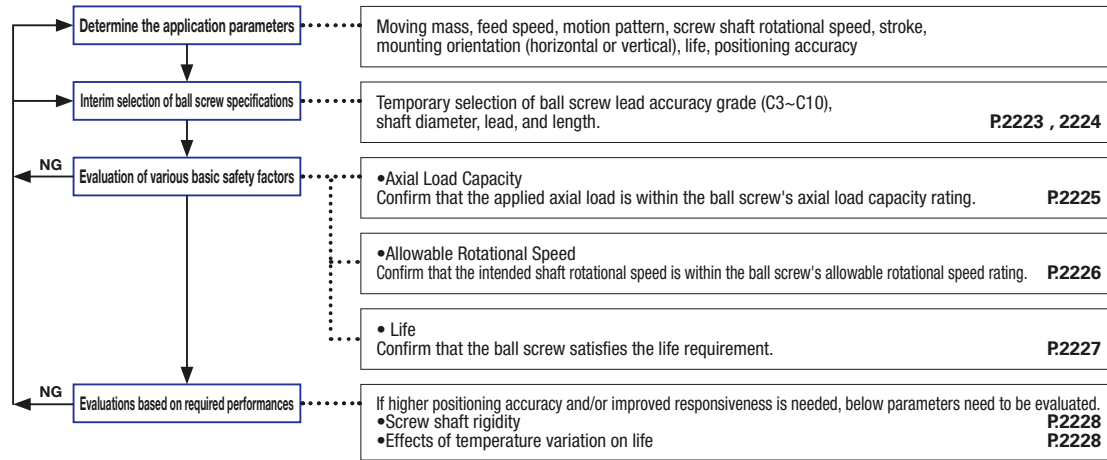


[Technical Data] Selection of Ball Screws 1

1. Ball Screw Selection Procedure

Basic ball screw selection procedure and required evaluation items are shown below.

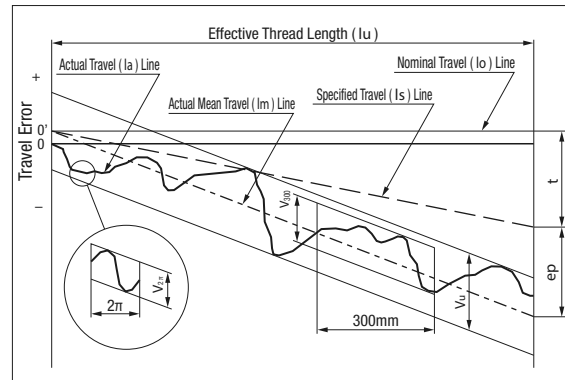


2. Ball Screw Lead Accuracy

Ball screw lead accuracy is defined by JIS Standards property parameters (ep, Vu, V300, V2π).

Parameter definitions and allowable values are shown below.

In general, a ball screw lead accuracy grade is selected by evaluating if the Actual Mean Travel Error of a candidate is within the allowable positioning error.



Terms	Symbols	Meaning
Actual Mean Travel Error	ep	A value that is Specified Travel subtracted from Actual Mean Travel.
Variation	Vu	The maximum difference of the actual travel contained between two lines drawn parallel to the actual mean travel, and is defined by three parameters below.
	V300	Variation for the effective thread length of screw shaft.
	V2π	Variation for an arbitrarily taken length of 300mm within the effective thread length of screw shaft.
Specified Travel	ls	Axial travel compensated for temperature rise and loading conditions, in relation to the Nominal Travel (Lead).
Specified Travel Target Value	t	A value that is Nominal Travel subtracted from Specified Travel, over the effective thread length. This value is set to compensate for possible screw shaft expansion and contraction due to temperature changes and applied loads. The value is to be determined based on experiments or experiences.
Actual Travel	la	Actually measured travel distance
Actual Mean Travel	lm	A straight line representing the actual travel trend. A straight line obtained by the least-squares method or other approximation methods from the curve representing the actual travel.

Table 1. Positioning Screw (C Class) Actual Mean Travel Error (±ep) and Variation (Vu) allowances Unit: μm

Thread Effective Length (mm)	Accuracy Grade				
	C3		C5		
over	or less	Actual Mean Travel Error	Variation	Actual Mean Travel Error	Variation
315	400	12	8	23	18
400	500	13	10	25	20
500	630	15	10	27	20
630	800	16	12	30	23
800	1000	18	13	35	25
1000	1250	21	15	40	27
1250	1600	24	16	46	30
		29	18	54	35

Table 2. Positioning Screws (C Class) variation per 300mm (300) Variation per rotation (2π) standard values Unit: μm

Accuracy Grade	C3		C5	
	V300	V2π	V300	V2π
Parameters				
Standard Values	8	6	18	8

Table 3. Transfer Screw (Ct Class) variation per 300mm (V300) Standards Unit: μm

Accuracy Grade	Ct7		Ct10	
	V300			
		52		210

Actual Mean Travel Error (ep) for Transfer Screws (Ct Class) is calculated as $ep=2L_u/300-V_{300}$

3. Axial Clearances of Ball Screws

Axial clearance does not affect positioning accuracy if the feed is unidirectional, but will generate backlash and negatively affect on positioning accuracy if the direction of the axial load is reversed.

Select the axial clearance in such a way that the current requirement for positioning accuracy are met.

Table 4. Axial Clearances of Rolled Ball Screws

Types	Prod. Example	Screw Shaft Dia.	Lead	Axial Clearance (mm)	Screw Shaft Length (mm)		
					MIN	MAX	
Existing Products Compact Nut Accuracy Grade C10	BSSC	8	2	0.05 or less	100	400	
					150	600	
		10	4		150	800	
					150	1200	
		12	5		200	1200	
					200	2000	
20	10	250	2000				
		200	2000				
Existing Products Standard Nut Accuracy Grade C10	BSSZ BSSR	8	2	0.05 or less	100	400	
					100	380	
		10	4		150	585	
					150	600	
		12	5		150	585	
					150	800	
		14	10	150	800		
				150	800		
		15	10	150	1200		
				200	1200		
		20	10	200	1200		
				200	2000		
25	5	0.10 or less	250	2000			
		0.10 or less	250	2000			
28	6	0.10 or less	250	2000			
		0.10 or less	300	2000			
32	32	0.15 or less	300	2000			
		0.15 or less	300	2000			
C-VALUE Products Standard Nut Accuracy Grade C10	C-BSSC	8	2	0.05 or less	100	400	
					150	585	
		10	4		150	600	
					150	800	
		12	5		150	800	
					150	1200	
		15	10	0.10 or less	200	1200	
				0.10 or less	200	1200	
		20	10	0.15 or less	200	2000	
				0.15 or less	250	2000	
		25	5	0.10 or less	200	2000	
				0.10 or less	200	2000	
25	10	0.20 or less	300	2000			
		0.12 or less	300	2000			
Existing Products Block Nut Accuracy Grade C10	BSBR	15	5	0.10 or less	150	1200	
					200	1200	
		20	10		150	1500	
					150	1200	
		25	10		0.15 or less	200	1200
					0.20 or less	200	1500
Existing Products Standard Nut Accuracy Grade C7	BSST	8	2	0.03 or less	100	380	
					150	585	
		10	4		150	795	
					150	1200	
		12	5		150	1200	
					200	1200	
		15	10	200	1200		
				200	1200		
		20	10	0.05 or less	250	2000	
				0.03 or less	250	2000	
		25	5	0.03 or less	200	2000	
				0.07 or less	300	2000	

Selection Example of Lead Accuracy

<Requirements>

- Ball screw diameter Ø15, lead 20.
- Stroke 720mm
- Positioning accuracy ±0.05mm/720mm

<Selection Details>

Select an appropriate lead accuracy grade based on the application requirements.

- Evaluating the screw thread length
Stroke+Nut Length+Margin=720+62+60=842
*The Margin shown above is an overrun buffer, and normally determined as 1.5~2 times the screw lead.
Lead 20x1.5x2 (both ends)=60
- Evaluating the lead accuracy
Verify the actual mean travel error ±ep for 842mm ball screw thread by referencing the Table 1. on **P.2223**.
C3 ... ±0.021mm/800~1000mm
C5 ... ±0.040mm/800~1000mm
- Determining the lead accuracy
It can be determined that a C5 grade (±0.040/800~1000mm) ball screw can satisfy the required positioning accuracy of ±0.05/720mm.

Table 5. Axial Clearances of Precision Ball Screws

Types	Prod. Example	Screw Shaft Dia.	Lead	Axial Clearance (mm)	Screw Shaft Length (mm)				
					MIN	MAX			
Existing Products Standard Nut Accuracy Grade C5	BSS	8	2	0.005 or less	100	210			
					100	315			
		10	4		150	380			
					150	450			
		12	5		150	445			
					150	400			
		15	5		150	450			
					200	600			
		15	10		150	1095			
					200	1095			
		20	10		230	1095			
					230	1000			
25	5	250	1500						
		250	1500						
C-Value Standard Nut Accuracy Grade C5	C-BSS	8	2	0.008 or less	100	210			
					100	315			
		10	4		150	380			
					150	445			
		12	5		150	450			
					200	600			
		15	5		150	1095			
					200	1095			
		20	10		230	1095			
					230	1000			
		25	5		250	1500			
					250	1500			
Existing Products Standard Nut Accuracy Grade C3	BSX	6	1	0 (Preloaded)	80	205			
					80	255			
		8	2		100	240			
					100	310			
		10	2		150	390			
					150	440			
		12	5		150	590			
					150	590			
		Existing Products Standard Nut Accuracy Grade C7	BSSE		8	2	0.030 or less	100	210
								100	315
					10	4		150	380
								150	445
12	5			150	450				
				200	600				
15	5			150	1095				
				200	1095				
20	10			230	1095				
				230	1000				
25	10			250	1500				
				300	1500				

Selection Example of Axial Clearance

<Requirements>

- Ball screw diameter Ø15, lead 5.
- Allowable backlash ±0.01mm

<Selection Details>

From Table 5., it can be determined that C5 grade with 0.005mm or less axial clearance satisfies the allowable backlash amount of 0.01mm for the Ø15 group.