Precision Linear Pack

THK General Catalog

A Product Descriptions

B Support Book (Separate)

Features of the Precision Linear Pack

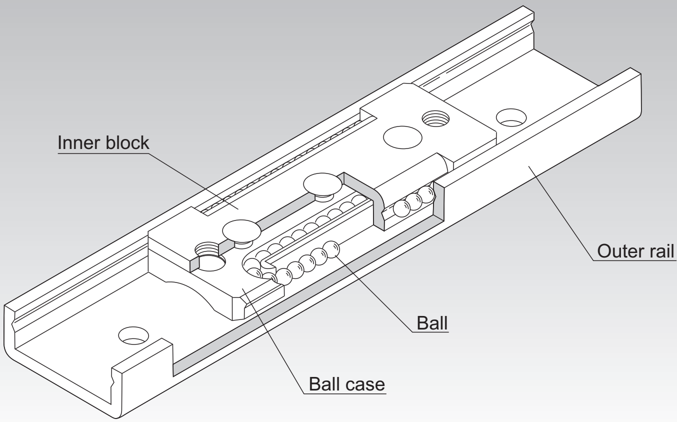


Fig. 1: Structure of Precision Linear Pack Model ER

Structure and Features

Model ER is a slide unit using a stainless steel plate that is precision formed, heat-treated, and then ground. It has a structure where balls roll between the V-shaped grooves machined on the outer rail and the inner block to allow the system to slide. It is an ultra-thin, lightweight unit in which the balls circulate in a ball case incorporated in the inner block to perform infinite linear motion.
This model is used in extensive applications such as magnetic disc devices, electronic equipment, semiconductor manufacturing equipment, medical equipment, measuring equipment, plotting machines, and photocopiers.

Reduced Design and Assembly Costs

It provides a highly accurate linear guide system with lower design cost and faster assembly than the conventional miniature ball bearings used in precision machines and other equipment.

Maintains Long-Term Stability

It is a ball-circulating slide unit with an extremely small friction coefficient. This slide unit maintains stable performance over a long period of time.

Lightweight and Compact with High-Speed Response

The outer rail and the inner block are composed of very thin stainless steel plates.
Since the linear pack is light, it has a small inertial moment and demonstrates superb high-speed response.

Load Rating and Nominal Life

Load Ratings in Each Direction

The basic load rating in the specification table indicates the load rating in the radial direction as shown in Fig. 2. The load ratings in the reverse-radial and lateral directions are obtained from Table 1 below.

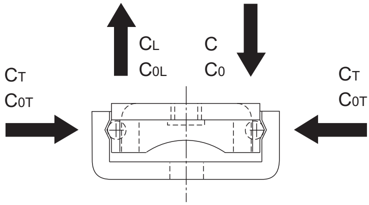


Fig. 2: Load Ratings in Each Direction

Table 1: Load Ratings in Each Direction

	Basic dynamic load rating	Basic static load rating
Radial direction	C (indicated in the dimensional table)	C_0 (indicated in the dimensional table)
Reverse-radial direction	C_L=C	C_{0L}=C_0
Lateral directions	C_T=1.47C	C_{0T}=1.73C_0

Static Safety Factor f_S

When the Model ER is stationary or in motion, an unexpected external force may be applied due to vibrations, impacts, or inertia caused by starting and stopping. It is necessary to take a safety factor into account with regard to this type of applied load.

$$f_S = \frac{f_C \cdot C_0}{P_C}$$

f_S : Static safety factor (see Table 2)
f_C : Contact factor (see Table 3 on A6-4)
C_0 : Basic static load rating (N)
P_C : Calculated load (N)

● Estimates of the Static Safety Factor

Treat the values in Table 2 as estimates for the lower limit of the static safety factor based on the operating conditions.

Table 2: Estimates of the Static Safety Factor (f_S)

Load conditions[1]	Lower limit of f_S
Without vibrations or impacts	1 to 1.3
With vibrations or impacts	2 to 7

[1] Vibrations and impacts are typically caused by factors such as acceleration and deceleration, sudden starting and stopping, vibrations and impacts from an external machine, and changes in processing power over time.

Precision Linear Pack

Calculating the Nominal Life

The nominal life of the THK precision linear pack is defined as 50 km. The nominal life (L_{10}) is calculated from the basic dynamic load rating (C) and the load acting on the precision linear pack (P_C) using the following formula.

$$L_{10} = \left(\frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots (1)$$

L_{10} : Nominal life (km)
C : Basic dynamic load rating (N)
P_C : Calculated load (N)

When comparing the nominal life (L_{10}), you must take into account whether the basic dynamic load rating was defined based on 50 km or 100 km. Convert the basic dynamic load rating based on ISO 14728-1 as necessary.

ISO-regulated basic dynamic load rating conversion formula:

$$C_{100} = \frac{C_{50}}{1.26}$$

C_{50} : Basic dynamic load rating based on a nominal life of 50 km
C_{100} : Basic dynamic load rating based on a nominal life of 100 km

Calculating the Modified Nominal Life

During use, a precision linear pack may be subjected to vibrations and shocks as well as fluctuating loads, which are difficult to detect. In addition, having precision linear packs arranged in close contact will have a decisive impact on the service life. Taking these factors into account, the modified nominal life (L_{10m}) can be calculated according to the following formula (2).

- Modified factor α

$$\alpha = \frac{f_C}{f_W}$$

α : Modified factor
f_C : Contact factor (see Table 3)
f_W : Load factor (see Table 4 on A6-5)

- Modified nominal life L_{10m}

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots (2)$$

L_{10m} : Modified nominal life (km)
C : Basic dynamic load rating (N)
P_C : Calculated load (N)

Calculating the Service Life Time

Once the nominal life (L_{10}) has been obtained, the service life time can be obtained using the following formula if the stroke length and the cycles per minute are constant.

$$L_h = \frac{L_{10} \times 10^6}{2 \times \ell_S \times n_1 \times 60}$$

L_h : Service life time (h)
ℓ_S : Stroke length (mm)
n_1 : Number of reciprocations per minute (min^{-1})

● f_C: Contact Factor

When multiple inner blocks are used in close contact with each other, their linear motion is affected by a moment load and mounting accuracy, making it difficult to achieve uniform load distribution. In such applications, multiply the basic load rating (C) and (C_0) by the corresponding contact factor in Table 3.

Table 3: Contact Factor (f_C)

Number of inner blocks in close contact with each other	Contact factor f_C
2	0.81
3	0.72
Normal use 1	1

● f_W: Load Factor

In general, reciprocating machines tend to involve vibrations or impacts during operation. It is extremely difficult to accurately determine vibrations generated during high-speed operation and impacts that occur during frequent starts and stops. Therefore, when the actual load applied on Model ER cannot be obtained, or when speed and vibrations have a significant influence, divide the basic dynamic load rating (C) by the corresponding load factor in Table 4 of empirically obtained data.

Table 4: Load Factor (f_W)

Vibrations/ impacts	Speed (V)	f_W
Faint	Very low $V \leqq 0.25$ m/s	1 to 1.2
Weak	Slow 0.25 m/s$<V\leqq 1$ m/s	1.2 to 1.5

Accuracy Standards

The running straightness of Model ER is indicated in Table 5. (See Fig. 3.)

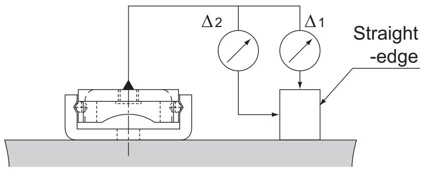


Fig. 3: Method for Measuring Running Straightness

Table 5: Running Straightness — Unit: mm

Stroke length		Running straightness of inner block in vertical directions Δ1	Running straightness of inner block in horizontal directions Δ2
Above	Up to		
—	20	0.002	0.004
20	40	0.003	0.006
40	60	0.004	0.008
60	80	0.005	0.010
80	100	0.006	0.012
100	120	0.008	0.016

Radial Clearance

The radial clearance of Model ER means the value for the motion of the central part of the inner block when the inner block is slightly moved with a vertically constant force in the middle of the outer rail in the longitudinal direction. The negative values in Table 6 indicate that the respective models are provided with a preload when assembled and have no clearance between their inner blocks and the outer rails.

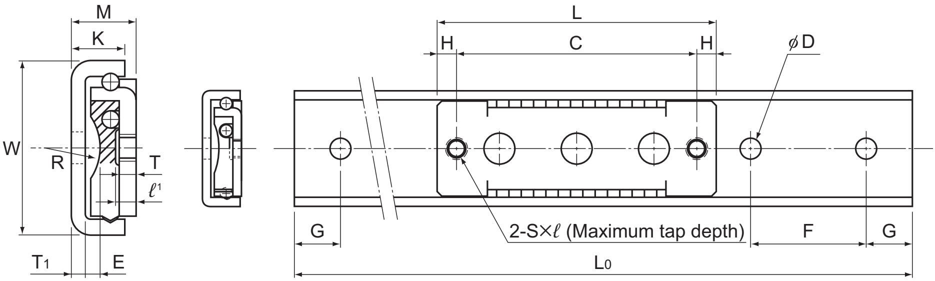
Table 6: Radial Clearance — Unit: μm

Model No.	Radial clearance	
	Normal	C1
ER 513	±2	–2 to 0
ER 616	±2	–3 to 0
ER 920	±2	–4 to 0
ER 1025	±3	–6 to 0

Note: When desiring normal clearance, add no symbol; when desiring C1 clearance, indicate “C1” in the model number. (See “Model Number Coding” on A6-8)

Precision Linear Pack

Model ER



Magnified view

Model No.	Inner block dimensions									
	Width W	Height M ±0.05	Length L	C	H	E	R	S	Maximum tap depth ℓ_1	T
ER 513	13	4.5	22	7	7.5	1.1	4.2	M2	1.3	0.9
ER 616	15.6	6	36	29	3.5	1.7	9.2	M3	1.8	1.1
ER 920	20	8.5	46	40	3	2.3	7.3	M3	2.5	1.9
ER 1025	25	10	56	48	4	2.9	9.3	M4	2.8	2.2

Model number coding

2 ER616 C1 +95L

- 2: Number of inner blocks used on the same rail (no symbol for a single slider)
- ER616: Model number
- C1: Radial clearance symbol[1]
- +95L: Outer rail length (in mm)

[1] See A6-5.

Unit: mm

	Outer rail dimensions						Basic load rating		Mass	
	K	T_1	D	L_0	F	G	C N	C_0 N	Inner block g	Outer rail g/m
	4	1.1	2.4	40, 60, 80	20	10	54.9	72.5	2.4	166
	5.5	1.4	2.9	45, 70, 95	25	10	71.6	125	5.6	268
	7.5	1.9	3.5	50, 80, 110	30	10	144	201	14.4	474
	9	2.2	4.5	60, 100, 140	40	10	215	315	27	677

[1] Set the screw length so that it does not exceed the Maximum tap depth ℓ.

Note: To secure the outer rail of models ER513 and ER616, use cross-recessed pan head screws for precision equipment (No. 0 screw). To secure the outer rail of models ER920 and ER1025, use cross-recessed pan head screws.

Model No.	Type	Screw type × pitch
ER 513	No. 0 pan head screw[1] (class 1)	M2×0.4
ER 616		M2.6×0.45
ER 920	Cross-recessed pan head screw[2]	M3×0.5
ER 1025		M4×0.7

[1] Japan Camera Industry Association Standard JCIS 10-70 Cross-recessed screw for precision equipment (No. 0 screw)
[2] Cross-recessed pan head screw JIS B 1111

Model Number Coding

Model number configurations differ depending on the model features. Refer to the corresponding sample model number configuration.

Precision Linear Pack

● **Model ER**

2 ER616 C1 +95L

- 2: Number of inner blocks used on the same rail (no symbol for products with one nut)
- ER616: Model No.
- C1: Radial clearance symbol[1]
- +95L: Outer rail length (mm)

[1] See A6-5.

Handling

(1) Do not disassemble the parts. This will result in loss of functionality.
(2) Take care not to drop or strike the precision linear pack. Otherwise, it may cause injury or damage the unit. Even if there is no outward indication of damage, a sudden impact could prevent the unit from functioning properly.
(3) Removing the inner block of the precision linear pack from the outer rail or letting it overshoot will cause balls to fall out.
(4) Wear appropriate safety gear, such as protective gloves and safety shoes, when handling the product.

Use

(1) Prevent foreign material, such as cutting chips or coolant, from entering the product. Failure to do so could damage the product.
(2) If foreign materials such as cutting chips adhere to the product, replenish the lubricant after cleaning the product.
(3) Do not use the product at temperatures of 80℃ or higher.
(4) Using the product while rolling elements are missing could lead to premature failure of the product.
(5) If any rolling elements fall out, contact THK. Do not use the product in that condition.
(6) If the mounting material lacks sufficient rigidity or accuracy, the bearing load may be focused in one area, and bearing functionality will dramatically decrease. Therefore, carefully consider the rigidity and accuracy of the housing and base, and the strength of the securing bolts.
(7) Very small strokes can inhibit the formation of an oil film between the raceways and the areas of contact on the rolling elements, resulting in fretting. Therefore, be sure to use a type of grease with high fretting resistance properties if the stroke will be small. We recommend periodically allowing the nut to stroke a distance roughly equal to its length to help ensure that a film forms between the raceways and rolling elements.

Lubrication

(1) Thoroughly remove anti-rust oil with a cleaning detergent and apply lubricant before using the product. As the most suitable grease, we recommend THK AFC Grease, which maintains lubricity over a long period of time. For lubrication in a clean room, low-dust-generation THK AFE-CA Grease and THK AFF Grease are recommended.
(2) Do not mix different lubricants. Even greases containing the same type of thickening agent may, if mixed, interact negatively due to disparate additives or other ingredients.
(3) When using the product in locations exposed to constant vibrations or in special environments such as clean rooms, vacuums, and extreme heat or cold, use a lubricant suitable for its use/environment.
(4) When lubricating the product, apply grease directly on the raceway and stroke the product several times to let the grease spread inside.
(5) The consistency of grease changes according to the temperature. Please keep in mind that the precision linear pack's sliding resistance may be affected by changes in viscosity.
(6) After lubrication, the sliding resistance of the precision linear pack may increase due to the stirring resistance of the grease. Be sure to perform a warm-up operation and allow the grease to break in sufficiently before operating the machine.
(7) Excess grease may spatter after lubrication. Wipe off spattered grease as necessary.

(8) Grease deteriorates over time, which decreases the lubricity, so perform regular grease inspections and replenish grease based on frequency of use.
(9) However, note that the lubrication interval may vary according to operating conditions and the service environment. Set the final lubrication interval/amount based on the actual machine.

Installation

The mounting surface of the Precision Linear Pack Model ER must be finished with the highest possible precision.
Use commercially available No. 0 pan head machine screws designed for precision equipment to anchor the outer rail of models ER513 and ER616. (With ordinary screws, the head of the screw could come into contact with the inner block.) Use commercially available cross-recessed pan head machine screws to anchor the outer rail of models ER920 and ER1025. (See Table 1.)

Table 1: Outer Rail Mounting Screws

Model No.	Type	Screw type × pitch
ER513	No. 0 pan head screw[1] (class 1)	M2×0.4
ER616		M2.6×0.45
ER920	Cross-recessed pan head screw[2]	M3×0.5
ER1025		M4×0.7

[1] Japan Camera Industry Association Standard JCIS 10-70 Cross-recessed screw for precision equipment (No. 0 screw)
[2] Cross-recessed pan head screw JIS B 1111

Storage

When storing the precision linear pack, pack it as designated by THK and store it indoors in a horizontal position away from extreme heat or cold and high humidity.
If you request that we do not apply anti-rust oil to a product, please be aware that it may rust due to the storage environment or length of storage.

Disposal

The product should be treated as industrial waste and disposed of appropriately.

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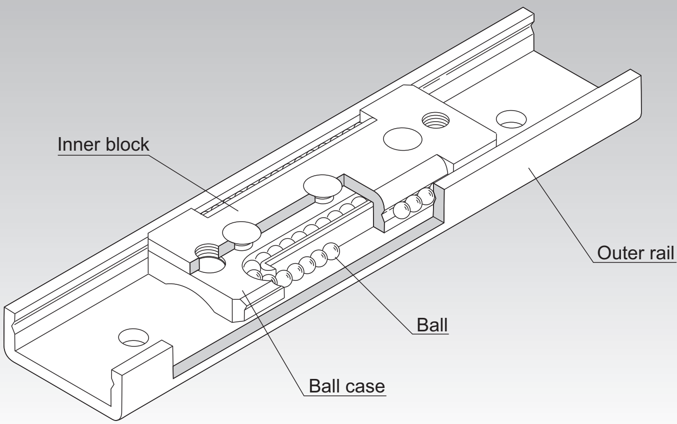

Fig. 1: Structure of Precision Linear Pack Model ER

Structure and Features

Model ER is a slide unit using a stainless steel plate that is precision formed, heat-treated, and then ground. It has a structure where balls roll between the V-shaped grooves machined on the outer rail and the inner block to allow the system to slide. It is an ultra-thin, lightweight unit in which the balls circulate in a ball case incorporated in the inner block to perform infinite linear motion.
This model is used in extensive applications such as magnetic disc devices, electronic equipment, semiconductor manufacturing equipment, medical equipment, measuring equipment, plotting machines, and photocopiers.

Reduced Design and Assembly Costs

It provides a highly accurate linear guide system with lower design cost and faster assembly than the conventional miniature ball bearings used in precision machines and other equipment.

Maintains Long-Term Stability

It is a ball-circulating slide unit with an extremely small friction coefficient. This slide unit maintains stable performance over a long period of time.

Lightweight and Compact Design with High-Speed Response

The outer rail and the inner block are composed of very thin stainless steel plates.
Since the linear pack is light, it has a small inertial moment and demonstrates superb high-speed response.

Load Rating and Nominal Life

Load Ratings in Each Direction

The basic load rating in the specification table indicates the load rating in the radial direction as shown in Fig. 2. The load ratings in the reverse-radial and lateral directions are obtained from Table 1 below.

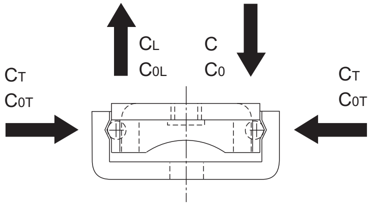

Fig. 2: Load Ratings in Each Direction

Table 1: Load Ratings in Each Direction

	Basic dynamic load rating	Basic static load rating
Radial direction	C (indicated in the dimensional table)	C_0 (indicated in the dimensional table)
Reverse-radial direction	C_L=C	C_{0L}=C_0
Lateral directions	C_T=1.47C	C_{0T}=1.73C_0

Static Safety Factor f_S

When the Model ER is stationary or in motion, an unexpected external force may be applied due to vibrations, impacts, or inertia caused by starting and stopping. It is necessary to take a safety factor into account with regard to this type of applied load.

$$f_S = \frac{f_C \cdot C_0}{P_C}$$

f_S : Static safety factor (see Table 2)
f_C : Contact factor (see Table 3 on B6-5)
C_0 : Basic static load rating (N)
P_C : Calculated load (N)

● Estimates of the Static Safety Factor

Treat the values in Table 2 as estimates for the lower limit of the static safety factor based on the operating conditions.

Table 2: Estimates of the Static Safety Factor (f_S)

Load conditions[1]	Lower limit of f_S
Without vibrations or impacts	1 to 1.3
With vibrations or impacts	2 to 7

[1] Vibrations and impacts are typically caused by factors such as acceleration and deceleration, sudden starting and stopping, vibrations and impacts from an external machine, and changes in processing power over time.

Calculating the Nominal Life

The nominal life of the THK precision linear pack is defined as 50 km. The nominal life (L_{10}) is calculated from the basic dynamic load rating (C) and the load acting on the precision linear pack (P_C) using the following formula.

$$L_{10} = \left(\frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots(1)$$

L_{10} : Nominal life (km)
C : Basic dynamic load rating (N)
P_C : Calculated load (N)

When comparing the nominal life (L_{10}), you must take into account whether the basic dynamic load rating was defined based on 50 km or 100 km. Convert the basic dynamic load rating based on ISO 14728-1 as necessary.

ISO-regulated basic dynamic load rating conversion formula:

$$C_{100} = \frac{C_{50}}{1.26}$$

C_{50} : Basic dynamic load rating based on a nominal life of 50 km
C_{100} : Basic dynamic load rating based on a nominal life of 100 km

Calculating the Modified Nominal Life

During use, a precision linear pack may be subjected to vibrations and shocks as well as fluctuating loads, which are difficult to detect. In addition, having precision linear packs arranged in close contact will have a decisive impact on the service life. Taking these factors into account, the modified nominal life (L_{10m}) can be calculated according to the following formula (2).

- Modified factor α

$$\alpha = \frac{f_C}{f_W}$$

α : Modified factor
f_C : Contact factor (see Table 3 on B6-5)
f_W : Load factor (see Table 4 on B6-5)

- Modified nominal life L_{10m}

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots(2)$$

L_{10m} : Modified nominal life (km)
C : Basic dynamic load rating (N)
P_C : Calculated load (N)

Calculating the Service Life Time

Once the nominal life (L_{10}) has been obtained, the service life time can be obtained using the following formula if the stroke length and the cycles per minute are constant.

$$L_h = \frac{L_{10} \times 10^6}{2 \times \ell_S \times n_1 \times 60}$$

L_h : Service life time (h)
ℓ_S : Stroke length (mm)
n_1 : Number of reciprocations per minute (min^{-1})

● f_C: Contact Factor

When multiple inner blocks are used in close contact with each other, their linear motion is affected by a moment load and mounting accuracy, making it difficult to achieve uniform load distribution. In such applications, multiply the basic load rating (C) and (C_0) by the corresponding contact factor in Table 3.

Table 3: Contact Factor (f_C)

Number of inner blocks in close contact with each other	Contact factor f_C
2	0.81
3	0.72
Normal use 1	1

● f_W: Load Factor

In general, reciprocating machines tend to involve vibrations or impacts during operation. It is extremely difficult to accurately determine vibrations generated during high-speed operation and impacts that occur during frequent starts and stops. Therefore, when the actual load applied on model ER cannot be obtained, or when speed and vibrations have a significant influence, divide the basic dynamic load rating (C) by the corresponding load factor in Table 4 of empirically obtained data.

Table 4: Load Factor (f_W)

Vibrations/ impacts	Speed (V)	f_W
Faint	Very low $V \leqq 0.25$ m/s	1 to 1.2
Weak	Slow 0.25 m/s$<V\leqq$1 m/s	1.2 to 1.5

Model Number Coding

Model number configurations differ depending on the model features. Refer to the corresponding sample model number configuration.

Precision Linear Pack

● **Model ER**

2 ER616 C1 +95L

- 2: Number of inner blocks used on the same rail (no symbol for products with one nut)
- ER616: Model No.
- C1: Radial clearance symbol[1]
- +95L: Outer rail length (mm)

[1] See A6-5.

Handling
(1) Do not disassemble the parts. This will result in loss of functionality.
(2) Take care not to drop or strike the precision linear pack. Otherwise, it may cause injury or damage the unit. Even if there is no outward indication of damage, a sudden impact could prevent the unit from functioning properly.
(3) Removing the inner block of the precision linear pack from the outer rail or letting it overshoot will cause balls to fall out.
(4) Wear appropriate safety gear, such as protective gloves and safety shoes, when handling the product.

Use
(1) Prevent foreign material, such as cutting chips or coolant, from entering the product. Failure to do so could damage the product.
(2) If foreign materials such as cutting chips adhere to the product, replenish the lubricant after cleaning the product.
(3) Do not use the product at temperatures of 80℃ or higher.
(4) Using the product while rolling elements are missing could lead to premature failure of the product.
(5) If any rolling elements fall out, contact THK. Do not use the product in that condition.
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Lubrication
(1) Thoroughly remove anti-rust oil with a cleaning detergent and apply lubricant before using the product. As the most suitable grease, we recommend THK AFC Grease, which maintains lubricity over a long period of time. For lubrication in a clean room, low-dust-generation THK AFE-CA Grease and THK AFF Grease are recommended.
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Table 1: Outer Rail Mounting Screws

<table>
<tr><th>Model No.</th><th>Type</th><th>Screw type × pitch</th></tr>
<tr><td>ER513</td><td rowspan="2">No. 0 pan head screw[1] (class 1)</td><td>M2×0.4</td></tr>
<tr><td>ER616</td><td>M2.6×0.45</td></tr>
<tr><td>ER920</td><td rowspan="2">Cross-recessed pan head screw[2]</td><td>M3×0.5</td></tr>
<tr><td>ER1025</td><td>M4×0.7</td></tr>
</table>

[1] Japan Camera Industry Association Standard JCIS 10-70 Cross-recessed screw for precision equipment (No. 0 screw)
[2] Cross-recessed pan head screw JIS B 1111

Storage

When storing the precision linear pack, pack it as designated by THK and store it indoors in a horizontal position away from extreme heat or cold and high humidity.
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The product should be treated as industrial waste and disposed of appropriately.