

Starting with the fundamentals

Coupling Basics

Starting from coupling fundamentals, learn about types, characteristics and how to select the couplings you need.

This booklet holds everything you need to know about the basics of couplings.



NBK®

The Motion Control Components

About Couplings

A coupling is a mechanical component that connects the drive shaft and driven shaft of a motor, etc., in order to transmit power.

Couplings introduce mechanical flexibility, providing tolerance for shaft misalignment. As a result, this coupling flexibility can reduce uneven wear on the bearing, equipment vibration, and other mechanical troubles due to misalignment.



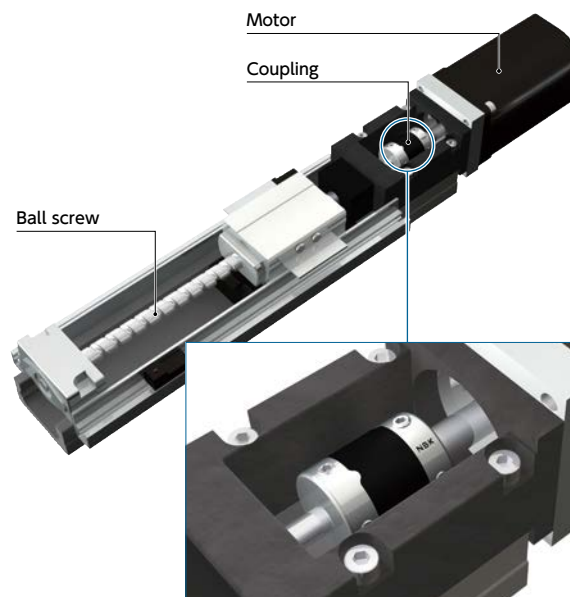
Why do we need couplings?

The main roles of a coupling include the following:

1. Connecting drive shafts of motors, etc. with driven shafts of ball screws etc. to transmit power.
2. Providing tolerance for errors (misalignment) between the cores of the drive shaft and the driven shaft.
3. Absorbing equipment impacts and vibration.
4. Improving equipment performance.

1. Connecting drive shafts with driven shafts to transmit power

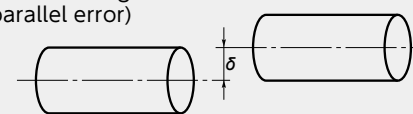
The most important role of a coupling is to connect the drive shaft of a motor etc. with the driven shaft of a ball screw etc. to transmit the motor power to the driven shaft, as shown in the figure below. There are various types of shaft fastening, such as “the set screw type” which fastens by directly pressing screws against the shaft, “the clamping type” which fastens with frictional force, and “the bushing type” which uses the wedge effect. Fastening Methods → P.9



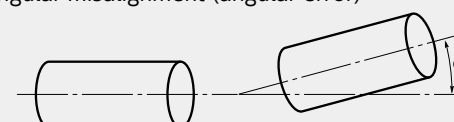
2. Providing tolerance for mounting errors (misalignment) between the drive shaft and the driven shaft

The offset between the cores of the driving shaft and the driven shaft is called misalignment. There are three different types of misalignment: lateral, angular, and axial (offset in axial direction). These should be minimized in order to avoid equipment issues such as vibration, noise, uneven wear on the bearing and so on. Alignment Adjustment → P.10

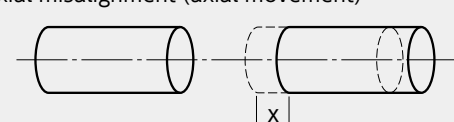
Lateral misalignment (parallel error)



Angular misalignment (angular error)



Axial misalignment (axial movement)



However, it is extremely difficult to completely eliminate misalignment when assembling equipment. Couplings provide tolerance for the misalignment remaining after assembly.

3. Absorbing equipment impacts and vibration

Jaw type couplings have elastic bodies such as elastomer built in as an intermediate component that functions to absorb impacts and vibration.












4. Improving equipment performance

Depending on the type of coupling, it can also work to improve equipment performance in addition to the roles described so far. As an example, high-gain rubber type couplings have integrally molded vibration-proof rubber that suppresses servomotor resonance. This improves limit gain, thus reducing stabilization time and improving productivity.

Types and Features of NBK's Couplings

Various types of couplings exist, each with their own strengths and fields of application.

Select the coupling best suited for the requirements of the equipment in which it is used, based on its characteristics.

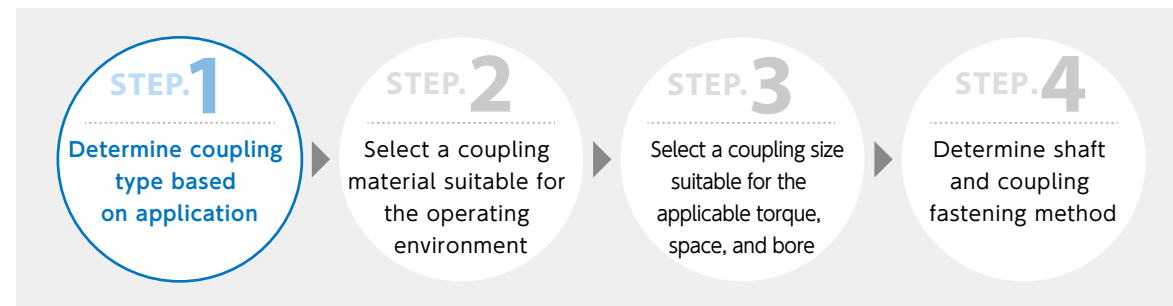
		High-gain Rubber Type	Disk Type	Jaw Type	Oldham Type		Slit Type	Rigid Type	Bellows Type	Cross Joint Type	Serration Type
											
Zero Backlash		◎	◎	△			◎	◎	◎	○	
High Torque		◎	○	◎	○		△	◎	△		△
Allowable Misalignment		○	○	○	◎		△		○	○	○
Cost		○	△	○	◎		△	◎	○	△	◎
Torsional Stiffness		○	◎	△			○	◎	○	○	
Vibration Absorption Characteristics		◎		○							
Applicable Motors	Servo/Stepping	◎	○	○			△	○		○	
	General-purpose	○		◎	◎						◎
Characteristics		Best suited for servomotors Integrally molded vibration-proof rubber that suppresses servomotor resonance. Shortens the stabilization time required for equipment setting and contributes to productivity improvement.	Supports servomotor performance second only to rubber types Disk (metal spring) flexibility allows for misalignment. Highest torsional rigidity among flexible couplings.	Best suited for power transmission applications High torque can be transmitted. Resin sleeve placed in the middle of the structure provides cushioning that damps vibration and absorbs shock.	High allowable misalignment Sliding of the spacer in the middle portion accommodates larger misalignment. Easily mounted and ideal as well when accurate alignment adjustment cannot be done.		Classical type that can also be custom made The simple structure consists of a slitted metal cylinder. Various materials are available, so couplings can be manufactured to match the operating environment.	Highly coaxial fastening Ideal for connecting to two shafts, as it does not tolerate misalignment and has extremely high coaxiality. Highest torsional rigidity among all couplings.	Best suited for encoders Metal bellows tolerate misalignments. Ideal for encoders, as revolution at constant speed can be achieved even in the presence of misalignment.	Reduces load on shaft Since there is minimal eccentric reaction force due to misalignment, the force acting on the bearing is small and thus unlikely to apply load to peripheral devices.	Low cost Separable components enable easy assembling.
NBK Representative Products		XGT2 XGT-CS	XHW	MJC	MOR		MST	XRP	MFB	XUT	MSF

◎=Excellent ○=Very Good △=Good

How to Select Miniature Couplings

As seen on the previous page, various types of couplings exist. This section discusses how to select the optimal coupling type.

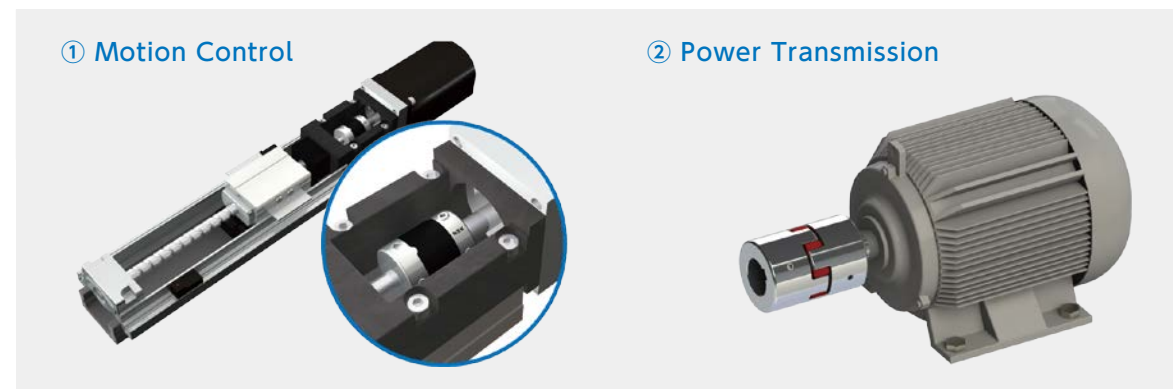
Standard miniature couplings selection procedure



4 simple steps to selection.
This section discusses "Step 1 Determine coupling type based on application".

Step 1 Determine coupling type based on application

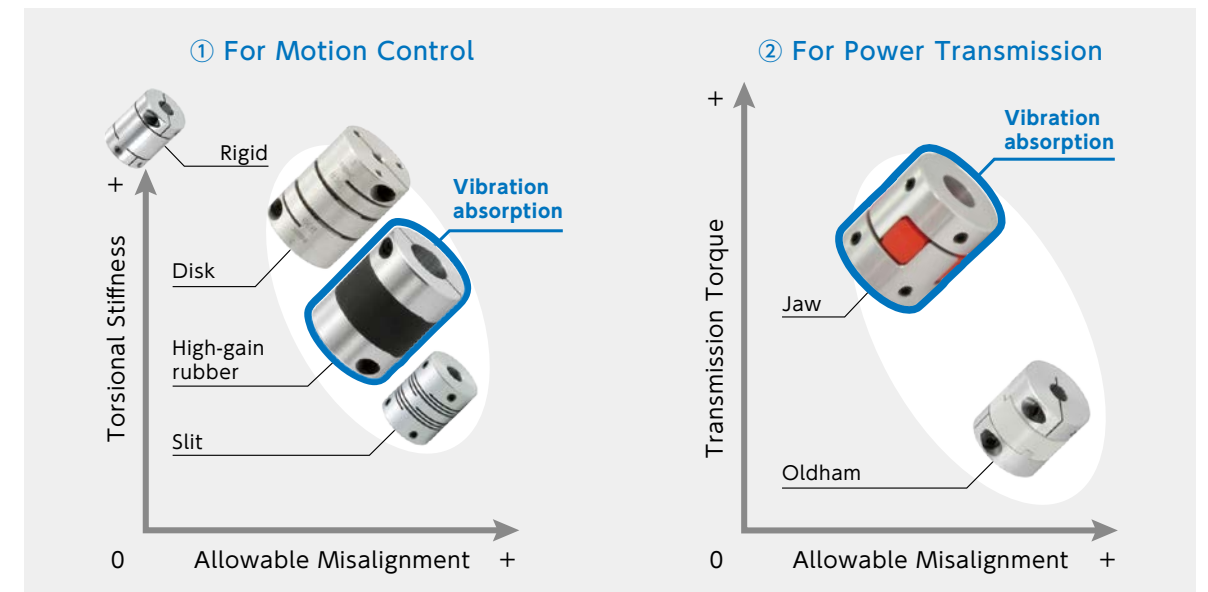
FA Miniature Couplings - Two Applications



FA miniature coupling applications can be roughly divided into two categories. The first is "motion control," in which the movement of a device is controlled, such as the use of couplings for servomotors or stepping motors. The other application is "power transmission," in which couplings are combined with general-purpose motors.

For "motion control", couplings require positioning accuracy. Accordingly, it is essential to select a type without chatter in the rotation direction, or in other words, a zero backlash type. Elsewhere, for "power transmission," couplings with high torque transmission strength are called for.

Performance Chart of Couplings by Type



* Simplified figure

① For "motion control"

Previously the use of disk couplings, featuring an all-metal body with high torsional rigidity, was recommended. However, now that motor performance has dramatically improved, high-gain rubber couplings are ideal. High vibration absorption and optimal torsional rigidity prevent system resonance, allowing motor performance to be maximized. On the other hand, depending on the equipment and environment, the continued use of traditional types may be preferable. For these applications, we recommend slit couplings with a simple integrated structure. Rigid couplings with superbly high precision are ideal for connecting to two shafts, as they do not tolerate misalignment and have extremely high coaxiality.

② For "power transmission"

In general, jaw couplings are ideal. High torque can be transmitted, and their misalignment tolerance is excellent. Jaw couplings, which also have vibration absorption properties, are adopted for use in a wide range of applications. For even higher misalignment tolerance, the use of Oldham type couplings is recommended.

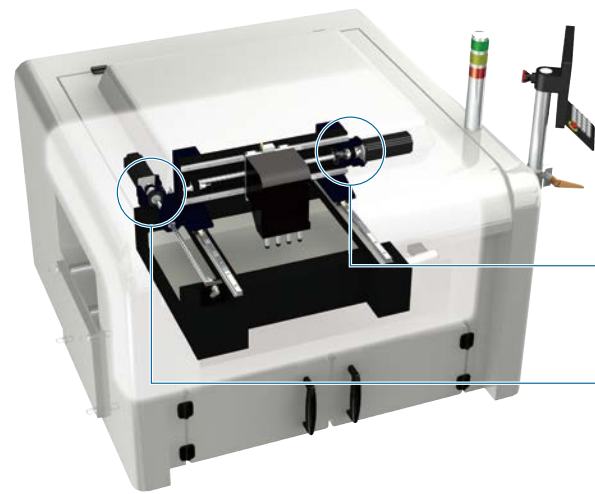
Focusing on the applications of miniature couplings, the ideal coupling type for each application can be selected from among multiple options, depending on the characteristics called for, such as vibration absorption and torsional rigidity.

From Step 2 on...

Once the coupling type is chosen in Step 1, the next three steps ("Material selection," "Size selection," and "Fastening method selection") are relatively simple. Try selecting your couplings on the NBK website, which makes the process even easier by allowing selection via these criteria.

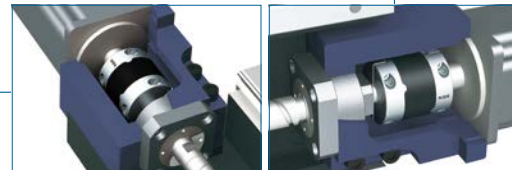
* The above comparison figure is simplified to clarify the general characteristics of each type. Each type of coupling introduced has a performance range of torsional rigidity, etc., depending on the coupling size and material.

Examples of Coupling Use



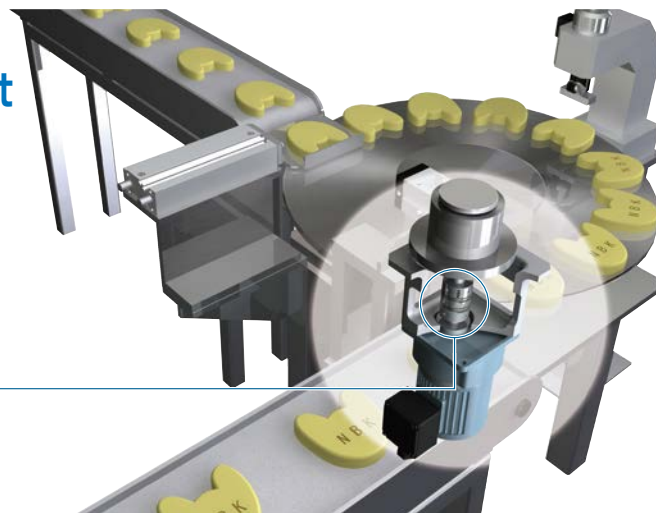
Equipment Use Example 01 Surface-Mount Machine

- Equipment issue: Improve productivity (high throughput)
- Selection point: Reduced settling time due to the high-gain compatible servo motor
- Product used: High-gain rubber type **XGT2**



Equipment Use Example 02 Confectionery Equipment

- Equipment issue: Corrosion resistance
- Selection point: All-stainless steel couplings
- Product used: Slit type **MSTS**



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NBK Couplings Search

Even more equipment use examples, points for achieving a higher speed servo system and various other useful information can be accessed.

Glossary

Rated Torque

The torque value that the coupling can transmit continuously.
This value allows for load fluctuations during operation, so rated torque compensation is not required when making a selection (excluding Oldham types).
Select a coupling such that the load torque generated during continuous operation does not exceed the rated torque.

Maximum Torque

The torque value that the coupling can transmit momentarily.

Misalignment

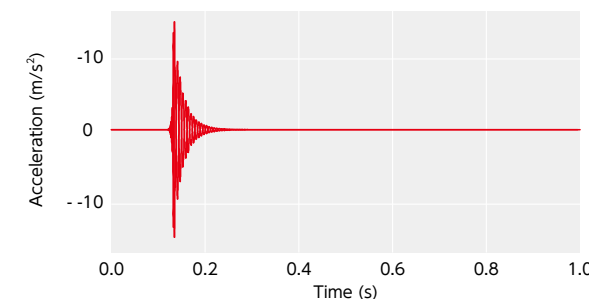
Shaft core error. There are three types of misalignment: lateral, angular, and axial.
Alignment Adjustment → P.10

Maximum Rotational Frequency

The maximum rotational frequency at which the coupling can be used.
This indicates the calculated value for a peripheral speed of 33m/s, at which tests have confirmed that there will be no damage. (Excluding **MOM** **MOHS** **MKM** **MWBS**)

Damping Ratio

This parameter shows the damping characteristics in terms of vibration amplitude.
XGT2 **XGL2** **XGS2** have high damping ratios and can increase servomotor gain.

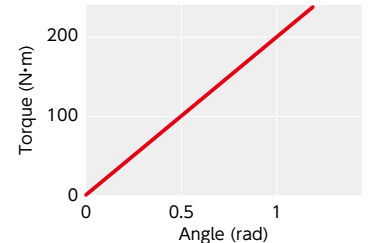


Moment of Inertia

This value indicates the coupling's resistance to rotation. The lower the moment of inertia, the less load torque is required when starting and stopping.

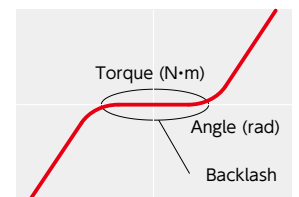
Static Torsional Stiffness

This is the coupling's rigidity with respect to torsion, with the slope of the below graph indicating the static torsional stiffness.
It indicates static torsional stiffness for the entire coupling, including the hub, not only the deflection area.



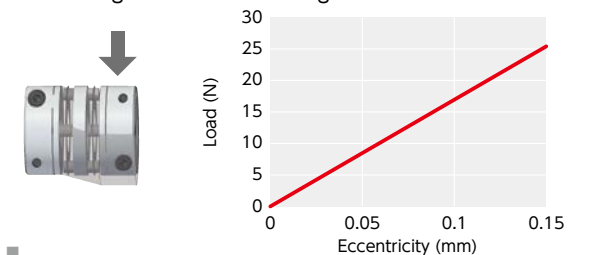
Backlash

This is rattling in the coupling's direction of rotation.
When high-precision positioning is required, select a zero backlash coupling.



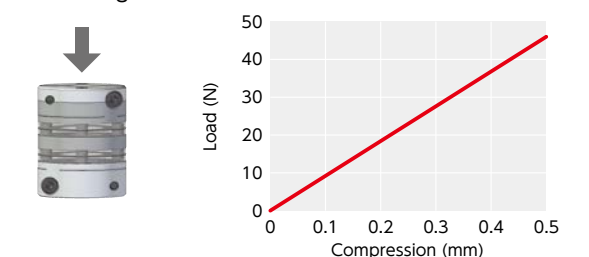
Eccentric Reaction Force

This is the force generated when placing a coupling in an eccentric condition.
As the eccentric reaction force becomes smaller, the force acting on the shaft bearing also becomes smaller.



Thrust Reaction Force

This is the force generated when compressing a coupling in the axial direction.
As the thrust reaction force becomes smaller, the force acting on the motor also becomes smaller.



Fastening Methods / Alignment Adjustment

Fastening Methods

The following 7 types of methods for fastening couplings to shafts exist. Select one to suit the application.

① Set Screw Type

Inexpensive, this is the most commonly used fastening method. However, care must be taken as the screw tip directly contacts the shaft, possibly scratching it or making it difficult to remove.



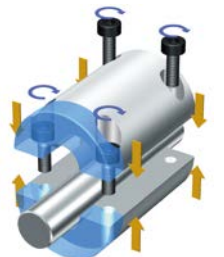
② Clamping Type

The screw fastening force compresses the bore, clamping the shaft. Mounting and removing are easy and there is no risk of scratching the shaft.



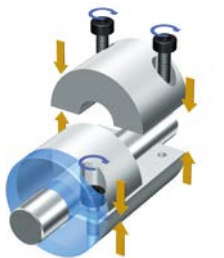
③ Split Type

The bore part can be completely split. As such, mounting and removing can be done easily without moving the equipment. There is also no risk of scratching the shaft.



④ Semi-split Type

A fastening method in which one end of the hub is clamping type, while the other is split type. This allows the split side alone to be connected to equipment while the clamping side remains in the fastened state.



⑤ Key Type

A general fastening method similar to the set screw type, but enabling use for relatively higher torque transmission applications. Used together with a set screw or clamping type mechanism to prevent movement in the axial direction.



⑥ Bushing Type

Secure and stable fastening can be achieved with this fastening method, utilizing the wedge effect of the taper. Suitable for high torque transmission and ideal for machine tool spindles.



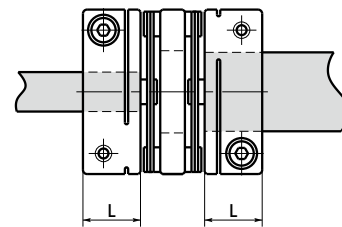
⑦ Adapter + Clamping Type

A clamping type with an adapter inserted that allows it to be used with the 1/10 taper shafts of servomotors.



Shaft Insertion Amount

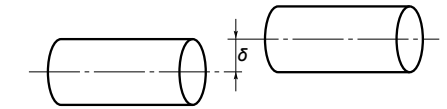
The length of the shaft that should be inserted into the coupling is the hub length (L dimension) listed in the catalog. If the inserted amount is too short, the shaft may slip or the clamping part may break. If the inserted amount is too long, there may be shaft interference within the coupling, leading to damage.



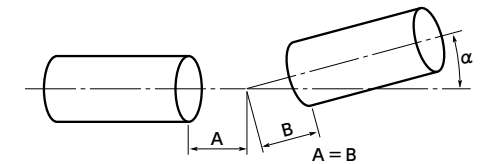
Alignment Adjustment

- Flexible couplings can tolerate misalignment and still transmit the rotation angle or torque, but if the misalignment exceeds the allowable value then vibration will occur, rapidly shortening the coupling life. Be sure to perform alignment adjustment.
- Types of shaft misalignment include lateral (parallel error between the two shaft cores), angular (angular error between the two shaft cores) and axial (movement of the shaft in the axial direction). Adjust the shaft alignment so as not to exceed the allowable value listed in the NBK General Catalog dimensions/performance tables.
- The allowable value for misalignment listed in the dimensions/performance tables assumes only one form of misalignment: lateral, angular, or axial. For composite misalignment with two or more sources, each allowable value should be 1/2 of the listed value.
- Misalignment can be caused not only when installing in equipment, but also by vibration during operation, thermal expansion, bearing wear, etc. As such, we recommend keeping misalignment at or below 1/3 of the allowable value.

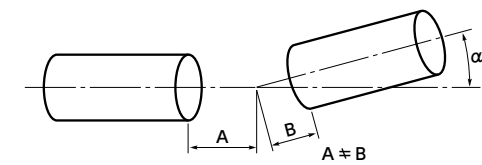
• Lateral Misalignment



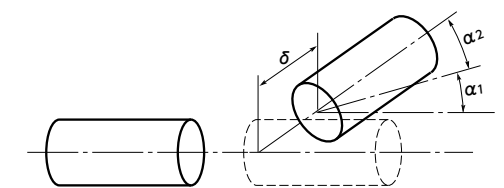
• Angular Misalignment (Core Match)



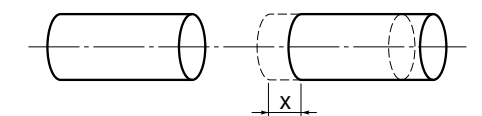
• Angular Misalignment (Core Mismatch)



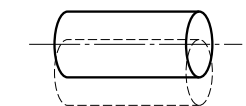
• Composite Lateral and Angular Misalignment



• Axial Misalignment



• Runout



Overcome Your Challenges!



The Motion Control Components

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We look forward to your visit.**

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