U.S. TSUBAKI POWER-LOCK®

Technical Notes

(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.

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

n: RPM sf : Safety Factor

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

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.

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

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.

$M_t \geqq T_{max}$ or M_R → Acceptable
$M_t < T_{max}$ or M_R → Use larger or multiple units.

(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.

$$\sigma_{0.2S} \geqq K_2 \times P \qquad \sigma_{0.2B} \geqq K_2 \times P'$$

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
K_2 : Series coefficient (Table 2)

Series Coefficient K_2 (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.

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

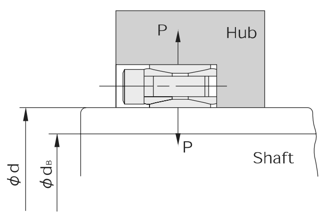
D_N : Hub outer diameter
D : Hub inner diameter
P′ : Hub contact pressure
$\sigma_{0.2B}$: Yield point of hub material
K_3: Hub configuration coefficient

Technical Notes

(3) Hollow Shaft Inner Diameter

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

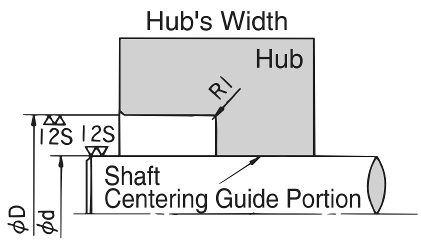
$$\text{Hollow shaft inner diameter } d_B \leqq d \times \sqrt{\frac{\sigma_{0.2S} - 2 \cdot P \cdot K_3}{\sigma_{0.2S}}}$$



- 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 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.



STEP 3 Radial Load

If radial loads apply to POWER-LOCKs as in wheel applications, calculate the contact pressure on the shaft Prad, 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 Prad and P'rad to P and P' respectively.

Table 4. Allowable Contact Pressure

Series	Prad(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.

$$\sigma_{0.2S} \geqq 1.2 \times P \qquad \sigma_{0.2B} \geqq 1.2 \times P'$$

- 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 (σw)

$$\sigma W = -P$$

P: Shaft contact pressure

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

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

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

- 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)

$$\tau_B = \frac{16000 \times Tmax \cdot dw}{\pi\,(d^4 - dw^4)}$$

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

$$\sigma v = \sqrt{\sigma t^2 + \sigma w^2 - \sigma t \cdot \sigma w + 3 \times \tau_B^2}$$

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

EL Series

STEP 1 Actual Locking Force, Transmissible Torque and Contact Pressure

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

Calculate the actual locking force Fe, thrust Pax, contact pressure P and P' using the following formulas.

$C_1 = Mt / [Mt]$ (Required transmissible torque ratio)

$Fe = C_1 \times [Fe]$ (Actual locking force)

$F = Fo + Fe$ (Total Force)

$Pax = C_1 \times [Pax]$ (Transmissible thrust)

$P = C_1 \times [P]$ (Contact pressure on the shaft)

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

Mt : Required transmissible torque

Fo, [Fe], [Mt], [Pax], [P']: Values are listed in EL Series Specifications table

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

Calculate transmissible torque Mt, thrust Pax, contact pressure P and P' using the following formulas.

$C_2 = Fe / [Fe]$ (Required actual locking force ratio)

$Mt = C_2 \times [Mt]$ (Transmissible torque)

$Pax = C_2 \times [Pax]$ (Transmissible thrust)

$P = C_2 \times [P]$ (Contact pressure on the shaft)

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

Fe : Required actual locking force

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.

$$\sigma_{0.2S} \geqq 1.4 \times P$$
$$\sigma_{0.2B} \geqq 1.4 \times P'$$

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

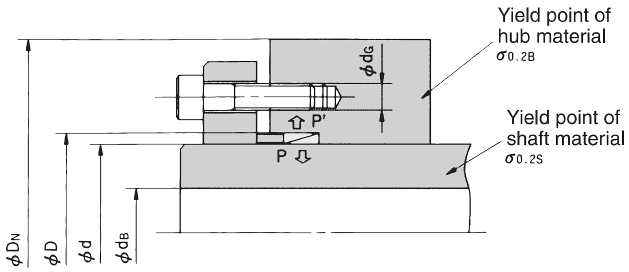
P, P´ : Contact pressure on the shaft and hub bore

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

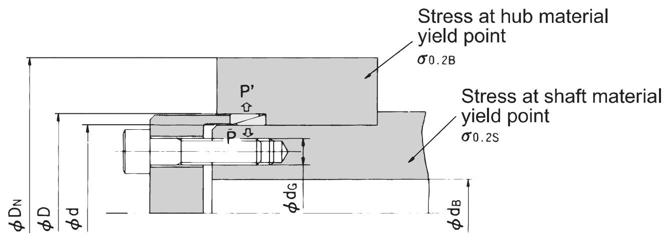
Hubs must have a D_N that is greater than the value obtained from the following formula.

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



(b) Bolts Fastened to the Shaft Section



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

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

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

STEP 3 Selecting Locking Bolts

(1) Bolt Strength Classes and Mechanical Properties

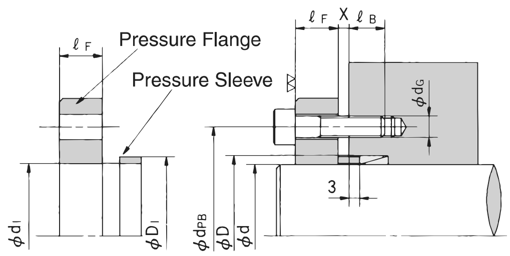
In general, 10.9 and 12.9 class bolts should be used. These bolts are less affected by vibration and do not loosen as easily as others.

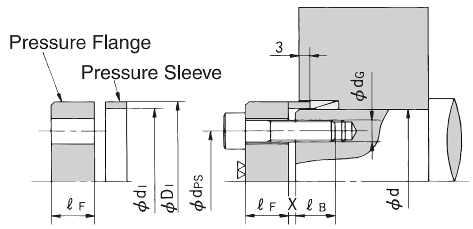
(2) Bolt Head Bearing Surface Pressure

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

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 d_1, D_1 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.

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

U.S. TSUBAKI POWER-LOCK®

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.

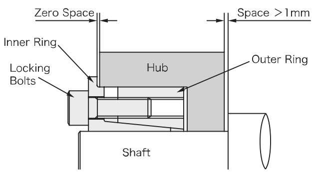
Note: Do not use silicone or molybdenum lubricants. Otherwise, friction coefficient will reduce, and standard torque will not be achieved.

(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

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

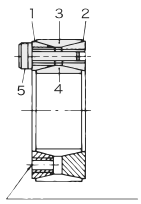
(1) Verify that no torque or thrust is applied to the hub and shaft.

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.

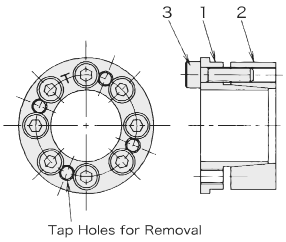
(2) If the unit does not remove even after loosening all the bolts, tighten the bolts into the screw holes prepared for removal. This will release the lock.

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



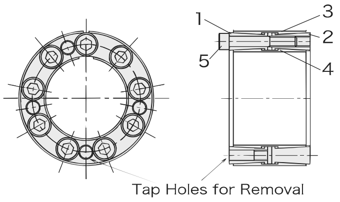
AS Series

Parts
1: Taper Ring A
2: Taper Ring B
3: Outer Ring
4: Inner Ring



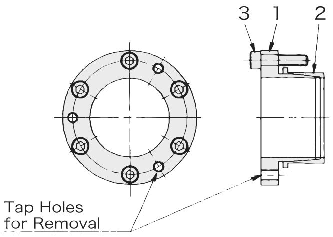
KE Series

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



AD Series

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



EF Series

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.

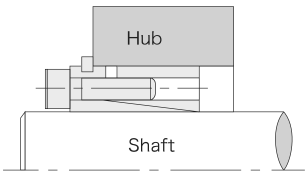
(3) Using a torque wrench, tighten the bolts at quarter of the specified torque M_A, starting with one bolt then another diagonally across and repeating for the other bolts. Then, tighten the bolts further to one-half the specified torque M_A in the same crisscross sequence. Finally, tighten each bolt 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

■ **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

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.

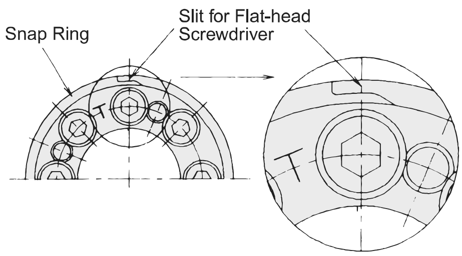


Illustration 1 Removing a Snap Ring

■ 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.

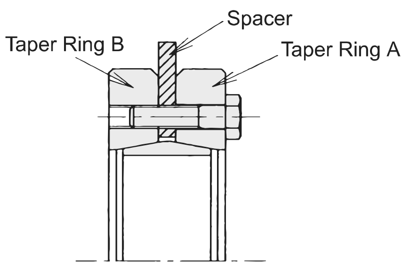


Illustration 2

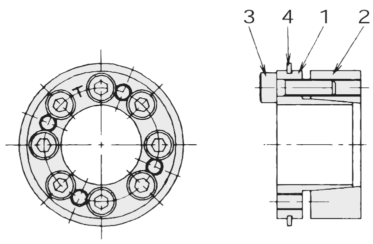
B. Removal

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

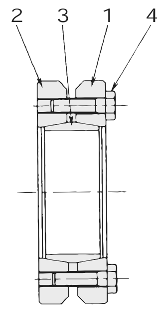
Note that in cases where a heavy shaft, hub or chain is used, disassembly may be slightly complicated. After removing the load, disassemble the unit by loosening the bolts in the correct order described in Installation A.

⚠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

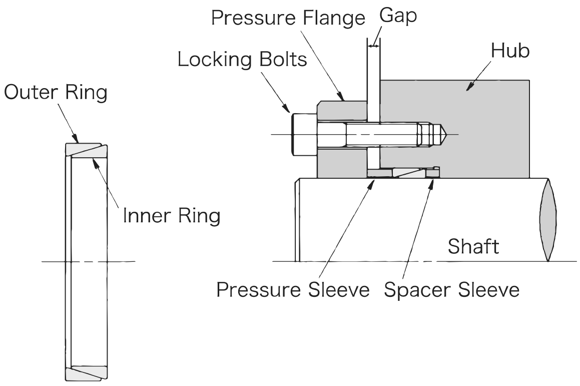
C. Reusability

(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

EL Installation and Removal

A. Removal



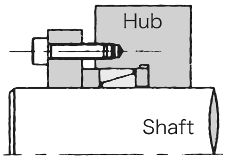
(1) Verify that the shaft and the inner surface of the hub are clean, we recommend to lightly oil surfaces.

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

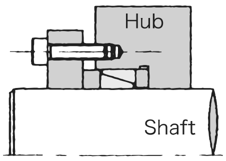
(2) If an indentation in the inner hub corner or a large R is machined, a spacer sleeve must be used.

(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

(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 M_A 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.

PRECAUTIONS

Technical Notes

Precautions

1. Installing to Keyed Shafts

Mounting to keyed shafts such as motored shafts will reduce the transmissible torque Mt and transmissible thrust Pax by 10%.

Transmissible torque : Mt ×0.9

Transmissible thrust : Pax×0.9

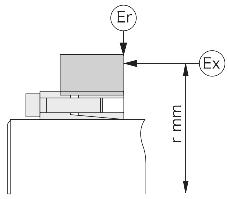
2. Installation Accuracy

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 x 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.

$\triangle D_N/2$

$2 \times K \times P'$

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 ±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 Pax.

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.

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

D : Inner Hub Diameter mm
D_N : 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

(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.

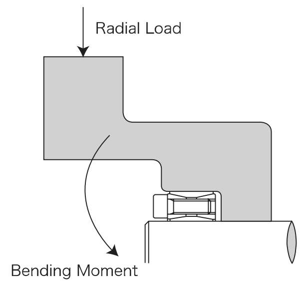
$$a_N = \frac{D_N}{D}$$

D : Inner Hub Diameter
D_N : Outer Hub Diameter

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

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