

Technical Notes



Selection Guide and Procedure.....D-86 ~ D-90

- (1) Maximum Torque and Maximum Thrust
- (2) Selection by Series
 - AS, AD, ADN, AE, FL, KE, RE, EF, TF Series
 - SL Series
 - EL Series



Installation and Removal.....D-91 ~ D-94

- AS, AD, ADN, AE, FL, KE, TF, EF Series
- AS-SS, KE-SS, RE-SS, SL Series
- EL Series



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1. Installing to Keyed Shafts
2. Installation Accuracy
3. Hub's Outer Diameter Deformation
4. Ambient Temperature
5. Allowable Deviation of Tightening Torque MA
6. Hub Movement
7. Assembly Lubrication
8. Bending Moment
9. Outdoor Use

Note:
AD series is referred to as ADN and AD-N in other parts of the world. All three describe an identical product.

(1) Maximum Torque and Maximum Thrust

Calculate maximum torque and thrust based on transmissible capacity and safety factor.

When using POWER-LOCKS for servo motor or stepping motor applications, use a safety factor greater than 1 for every maximum or peak torque.

$$T_{\max} = \frac{5252 \cdot \text{HP} \cdot \text{sf}}{n} \quad (\text{ft.}/\text{lbs.})$$

n: RPM sf: Safety Factor

$$P_{\max} = P_{ax} \cdot \text{sf}$$

P_{max}: Max. Thrust Load
P_{ax}: Thrust Load
sf: Safety Factor

sf: Safety Factor

Loading Conditions		Safety Factor
Smooth with no shock	Low inertia	1.5~2.5
Some shock	Medium inertia	2.0~4.0
Severe shock	High inertia	3.0~5.0

If torque and thrust apply simultaneously:
Calculate and compare the total load M_R with the rated transmissible torque M_t.

$$M_R = \sqrt{T_{\max}^2 + (P_{\max} \times \frac{d}{2})^2}$$

T_{max}: Max. transmissible torque
P_{max}: Max. transmissible thrust
d: Shaft diameter

Compare the T_{max} or M_R obtained from the above calculation with the catalog rated transmissible torque M_t.

M_t ≥ T_{max} or M_R → Acceptable

M_t < T_{max} or M_R → Use larger or multiple units.

*Installing multiple units is possible for some series. When installing more than one unit, multiply the M_t value with the appropriate multiplying ratio given below.

Multiplying Ratio by Series and Number of Units (Table 1)

No. of Units	1	2	3	4
AS	1	2	3	4
AD/ADN	1	2	N/A	N/A
TF KE	1	2	N/A	N/A
EL	1	1.55	1.85	2
Others	1	N/A	N/A	N/A

(2) Selection by Series

AS, AD, ADN, AE, FL, KE, RE, EF, TF Series

STEP 1 Shaft and Hub

(1) Material Strength

Large contact pressure applies to both the shaft and hub during installation.

Select shaft and hub materials that meet the following strength requirements.

$$\sigma_{0.2S} \geq K_2 \times P \quad \sigma_{0.2B} \geq K_2 \times P'$$

P: Contact pressure on the shaft
P': Contact pressure on the hub
σ_{0.2S}: Yield point of shaft material
σ_{0.2B}: Yield point of hub material
K₂: Series coefficient (Table 2)

Series Coefficient K₂ (Table 2)

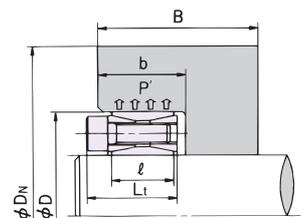
Series	Series Coefficient
AS, AD, ADN, TF	1.4
AE, EF, KE, RE	1.2

(2) Hub Outer Diameter

Refer to the Hub Diameters table provided for each series. If none of the materials listed apply, calculate the minimum hub diameter using the following formula.

$$\text{Hub outer diameter } D_N \geq D \sqrt{\frac{\sigma_{0.2B} + K_3 \cdot P'}{\sigma_{0.2B} - K_3 \cdot P}}$$

D_N: Hub outer diameter
D: Hub inner diameter
P': Hub contact pressure
σ_{0.2B}: Yield point of hub material
K₃: Hub configuration coefficient
(Refer to the appropriate Hub Diameters table.)



Note:

AD series is referred to as ADN and AD-N in other parts of the world. All three describe an identical product.

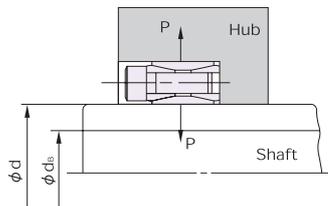
Technical Notes

(3) Hollow Shaft Inner Diameter

Calculate the inner diameter of a hollow shaft, using the following formula.

$$\text{Hollow shaft inner diameter } d_B \leq d \times \sqrt{\frac{\sigma_{0.2S} - 2 \cdot P \cdot K_3}{\sigma_{0.2S}}}$$

- d_B : Hollow shaft inner diameter
- d : Shaft diameter
- P : Contact pressure on the shaft
- $\sigma_{0.2S}$: Yield point of shaft material
- K_3 : Hub configuration coefficient (Refer to the Hub Diameters table by series.)



STEP 3 Radial Load

If radial loads apply to POWER-LOCKS as in wheel applications, calculate the contact pressure on the shaft P_{rad} , and hub P'_{rad} . Then, compare the values with those provided in the appropriate catalog table and confirm that they fall within the allowable range.

$$P_{rad} = \frac{1.3 \times Pr}{d \times \ell}$$

$$P'_{rad} = \frac{1.3 \times Pr}{D \times \ell}$$

- Pr : Radial load
- ℓ : POWER-LOCK width mm
- d : Shaft diameter
- D : Hub inner diameter
- P : Contact pressure on the shaft MPa
- P' : Contact pressure on the hub MPa

If a radial load applies, calculate the required hub outer diameter D_n and inner hollow shaft diameter d_B by adding P_{rad} and P'_{rad} to P and P' respectively.

STEP 2 AS Series Centering Guide Portion

Accurate centering is achieved by adjusting the hub's width to a value calculated based on the length of a centering portion, usually above $d/2$ (half of shaft diameter). In addition, the guide portion tolerance should be determined according to the required degree of accuracy.

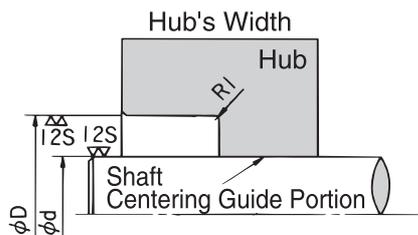


Table 4. Allowable Contact Pressure

Series	$P_{rad}(P'_{rad})/P(P')$
AS, AD, ADN, TF	50% and less
KE, AE, EF	20% and less

SL Series

STEP 1 Shaft and Hub

(1) Material Strength

Large contact pressure applies to both the shaft and hub during installation. Select shaft and hub materials that meet the following strength requirements.

$$\sigma_{0.2S} \geq 1.2 \times P \quad \sigma_{0.2B} \geq 1.2 \times P'$$

P : Contact pressure on the shaft

P' : Contact pressure on the hub

$\sigma_{0.2S}$: Yield point of shaft material

$\sigma_{0.2B}$: Yield point of hub material

(2) Hub Material Strength

Torque and contact pressure will combine and produce stress on the hub. Calculate this stress using one of the following four formulas.

(a) Stress applied to the hub from a normal direction (σ_w)

$$\sigma_w = -P$$

P: Shaft contact pressure

(b) Stress applied to the hub from a tangential direction (σ_t)

$$\sigma_t = \frac{P(1+Q^2) - 2 \times P'}{1-Q^2}$$

$$Q = \frac{d_w}{d}$$

P : Contact pressure on the shaft

P' : Contact pressure on the hub

d_w : Shaft diameter

d : Hub outer diameter

(c) Shearing stress applied to the hub by torsional force (τ_B)

$$\tau_B = \frac{16000 \times T_{max} \cdot d_w}{\pi (d^4 - d_w^4)}$$

(d) Combined stress applied to the hub (σ_v)

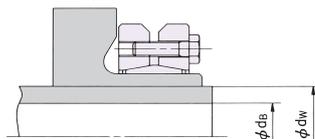
$$\sigma_v = \sqrt{\sigma_t^2 + \sigma_w^2 - \sigma_t \cdot \sigma_w + 3 \times \tau_B^2}$$

Make sure $\sigma_{0.2B}$ (yield point of the hub material) is greater than σ_v . $\sigma_v < \sigma_{0.2B}$

(3) Hollow Shaft Inner Diameter

Calculate the inner diameter of a hollow shaft using the following formula.

$$d_B \leq d_w \sqrt{\frac{\sigma_{0.2S} - 1.6 \times P}{\sigma_{0.2S}}}$$



d_B : Hollow shaft inner diameter

d_w : Hollow shaft outer diameter

$\sigma_{0.2S}$: Yield point of shaft material

P : Contact pressure between the inner ring and shaft

EL Series

STEP 1 Actual Locking Force, Transmissible Torque and Contact Pressure

(1) When the required transmissible torque M_t is different from the (M_t) listed in the EL Series Specifications table

Calculate the actual locking force F_e , thrust P_{ax} , contact pressure P and P' using the following formulas.

$$C_1 = M_t / [M_t] \quad \text{(Required transmissible torque ratio)}$$

$$F_e = C_1 \times [F_e] \quad \text{(Actual locking force)}$$

$$F = F_0 + F_e \quad \text{(Total Force)}$$

$$P_{ax} = C_1 \times [P_{ax}] \quad \text{(Transmissible thrust)}$$

$$P = C_1 \times [P] \quad \text{(Contact pressure on the shaft)}$$

$$P' = C_1 \times [P'] \quad \text{(Contact pressure on the hub)}$$

$$M_t : \text{Required transmissible torque}$$

F_0 , $[F_e]$, $[M_t]$, $[P_{ax}]$, $[P']$: Values are listed in EL Series Specifications table

2) When the required actual locking force F_e is different from the (F_e) listed in the EL Series Specifications table

Calculate transmissible torque M_t , thrust P_{ax} , contact pressure P and P' using the following formulas.

$$C_2 = F_e / [F_e] \quad \text{(Required actual locking force ratio)}$$

$$M_t = C_2 \times [M_t] \quad \text{(Transmissible torque)}$$

$$P_{ax} = C_2 \times [P_{ax}] \quad \text{(Transmissible thrust)}$$

$$P = C_2 \times [P] \quad \text{(Contact pressure on the shaft)}$$

$$P' = C_2 \times [P'] \quad \text{(Contact pressure on the hub)}$$

$$F_e : \text{Required actual locking force}$$

Note: $0.25 \leq C_2 \leq 2$

(3) Multiple POWER-LOCK Installation

Calculate transmissible torque M_{tz} , thrust P_{axz} and contact pressure P_z and P'_z using the following formulas. (z is the number of EL units installed.)

$$M_{tz} = S \cdot M_{t1}$$

$$P_{axz} = S \cdot P_{ax1}$$

$$P_z = P_1 \quad \text{(Contact pressure on the shaft)}$$

$$P'_z = P'_1 \quad \text{(Contact pressure on the hub)}$$

M_{t1} , P_{ax1} , P'_1 apply to single unit installation.

z	S
1	1
2	1.55
3	1.85
4	2

Technical Notes

STEP 2 Shaft and Hub

EL Series POWER-LOCKS do not have a self-centering function. A hub must be pre-centered, using the guide portion provided between the shaft and hub. A guide portion length above $d/2$ is generally preferred. Also, select guide tolerance based on the degree of accuracy you desire.

(1) Material Strength

Select shaft and hub materials that meet the following strength requirements.

$$\sigma_{0.2S} \geq 1.4 \times P$$

$$\sigma_{0.2B} \geq 1.4 \times P'$$

$\sigma_{0.2S}$, $\sigma_{0.2B}$: Yield point of shaft and hub material

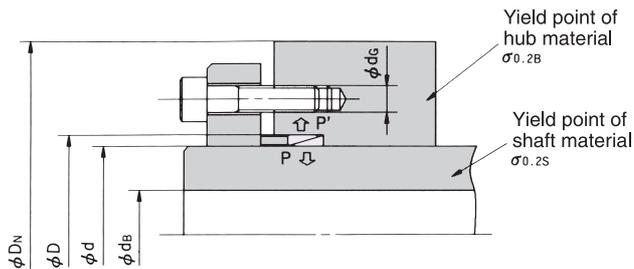
P , P' : Contact pressure on the shaft and hub bore

(2) Required Hub Outer Diameter D_N and Allowable Hollow Shaft Bore Diameter d_B

Hubs must have a D_N that is greater than the value obtained from the following formula.

If using a hollow shaft, its bore must be equivalent to or less than the d_B obtained from the appropriate formula below.

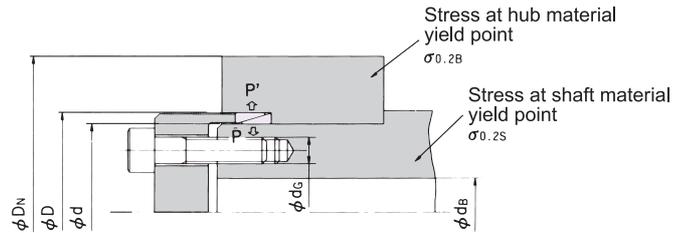
(a) Bolts Fastened to the Hub Section



$$D_N \geq D \sqrt{\frac{\sigma_{0.2B} + 0.8 \times P'}{\sigma_{0.2B} - 0.8 \times P'}} + d_G$$

$$d_B \leq d \sqrt{\frac{\sigma_{0.2S} - 1.2 \times P}{\sigma_{0.2S}}}$$

(b) Bolts Fastened to the Shaft Section



$$D_N \geq D \sqrt{\frac{\sigma_{0.2B} + 0.6 \times P'}{\sigma_{0.2B} - 0.6 \times P'}}$$

$$d_B \leq d \sqrt{\frac{\sigma_{0.2S} - 1.6 \times P}{\sigma_{0.2S}}} - d_G$$

P , P' : Contact pressure on the shaft and hub.

STEP 3 Selecting Locking Bolts

(1) Bolt Strength Classes and Mechanical Properties

In general, 10.9 and 12.9 class bolts should be used. These bolts are less affected by vibration and do not loosen as easily as others.

(2) Bolt Head Bearing Surface Pressure

When using 10.9 or 12.9 bolts, check the pressure at their bearing surfaces. If this pressure exceeds the maximum values provided below, the bearing surfaces will eventually deform, causing the bolts to loosen from decreased axial force. When the bearing pressure rises above the maximum values, reduce by increasing the strength of pressure flange (either change the material or treat with heat) or by lowering the tightening torque in order to prevent the bearing surfaces from deforming.

Bearing surface area = A_s

$$A_s = \frac{\pi}{4} (D^2 - d_{a^2 \max}) \text{ mm}^2$$

D : Bolt head diameter mm

$d_{a \max}$: Nominal diameter mm

Bearing surface pressure

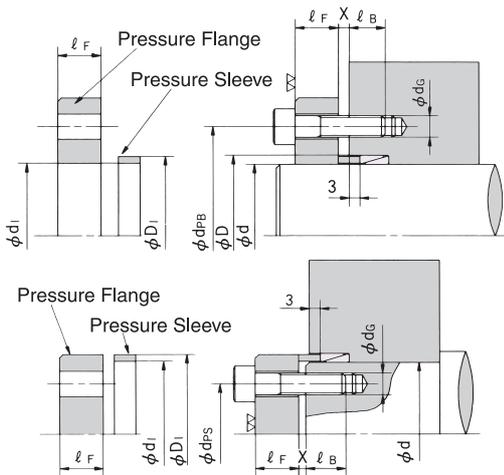
$$P_s = F_v / A_s$$

F_v : Tightening torque

SELECTION GUIDE AND PROCEDURE

STEP 4 Pressure System Designs

Pressure flanges experience a great deal of stress while locking bolts are being tightened. To avoid plastic deformation, use a pressure flange with the appropriate material strength and provide enough leeway in the design to account for some stress. Provided below are example pressure system design and calculations.



See table on the right for d1, D1 and X dimensions.

(1) Bolt Pitch Circle Diameter d_{PB} , d_{PS} mm

(When $d = \phi 10 \sim \phi 30$)

$$d_{PB} = D + 8 + d_g$$

$$d_{PS} = d - 8 - d_g$$

(When $d = \phi 32 \sim \phi 150$)

$$d_{PB} = D + 10 + d_g$$

$$d_{PS} = d - 10 - d_g$$

However, if you are mounting a pressure flange to the hub, use 1/2 of the maximum number of bolts allowed or less, so that they may fit into the d_{PB} circumference.

(2) Thickness of Pressure Flange l_F mm

$$l_F \geq 2 \times d_g$$

(3) Strength of Pressure Flange ($\sigma_{0.2F}$)

When tightening with the torque required for 8.8 bolts.

$$\sigma_{0.2F} \geq 42,600 \text{ psi (1035 steel)}$$

When tightening with the torque required for 10.9 bolts.

$$\sigma_{0.2F} \geq 49,700 \text{ psi (1045 steel)}$$

When tightening with the torque required for 12.9 bolts.

$$\sigma_{0.2F} \geq 56,900 \text{ psi (1055 steel)}$$

$\sigma_{0.2F}$: Yield point of pressure flange

(4) Functioning Length of the Screw l_B mm

$$l_B \geq 1.5 \times d_g$$

Model Number	Dimension X (mm) No. of EL installed				Pressure Sleeve Diameters (mm)	
	1	2	3	4	d1	D1
PL010X013E	2	2	3	3	10.1	12.9
PL011X014E	2	2	3	3	11.1	13.9
PL012X015E	2	2	3	3	12.1	14.9
PL013X016E	2	2	3	3	13.1	15.9
PL014X018E	3	3	4	5	14.1	17.9
PL015X019E	3	3	4	5	15.1	18.9
PL016X020E	3	3	4	5	16.1	19.9
PL017X021E	3	3	4	5	17.1	20.9
PL018X022E	3	3	4	5	18.1	21.9
PL019X024E	3	3	4	5	19.2	23.8
PL020X025E	3	3	4	5	20.2	24.8
PL022X026E	3	3	4	5	22.2	25.8
PL024X028E	3	3	4	5	24.2	27.8
PL025X030E	3	3	4	5	25.2	29.8
PL028X032E	3	3	4	5	28.2	31.8
PL030X035E	3	3	4	5	30.2	34.8
PL032X036E	3	3	4	5	32.2	35.8
PL035X040E	3	3	4	5	35.2	39.8
PL036X042E	3	3	4	5	36.2	41.8
PL038X044E	3	3	4	5	38.2	43.8
PL040X045E	3	4	5	6	40.2	44.8
PL042X048E	3	4	5	6	42.2	47.8
PL045X052E	3	4	5	6	45.2	51.8
PL048X055E	3	4	5	6	48.2	54.8
PL050X057E	3	4	5	6	50.2	56.8
PL055X062E	3	4	5	6	55.2	61.8
PL056X064E	3	4	5	7	56.2	63.8
PL060X068E	3	4	5	7	60.2	67.8
PL063X071E	3	4	5	7	63.2	70.8
PL065X073E	3	4	5	7	65.2	72.8
PL070X079E	3	5	6	7	70.3	78.7
PL071X080E	3	5	6	7	71.3	79.7
PL075X084E	3	5	6	7	75.3	83.7
PL080X091E	4	5	6	8	80.3	90.7
PL085X096E	4	5	6	8	85.3	95.7
PL090X101E	4	5	6	8	90.3	100.7
PL095X106E	4	5	6	8	95.3	105.7
PL100X114E	4	6	7	9	100.3	113.7
PL110X124E	4	6	7	9	110.3	123.7
PL120X134E	4	6	7	9	120.3	133.7
PL130X148E	5	7	9	11	130.4	147.6
PL140X158E	5	7	9	11	140.4	157.6
PL150X168E	5	7	9	11	140.4	167.6

NOTE: Dimension X plus 3-mm is the minimum Pressure Sleeve length.

Technical Notes

AS, AD, ADN, AE, FL, KE, TF, EF Series Installation and Removal

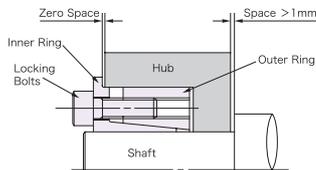
A. Installation

- (1) Verify that the shaft and the inner surface of the hub are clean, we recommend to lightly oil surfaces.

Note: Do not use silicone or molybdenum lubricants. Otherwise, friction coefficient will reduce, and standard torque will not be achieved.

- (2) Remove the bolts and clean all contact surfaces. Lightly coat the bolts, including their bearing surfaces, with oil or grease. For AD/ADN Series POWER-LOCKS, use an oil bath or a spray method to thoroughly lubricate each part.
- (3) Tighten the bolts part way, and preliminarily assemble the POWER-LOCK.

- Notes: 1. Pre-assemble by keeping the phases of the slit and the taps for removal out of synch. For AD/ADN Series, maintain maximum space between the taper rings.
2. In the case of step shaft installation for AE Series, make sure the space between the hub and the steps is greater than 1 mm.



- (4) Mount hub to shaft, and lightly push the POWER-LOCK to the end of the hub. Take caution in carrying out this process with the AD/ADN Series for their taper angles are relatively small.

When the hub does not smoothly slide onto the shaft, either loosen the bolts or lightly tap on the hub until it is fixed into place.

- Notes: 1. Do not hit the POWER-LOCK with a hammer. This will severely damage the product and possibly lead to accidents.
2. Included spacer must be used with a TF Series POWER-LOCK. Without the spacer, the unit will not transmit torque.

- (5) Determine the position of the hub along the shaft circumference and length. Using a torque wrench, tighten one bolt to approximately quarter of the specified torque M_A , and then tighten the one diagonally across in the same manner. Repeat for the other bolts.
- (6) Using the torque wrench, tighten the bolts to one-half the specified torque M_A and repeat the tightening procedure in step (5).
- (7) Bring up to full tightening torque M_A and tighten as in step (5).
- (8) Tighten each bolt to full torque M_A in a circular order. Repeat a few times until the bolts are completely tightened.

Notes: 1. A torque wrench must be used to tighten the locking bolts. Be sure to follow the above instructions to tighten the bolts to the specified torque. Hand-tightening or tightening with a wrench other than a torque wrench will result in incomplete installation, and lead to accidents.

2. Exceeding the specified tightening torque M_A will damage the bolts. On the other hand, tightening to torque below M_A will cause the bolts to loosen during operation. Be sure to use the correct torque to tighten these bolts.
3. Do not use bolts other than those provided. Otherwise, bolts may damage and cause accidents. If you misplace or damage any bolts, contact U.S. Tsubaki for replacement.

B. Removal

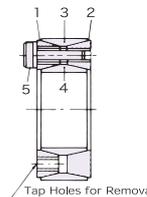
- (1) Verify that no torque or thrust is applied to the hub and shaft.

Note that in cases where a heavy shaft, hub or chain is used, disassembly may be slightly complicated. After removing the load, disassemble the unit by loosening the bolts in the correct order described in Installation A.

⚠ Caution: Loosening the bolts will release the locking function, which may cause the shaft to spin or jump out.

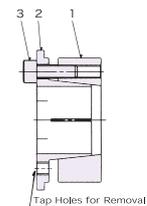
- (2) If the unit does not remove even after loosening all the bolts, tighten the bolts into the screw holes prepared for removal. This will release the lock.

Note: Take caution in installing and removing AD/ADN Series POWER-LOCKS for they have relatively smaller taper angles.



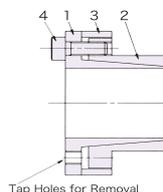
AS Series

- Parts
- 1: Taper Ring A
 - 2: Taper Ring B
 - 3: Outer Ring
 - 4: Inner Ring
 - 5: Locking Bolts



AE Series

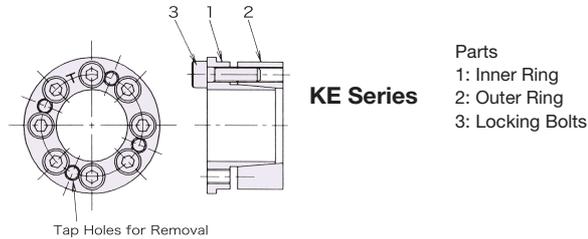
- Parts
- 1: Outer Ring
 - 2: Inner Ring
 - 3: Locking Bolts



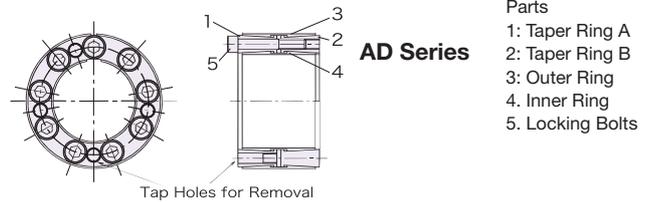
TF Series

- Parts
- 1: Inner Ring
 - 2: Outer Ring
 - 3: Spacer
 - 4: Locking Bolts

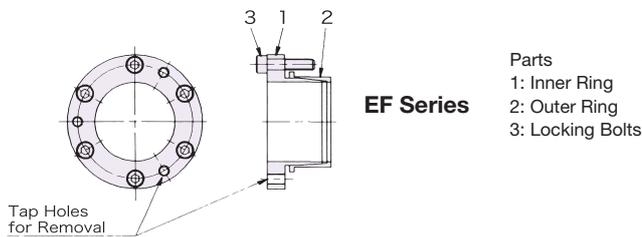
INSTALLATION AND REMOVAL



- Parts
 1: Inner Ring
 2: Outer Ring
 3: Locking Bolts



- Parts
 1: Taper Ring A
 2: Taper Ring B
 3: Outer Ring
 4: Inner Ring
 5: Locking Bolts



- Parts
 1: Inner Ring
 2: Outer Ring
 3: Locking Bolts

C. Reusability

Assembly and disassembly of the POWER-LOCKS may be repeated a few times. However, if the hub and shaft material yield stresses $\sigma < 0.2$ cannot tolerate the contact pressure P and P' , repeated assembly and disassembly may damage certain parts of the hub-shaft contact surfaces.

AS-SS, AS-KP, KE-SS, KE-KP, TF-KP, RE-SS, SL Installation and Removal

A. Installation

- (1) Remove dust and oil from the hub and shaft with a cloth or alcohol. Be sure to completely remove any grease and oil. Otherwise, standard torque may not be achieved.

Note: The locking bolts are coated with a special substance so no lubrication is required.

- (2) Mount the POWER-LOCK onto the hub or shaft. Loosen the bolts or nut if difficult to install.
- (3) Using a torque wrench, tighten the bolts at quarter of the specified torque M_A , starting with one bolt then another diagonally across and repeating for the other bolts. Then, tighten the bolts further to one-half the specified torque M_A in the same crisscross sequence. Finally, tighten each bolt to full torque M_A in a circular order. Repeat until each bolt is completely tightened.

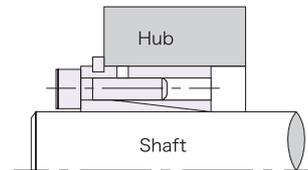
Notes: 1. Do not hit the POWER-LOCK with a hammer. This will severely damage the product and possibly lead to accidents.

2. **A torque wrench must be used to tighten the locking bolts.** Be sure to follow the above instructions to tighten the bolts to the specified torque. Hand-tightening or tightening with a wrench other than a torque wrench will result in incomplete installation, and lead to accidents.
3. Exceeding the specified tightening torque M_A will damage the bolts. On the other hand, tightening to torque below M_A will cause the bolts to loosen during operation. Be sure to use the correct torque to tighten these bolts.
4. Do not use bolts or nuts other than those provided. Otherwise, bolts and nuts may damage and lead to accidents.

■ Notes on RE Series

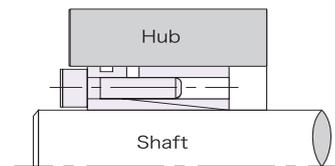
(1) Installation A: With a Snap Ring

- ① Use a snap ring to prevent the hub from moving in the direction of the thrust.



(2) Installation B: Without a Snap Ring

- ① The hub will move in the direction of the thrust while the unit is being installed. See RE Series Movement in the Shaft Direction for amount of hub movement.
- ② Compared to Installation A, installation without a snap ring can transmit torque up to 1.7 times. Take note of the hub and shaft material strengths for this installation. The contact pressure generated at the hub and shaft from this setup is much larger than that achieved from Installation A. It is very important to check the hub material strength, for if the contact pressure is too high, the hub may displace itself. For required hub diameters, refer to the appropriate Hub Diameters table.



Technical Notes

③ The snap ring can be easily removed with a flat-blade screwdriver.

- Removing a snap ring:

The snap rings for POWER-LOCKS are shaped like spirals. Insert a flat-blade screwdriver in the slit of the snap ring and slightly lift to remove. See Illustration 1.

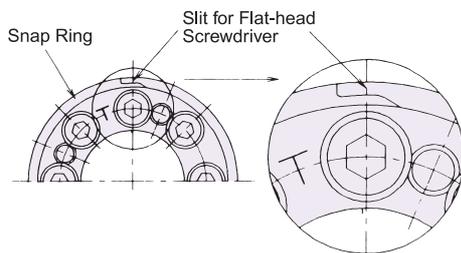


Illustration 1 Removing a Snap Ring

■ Notes on SL Series

Before installing an SL POWER-LOCK, loosen the locking bolts and remove the spacer inserted between the taper rings A and B. See Illustration 2.

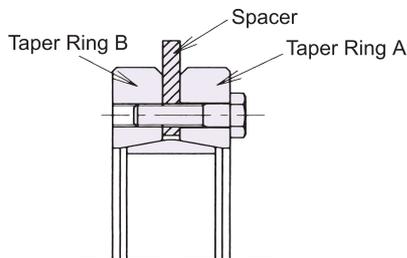


Illustration 2

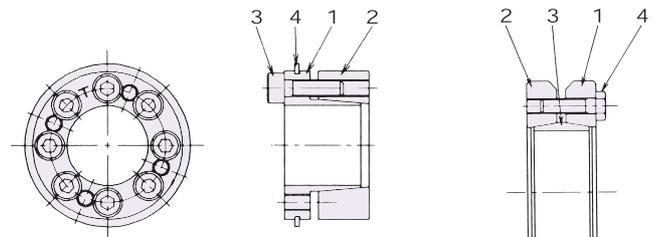
B. Removal

- (1) Verify that no torque or thrust is applied to the hub and shaft.

Note that in cases where a heavy shaft, hub or chain is used, disassembly may be slightly complicated. After removing the load, disassemble the unit by loosening the bolts in the correct order described in Installation A.

⚠ Caution: Loosening the bolts will release the locking function, which may cause the shaft to spin or jump out.

- (2) If the unit does not remove even after loosening all the bolts, tighten the bolts into the screw holes prepared for removal. This will instantly release the lock.



RE Series

- 1: Inner Ring
- 2: Outer Ring
- 3: Locking Bolts
- 4: Snap Ring

SL Series

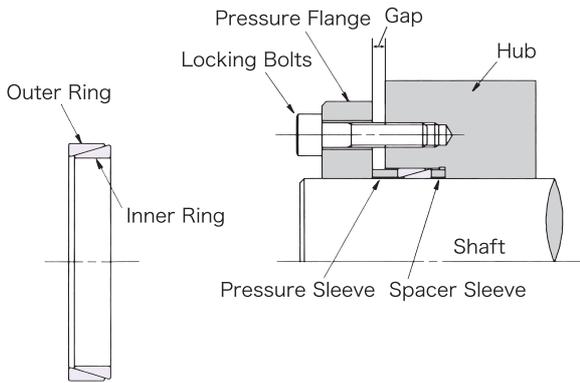
- 1: Taper Ring A
- 2: Taper Ring B
- 3: Inner Ring
- 4: Locking Bolts

C. Reusability

- (1) When POWER-LOCKS with specially lubricated bolts and inner rings start to flake, they cannot be reused. Also, if the end of a locking bolt seems to be damaged or if other parts show signs of wear, the product cannot be reused.
- (2) Assembly and disassembly of the POWER-LOCKS may be repeated a few times. However, if the hub and shaft material yield stresses $\sigma_{0.2}$ cannot tolerate the contact pressure P and P' , repeated assembly and disassembly may damage certain parts of the hub-shaft contact surfaces.

EL Installation and Removal

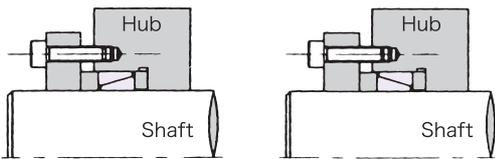
A. Removal



- (1) Verify that the shaft and the inner surface of the hub are clean, we recommend to lightly oil surfaces.

Note: Do not use silicone or molybdenum lubricants. Otherwise, friction coefficient will reduce, and standard torque will not be achieved.

- (2) If an indentation in the inner hub corner or a large R is machined, a spacer sleeve must be used.
- (3) An EL POWER-LOCK can be installed in two ways, resulting in different transmissible torque: (a) Install by pressurizing the outer ring or (b) by pressurizing the inner ring. Pay close attention to the installation position during this procedure.
- (4) Mount the POWER-LOCK so that it slightly moves in parallel to the shaft.



(a) Mounting by Pressurizing the Outer Ring (b) Mounting by Pressurizing the Inner Ring

- (5) Mount by tightening the bolts on the pressure flange evenly, in a crisscross sequence. Make sure that the amount of space between the pressure flange and the hub is uniform throughout the circumference.

Note: If the pressure flange material strength is insufficient, adequate pressure cannot be achieved. Confirm the catalog rate for pressure flange material strength before installing and avoid damages to the POWER-LOCK and the bolt head bearing surfaces.

- (6) Hand-tighten the bolts until the pressure flange no longer moves in the shaft direction. Then, adjust the hub position and phase.

Note: Do not use a spring washer or toothed washer with the pressure flange and bolts.

- (7) Using a torque wrench or a hexagonal spanner wrench tighten the bolts to approximately quarter of the specified torque.
- (8) Using the wrench tighten the bolts to one-half the specified torque.
- (9) Bring up to full tightening torque MA until the bolts do not turn any further. Use the torque wrench to complete this final step and make sure that the space between the pressure flange and the hub or shaft end is uniform throughout the circumference.

Notes on AS and EL Series

When using a POWER-LOCK that is not self-centering, mount a guiding unit to the hub. Do not center by tightening the bolts. Instead, center or align the hub and shaft by adjusting the guide portion itself. The alignment accuracy is determined by the length and tolerance of the guide portion.

B. Removal

- (1) Tighten the bolts in a crisscross sequence.
Normally, when the bolts are loosened, the POWER-LOCK will remove itself.
- (2) If it does not remove after loosening all the bolts, clean the surrounding surface and lightly hit the POWER-LOCK with a hammer.
- (3) If an EL POWER-LOCK does not remove by procedure (2), an increase in friction coefficient may have taken place due to damaged contact surfaces or a dislocation of the unit may have happened due to incorrect mounting or a plastic deformation may have occurred. In these cases, the unit must be disassembled and the problem investigated before reassembling.

C. Reusability

- (1) An EL POWER-LOCK cannot be reused if the bolts or other parts are damaged.
- (2) Assembly and disassembly of the POWER-LOCKS may be repeated a few times. However, if the hub and shaft material yield stresses $\sigma_{0.2}$ cannot tolerate the contact pressure P and P', repeated assembly and disassembly may damage certain parts of the hub-shaft contact surfaces.

PRECAUTIONS

Technical Notes

Precautions

1. Installing to Keyed Shafts

Mounting to keyed shafts such as motored shafts will reduce the transmissible torque M_t and transmissible thrust P_{ax} by 10%.

Transmissible torque : $M_t \times 0.9$

Transmissible thrust : $P_{ax} \times 0.9$

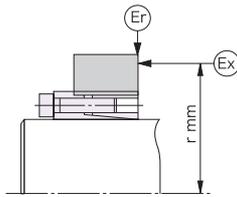
2. Installation Accuracy

When a POWER-LOCK is installed into a straight hub bore, the installation accuracy depends on the hub's length as shown below.

Ex: Hub End Face Runout Below $0.002 \times r$ mm

Er: Outer Hub Diameter Runout Below 0.05mm

Series	Hub Length B
ADN	L
AE	L_2
RE	L_2
KE	L_2
TF	ℓ
EF	ℓ



AS and EL are not self-centering.
Refer to Selection Procedure for details.

3. Hub's Outer Diameter Deformation

Note: Following contains metric numbers and equations.
If there are questions, contact U.S. Tsubaki.

When a POWER-LOCK is mounted onto a hub, contact pressure P' will exert on the hub's inner surface, causing the hub's outer diameter to experience a plastic deformation. The specific degree of deformation cannot be determined for it depends on the distribution of P' and the type of hub. However, the following formula can be used to obtain rough deformation values.

$$\Delta DN \approx \frac{DN}{E} \times \frac{2 \times K_3 \times P'}{\left(\frac{DN}{E}\right)^2 - 1}$$

P' : Contact pressure of the hub MPa

E : Young's Modulus

For steel: $E=205800$ MPa

D : Hub inner diameter mm

DN : Hub outer diameter mm

ΔDN : Hub's outer diameter deformation mm

K_3 : Hub configuration coefficient

(See appropriate Hub Diameters table.)

4. Ambient Temperature

POWER-LOCKS must be operated in an appropriate environment with a temperature ranging from -22°F to 392°F .

5. Allowable Deviation of Tightening Torque M_A

The allowable deviation from the specified tightening torque is $\pm 5\%$. If the bolts are correctly tightened within this range with a torque wrench as instructed, the unit should achieve adequate transmissible torque M_A and thrust P_{ax} .

6. Hub Movement

The hub may move, depending on the type of POWER-LOCK installed. See Selection and Procedure for details.

(1) RE Series Hub Movement

The hub will move when installing an RE POWER-LOCK without a snap ring. This movement is caused by the deformation of the shaft and hub and varies depending on the hub's inner-to-outer diameter ratio a_N . See table below.

$$a_N = \frac{DN}{D}$$

D : Inner Hub Diameter mm
 DN : Outer Hub Diameter mm

Model Number	Hub Movement inch		
	$a_N=3$	$a_N=2$	$a_N=1.5$
PL005X018 RE-SS	0.002	0.003	0.004
PL006X019 RE-SS	0.002	0.003	0.004
PL008X021 RE-SS	0.003	0.004	0.005
PL010X026 RE-SS	0.004	0.005	0.007
PL011X027 RE-SS	0.005	0.006	0.007
PL012X028 RE-SS	0.006	0.007	0.009
PL014X030 RE-SS	0.006	0.007	0.001
PL015X031 RE-SS	0.006	0.007	0.001
PL016X032 RE-SS	0.006	0.007	0.001
PL017X033 RE-SS	0.006	0.007	0.009
PL018X034 RE-SS	0.006	0.007	0.009
PL019X035 RE-SS	0.007	0.009	0.012
PL020X039 RE-SS	0.009	0.011	0.015
PL022X041 RE-SS	0.009	0.011	0.015
PL024X043 RE-SS	0.012	0.014	0.019
PL025X044 RE-SS	0.012	0.014	0.019
PL028X049 RE-SS	0.013	0.015	0.021
PL030X050 RE-SS	0.013	0.016	0.021
PL032X052 RE-SS	0.013	0.015	0.021
PL035X058 RE-SS	0.015	0.018	0.024
PL038X060 RE-SS	0.017	0.020	0.028
PL040X063 RE-SS	0.017	0.020	0.028
PL042X066 RE-SS	0.019	0.023	0.031
PL045X068 RE-SS	0.020	0.023	0.031
PL048X072 RE-SS	0.022	0.026	0.035
PL050X075 RE-SS	0.022	0.026	0.035

PRECAUTIONS

(2) EF Series Hub Movement

The hub will move when connecting a shaft and hub with an EF POWER-LOCK. This movement is caused by the deformation of the shaft and hub bore and varies depending on the hub's inner-to-outer diameter ratio a_N .

$$a_N = \frac{D_N}{D} \quad \begin{array}{l} D : \text{Inner Hub Diameter} \\ D_N : \text{Outer Hub Diameter} \end{array}$$

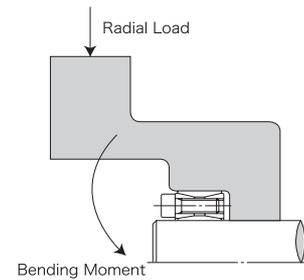
Model Number	Hub Movement inch		
	$a_N=1.5$	$a_N=2$	$a_N=3$
PL010X013 EF	0.011	0.009	0.007
PL011X014 EF	0.011	0.009	0.007
PL012X015 EF	0.011	0.009	0.007
PL014X018 EF	0.011	0.009	0.007
PL015X019 EF	0.011	0.009	0.007
PL016X020 EF	0.017	0.013	0.011
PL017X021 EF	0.017	0.013	0.011
PL018X022 EF	0.019	0.014	0.012
PL019X024 EF	0.019	0.014	0.012
PL020X025 EF	0.019	0.014	0.012
PL022X026 EF	0.019	0.014	0.012
PL024X028 EF	0.019	0.014	0.012
PL025X030 EF	0.019	0.014	0.012
PL028X032 EF	0.028	0.021	0.018
PL030X035 EF	0.028	0.021	0.018
PL032X036 EF	0.024	0.018	0.015
PL035X040 EF	0.025	0.018	0.015
PL038X044 EF	0.035	0.026	0.022
PL040X045 EF	0.028	0.021	0.018
PL042X048 EF	0.038	0.028	0.024
PL045X052 EF	0.043	0.032	0.027
PL048X055 EF	0.043	0.032	0.027
PL050X057 EF	0.043	0.032	0.027
PL055X062 EF	0.043	0.032	0.027
PL060X068 EF	0.039	0.029	0.024
PL065X073 EF	0.052	0.038	0.032
PL070X079 EF	0.049	0.036	0.031
PL075X084 EF	0.061	0.045	0.038
PL080X091 EF	0.056	0.041	0.035
PL085X096 EF	0.071	0.052	0.044
PL090X101 EF	0.071	0.052	0.044
PL095X106 EF	0.071	0.052	0.044
PL100X114 EF	0.065	0.048	0.041
PL110X124 EF	0.065	0.048	0.041
PL120X134 EF	0.078	0.058	0.049

7. Assembly Lubrication

A POWER-LOCK's main body and bolts must be lubricated during assembly. Some may be concerned that the lubrication may cause POWER-LOCKS to slip, or the bolts to loosen. However, specified tightening torque for the bolts is calculated provided that the bolts are thoroughly lubricated. Oil is also required for the tapered surfaces to slide smoothly. If the unit is not lubricated, transmissible torque will decrease approximately 25% due to a reduction in axial force. The bolts may also deform and lead to failure. In the case of a stainless steel or an electroless nickel-plated model, however, the bolts are coated with a special substance and the main unit is prepared so that it can be operated in the "dry state". Do not lubricate these models during assembly.

8. Bending Moment

POWER-LOCKS cannot tolerate bending moments. Contact U.S. Tsubaki if a bending moment applies as illustrated below.



9. Outdoor Use

POWER-LOCK performance is not affected by moisture or rain due to the tight seal of parts maintained by their high interfacial contact pressure. However, the exterior surfaces will begin to rust. The rust will reduce the bolts' tensile strengths and cause a sudden drop in the general tightening force. In order to prevent this, you must use a cover, thoroughly grease the unit and take countermeasures against corrosion. If the cover causes any inconvenience, opt for the anticorrosive stainless steel or electroless nickel-plated models. Also, note that although the exterior surfaces of SL POWER-LOCKS are coated with a special lubricant, it may not be effective after a certain period of time. It may be wise to lubricate them after assembly.