

4. Accuracy of the Ball Screw

4.1. Lead Accuracy

The accuracy of the Ball Screw in lead is controlled in accordance with JIS standards (JIS B 1192 - 1997). Accuracy grades C0 to C5 are defined in linearity and directional property, and C7 to C10 in travel distance error in relation to 300 mm.

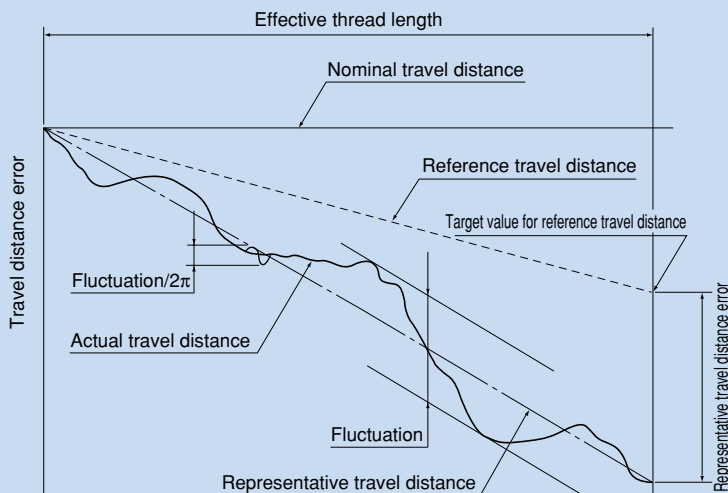


Fig. 1 Terms on Lead Accuracy

● Actual travel distance

An error in travel distance measured with an actual Ball Screw.

● Reference travel distance

Generally, it is the same as nominal travel distance, but can be an intentionally corrected value of nominal travel distance according to the intended use.

● Target value for reference travel distance

You may provide tension in order to prevent the screw shaft from running out, or set the reference travel distance in "negative" or "positive" value in advance given possible expansion/contraction from external load or temperature. In such cases, indicate a target value for the reference travel distance.

● Representative travel distance

It is a straight line representing the tendency in actual travel distance, and obtained with the least squares method from the curb that indicates the actual travel distance.

● Representative travel distance error (in \pm)

Difference between the representative travel distance and the reference travel distance.

● Fluctuation

It is the maximum width of the actual travel distance between two straight lines drawn in parallel with the representative travel distance.

● Fluctuation/300

It indicates a fluctuation against a given thread length of 300 mm.

● Fluctuation/2 π

It is a fluctuation in one revolution of the screw shaft.

Table 1 Lead Accuracy (permissible value)

Unit: mm

| | | Precision Ball Screw | | | | | | | | | | Rolled Ball Screw | | |
|-------------------------|---------|--|-------------|--|-------------|--|-------------|--|-------------|--|-------------|-----------------------|-----------------------|-----------------------|
| | | | | | | | | | | | | C7 | C8 | C10 |
| Accuracy grade | | C0 | | C1 | | C2 | | C3 | | C5 | | Travel distance error | Travel distance error | Travel distance error |
| Effective thread length | | Represent active travel distance error | Fluctuation | Represent active travel distance error | Fluctuation | Represent active travel distance error | Fluctuation | Represent active travel distance error | Fluctuation | Represent active travel distance error | Fluctuation | | | |
| Above | Or less | | | | | | | | | | | | | |
| — | 100 | 3 | 3 | 3.5 | 5 | 5 | 7 | 8 | 8 | 18 | 18 | ±50 /300mm | ±100 /300mm | ±210 /300mm |
| 100 | 200 | 3.5 | 3 | 4.5 | 5 | 7 | 7 | 10 | 8 | 20 | 18 | | | |
| 200 | 315 | 4 | 3.5 | 6 | 5 | 8 | 7 | 12 | 8 | 23 | 18 | | | |
| 315 | 400 | 5 | 3.5 | 7 | 5 | 9 | 7 | 13 | 10 | 25 | 20 | | | |
| 400 | 500 | 6 | 4 | 8 | 5 | 10 | 7 | 15 | 10 | 27 | 20 | | | |
| 500 | 630 | 6 | 4 | 9 | 6 | 11 | 8 | 16 | 12 | 30 | 23 | | | |
| 630 | 800 | 7 | 5 | 10 | 7 | 13 | 9 | 18 | 13 | 35 | 25 | | | |
| 800 | 1000 | 8 | 6 | 11 | 8 | 15 | 10 | 21 | 15 | 40 | 27 | | | |
| 1000 | 1250 | 9 | 6 | 13 | 9 | 18 | 11 | 24 | 16 | 46 | 30 | | | |
| 1250 | 1600 | 11 | 7 | 15 | 10 | 21 | 13 | 29 | 18 | 54 | 35 | | | |
| 1600 | 2000 | — | — | 18 | 11 | 25 | 15 | 35 | 21 | 65 | 40 | | | |
| 2000 | 2500 | — | — | 22 | 13 | 30 | 18 | 41 | 24 | 77 | 46 | | | |
| 2500 | 3150 | — | — | 26 | 15 | 36 | 21 | 50 | 29 | 93 | 54 | | | |
| 3150 | 4000 | — | — | 30 | 18 | 44 | 25 | 60 | 35 | 115 | 65 | | | |
| 4000 | 5000 | — | — | — | — | 52 | 30 | 72 | 41 | 140 | 77 | | | |
| 5000 | 6300 | — | — | — | — | 65 | 36 | 90 | 50 | 170 | 93 | | | |
| 6300 | 8000 | — | — | — | — | — | — | 110 | 60 | 210 | 115 | | | |
| 8000 | 10000 | — | — | — | — | — | — | — | — | 260 | 140 | | | |

Note: Unit of effective thread length: mm

Table 2 Fluctuation in Thread Length of 300 mm and in One Revolution (permissible value)

Unit: mm

| Accuracy grade | C0 | C1 | C2 | C3 | C5 | C7 | C8 | C10 |
|---------------------|-----|----|----|----|----|----|----|-----|
| Fluctuation/300 mm | 3.5 | 5 | 7 | 8 | 18 | — | — | — |
| Fluctuation/2 π | 3 | 4 | 5 | 6 | 8 | — | — | — |

Example: When the lead of a Ball Screw manufactured is measured with a target value for reference travel distance being $-9 \mu\text{m}/500 \text{ mm}$, the following data are obtained.

Table 3 Measurement Data on Travel Distance Error

Unit: mm

| | | | | |
|-----------------------------|---------|---------|---------|---------|
| Command position (A) | 0 | 50 | 100 | 150 |
| Travel distance (B) | 0 | 49.998 | 100.001 | 149.996 |
| Travel distance error (A-B) | 0 | -0.002 | +0.001 | -0.004 |
| | 200 | 250 | 300 | 350 |
| | 199.995 | 249.993 | 299.989 | 349.885 |
| | -0.005 | -0.007 | -0.011 | -0.015 |
| | 400 | 450 | 500 | |
| | 399.983 | 449.981 | 499.984 | |
| | -0.017 | -0.019 | -0.016 | |

The measurement data are expressed in a graph as shown in Fig. 2.

The positioning error (A-B) is indicated as the actual travel distance while the straight line representing the tendency of the (A-B) graph refers to the representative travel distance.

The difference between the reference travel distance and the representative travel distance appears as the representative travel distance error.

