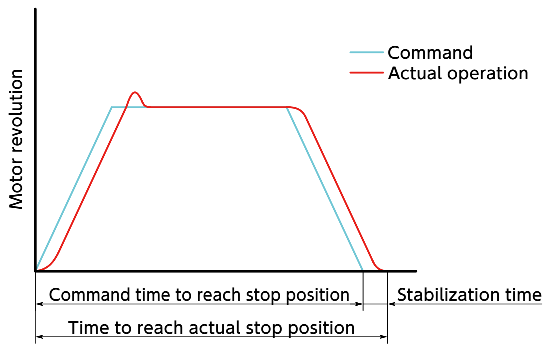
Technical Information

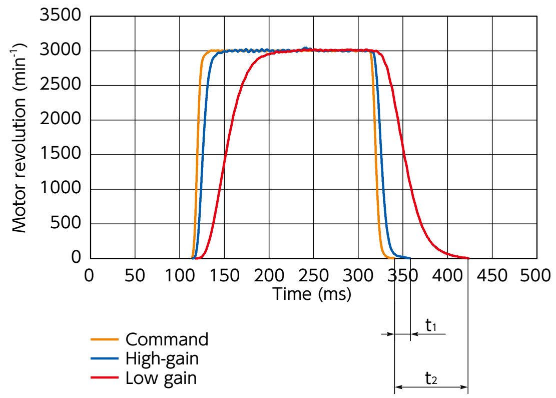
● Productivity and stabilization time

In a production facility which uses servomotors, single-axis actuators and ball screws, the key to improved productivity is operating these components accurately, as directed by a program. However, occasionally the command execution may be delayed.
For example, when trying to stop the actuator at a predetermined position, sometimes it will stop later than the command, which we refer to as a delay in stabilization time. Since the operation does not shift to the next process until the actuator completely stops, it is important to shorten stabilization time and thereby improve productivity.



● Gain and stabilization time of servomotor

This shows how the servomotor gain movement follows the command.
Increasing the gain helps to reduce stabilization time, but increasing it too far causes hunting, making servomotor control impossible.
Increasing the gain while suppressing hunting requires fine adjustment of the servomotor parameters.
However, when a servomotor is combined with a coupling with a metal disk type in the elastic segment, raising the gain tends to cause hunting, making it difficult to resolve the problem by fine adjustments to parameters.
When hunting occurs, it is generally recommended to change to a coupling with higher rigidity to increase the rigidity of the rotating system.
However, in reality, it may not be effective to increase the rigidity of the entire rotating system including the ball screw simply by increasing coupling rigidity.



t_1: Stabilization time at high-gain
t_2: Stabilization time at low-gain

● The Vibration-Absorption Capable Disk Type

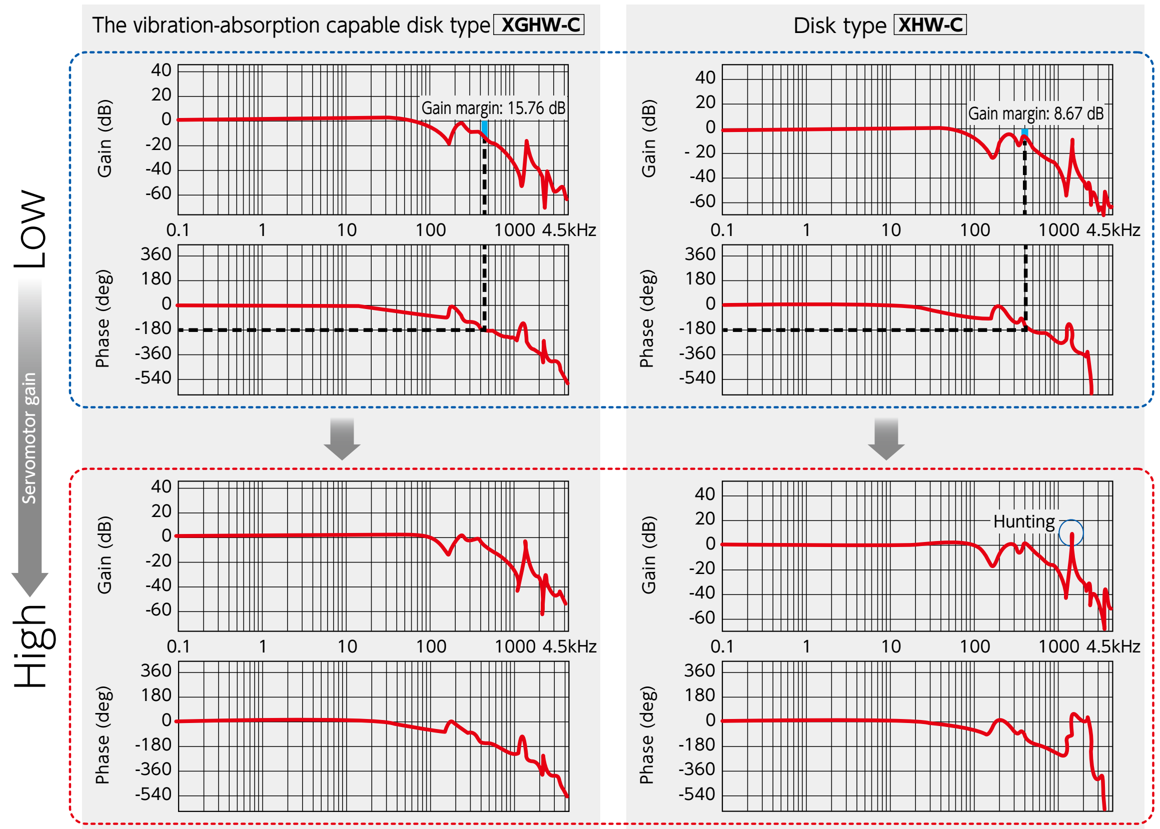
The vibration-absorption capable disk type **XGHW-C** has a dynamic vibration absorber on the high rigidity disk. It enables vibration absorption and use of higher gain levels when compared to regular disk types, thereby also allowing a shorter stabilization time. The vibration absorption function reduces the amount of parameter adjustment work, and lowers the time required to find optimal parameters.

● Why can gain be increased even further with the vibration-absorption capable disk type XGHW-C when compared with the disk type XHW-C ?

The Bode plot clearly illustrates why **XGHW-C** can increase servomotor gain beyond the capacity of disk types **XHW-C**.
The width of the gain relative to 0 dB when the phase delay on the Bode plot is –180° is called the gain margin and the phase width relative to the frequency intersecting at 180° is called the phase margin.
General guidelines for servo systems call for setting the gain margin between 10 and 20 dB and the phase margin between 40° and 60°, but as the servomotor gain is increased, the gain margin decreases. When the gain margin falls below 10 dB, hunting tends to occur.
A comparison of the **XGHW-C** and **XHW-C** limit gain (upper limit of the gain in which coupling can be used without hunting) shows not only that **XGHW-C** features a larger gain margin, but that in fact the gain margin is over 10 dB. This is why the servomotor gain is greater in **XGHW-C** compared to **XHW-C**.

Gain margin at the disk type limit gain
XGHW-C : 15.76dB
XHW-C : 8.67dB

● Bode Plot



● Larger gain margin compared to **XHW-C**
● Allows higher servomotor gain settings

● Smaller gain margin compared to **XGHW-C** increases the risk of hunting

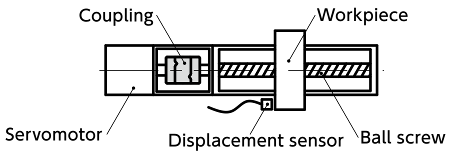
Technical Information

Comparison of The Vibration-Absorption Capable Disk Type and Disk Type

In tests using servomotors and actuators, the following information is confirmed.

- Stabilization Time
  Increasing the gain enables the stabilization time to be shortened, and the gain can be set especially high with the vibration-absorption capable disk type when compared to the disk type.
- Positioning Accuracy/Repeated Positioning Accuracy
  No differences attributable to factors such as gain or coupling were observed.
- Overshoot
  Increasing the gain increases the overshoot, and the same gain resulted in no difference in the overshoot.
- Conclusion
  The vibration-absorption capable disk type allows higher gain to be set than the disk type, enabling shorter stabilization time. The positioning accuracy, repetition positioning accuracy and overshoot did not differ due to coupling.
  As a result, it was confirmed that the vibration-absorption capable disk type is effective for shortening the cycle time of devices and equipment.

- Test Devices
  Actuator : KR30H Manufactured by THK (Co., Ltd.)
  ∗ Ball screw lead 10 mm
  Servomotor : HG-KR13 Manufactured by Mitsubishi Electric Corporation
- Test Conditions
  Motor revolution : 3000 min^{-1}
  Acceleration/deceleration time : 50 ms
  Workpiece load : 3.0 kg
  Ratio of moment of inertia of load : 2.3
- Test Operation
  Normal rotation (1 rev) → Stop (500 ms) → Reverse rotation (1 rev)
- Test Method
  A displacement sensor is used to measure work movement, travel distance and stabilization time.

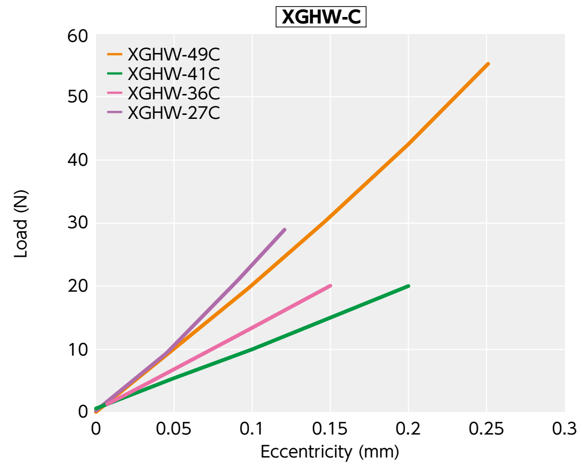


- Measurement of Stabilization Time, Positioning Accuracy and Overshoot

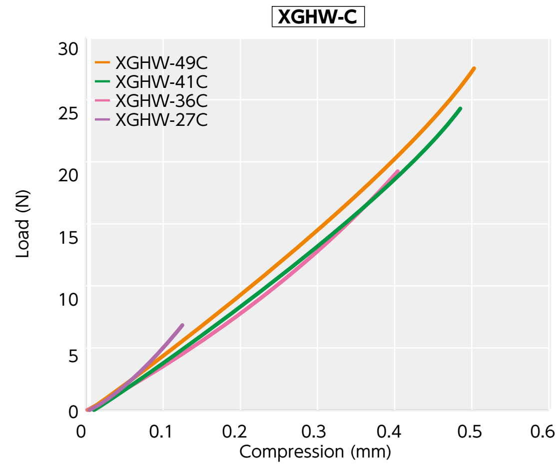
Gain∗1		The Vibration-Absorption Capable Disk Type	Disk Type	Consideration
23	Stabilization Time (ms)	35	32	This is the upper gain limit for the disk type. The vibration-absorption capable disk type can be used without any problems.
	Positioning Accuracy (mm)	0.014	0.014	
	Repeated Positioning Accuracy (mm)	±0.002	±0.002	
	Overshoot (μm)	1	1	
32	Stabilization Time (ms)	8	Occurrence of Hunting	This is the upper gain limit for the vibration-absorption capable disk type. The disk type is not usable due to hunting.
	Positioning Accuracy (mm)	0.016		
	Repeated Positioning Accuracy (mm)	±0.001		
	Overshoot (μm)	2		

∗1 : Values with all gains, such as position control gain and speed control gain, adjusted (Min: 1 - Max: 32)
Positioning Accuracy
: Positioning operation is performed and the absolute value of the difference between the target point and the actual stop position is determined. Max. value is found by performing this measurement from the home position at all positions within the max. stroke range.
Repeated Positioning Accuracy
: Positioning is repeated 7 times from the same direction of movement to a randomly-selected point, the stopping positions are measured, and the difference between the max. and minimum values of the stopping position is determined. This method of measurement is applied at positions at the middle and both ends of the max. stroke range, then the max. value becomes the measured value, halved and prefixed with ±.
- The values in the table vary depending on testing conditions.

Eccentric Reaction Force

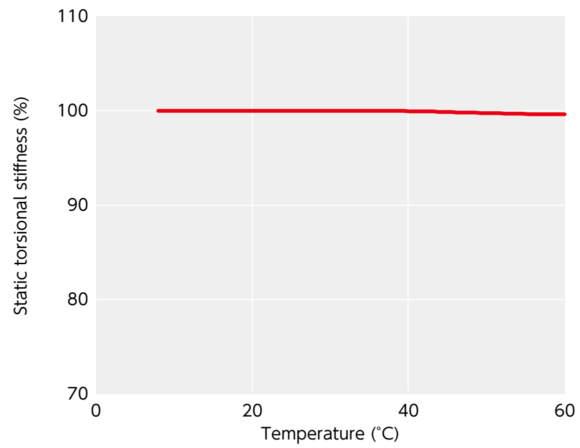


Thrust Reaction Force



Change in static torsional stiffness due to temperature

This is a value under the condition where the static torsional stiffness at 20℃ is 100%.
The change of XGHW-C in torsional stiffness due to temperature is small and the change in positioning accuracy is extremely small. If the unit is used under higher temperature, be careful about misalignment due to elongation or deflection of the shaft associated with thermal expansion.



Slip Torque

As in the table below, the clamping type XGHW-C has different slip torque according to the bore diameter.
Take care during selection.

Unit : N・m

Outside Diameter	Bore Diameter (mm)								
	3	4	5	6	6.35	8	9.525	10	11
27	0.7	1.7	3						
36		2	2.9	4	4.2	5.8			
41			3.5	4.9	5.5	7.9	10	11	12
49				6	8	13	18	19	23

- These are test values based on the conditions of shaft dimensional allowance: h7, hardness: 34 - 40 HRC, and screw tightening torque of the values described in XGHW-C dimension tables. They are not guaranteed values.
- Slip torque changes with usage conditions. Carry out tests under conditions similar to actual conditions in advance.