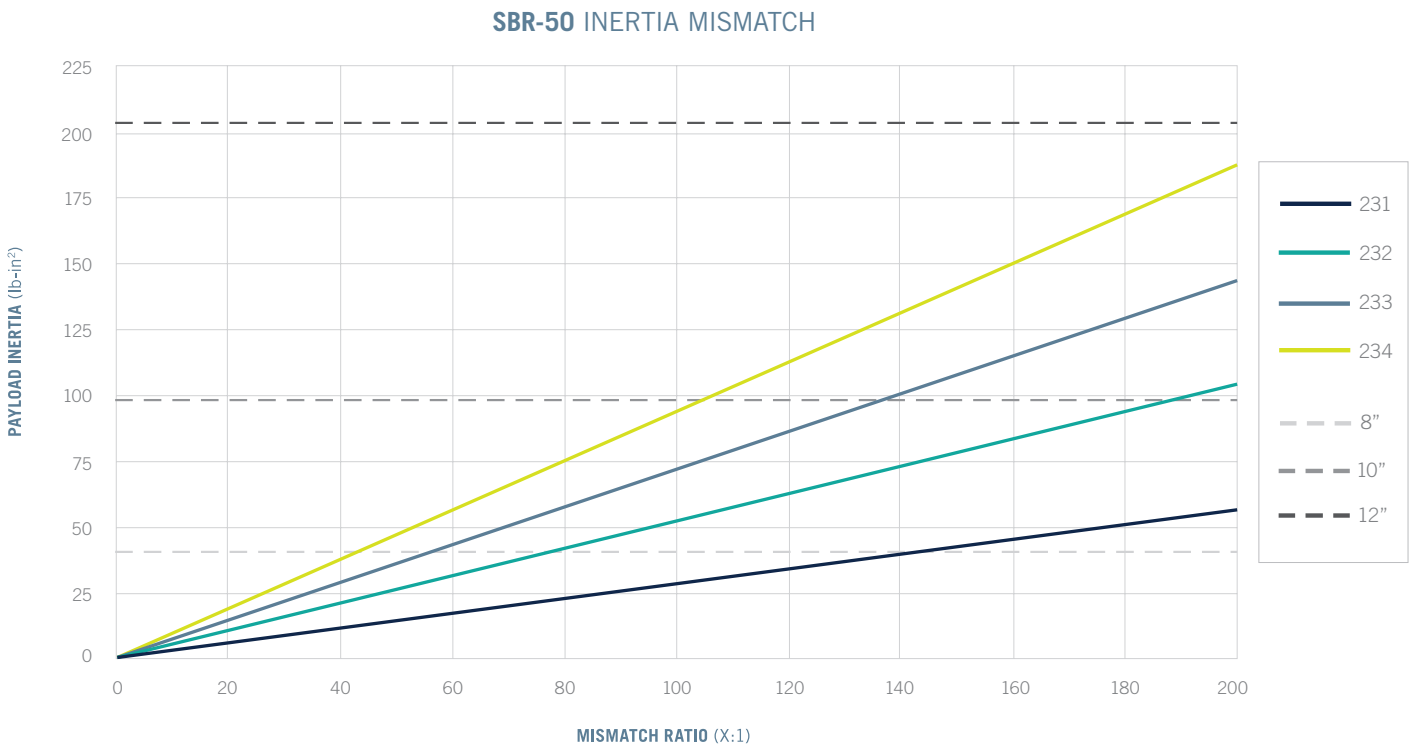


Affects Servo Authority

Inertia Mismatch Capabilities

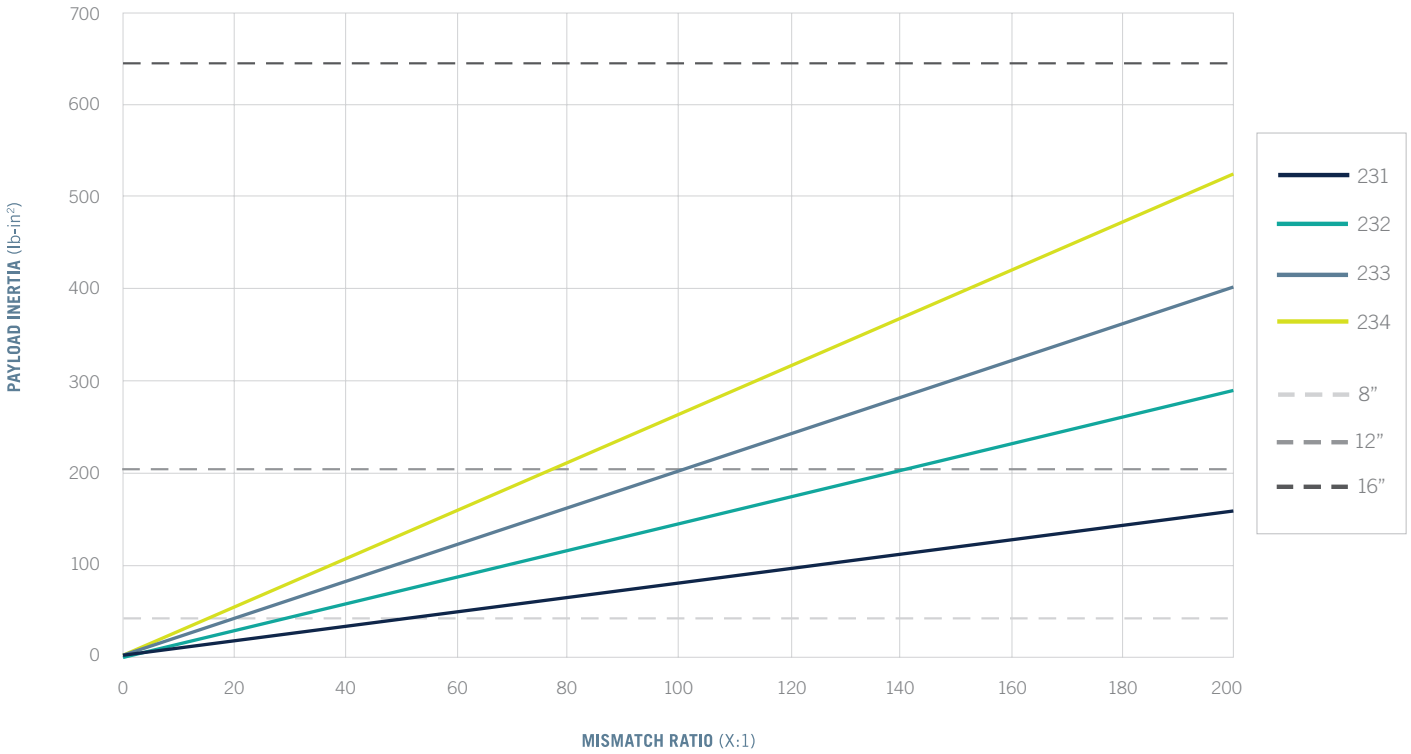
The rotational inertia influences the inertia mismatch between the payload and motor, which in turn affects the servo system's ability to control motion. While keeping the inertia mismatch below a 10:1 ratio is a good rule of thumb for applications using plug-and-play motors and drives, modern control systems can remain stable at far higher mismatches as long as you have no disturbances and are able to adjust the PID tuning. An SBR can easily be tuned for stable indexing at up to 200:1 and beyond.

Sample payloads are shown below with dotted lines representing one-inch thick aluminum plates of various outer diameters. This information can serve as a quick guide to controllable inertia ratios for different SBR and motor combinations. Other cases can be quickly assessed by mentally moving a dashed line downwards in proportion to your payload thickness. For example, if your table has a 12-inch diameter and 0.5-inch thickness, shift the 12-inch dashed line down by half to find the mismatch for a given house motor. Or, consider your actual payload inertia if known.

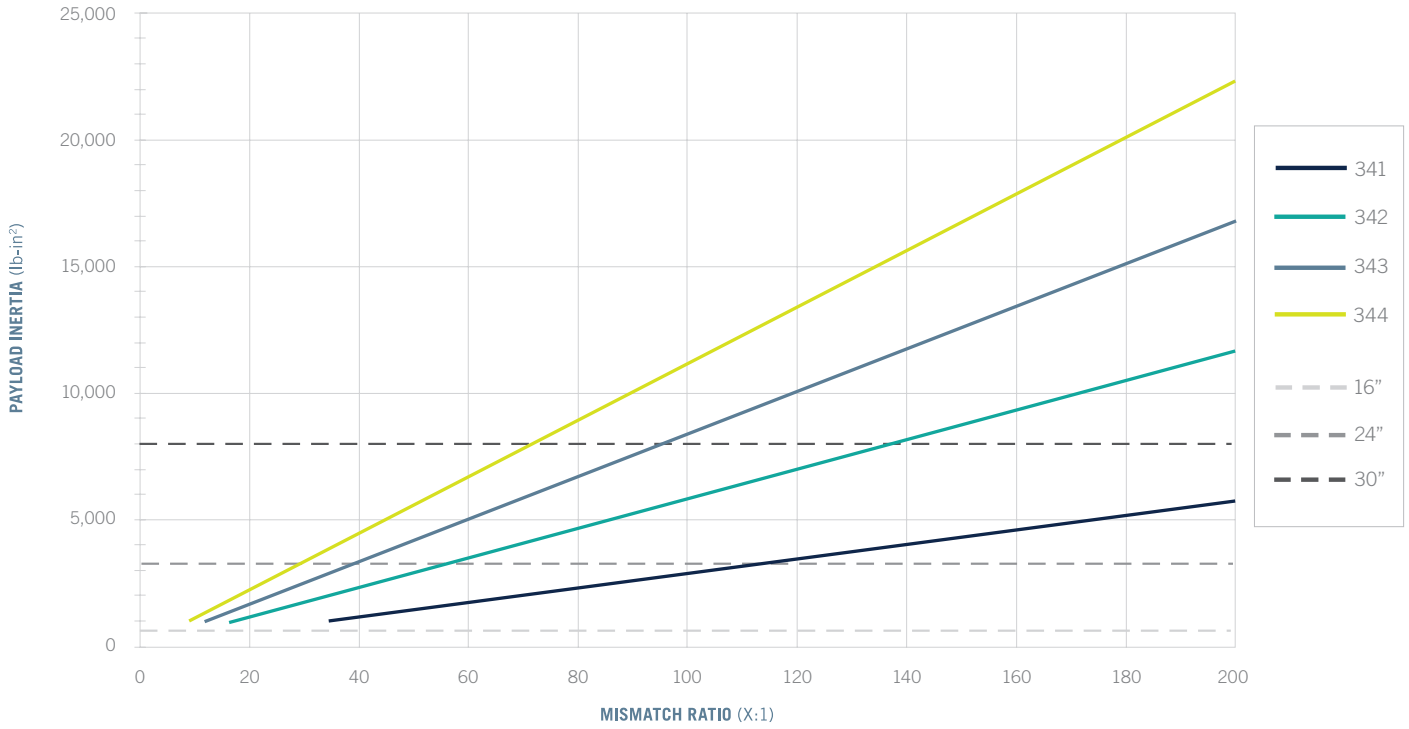


You can learn more about the importance of inertia when designing rotary stages at **www.bell-everman.com/inertia**

SBR-100 INERTIA MISMATCH



SBR-200 INERTIA MISMATCH



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