



OIL SEALS & O-RINGS



JTEKT | JTEKT CORPORATION
KOYO SEALING TECHNO CO., LTD.



CAT. NO.R2001E-3



OIL SEALS & O-RINGS

- **Koyo Oil Seals: Features**
- **Koyo O-Rings: Features**
- **Koyo Functional Products: Features**
- **FEM (Finite Element Method) Analysis**

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Engineering Section

Dimensional Tables

2. O-Rings

Engineering Section

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3. Application Examples

of Oil Seals and O-Rings

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for Oil Seal Design and Production



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Preface

This catalog lists Koyo oil seals and O-rings, including all items of the dimension series specified in ISO, JIS and JASO (Japanese Automobile Standards Organization) standards. This catalog is also based on knowledge gained from our supply record, experience, expertise, technologies, and research developments that JTEKT and KOYO SEALING TECHNO have acquired in cooperation with customers since its foundation in 1964.

A specialty of this new catalog is the comprehensive information, it offers regarding the selection and handling of oil seals and O-rings.

Energy-saving, efforts to protect global environment are in great demand, and we make efforts to continue further research and development in response to these.

We look forward to receiving your further loyal patronage of Koyo products.

If you have any questions or requests in selecting oil seals, please fill out the Request Forms for Oil Seal Design and Production provided at the end of this catalog and send them by fax to your nearest JTEKT operation.

- ★ The contents of this catalog are subject to change without prior notice. Every possible effort has been made to ensure that the data listed in this catalog is correct. However, we can not assume responsibility for any errors or omissions.

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Koyo Oil Seals: Features

1. Lightweight, compact, and energy-saving

Koyo oil seals offer high sealing performance, while being compact with reduced seal width. They help reduction of machine weight, size, and resource consumption

2. High sealing performance by optimum lip design

Koyo oil seals employ a linear-contact lip, which provides proper radial lip load. The lip design ensures excellent sealing performance, low torque, proper flexibility and high allowability for eccentricity.

3. Low heat generation and long service life by highly self-lubricating rubber materials

Based on extensive research and experimentation, JTEKT has succeeded in developing seal rubber materials with high self-lubrication performance. These rubber materials show limited chemical changes such as hardening, softening and/or aging.

These materials, having excellent durability, can offer long service life with less heat generated even under high-peripheral speed.

4. High sealing performance and long service life by hydrodynamic ribs (Perfect Seal, Helix Seal, Super Helix Seal)

The sealing lip has special spiral threads (hydrodynamic ribs) in one or two directions, which drastically improved sealing performance and service life.



Various oil seals



Large-size oil seals

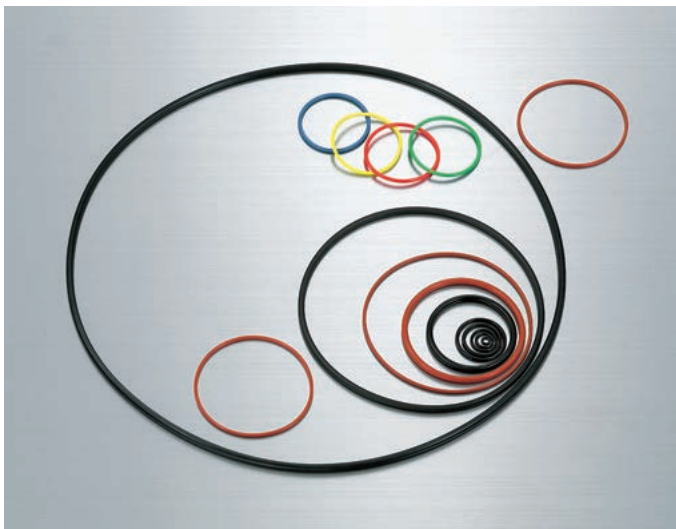
■ Koyo O-Rings: Features

1. High sealing performance and reliability

High sealing performance against water, oil, air, various gases and chemicals.

2. Available in a full lineup of designs and sizes

3. Easy handling



■ Various O-rings

Koyo Functional Products: Features

JTEKT produces various functional products based on advanced sealing technologies and sophisticated manufacturing expertise acquired through extensive research and development.

Koyo functional products are very helpful in improving

machine performance, reducing weight, size, noise and vibration.

Consult JTEKT if there is no product in this catalog that exactly matches your requirements--JTEKT can custom-design products.

1. Functional products for automobiles and industrial machinery



- Center bearing unit
- Bearings molded with vibration isolating rubber
- Spark-plug tube gasket
- Plastic gear shafts
- Dust covers

■ Various functional products



■ Bonded piston seals for automatic transmissions and CVT



■ Friction dampers for manual transmissions and engine balance shafts

2. Functional products for motorcycles



- Air cleaner joint
- Carburetor joint
- Muffler joints
- Plastic gear shafts
- Oil strainer
- Mesh gasket
- Ball-component clutch releases
- Vertical gaskets
- Chain tensioner
- Chain guide

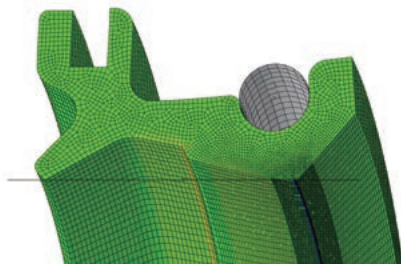
■ Various functional products

FEM (Finite Element Method) Analysis

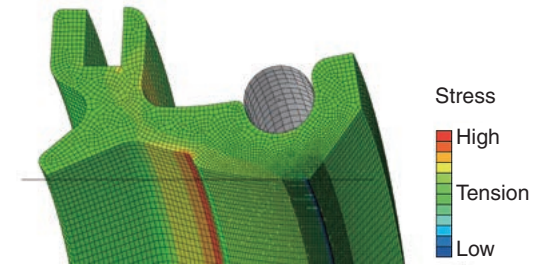
JTEKT uses the non-linear finite element method to analyze non-linear materials such as rubber, for which accurate analysis was difficult before. The company has been studying sealing-mechanism theories by this method in order to develop new products.

The findings so far have been very useful for basic research as well as for rubber-component design. The FEM is our common design tool today, enabling highly reliable analysis and evaluation, speeding up research and product development.

Pressure deflection, stress analysis



Under no load



Under load (stress distribution diagram)

Metal ring three-dimensional stress analysis

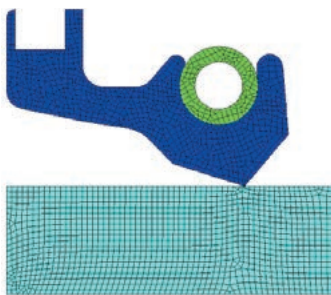


Under no load

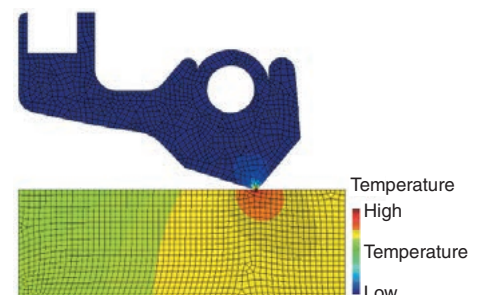


Under load (stress distribution diagram)

Heat transfer analysis (temperature distribution)



When the shaft is standstill

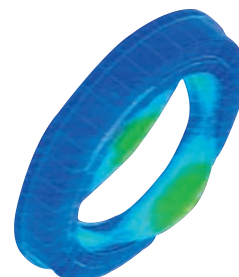


After the shaft is rotated (heat temperature distribution chart)

Three-dimensional seal lip vibration analysis



Under no load



At resonance

1

Oil Seals

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1.1 Nomenclature and functions of seal components

(1) Nomenclature of components

Oil seals work to prevent leakage of sealed objects such as lubricants from inside and also to prevent the entry of dust and contaminants from outside.

Oil seals are designed in a variety of shapes according to the applications and substances to be sealed.

Fig. 1.1.1 shows a typical shape of seal and its component nomenclature.

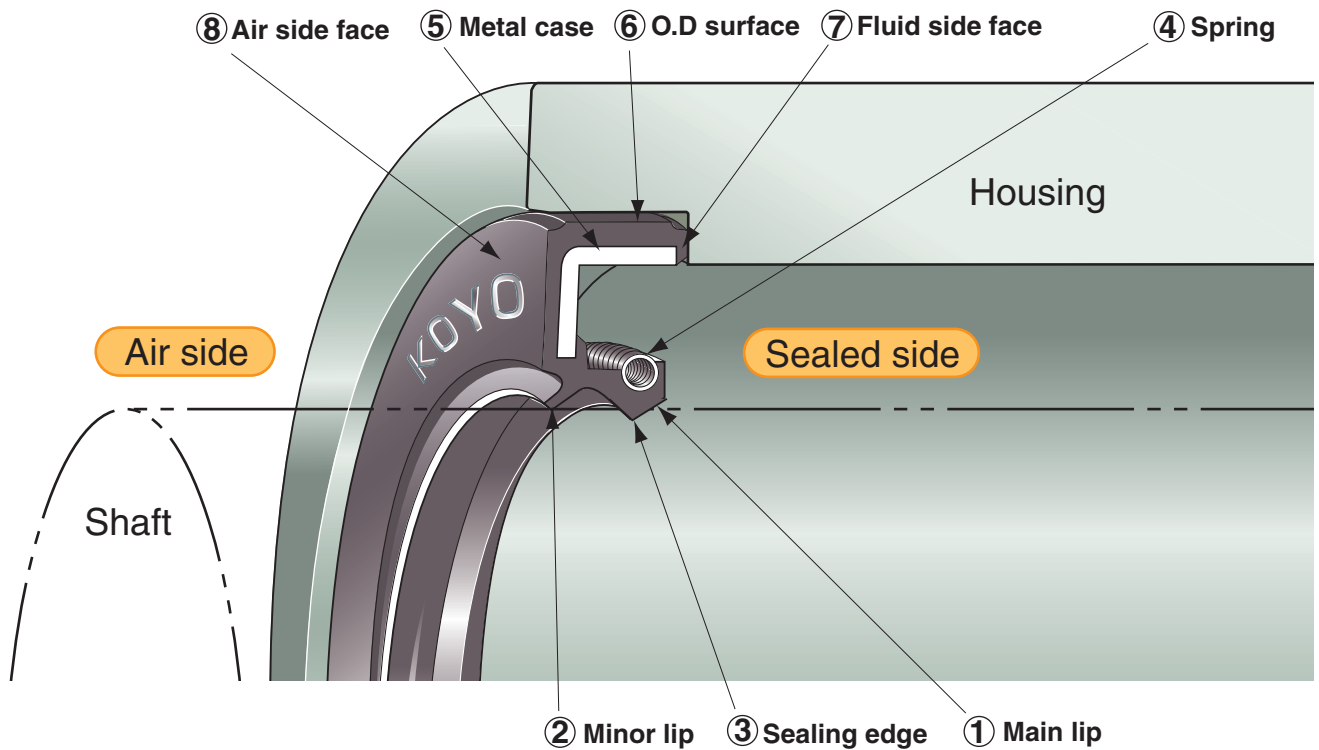


Fig. 1.1.1 Typically shaped oil seal and component nomenclature

(2) Component functions

① Main lip

The main lip is the most critical component of seals. Its sealing edge contacts around the shaft surface in order to provide excellent sealing performance.

During service, seals are placed under various stresses, such as machine vibration, shaft runout, and changes in the temperature and pressure of substances to be sealed.

The main lip is designed so as to generate force (radial lip load) and to keep the sealing edge consistently in contact with the shaft under such stresses.

For such stresses, seal rubber material is made from synthetic rubber, which is highly elastic and abrasion-resistant.

② Minor lip

The minor lip prevents the entry of dust and contaminants from outside. As a lubricant, grease can be retained in the space between main lip and minor lip.

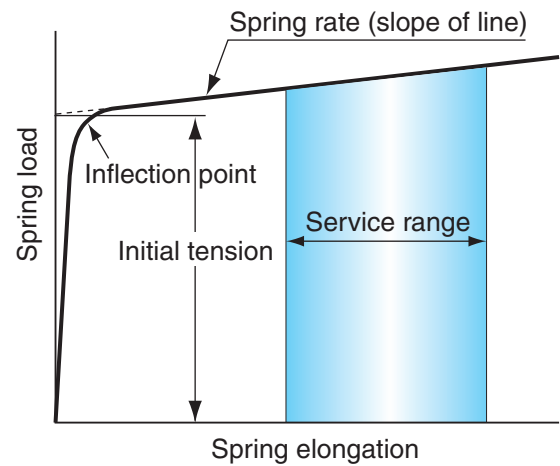
③ Sealing edge

Section of the sealing edge is wedge-shaped to be pressed against the shaft surface and linearly contacts with the shaft to ensure sufficient sealing performance and suitability for operation at high peripheral speed.

④ Spring

The spring supplements the tension at the sealing edge to ensure tight contact between the shaft and the sealing edge and enhanced sealing performance. The spring also prevents the deterioration of main lip sealing performance caused by high heat or others.

Because this spring is a closely wound type coil, the initial tension can be obtained high level, and then changes in load characteristics can be gradual with respect to spring elongation. Tension at the sealing edge can thus be kept stable at an appropriate level.



⑤ Metal case

The metal case provides rigidity on seal, helping it settle on the housing securely. It also ensures easy seal handling and mounting.

⑥ O.D surface

Seals are fitted tightly into the housing bore generally. O.D surface prevents the oil leakage through fitting area, while excluding contaminants. This surface may be made of either metal or rubber and selected depending on the application.

⑦ Fluid side face

The front end face of the seal is called the nose. Seals are usually mounted for the nose to face the substances to be sealed. The nose is made of rubber and forms a gasket seal when compressed on housing shoulder.

⑧ Air side face

The oil seal surface vertical to the center line of the shaft on the side that does not come in contact with substances to be sealed is generally called the back face. Either metal or rubber peripheral surface is available, depending on the application.

Fig. 1.1.2 Spring properties for seal

1.2 Seal numbering system

Table 1.2.1 Seal numbering system

Example

MH S A 45 70 8 J

Special shape code J: Additional code is added here as an identifier when two or more seals have exactly the same type codes and dimensional numbers.

Dimensional numbers [Shaft number 45: The seal suits the shaft diameter of $\phi 45$ mm.
Housing bore number ... 70: The seal suits the housing bore diameter of $\phi 70$ mm.
Width number 8: The seal width is 8 mm.

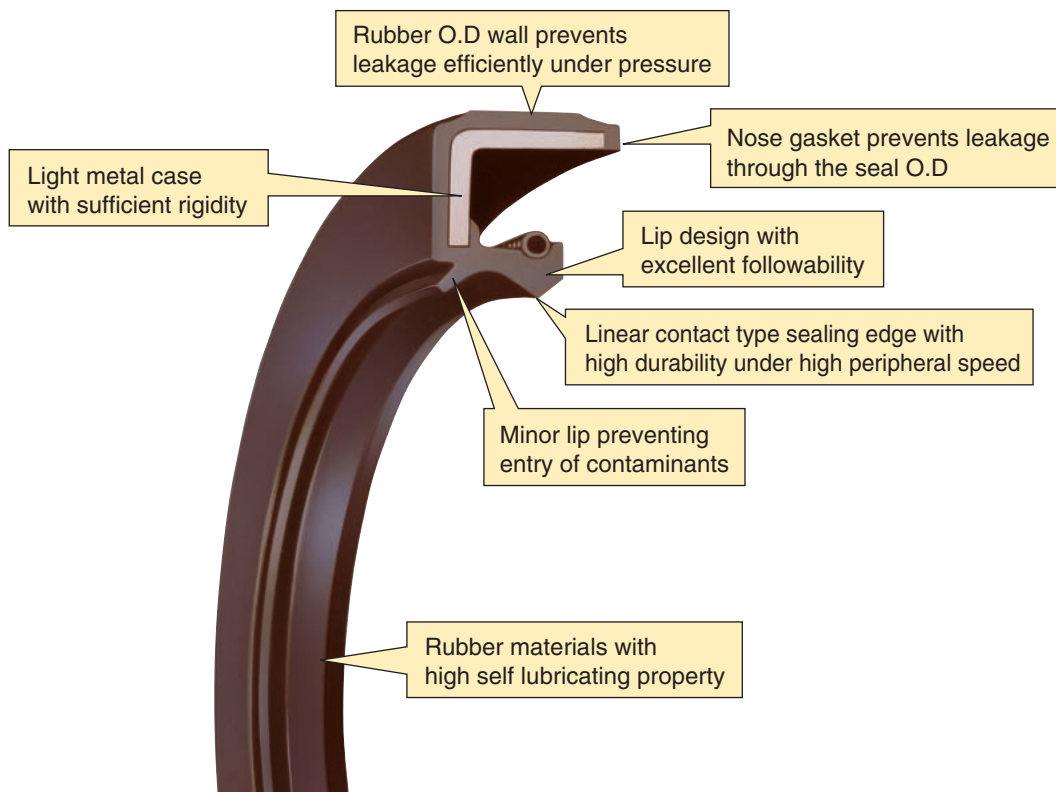
Lip type code No code: without minor lip
A: with minor lip

Spring code No code: without spring
S: with spring

Seal type code [MH: O.D wall is rubber material
HM: O.D wall is metal case
HM(S)H: O.D wall is metal with a reinforcing inner metal case.
(A spring is always provided for this type.)

Remark) For the type codes of special type seals, refer to Section 1.3.

■ Koyo oil seals: Features



1.3 Seal types

(1) Common seal types and their features

Seals are classified by O.D wall material, lip type and whether with spring or without spring. Major oil seals are specified in ISO 6194, JIS B 2402, and JASO F 401. Table 1.3.1 shows common seal types.

Table 1.3.2 lists the seal type codes used at JTEKT, along with the corresponding codes used in the ISO, JIS, and JASO standards.

Table 1.3.1 Oil seals of common types

| | With spring ¹⁾ | | | Without spring | |
|------------------------------|--|------------------------------|---|-------------------------------|------------------------------|
| | Rubber O.D wall ²⁾ | Metal O.D wall ³⁾ | Metal O.D wall (with a reinforcing inner metal case) ^{3) 4)} | Rubber O.D wall ²⁾ | Metal O.D wall ³⁾ |
| Without minor lip | | | | | |
| Type code | MHS | HMS | HMSH | MH | HM |
| With minor lip ⁵⁾ | | | | | |
| Type code | MHSA | HMSA | HMSAH | MHA | HMA |
| Features of each type | 1) With spring type secures stable sealing performance 2) Rubber O.D wall type provides stable sealing performance around the seal O.D surface 3) Metal O.D wall type ensures improved fitting retention between the seal O.D and the housing bore 4) Reinforcing inner metal case in the metal O.D wall type protects the main lip 5) With minor lip type is used for applications where there are contaminants, such as dust and foreign matter, on the air side face of the oil seal. | | | | |

Table 1.3.2 Koyo oil seal type codes corresponding to the codes used in Industrial standards

| KOYO | ISO ¹⁾ · JIS ²⁾ | Old JIS |
|-------|---------------------------------------|---------|
| MHS | Type 1 | S |
| HMS | Type 2 | SM |
| HMSH | Type 3 | SA |
| MH | — | G |
| HM | — | GM |
| MHSA | Type 4 | D |
| HMSA | Type 5 | DM |
| HMSAH | Type 6 | DA |
| MHA | — | — |
| HMA | — | — |

Notes 1) ISO : International Organization Standardization

2) JIS : Japanese Industrial Standard

(2) Special seal types and their features

JTEKT and Koyo sealing techno Co.,Ltd. provide special seals to meet a wide variety of machines and applications:

Table 1.3.3 Oil seals of special types (1)

⊙: For bi-directional rotation ○: For uni-directional rotation

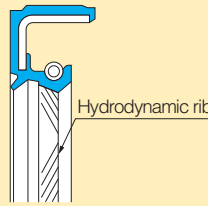
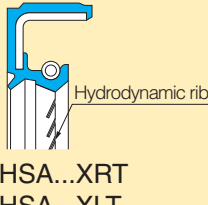
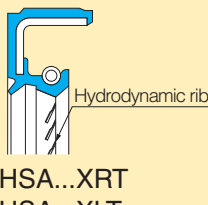
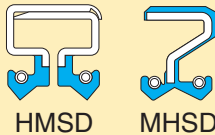
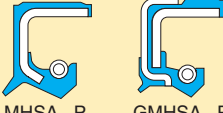

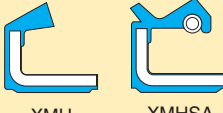
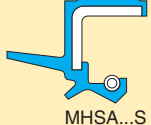


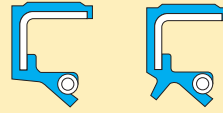
| Seal type | Type code and shape | Motion | Features | Applications |
|--------------------------|--|--------|--|--|
| Perfect Seals |  <p>MHSA...XBT</p> | ⊙ | The hydrodynamic ribs provided in two directions on the sealing surface ensure improved pumping effect and higher sealing performance in both rotational directions of the shaft. | Reduction gears input shafts Differential gear sides |
| Helix Seals |  <p>MHSA...XRT MHSA...XLT</p> | ○ | The hydrodynamic ribs provided in a direction on the sealing surface ensure improved pumping effect and higher sealing performance. | Engine crankshafts Oil pumps Differential gear sides Reduction gears input shafts |
| Super Helix Seals |  <p>MHSA...XRT MHSA...XLT</p> | ○ | The hydrodynamic ribs (a combination of fixed-width ribs and wedge-shaped ribs) provided in a direction on the sealing surface ensure improved pumping effect and enhanced durability. | Engine crankshafts Oil pumps Differential gear sides Reduction gears input shafts |
| Double Lip Seals |  <p>HMSD MHSD</p> | ⊙ | These seals can separate and seal two kinds of oil or fluid on one shaft | Engaged positions of transfer system |



Table 1.3.3 Oil seals of special types (2)

⊙: For bi-directional rotation -: For reciprocation

| Seal type | Type code and shape | Motion | Features | Applications |
|---|--|--------|--|--|
| Pressure-resistant Seals |  MHP...P GMHP...P | ⊙ | These seals are designed to reduce lip deformation caused by oil pressure. Sealing performance does not being deteriorated under high pressure | Hydraulic motors Motorcycle engine crankshafts Power steering input shafts |
| Reciprocating Seals |  MHR...R | ⊙ | These seals are designed to accommodate shaft strokes and to lessen lip deformation caused by shaft reciprocating motion | CVT shafts of motorcycles |
| External Lip Seals |  XM XMHP | ⊙ | This type of seal has the lip on its outside, sealing the contact with housing | Front hubs Rear hubs |
| Seals with Side Lip |  MHP...S | ⊙ | A large side lip ensures prevention of entry of dust/water | Differential gear sides Differential pinion gear |
| Mud-resistant Seals with Integrated Sleeve |  D | ⊙ | These seals are designed to enhance prevention of entry of mud | Wheel hubs |
| HR Seals |  HRSA | ⊙ | HR seals ensures sealing performance around seal O.D and retain fitting with housing | Engine crankshafts Wheel hubs |
| SIM Seals |  MHR MHP | ⊙ | The seals are spring-in mold type, which protect the spring from dust / water and enhance durability | Plug tubes Wheel hubs |



■ Seal with Side Lip




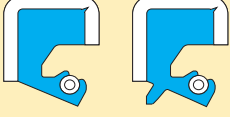
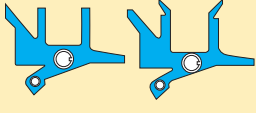

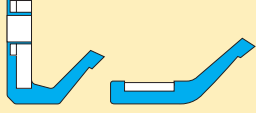

■ HR Seal



■ SIM Seal

Table 1.3.3 Oil seals of special types (3)

⊙: For bi-directional rotation

| Seal type | Type code and shape | Motion | Features | Applications |
|--------------------------|--|--------|--|---|
| Full Rubber Seals |  MS | ⊙ | Mounting is easy because of full rubber construction. Split type seals are available which can be mounted directly, not necessarily mounting from the shaft end | Long shafts, complex shaped shaft |
| YS Type Seal |  YS YSA | ⊙ | Wide range sizes for medium and large shafts are available | Rolling mills Various medium and large size machines |
| MORGOIL Seals |  MS...J MS...NJ | ⊙ | MORGOIL seals are used exclusively on MORGOIL bearings | MORGOIL bearings |
| Water Seals |  XMHE | ⊙ | The double lips ensure improved water-proof performance | Rolling mill roll necks |
| Scale Seals |  WR WR...BJ | ⊙ | These seals prevent the ingress of scales in rolling oil | Rolling mill roll necks |
| V-Rings |  MV...A | ⊙ | With these rings, shafts can be sealed at the end. The V-rings can be mounted easily in limited spaces | Rolling mill roll necks |

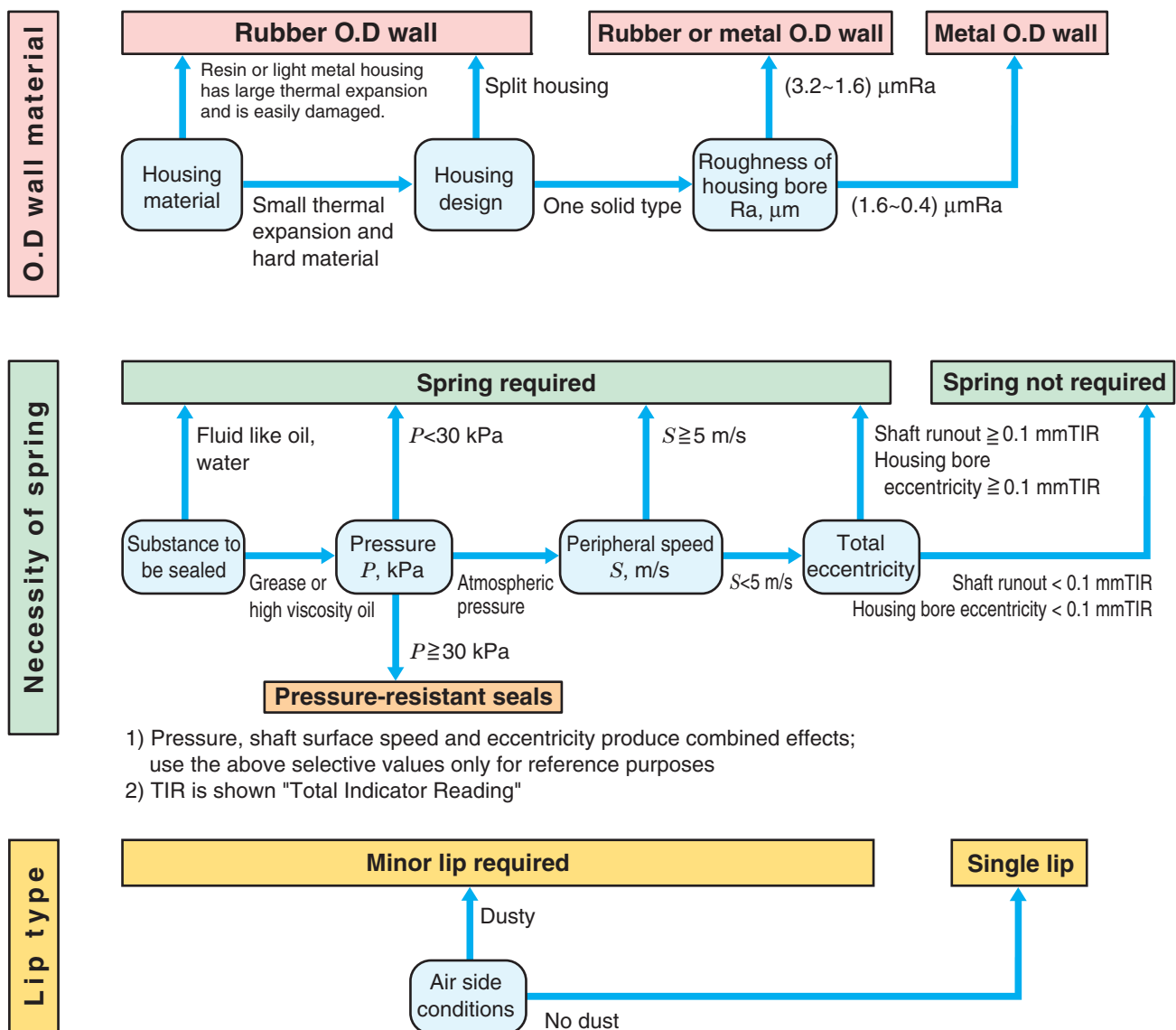
1.4 Selection of seal

(1) Selection of seal type

To select a seal type, seal O.D wall material, lip type, and whether a spring should be provided or not should be decided based on operational conditions as shown in flowcharts below.

If you need oil seals used under special conditions not covered in the flowcharts, refer to Section 1.3 Paragraph (2), "Special seal types and their features."

Table 1.4.1 Flowcharts for oil seal selection



★ Seal selection example

- Housing: Made of steel, one solid design, housing bore surface roughness 1.8 μmRa
- Substance to be sealed: Grease
- Pressure: Atmospheric
- Shaft surface speed: 6 m/s
- Air side condition: Dusty

According to the above flowcharts, a seal with a rubber or metal O.D wall, spring, and minor lip is the most suitable for these conditions. The MHSA or HMSA seal is recommended in this case.

(2) Selection of rubber material

Rubber materials should be selected according to temperature conditions and substances to be sealed.

Table 1.4.2 lists rubber materials along with their operational temperature ranges and their stability to fluids.

- ⊙ : The rubber has excellent resistance to the substance to be sealed
- : The rubber has good resistance to the substance except under extreme conditions
- △ : The rubber is not resistant to the substance except under specific favorable conditions
- × : The rubber is not resistant to the substance

Table 1.4.2 Rubber materials, operational temperature ranges and their stability to fluids⁴⁾

| Rubber material (ASTM ³⁾ code) | Grade | Features | Operational temperature range ^{1) 2)} Lower limit Upper limit Normal operation range -50 0 50 100 150 200 °C | Fuel oil | | | Lubrication oil and hydraulic fluid | | | | | | | Grease | | | | | Chemicals and water | | | | | | | | | | |
|---|--|---|--|--------------------|--------------------|---------------------|-------------------------------------|-------------|------------|------------------------------|-------------|----------------|------------------|-----------|-------------|-------------|--------------|-----------|---------------------|---------------|---------------|---------|-------|--------|-------|-------------------------------------|--------------------------------|-------------------------------|--------------------------|
| | | | | Gasoline (regular) | Gasoline (premium) | Kerosene, light oil | Gear oil | Turbine oil | Engine oil | Automatic-transmission fluid | Mineral oil | Water + glycol | Phosphoric ester | Brake oil | Cutting oil | Machine oil | Lithium base | Urea base | Ester base | Silicone base | Fluorine base | Alcohol | Ether | Ketone | Water | Concentrate inorganic acid solution | Dilute inorganic acid solution | Concentrate alkaline solution | Dilute alkaline solution |
| Nitrile rubber (NBR) | Standard type | Well-balanced rubber in resistance to high-, low- temperature, and to abrasion | -30 100 | ○ | ○ | ⊙ | | | | | | | | | | | | | | | | | | | | | | | |
| | Low-temperature resistant type | High resistant to both high- and low-temperatures and to abrasion | -40 100 | △ | △ | ○ | | | | | | | | | | | | | | | | | | | | | | | |
| | High- and low-temperature resistant type | Very strong and low strain. Superior in resistance to high- and low-temperature | -40 110 | △ | △ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ○ | × | × | ○ | ○ | ⊙ | ⊙ | △ | ⊙ | ⊙ | ○ | △ | × | ⊙ | × | △ | ○ | ○ | |
| | Heat resistant type | Enhanced heat and abrasion resistance. Highly compatible with synthetic oil | -20 120 | ○ | ○ | ⊙ | | | | | | | | | | | | | | | | | | | | | | | |
| | For food processing machines | Nitrile rubber passed tests specified in the Food Sanitation Law | -30 100 | △ | △ | ○ | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrogenated nitrile rubber (HNBR) | Standard type | Compared with nitrile rubber, superior in resistance to heat and to abrasion | -30 140 | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ○ | × | × | ⊙ | ⊙ | ⊙ | ⊙ | △ | ⊙ | ⊙ | ○ | △ | × | ⊙ | × | △ | ○ | ○ | |
| Acrylic rubber (ACM) | Standard type | High resistant to oil and to abrasion | -20 150 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | High- and low-temperature resistant type | Improved low-temperature resistance. Low strain and same level heat resistance as standard type | -30 150 | △ | △ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | × | × | × | △ | ⊙ | ⊙ | ⊙ | × | ⊙ | ⊙ | × | × | × | × | × | × | × | |
| Silicone rubber (VMQ) | Standard type | Wide operational temperature range and good abrasion resistance | -50 170 | × | × | ○ | × | ○ | ○ | △ | ⊙ | △ | ○ | △ | △ | × | ○ | ○ | ○ | × | △ | ○ | × | ○ | ○ | △ | ○ | ⊙ | ⊙ |
| Fluorocarbon rubber (FKM) | Standard type | Most superior in heat resistance and good abrasion resistance | -20 180 | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | △ | × | △ | ⊙ | ⊙ | ⊙ | △ | ⊙ | ⊙ | ⊙ | ○ | × | × | △ | ○ | ⊙ | × | △ | |

* The information provided in the above chart is for reference only. For specific details, consult JTEKT.
 Notes 1) Operational temperature means the lip (Sliding part) temperature. It should be determined based on ambient temperature, heat generated by the machine, lip friction heat, heat generation by the agitation of the substance to be sealed and heat transferred from other components etc.
 2) The highest normal-operation temperature may be lower than indicated in this table, depending on the kind and properties of the substance to be sealed (Refer to Table 1.4.3.)
 3) ASTM : American Society for Testing and Materials.
 4) Properties above may be affected by the components of rust preventing oil and cleaning fluid. Consult JTEKT.

Table 1.4.3 Upper limits guideline of normal operation temperature of rubber materials used with different oils (°C)

| Rubber material | Gear oil | Turbine oil | Engine oil | ATF |
|-----------------------------|--------------|-------------|------------|-------|
| Nitrile rubber | (100) | 100 | 120 | (120) |
| Hydrogenated nitrile rubber | 140 | ← | ← | ← |
| Acrylic rubber | 150 | ← | ← | ← |
| Silicone rubber | Incompatible | 150 | 170 | (150) |
| Fluorocarbon rubber | 180 | ← | ← | ← |

Remark)
 The () indicates oil with extreme pressure additives. Extreme pressure additives are compounds of phosphor, sulfur or chlorine base, added to prevent wear or seizure on sliding or rotating surfaces. These compounds are activated by heat and chemically react against rubber, which deteriorates rubber properties.

Small talk 1

A new salesman's resolution

When the new salesman asked the chief engineer how the elastic rubber is made, he got the reply: "After adding cross-linking chemicals to rubber polymers made from naphtha, high pressure is applied under high temperature. This creates a long-

lasting elasticity. High stress conditions do wonders to things, even to humans."
 Hearing this, the new salesman resolved to live like rubber, resilient and bouncing back into shape.

(3) Selection of metal case and spring materials

The materials of metal case and spring can be selected according to the substance to be sealed.

Table 1.4.4 Compatibility of metal-case and spring materials with substance to be sealed

| Material Substance to be sealed | Metal case | | Spring | |
|------------------------------------|---|------------------------------------|----------------------------------|-----------------------------------|
| | Cold rolled carbon steel sheet (JIS SPCC) | Stainless steel sheet (JIS SUS304) | High carbon steel wire (JIS SWB) | Stainless steel wire (JIS SUS304) |
| Oil | ○ | — | ○ | — |
| Grease | ○ | — | ○ | — |
| Water | × | ○ | × | ○ |
| Seawater | × | ○ | × | ○ |
| Water vapor | × | ○ | × | ○ |
| Chemicals | × | ○ | × | ○ |
| Organic solvent | ○ | ○ | ○ | ○ |

○ : Compatible × : Incompatible — : Not applicable

Small talk 2

A service engineer's finding

One customer called, "Some seals show oil leakage and some are OK. Please come and see immediately." A JTEKT service engineer visited the customer.

He checked shaft diameter and any damage, also visually checked the seals, but no possible cause of oil leakage was found.

He asked how the shaft surface was finished. It was paper lapped to get the desired level of surface roughness. He then checked the shaft surface and found that the leaking shaft had lead marks (spiral traces of lapping) running in the leaking direction. When he rotated the shaft in the reversing direction, no leakage occurred.

Showing a catalog, he advised the customer to finish shafts by plange cut grinding. Satisfied, he went back and felt it was a good day.

1.5 Shaft and housing design

(1) Shaft design

Oil seals can show good sealing performance when mounted on properly designed shafts. To design shafts properly, follow the specifications below.

1) Material

Shafts should be made from carbon steels for machine structural use, low-alloy steel, or stainless steel. Brass, bronze, aluminum, zinc, magnesium alloy and other soft materials are not suitable, except for special applications such as for low-speed or in a clean-environment.

2) Hardness

Shaft hardness should be at least 30 HRC. In a clean environment, shaft hardness does not influence seal performance. However, in an environment where dust, contaminated oil, etc. exists, a shaft hardness of 50 to 60 HRC is recommended in consideration of factors such as shaft wear.

Hard shaft is advantageous regarding seal damage prevention.

3) Dimensional accuracy

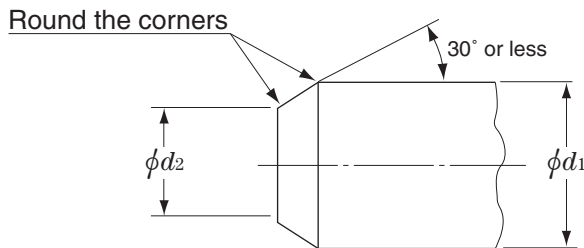
The shaft diameter tolerance should be h8. Seals are designed to suit shafts with the tolerance of h8. When mounted on other tolerance shafts, seals may be unable to provide sufficient sealing performance. For use of shaft diameter tolerances larger than h8, consult JTEKT.

Table 1.5.1 h8 Shaft tolerance

| Nominal shaft diameter <i>d</i> , mm | | Tolerance μm | |
|--------------------------------------|-------|--------------|-------|
| | | h8 | |
| Over | Up to | Upper | Lower |
| 3 | 6 | 0 | -18 |
| 6 | 10 | 0 | -22 |
| 10 | 18 | 0 | -27 |
| 18 | 30 | 0 | -33 |
| 30 | 50 | 0 | -39 |
| 50 | 80 | 0 | -46 |
| 80 | 120 | 0 | -54 |
| 120 | 180 | 0 | -63 |
| 180 | 250 | 0 | -72 |
| 250 | 315 | 0 | -81 |
| 315 | 400 | 0 | -89 |
| 400 | 500 | 0 | -97 |
| 500 | 630 | 0 | -110 |
| 630 | 800 | 0 | -125 |
| 800 | 1 000 | 0 | -140 |

4) Shaft end chamfer

To protect seals from damage at mounting onto shafts, recommended chamfer on the shaft end is shown below.



| Nominal shaft diameter d_1 , mm | | d_1-d_2 mm | Nominal shaft diameter d_1 , mm | | d_1-d_2 mm |
|-----------------------------------|-------|--------------|-----------------------------------|-------|--------------|
| Over | Up to | | Over | Up to | |
| — | 10 | 1.5 min. | 50 | 70 | 4.0 min. |
| 10 | 20 | 2.0 min. | 70 | 95 | 4.5 min. |
| 20 | 30 | 2.5 min. | 95 | 130 | 5.5 min. |
| 30 | 40 | 3.0 min. | 130 | 240 | 7.0 min. |
| 40 | 50 | 3.5 min. | 240 | 500 | 11.0 min. |

[Remark] When round chamfer is applied, take the above specified d_1-d_2 dimensional chamfer or more.

Fig. 1.5.1 Shaft end chamfer

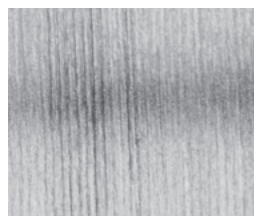
5) Surface roughness and finishing method

To ensure the sealing performance of seals, the shaft surface to be in contact with the lip should be finished to 0.1-0.32 μmRa and 0.8-2.5 μmRz in roughness.

Note that lead marks on the shaft surface may carry the substance to be sealed in the axial direction during shaft rotation, which interferes with the function of the seal. Finish shaft surface such that the lead angle will be no greater than 0.05° . To achieve this, plange cut grinding is most suitable. To avoid undulation on the shaft surface, the ratio of shaft rotational speed vs grinding-wheel rotational speed should not be an integer.



■ Good finished surface



■ Undesirable finished surface

The surface shows visible lead marks

Fig. 1.5.2 Shaft surface with and without lead marks

(2) Housing design

1) Material

Steel or cast iron is generally used as the material of housings. When aluminum or plastic housing is used, the following consideration and study are required, as seal seating in housing bore may become loose fitting under high temperature because the housing material and seal material have different linear expansion coefficients. This may cause problems such as leakage through the seal O.D., or seal dislocation.

2) Dimensional accuracy

The housing bore tolerance should be H7 or H8 when bore is 400 mm or less. For larger housing bores, recommended tolerance is H7.

Table 1.5.2 Housing bore tolerance

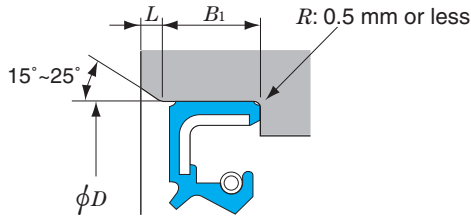
| Nominal bore diameter D , mm | | Tolerance μm | | | |
|--------------------------------|-------|-------------------------|-------|-------|-------|
| | | H7 | | H8 | |
| Over | Up to | Upper | Lower | Upper | Lower |
| 3 | 6 | +12 | 0 | +18 | 0 |
| 6 | 10 | +15 | 0 | +22 | 0 |
| 10 | 18 | +18 | 0 | +27 | 0 |
| 18 | 30 | +21 | 0 | +33 | 0 |
| 30 | 50 | +25 | 0 | +39 | 0 |
| 50 | 80 | +30 | 0 | +46 | 0 |
| 80 | 120 | +35 | 0 | +54 | 0 |
| 120 | 180 | +40 | 0 | +63 | 0 |
| 180 | 250 | +46 | 0 | +72 | 0 |
| 250 | 315 | +52 | 0 | +81 | 0 |
| 315 | 400 | +57 | 0 | +89 | 0 |
| 400 | 500 | +63 | 0 | — | — |
| 500 | 630 | +70 | 0 | — | — |
| 630 | 800 | +80 | 0 | — | — |
| 800 | 1 000 | +90 | 0 | — | — |
| 1 000 | 1 250 | +105 | 0 | — | — |
| 1 250 | 1 600 | +125 | 0 | — | — |

1.5 Shaft and housing design

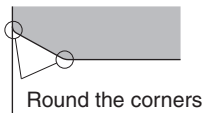
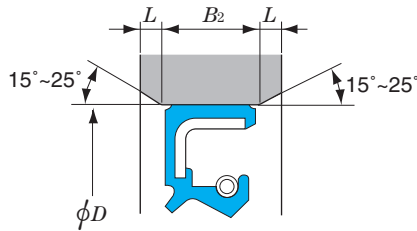
3) Chamfer

Provide the chamfer at the housing bore inlet as shown below so that a seal can be mounted easily and avoided from damages.

Shouldered bore



Straight bore



Unit : mm

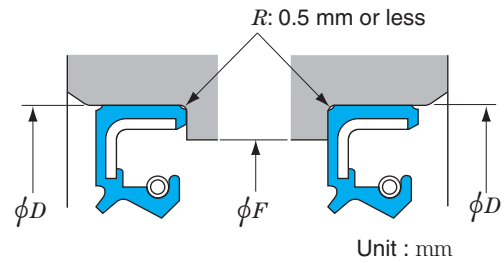
| Nominal seal width, b | | B_1 min. | B_2 min. | L |
|-------------------------|-------|---------------|---------------|-----|
| Over | Up to | | | |
| – | 10 | $b + 0.5$ | $b + 1.0$ | 1.0 |
| 10 | 18 | | | |
| 18 | 50 | $b + 0.8$ | $b + 1.6$ | 1.5 |

[Remark] b indicates the width of a seal.

Fig. 1.5.3 Recommended housing bore chamfers

4) Housing shoulder diameter

In case the housing bore has a shoulder, satisfy the following dimensional requirements.



| Nominal seal O.D, D | | F |
|-----------------------|-------|---------|
| Over | Up to | |
| – | 50 | $D - 4$ |
| 50 | 150 | $D - 6$ |
| 150 | 400 | $D - 8$ |

[Remark] D indicates the outer diameter of a seal.

Fig. 1.5.4 Recommended housing shoulder diameters

5) Surface roughness

To ensure seal sitting and to prevent leakage through seal O.D, finish bore surface to the roughness specified below.

Table 1.5.3 Housing bore surface roughness

| Seal type | Housing bore surface roughness |
|-------------------------------|--------------------------------|
| For metal O.D wall type seal | (1.6~0.4) μmRa |
| | (6.3~1.6) μmRz |
| For rubber O.D wall type seal | (3.2~1.6) μmRa |
| | (12.5~6.3) μmRz |

Seals with coated metal O.D wall are available in case metal O.D wall type seals with extremely high sealing performance are required.

Consult JTEKT for these oil seals.

(3) Total eccentricity

When the total eccentricity is excessive, the sealing edge of the seal lip cannot accommodate shaft motions and leakage may occur.

Total eccentricity is the sum of shaft runout and the housing-bore eccentricity. It is normally expressed in TIR (Total Indicator Reading).

Shaft runout is defined as being twice the eccentricity between the shaft center and center of shaft-center rotation trajectory.

This is also normally expressed in TIR.

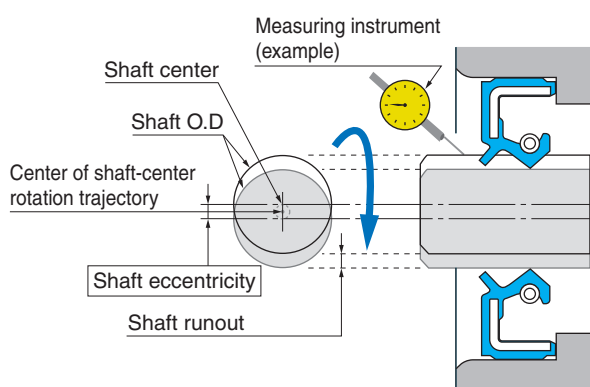


Fig. 1.5.5 Shaft runout

Housing bore eccentricity is defined as being the double of eccentricity between the housing-bore center and shaft rotation center. It is generally expressed in TIR (Total Indicator Reading).

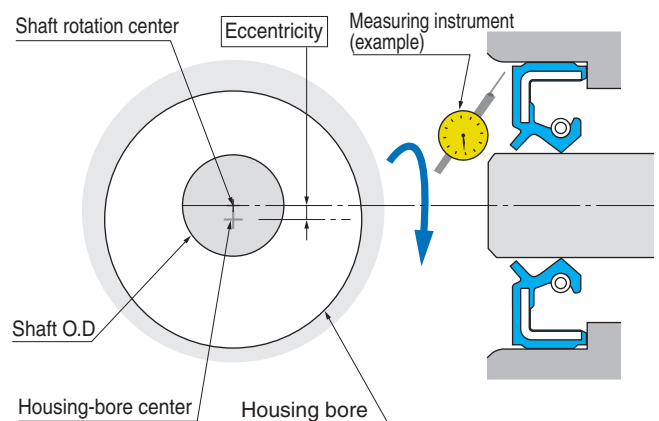


Fig. 1.5.6 Housing bore eccentricity

(4) Allowable total eccentricity

The allowable total eccentricity is the maximum total eccentricity at which the sealing edge can accommodate shaft rotation and retain adequate sealing performance. The allowable total eccentricity of seals is dependent not only on seal characteristics, such as seal type, seal size, and rubber material, but also on other conditions, including shaft diameter tolerance, temperature and rotational speed.

It is therefore difficult to determine the allowable total eccentricity of individual seals. The typical allowable total eccentricity values of seals are shown in Fig. 1.5.7.

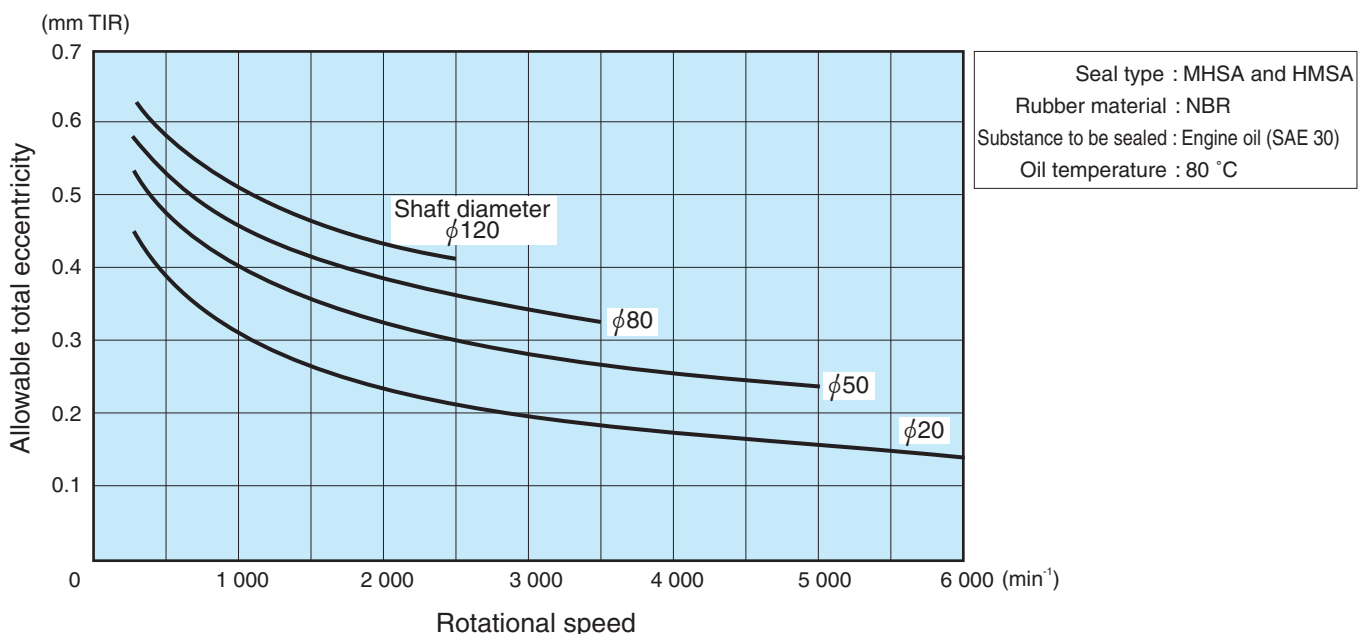


Fig. 1.5.7 Allowable total eccentricity for oil seal

1.6 Seal characteristics

(1) Sealing property

Oil seals are used to prevent lubricants or other fluids from leaking outside of the equipment or machine.

As shown in Fig. 1.6.1, the main lip shape and the contact with the rotating shaft surface produce a pumping effect that returns the fluid, thus ensuring the fluid is contained inside.

The pumping effect is measured and expressed by pumped fluid volume per time unit. The greater the pumped volume, the higher the sealing performance will be.

The pumped volume depends on multiple factors, such as rotational speed and fluid viscosity.

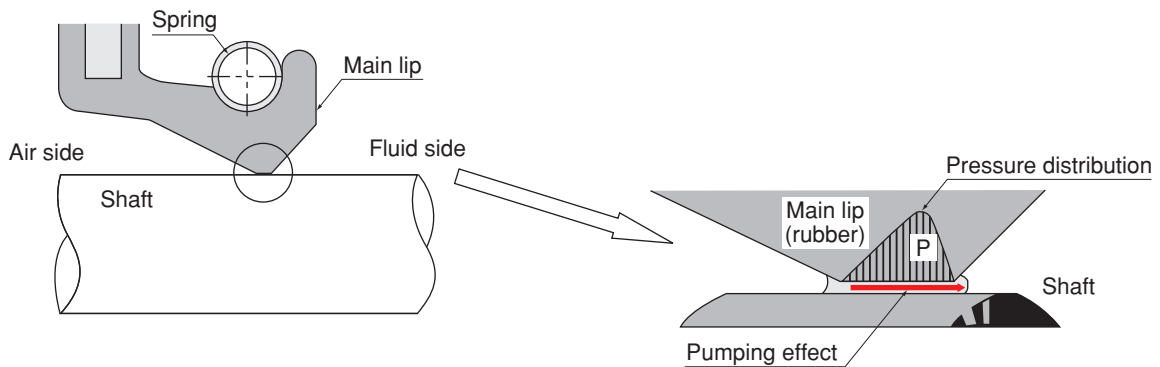


Fig. 1.6.1 Sealing property

As it can be observed in Fig. 1.6.2, which shows the relation between rotational speed and pumped volume, the pumped volume increases with the rotational speed.

Using the hydrodynamic ribs can further increase pumped volume.

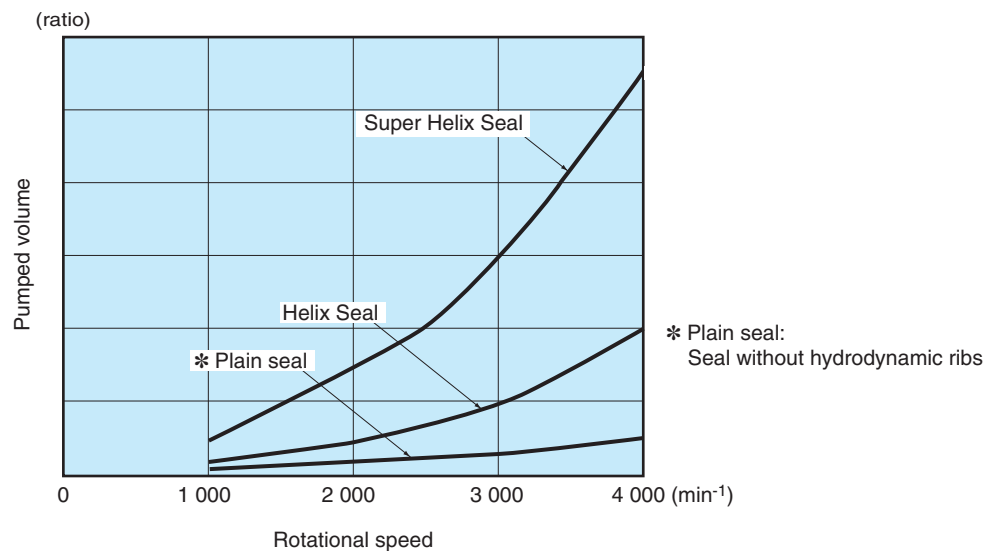


Fig. 1.6.2 Rotational speed and pumped volume

(2) Seal service life

The seal service life is defined as the time it takes to reach insufficient seal performance, which can be the result of wear on the lip rubber, chemical deterioration due to the use of oil or grease, or hardening.

It is not so easy to determine actual seal service life, because it is dependent on many factors, such as condition of operational temperature, eccentricity, rotational speed, substance to be sealed, and lubrication.

The diagram below (Fig. 1.6.3) shows the curves of estimated seal service life, obtained using major life-determining conditions as parameters, such as rubber material, lubricant, and lip temperature.

The service life shown in Fig. 1.6.3 is approximate, and the actual service life may be shorter depending on the operating conditions.

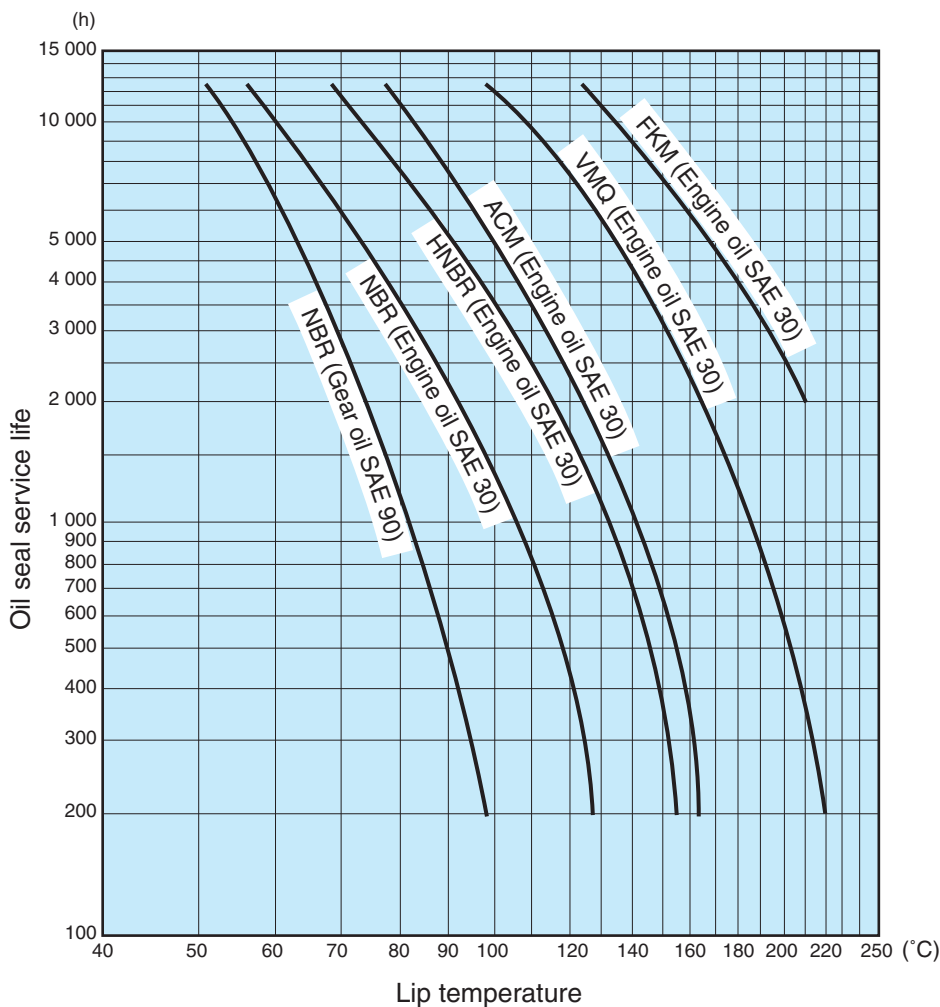


Fig. 1.6.3 Oil seal service life estimation curves

(3) Lip temperature

To determine the seal service life based on the above diagram, it is critical to estimate lip temperature precisely.

As the shaft rotates, the seal lip is heated due to friction. Lip temperature is dependent on the balance between the energy supplied by frictional heat and the radiated energy, which varies according to temperature

difference and the construction surrounding the seal.

Many factors influence lip temperature, so it is difficult to determine this precisely.

The following is the procedure for estimation of lip temperature.

● Lip temperature estimation method

- ① Calculate the peripheral speed at the sealing edge using the following equation

$$v = \frac{\pi dn}{(60 \times 1\,000)}$$

where,

- v : peripheral speed at the sealing edge, m/s
- π : Ratio of circle circumference to diameter (3.14)
- d : Shaft diameter, mm
- n : Rotational speed, min^{-1}

- ② Determine the supposed ambient temperature
- ③ Find the point at which the ambient temperature curve meets the calculated shaft surface speed in Fig. 1.6.4
- ④ Read the ordinate value of the point
- ⑤ Obtain the estimated lip temperature by the sum of the ordinate value and ambient temperature

Example

Shaft diameter: $\phi 50$ mm
 Rotational speed: $4\,000 \text{ min}^{-1}$
 Ambient temperature: 80°C
 Peripheral speed at the sealing edge can be obtained as follows;

$$v = \frac{\pi \times 50 \times 4\,000}{60 \times 1\,000} = 10.5 \text{ m/s}$$

In Fig. 1.6.4, the cross of the curve for ambient temperature 80°C and peripheral speed 10.5 m/s indicates that the lip temperature rise will be 20°C .

Therefore, lip temperature is estimated 100°C ($80 + 20 = 100^\circ\text{C}$).

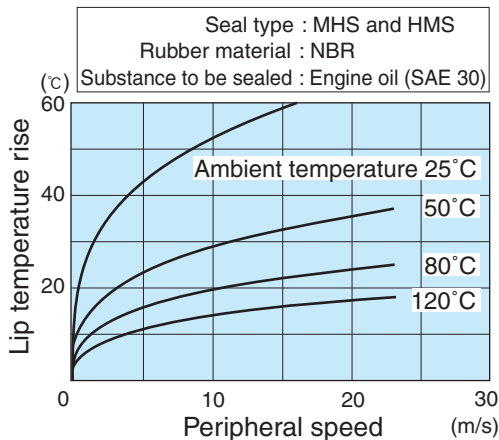


Fig. 1.6.4 Estimated lip temperature rise curves

(4) Allowable peripheral speed

The sealing edge of the seal should provide constant sealing performance, maintaining contact with the shaft while accommodating runout of the shaft (sum of shaft runout and mounting eccentricity).

When shaft rotation is extremely fast, the sealing edge eventually becomes unable to accommodate runout of the shaft (sum of shaft runout and housing-bore eccentricity), thus deteriorating sealing performance. The speed just before the sealing performance is deteriorated, is called the allowable peripheral speed for seals.

The allowable peripheral speed for seal is mostly influenced by shaft runout. When total eccentricity is small, the allowable peripheral speed is a constant value, depending on the rubber material and seal type.

The diagrams below show the typical allowable peripheral speed for seals mounted on the shaft and housing that are finished to a given level of accuracy.

Figs. 1.6.5 and 1.6.6 show the examples of allowable peripheral speed actually measured with the oil seals attached to the shaft finished with a certain accuracy and housing.

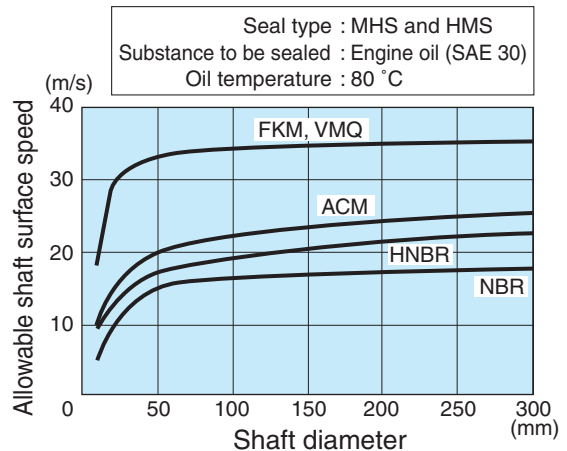


Fig. 1.6.5 Relation between rubber materials and allowable peripheral speed for seal

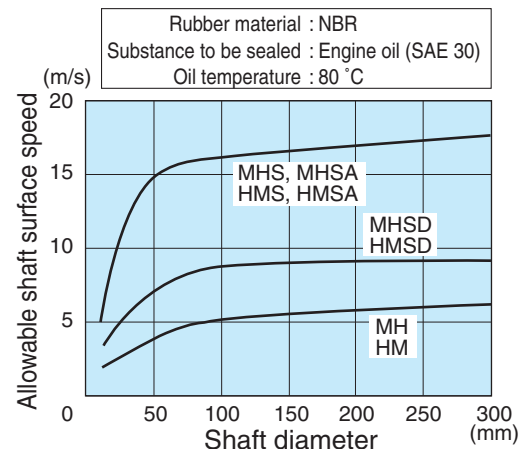


Fig. 1.6.6 Relation between seal types and allowable peripheral speed for seal

(5) Allowable internal pressure

Another factor that may deteriorate seal performance is internal pressure. The allowable internal pressure is also significantly dependent on runout of the shaft (sum of shaft runout and housing-bore eccentricity).

Fig.1.6.7 shows the example of allowable internal pressure actually measured with the oil seals attached to the shaft finished with the accuracy recommended in this catalogue and housing.

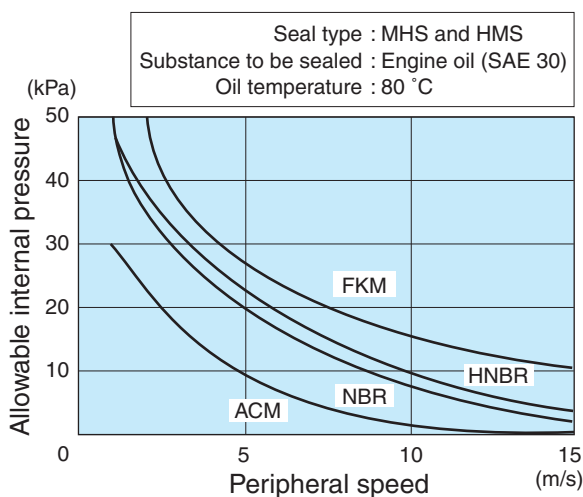


Fig. 1.6.7 Allowable internal pressure for seal

Small talk 3

A precious experience for a new salesman

"The oil seal melts down and oil leaks!"

Receiving an urgent phone call from a customer, a new salesman at JTEKT left the office immediately, believing that something critical had happened.

At the customer's site, the lip was abraded significantly and the rubber did look molten. The customer suspected that the material was the cause of the problem.

Browsing the catalog confusedly, he questioned the customer, remembering the sales-training lectures he had attended before. "How did you lubricate the seal before its initial use?"

Suspecting that insufficient initial lubrication might be the cause, he instructed the customer to coat grease around the lip and run the machine.

Two hours passed, and the seal still showed no leakage. An overhaul proved that the seal was in good condition, with negligible lip abrasion.

"I now thoroughly understand the importance of pre-lubrication," said the customer. It was a precious experience for the salesman as well.

(6) Seal torque

The seal torque is determined by lip radial load, coefficient of friction, and shaft diameter, and can be calculated by the following equation:

$$T = \frac{1}{2 \times 1000} \mu d R_L$$

where,

T : Seal torque, N · m

μ : Coefficient of friction at sealing edge
(including oil viscosity)

d : Shaft diameter, mm

R_L : Lip radial load, N

Lip radial load is determined by three factors: a component of stress caused by circumferential lip elongation that occurs when the seal is mounted on a shaft, a component stress caused by deflection at the lip base, and a component of spring load (Fig. 1.6.8).

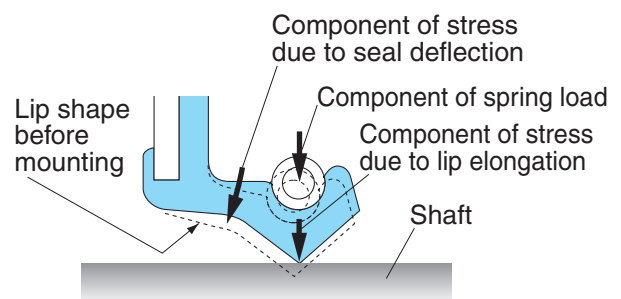


Fig. 1.6.8 Factors of lip radial load

The coefficient of friction at the sealing edge varies significantly depending on type of lubricants used and peripheral speed. To find rotational torques of oil seals, various operating conditions must be taken into consideration. For details, consult JTEKT.

1) Initial seal torque

Seal torque may be very high just after the seal mounting on a machine. However, it will become stable low torque within one or two hours (Fig. 1.6.9).

1.6 Seal characteristics

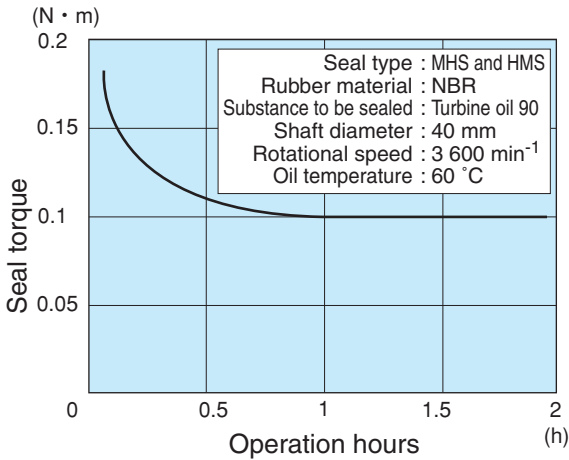


Fig. 1.6.9 Seal torque change with passing time

Initial high torque occurs because the coefficient of shaft-lip friction is unstable. As operation continues, the shaft and lip become running in each other, it stabilizes the friction coefficient and seal torque.

2) Factors for seal torque

Fig. 1.6.10 shows how rotational speed and lubricant influence seal torque. As this diagram shows, generally seal torque increases in proportion to shaft rotational speed increase. High viscosity lubricating oil also increases seal torque.

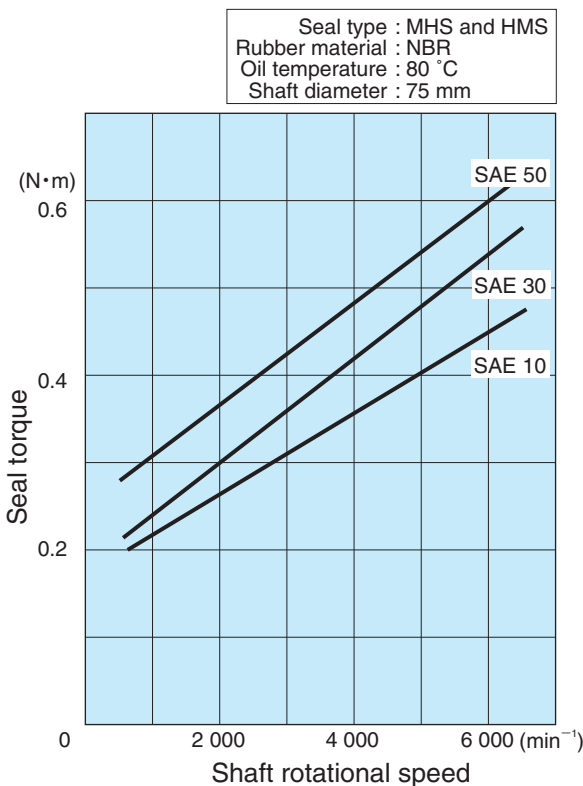


Fig. 1.6.10 Relation between rotational speed and seal torque

Fig. 1.6.11 shows how shaft diameter influences seal torque. The larger shaft diameter, the higher the seal torque correspondingly.

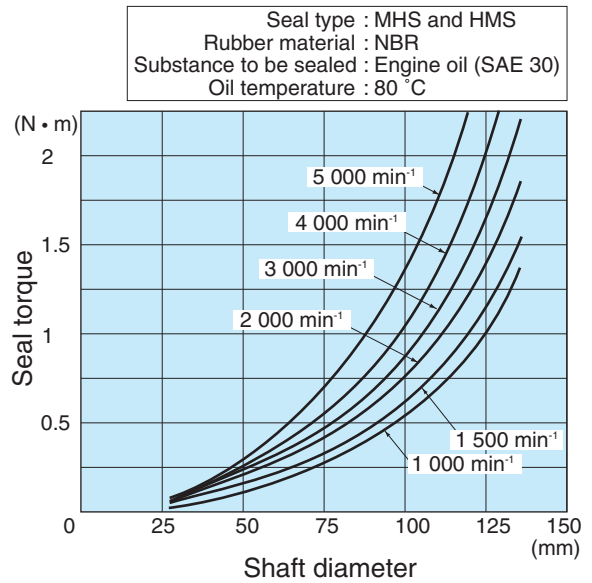


Fig. 1.6.11 Relation between shaft diameter and seal torque

Small talk 4

A discovery on a cold day

A second-year JTEKT sales rep received a harsh complaint from a customer. "Oil seals cannot be easily mounted today! When we press-fit them, the rubber tears."

He checked the seal at the customer's site, but could not find the reason. Then he consulted his manager by phone for advice.

"The seal is having a 'cold'," his manager responded. "Like humans, seals do not enjoy a cold environment. Tell them to warm up the room and try again." Following this advice, a stove was carried into the assembly shop and the seal was tried to remount after being slightly heated. To the surprise of the customer as well as the sales rep, the seal could be mounted smoothly without any problem.

The customer was very grateful to him. "Thank you for dealing with the problem. We also can now work in a warm environment." The sales rep returned to the office, feeling very proud of himself.

Back in the office, he heard another good piece of news from a material engineer: "Recent Koyo oil seals are made of improved material and can operate well in cold environments."

1.7 Handling of seal

Carelessness in seal handling may cause oil leakage. Correct action should be taken for good inwards, storage, transportation, handling and mounting.

(1) Storage

Follow the instructions below in the storing.

- Keep air-conditioned: Room temperature Max. 30 °C and humidity 40% to 70% on average. (See Fig. 1.7.1)
- Keep rule: Use older oil seals stored, first.
- Avoid: Direct/reflected of sunlight, ozone
- When storing oil seals in a worksite, keep them in sealed containers to protect them from dusts, sands, and other contaminations, as well as mechanical damages caused by various equipment or subjects dropped.
- Avoid storing oil seals in a stack or hung as such storage condition can lead to deformation of seal edges due to their own weight.
- When an oil seal is stored for a long time, a white, powdery substance (blooming) may appear on the surface of the rubber, but this does not affect performance.

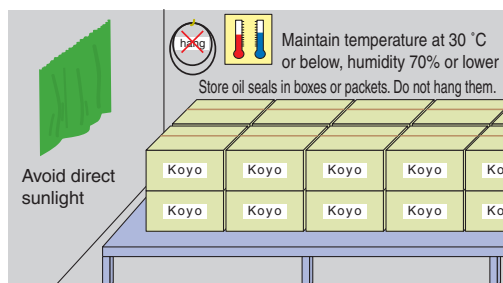


Fig. 1.7.1

(2) Handling

- When carrying oil seals, avoid excessive impact in order to prevent deformation and spring loss.
- Do not damage seals by knife or screw driver when opening wrap.
- Do not place seals for long time on table without sheet cover, due to chance of dust or sand adhesion.
- Do not hang by wire, string, or nail, which deforms or damages seal lip.
- Do not use cleaners, solvents, corrosive fluids, or chemical liquid. Use kerosene when washing seals.

(3) Mounting

- 1) Before mounting, confirm that there is no damage, no dirt or foreign particles on the seals.
- 2) Apply suitable, clean lubricant to the seal lip for initial lubrication. For oil seals with a minor lip, pack clean grease between main lip and minor lip (Fig. 1.7.2).

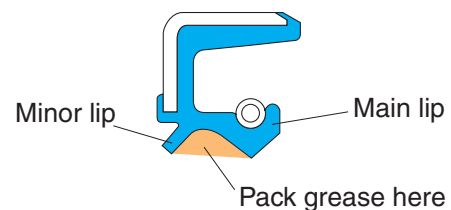


Fig. 1.7.2 Prelubrication for seals with minor lip

- 3) Recommended grease
 - Small penetration (soft grease)
 - Small penetration change by temperature
 - Wide serviceable temperature range
 - Lithium base type (avoid silicone base grease for silicon rubber seal, urea base grease for fluoroc rubber seal which may harden or deteriorate seal rubber)
- 4) When seal is mounted at cold area, warm seal up to have seal flexibility and then mount it.
- 5) To avoid damage on seal lip and shaft surface when seal is mounted onto shaft. Shaft edge should be chamfered or 0.2 mm smaller guide as illustrated below (Fig.1.7.3).

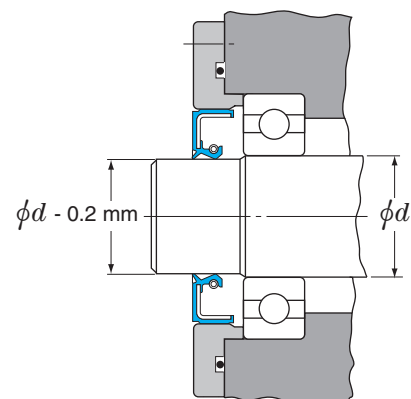
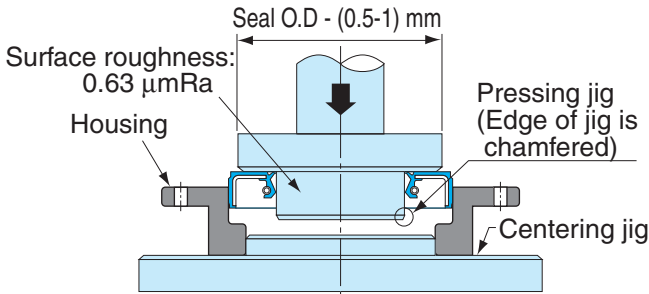


Fig. 1.7.3 Recommended shaft profile and machine construction to avoid damaging shaft surface

1.7 Handling of seal

6) When seal is pressed into housing bore, use pressing jig as shown in Fig. 1.7.4. When press-fitting an oil seal into the housing bore in the opposite direction, use the pressing jig as shown in Figs. 1.7.5 and 1.7.6.

Jig for shouldered housing bore



Jig for straight housing bore

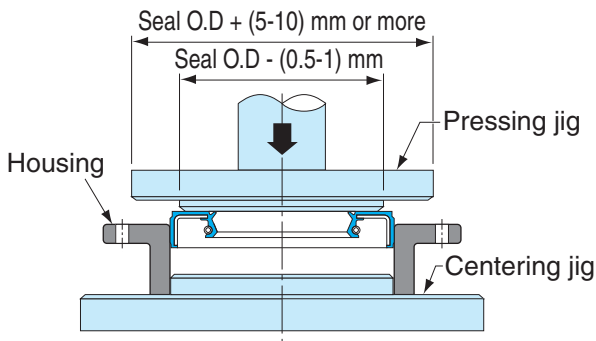


Fig. 1.7.4 Recommended seal press-fitting jigs

Seal press fit at a slant may cause the fit surface to have tear or scuffing and leakage. To ensure good sealing performance, seals need to be mounted at right angles to shafts. For right angled mounting, press the seal down thoroughly to reach the housing shoulder (Fig. 1.7.5).

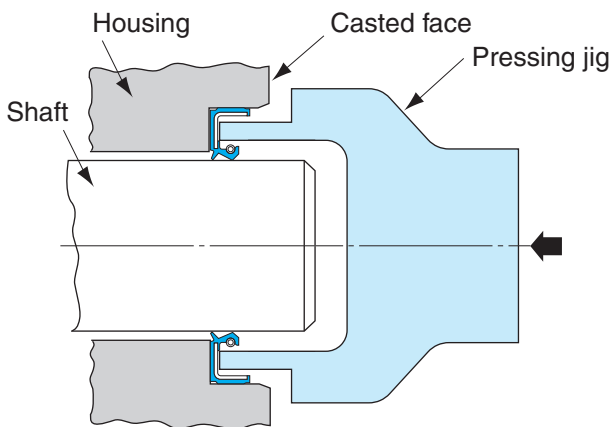


Fig. 1.7.5 Seal press-fitting jig for shouldered housing bore in the opposite direction

To mount seal into a straight housing bore, the jig should be contacted with the machine-finished surface to mount the seal at right angles to the housing bore (Fig. 1.7.6).

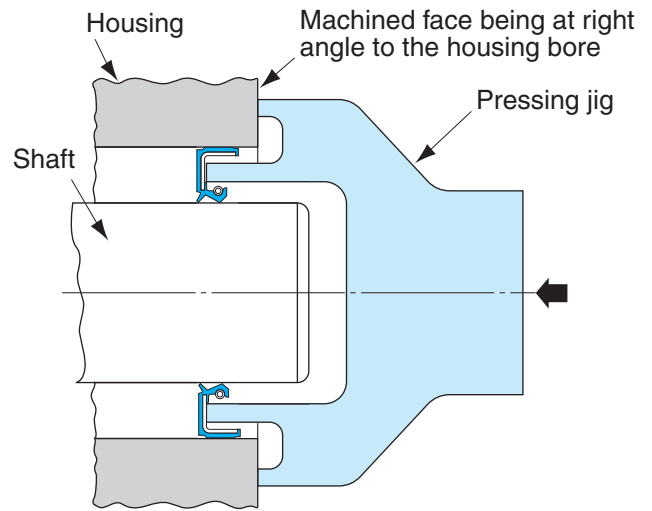
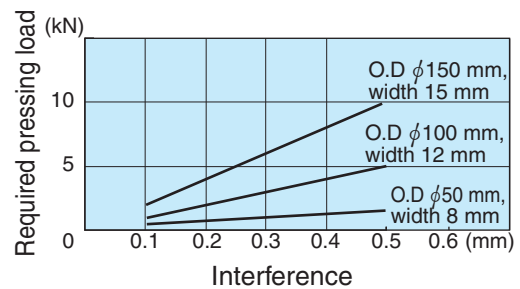


Fig. 1.7.6 Seal press-fitting jig for straight housing bore in the opposite direction

In the case of O.D wall being rubber, press the seal into housing by constant pressure 2-3 times at a constant speed to prevent spring back. Fig. 1.7.7 shows typical seal pressing load required to press-fit an oil seal into the housing. Refer to the shown data when press-fitting oil seals. Based on these diagrams, decide a slightly higher pressing load.

Measuring conditions
No lubricant
Surface roughness of housing bore: 1.6 μmRa

O.D wall: Rubber (Rubber material: NBR)



O.D wall: Metal

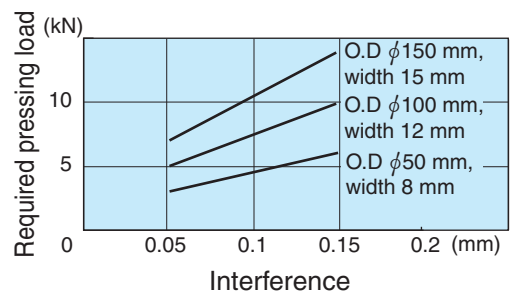


Fig. 1.7.7 Relation between required seal pressing load and seal interference

7) In case of shaft has spline, keyway, or holes, use seal protecting jig to prevent lip damage as illustrated below (Fig. 1.7.8).

If difficult to use jig, remove sharp corners, round the edges and coat enough grease.

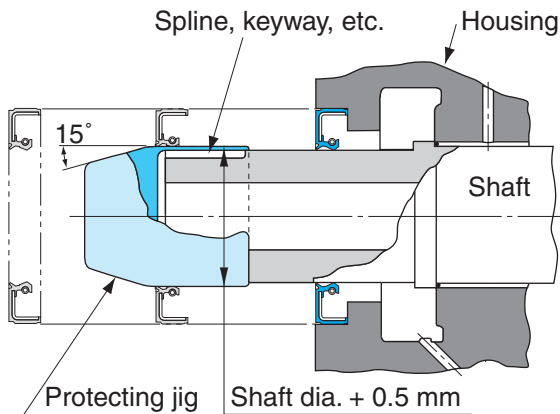


Fig. 1.7.8 Seal protecting jig for spline, keyway, holes on shaft

All the corners of the jig should be chamfered. Do not use a jig made from soft material such as aluminum; such a jig is prone to damages and a damaged jig may scratch the seal lip. Use a protecting jig made from steel or stainless steel.

8) When heavy housing with seal is assembled with shaft, or when long or heavy shaft is inserted into seal, seal damage should be avoided. Use the following guide jig to get centering (Figs. 1.7.9 and 1.7.10).

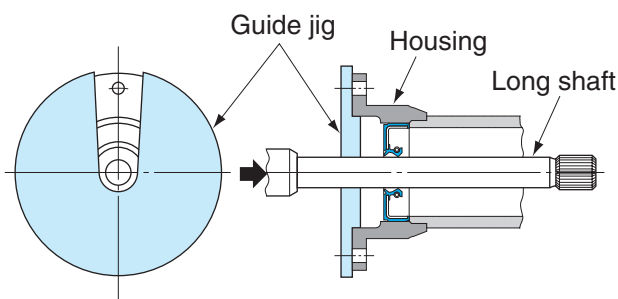


Fig. 1.7.9 Guide jig for inserting of long shaft into seal bore

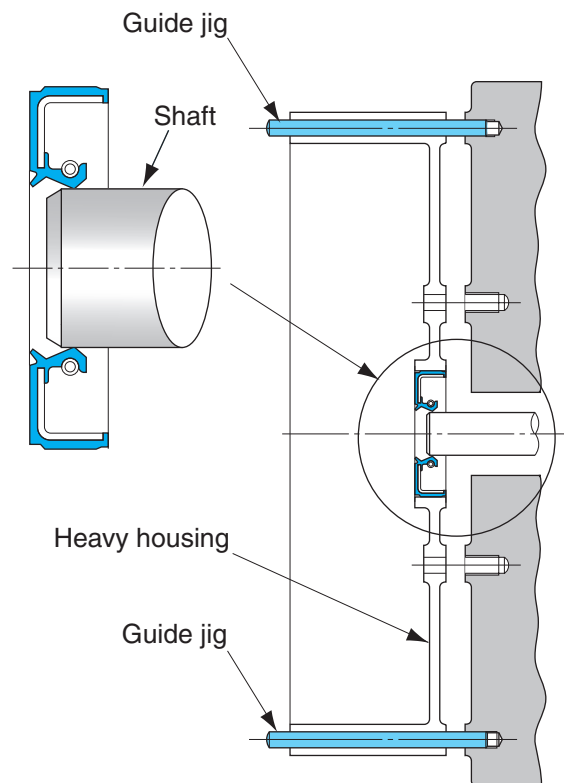


Fig. 1.7.10 Guide jig for mounting of heavy housing with seal onto shaft

If these methods cannot be applied (Fig. 1.7.10), assemble shaft and housing first, then mount seal.

9) When oil seal is removed, use a new oil seal instead of the seal used. Contact position of new seal lip on the shaft should be displaced to 0.5 mm (1~2 mm for large-size seals) from the old seal lip contact position by applying spacer as illustrated below (Fig. 1.7.11).

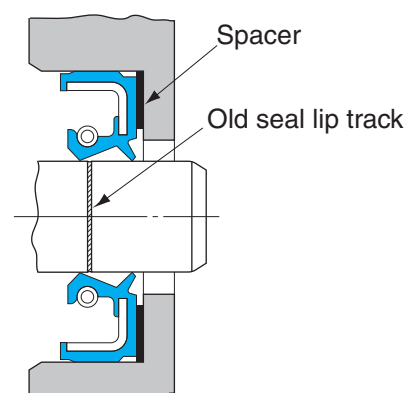


Fig. 1.7.11 Avoid old seal lip track

(4) Mounting of split MS-type seals

MS-type seal has one split in order to have easy mounting on to long shaft or complicated shaped shaft (Fig. 1.7.12).



Fig. 1.7.12 MS-type seal with one split

When fitting the oil seal of this type, do not bond the cut portion of it with adhesive agent. If bonding is absolutely necessary, pay close attention to avoid any step around the seal lip.

Mount a split MS-type seal on to the shaft as following procedure:

- ① Mount the spring first and connect spring by the hook (Fig. 1.7.13).
- ② Mount the seal and position split area to upwards on the shaft.
- ③ Place the spring on the seal spring groove, position spring joint area to 45° apart from seal split area.
- ④ Fix the seal by seal fixing ring. If seal fixing ring is split type, avoid position of ring split area from seal split area.



Fig. 1.7.13 Spring hook connection

(5) Cautions after mounting

- 1) If the area near the oil seal is painted, make sure to keep the seal lip and the shaft area in contact with the lip free from paint.
- 2) Avoid cleaning on the mounted seal area as much as possible. If cleaning is inevitable, perform it quickly and wipe off the detergent immediately when completed.

Small talk 5

A murmur of a female staff member

One day, a female staff member over-heard a conversation:

Third-year sales rep: "The rubber of oil seals is petroleum-based (naphtha-base), isn't it?"

Engineering leader: "Nitrile rubber and acrylic rubber are synthetically produced based on naphtha, but silicone rubber is made from silicon, which can be found naturally. Fluorocarbon rubber is produced synthetically from fluorine compounds extracted from fluorite, which is known for its fluorescent light emission."

"Oh, how knowledgeable our engineering leader is!" murmured the female staff member, impressed.

1.8 Causes of seal failures and countermeasures

(1) Causes of seal failures

To identify the causes of seal failure and take proper measures, it is critical to observe the seal lip closely and evaluate the failure in all respects, such as shaft surface

roughness, contaminants and lubrication. Causes of major seal failure are listed below (Table 1.8.1).

Table 1.8.1 Causes of seal failures

| Factor | | | | |
|--------------------------------------|--|--|--|--------------------|
| 1st | 2nd | 3rd | 4th | 5th |
| Leakage from seal | From lip | Damages on lip | Burrs on shaft chamfer Spline, keyway on shaft Entry of foreign materials Wrong handling | |
| | | Lip turned backward | Small shaft chamfer Center off set at mount Excessive inside pressure | |
| Missing spring | | Small shaft chamfer Center off set at mount Caused by Stick slip* | | |
| Lip hardened | | High oil temperature Poor lubrication Excessive inside pressure | | |
| Lip softened | | Improper rubber Long time dip in cleaner, solvent | | |
| Heavy wear on shaft | | Entry of foreign materials Chemical wear Poor lubrication Caused by Stick slip* | Depends on oil components | |
| Heavy wear on lip | | Poor lubrication Excessive internal pressure Rough shaft surface finish Entry of foreign materials | | |
| Uneven wear on lip | | Excessive eccentricity at mount Inclined seal mounting | | |
| Rough face, Steaks on lip | | Entry of foreign materials Poor lubrication | | |
| Tear at seal heel bottom | | Wrong handling Reaction by impact pressure Excessive inside pressure | | |
| Lip deformation (small interference) | | High oil temperature | | |
| Lip face contact | | Excessive inside pressure Minus pressure between lips Big shaft runout | | |
| Lip tear | | Larger shaft diameter Caused by Stick slip* Reaction by impact pressure | Poor lubrication Improper rubber | |
| Blisters on lip | | Deterioration of lubrication (directly under lip) Mirror finish on shaft surface Higher peripheral speed Higher radial lip load | | |
| No abnormality on seal | | Smaller shaft diameter Improper shaft roughness Damages on shaft Lead machining on shaft Poor lip followability | Small interference Big shaft runout Big eccentricity Small interference Lip high rigidity Poor low temperature resistance | |
| From fitting area | | Inclined mounting on seal | Smaller housing bore diameter Small housing bore chamfer Rough housing bore surface finish Improper mounting tool | Large interference |
| | | Oil seal fall-out | Larger housing bore Smaller oil seal O.D Improper oil seal press-fit position | |
| | No abnormality on seal | Larger housing bore Smaller seal O.D Rough housing bore surface finish Damages or blowholes on housing bore Wrong direction of seal mounting | Small interference Small interference | |
| | Peeling, Scuffing, Damages, Deformation, | | | |

* Stick slip:
A friction related phenomena in which the sealing element tends to adhere and rotate with the shaft surface momentarily until the elastic characteristics of the sealing element overcome the adhesive force, causing the seal lip to lose contact with the rotating shaft long enough to allow leakage.
This cycle repeats itself continuously and is normally associated with non-lubricated and boundary-lubricated conditions.

(2) Causes of seal failures and countermeasures

Table 1.8.2 below lists the possible causes of seal failures and countermeasures.

Table 1.8.2 Causes of seal failures and countermeasures (1)

Oil leakage from lip (1)

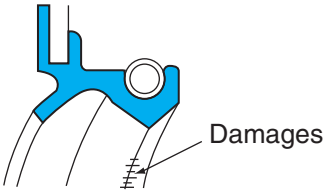
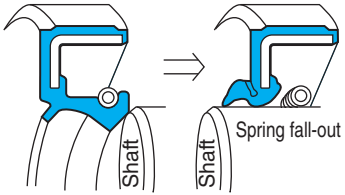
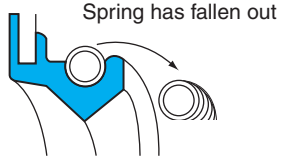
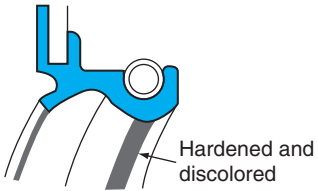

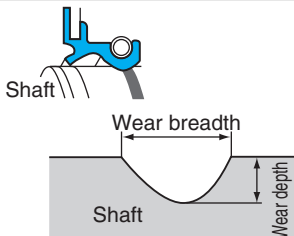
| Symptom | Phenomenon | Causes | Countermeasures |
|-------------------------|---|--|---|
| Damages on sealing edge | Visible damage on lip edge  | <ol style="list-style-type: none"> 1) Sharp edge or burrs on shaft chamfer 2) Shaft spline or keyway 3) Entry of foreign materials 4) Poor handling | <ul style="list-style-type: none"> • Remove burrs and polish • Use shaft protecting jig (See Fig. 1.7.8 on page 29.) • Clean work shop • Improve handling manner (Consult JTEKT.) |
| Lip turned backward |  | <ol style="list-style-type: none"> 1) Too small chamfer on shaft end 2) Center offset between shaft and housing 3) Excessive inside pressure happened | <ul style="list-style-type: none"> • Correct shaft chamfer (See Fig. 1.5.1 on page 19.) • Improve center offset (Consult JTEKT.) • Apply high pressure proof seal or breather (vent) |
| Missing spring |  | <ol style="list-style-type: none"> 1) Inadequate shaft end chamfer 2) Center offset between shaft and housing 3) Caused by Stick slip | <ul style="list-style-type: none"> • Improve shaft end chamfers (See Fig. 1.5.1 on page 19.) • Improve center offset (Consult JTEKT.) • Improve lubrication including pre-lubricating on seal |
| Lip hardened |  | <ol style="list-style-type: none"> 1) Temperature exceeded seal service temperature range 2) Poor lubrication 3) Excessive inside pressure happened | <ul style="list-style-type: none"> • Change rubber material to high temperature proof rubber (See Table 1.4.2 on page 16.) • Improve lubricating method and lubricant supply volume • Apply high pressure proof seal or breather (vent) |
| Lip softening |  | <ol style="list-style-type: none"> 1) Mis-selection of rubber material 2) Long time dip in cleaning oil or organic solvent | <ul style="list-style-type: none"> • Change rubber to material not swelling in lubricant (See Table 1.4.2 on page 16.) • To clean the seal, apply the oil used for lubrication as cleaning oil. In an application where grease is used for lubrication, use kerosene as cleaning oil |
| Heavy wear on shaft |  | <ol style="list-style-type: none"> 1) Entry of foreign materials 2) Chemical wear due to high temperature or excessive pressure additive 3) Poor lubrication 4) Caused by Stick slip | <ul style="list-style-type: none"> • Attach prevention device for entry of foreign materials • Take countermeasure to prevent high temperature and change lubricants (Consult JTEKT.) • Improve lubrication on lip including pre-lubricating (Improve quantity of lubricant or lubricating method) |

Table 1.8.2 Causes of seal failures and countermeasures (2)

Oil leakage from lip (2)

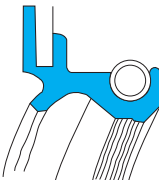
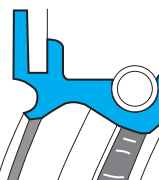
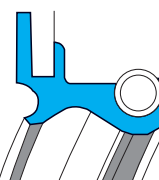
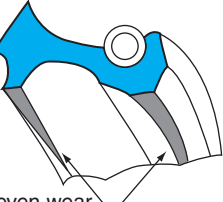
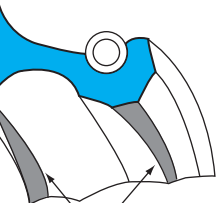
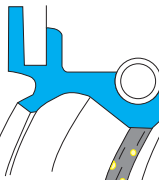
| Symptom | Phenomenon | Causes | Countermeasures |
|-------------------------------|--|--|---|
| Heavy wear on lip | Rough face, Streaks  | 1) Poor lubrication 2) Rough shaft surface finish 3) Entry of foreign materials | <ul style="list-style-type: none"> • Take pre-lubrication on lip • Improve lubrication • Improve shaft surface finish (See page 19.) • Attach prevention device for foreign materials |
| | Hardening, Cracks  | Excess heat generation due to 1) Poor lubrication 2) Running under conditions beyond specifications a) Excess peripheral speed b) Excessive inside pressure | <ul style="list-style-type: none"> • Improve lubrication • Examine cause of heat source • Change rubber to heat proof rubber (See Table 1.4.2 on page 16.) • Apply high pressure proof seal or breather (vent) |
| | Double-faced wear  | <ul style="list-style-type: none"> • Excessive inside pressure | <ul style="list-style-type: none"> • Apply high pressure proof seal or breather (vent) |
| Lip uneven wear | Wear track width is uneven. Max. wear positions of main lip and minor lip are same.  | 1) Center offset between shaft and housing 2) Inclination of shaft | <ul style="list-style-type: none"> • Examine misalignment for shaft to housing (Take countermeasure to reduce offset) |
| | Wear track width is uneven. Max. and Min. wear areas are located 180° apart. (Main and minor lips show opposite pattern.)  | Inclined seal was mounted into housing 1) Improper housing bore diameter 2) Improper housing bore chamfer 3) Improper housing bore corner radius 4) Improper mounting tool | <ul style="list-style-type: none"> • Correct housing bore diameter (See Table 1.5.2 on page 19.) • Correct housing bore chamfer (See Fig. 1.5.3 on page 20.) • Correct housing bore corner radius (See Fig. 1.5.4 on page 20.) • Improve mounting tool (Consult JTEKT.) |
| Rough face and streaks on lip | Rough face and streaks on sealing edge  | 1) Entry of foreign materials 2) Poor lubrication | <ul style="list-style-type: none"> • Attach prevention device for entry of foreign materials • Improve lubrication |

Table 1.8.2 Causes of seal failures and countermeasures (3)

Oil leakage from lip (3)

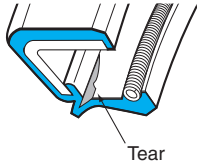
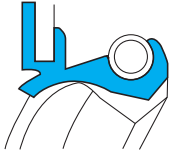
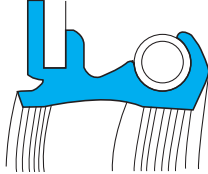
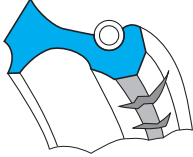
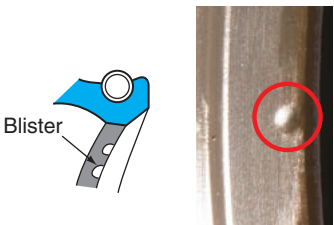
| Symptom | Phenomenon | Causes | Countermeasures |
|--------------------------|--|---|---|
| Tear at seal heel bottom |  | <ol style="list-style-type: none"> 1) Improper handling 2) Excessive inside pressure 3) Reaction by impact pressure | <ul style="list-style-type: none"> • Improve handling manner (Consult JTEKT.) • Apply high pressure proof seal or breather (vent) • Prevention of impact pressure by design change of machine structure |
| Lip deformation | Reduction of tightening interference due to rubber hardened  | <ul style="list-style-type: none"> • Oil temperature rose up during operation | <ul style="list-style-type: none"> • Change rubber to high temperature proof rubber (See Table 1.4.2 on page 16.) • Examination of and countermeasure against the cause of temperature increase are required. |
| Lip face contact | Whole lip face shows sliding contact pattern  | <ol style="list-style-type: none"> 1) Excessive inside pressure happened 2) Minus pressure happened between lips 3) Big shaft runout 4) Larger shaft diameter | <ul style="list-style-type: none"> • Prevent excess pressure (change of machine structure) • Give clearance for minor lip • Improve shaft accuracy • Correct shaft diameter |
| Lip tear |  | <ol style="list-style-type: none"> 1) Caused by Stick slip <ol style="list-style-type: none"> a) No or poor lubrication b) Mirror surface finish on shaft c) Excessive shaft surface speed 2) Impact pressure | <ul style="list-style-type: none"> • Improve lubrication including pre-lubricating on seal • Correct shaft surface finish to (0.63-0.2) μmRa and (2.5-0.8) μmRz • Review machine structure to reduce impact pressure |
| Blister |  | <ul style="list-style-type: none"> • Increased agglomeration of high-temperature oil that entered the sliding surface <ol style="list-style-type: none"> a) Deterioration of lubrication (directly under lip) b) Mirror finish on shaft surface c) Higher peripheral speed d) Higher radial lip load | <ul style="list-style-type: none"> • Improve lip lubrication • Correct shaft surface finish to (0.63-0.2) μmRa and (2.5-0.8) μmRz • Reduce radial lip load of oil seal |
| – | No abnormality on seal but oil leakage is observed | <ol style="list-style-type: none"> 1) Smaller shaft diameter 2) Improper shaft roughness 3) Damages on shaft 4) Lead machining on shaft 5) Poor lip followability <ol style="list-style-type: none"> a) Big shaft runout b) Big housing-bore eccentricity c) Small interference d) Lip high rigidity e) Poor low temperature resistance 6) Wrong direction of seal mounting 7) Adhesion of foreign particles at mounting | <ul style="list-style-type: none"> • Improve and correct shaft accuracy • Improve shaft surface finish (0.63-0.2) μmRa and (2.5-0.8) μmRz • Remove sharp corners and burrs, or replace shaft • Change the grinding method (avoid axial feed) • Reduce center offset (Consult JTEKT.) • Improve and correct shaft accuracy • Use low torque seal • Change rubber material to low temperature proof one (See Table 1.4.2 on page 16) • Correct seal direction • Improve handling manner |

Table 1.8.2 Causes of seal failures and countermeasures (4)

Oil leakage from seal fitting area (1)

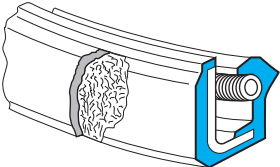
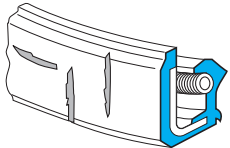
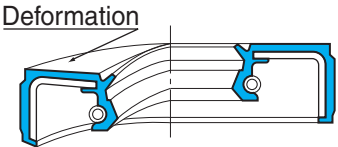
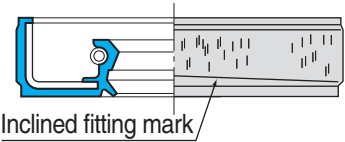
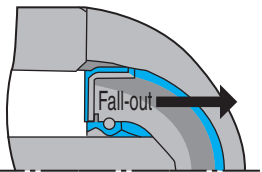




















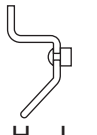
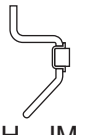
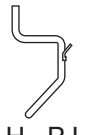
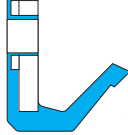
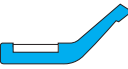
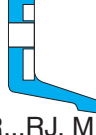
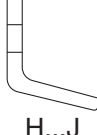


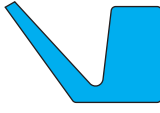
| Symptom | Phenomenon | Causes | Countermeasures |
|-------------------------------|---|---|--|
| Peeling, scuffing on O.D wall |  | <ol style="list-style-type: none"> 1) Smaller housing bore 2) In adequate housing bore chamfer 3) Rough housing bore surface finish 4) Centering offset between housing and seal mounting | <ul style="list-style-type: none"> • Correct housing bore diameter (See Table 1.5.2 on page 19.) • Correct housing bore chamfer (See Fig. 1.5.3 on page 20.) • Improve mounting tool and handling manner (See Figs. 1.7.3 to 1.7.5 on page 27 to 28.) |
| Damages on O.D wall |  | <ol style="list-style-type: none"> 1) Burrs on housing bore 2) Damages, or blowholes on housing bore | <ul style="list-style-type: none"> • Remove burrs, chips • Repair housing bore to eliminate damage, blowhole |
| Deformation | <p>Deformation</p>  | <ol style="list-style-type: none"> 1) Smaller housing bore 2) Small housing bore chamfer 3) Improper seal mounting tool | <ul style="list-style-type: none"> • Correct housing bore diameter (See Table 1.5.2 on page 19.) • Correct housing bore chamfer (See Fig. 1.5.3 on page 20.) • Improve mounting tool (Consult JTEKT.) |
| Seal inclined mounting | <p>Uneven fitting marks on seal O.D face</p>  <p>Inclined fitting mark</p> | <ol style="list-style-type: none"> 1) Smaller housing bore 2) Small housing bore chamfer 3) Poor parallel accuracy between mounting tool and housing | <ul style="list-style-type: none"> • Correct housing bore diameter (See Table 1.5.2 on page 19.) • Correct housing bore chamfer (See Fig. 1.5.3 on page 20.) • Improve mounting tool (Consult JTEKT.) |
| Oil seal fall-out | <p>Housing</p>  <p>Shaft</p> <p>Fall-out</p> | <ol style="list-style-type: none"> 1) Larger housing bore 2) Smaller oil seal O.D 3) Improper oil seal press-fit position 4) Deformation of housing | <ul style="list-style-type: none"> • Use appropriate housing bore diameter (See Table 1.5.2 on page 19.) • Correct the oil seal press-fit position (Consult JTEKT.) • Improve the rigidity of housing |

Table 1.8.2 Causes of seal failures and countermeasures (5)

Oil leakage from seal fitting area (2)

| Symptom | Phenomenon | Causes | Countermeasures |
|---------|--|---|--|
| – | No abnormality on seal but oil leakage is observed | <ol style="list-style-type: none"> 1) Larger housing bore 2) Smaller seal O.D 3) Rough housing bore surface finish 4) Damages or blowholes on housing bore 5) Wrong direction of seal mounting | <ul style="list-style-type: none"> • Correct housing bore diameter (See Table 1.5.2 on page 19.) • Replace seal • Improve housing bore surface finish (See Table 1.5.3 on page 20.) (In urgent cases, apply liquid gasket to housing bore.) • Remove damages and blowholes • Correct seal direction |

1.9 Seal dimensional tables (Contents)

| | | Type | | | | Page | |
|---------------------|--|---|---|---|--|--|----|
| Standard type seals | Metal O.D wall seals d_1 7~540 |  HM |  HMA |  HMS |  HMSA | 38 | |
| | Rubber O.D wall seals d_1 6~300 |  MH |  MHA |  MHS |  MHSA | | |
| Special seals | YS type seals d_1 220~1 640 |  YS |  YSN |  YSA |  YSAN | 56 | |
| | Assembled seals d_1 68~440 |  HMSH |  HMSAH |  HMSH...J |  HMSH...J |  HMSH...J | 72 |
| | Full rubber seals d_1 10~3 530 |  MS | | | | | 78 |
| | MORGOIL seals Seal inner rings d_1 167~1 593 |  MS...J |  MS...NJ |  H...J |  H...JM |  H...PJ | 84 |
| | Scale seals Scale covers d 195~1 595 |  WR |  WR...BJ |  WR...RJ, MH...J | |  H...J | 86 |
| | Water seals d_1 219.2~1 460 |  XMH |  XM, XMHE | | | | 90 |
| | V-rings d 38~875 |  MV...A | | | | 92 | |

Standard types

d_1 (20)~(28)

HM HMA HMS HMSA
MH MHA MHS MHSA

Remarks

- 1) For seals marked ●, JTEKT owns moulding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: HMSA55729(55×72×9 mm).
- 3) Rubber code N represents nitrile rubber, A: acrylic rubber, S: silicone rubber, and F: fluorocarbon rubber.
- 4) Consult JTEKT separately for information on inventory, delivery, and production lots.

d_1 (20)~(25)

| | | | | Metal O.D wall | | | | Rubber O.D wall | | | | | | | | | | | | |
|-------------------------|-----|-----|---|----------------|---|-----|---|-----------------|---|------|---|----|---|-----|---|-----|---|------|---|---|
| | | | | | | | | | | | | | | | | | | | | |
| Boundary dimensions, mm | | | | HM | | HMA | | HMS | | HMSA | | MH | | MHA | | MHS | | MHSA | | |
| d_1 | D | b | | N | A | S | F | N | A | S | F | N | A | S | F | N | A | S | F | |
| 20 | 45 | 12 | | | | | | ● | | | | | | | | ● | | | | |
| | 47 | 5 | | | | | | | | | | | | | | | | | | ● |
| | 47 | 6 | ● | | | | | | | | | ● | | | | | | | | ● |
| | 47 | 7 | | | | | | | | | | | | | | | | | | ● |
| | 52 | 8 | | | | | | | | | | | | | | | | | | ● |
| 21 | 40 | 7 | | | | | | | | | | | | | | | | | | ● |
| | 22 | 28 | 4 | ● | | | | | | | | | | | ● | | | | | |
| 22 | 29 | 4 | | | | | | | | | | | | | ● | | | | | |
| | 30 | 4 | ● | | | ● | | | | | | | | | ● | | | | | |
| | 32 | 7 | | | | | | | | | | | | | | ● | | | | ● |
| | 34 | 5 | | | | | | | | | | | | | | ● | | | | |
| | 35 | 5 | ● | | ● | | | | | | | | | | | ● | | | | |
| | 35 | 7 | | | | | | | | | | | | | | ● | ● | ● | | ● |
| | 35 | 8 | | | | | | | | | | | | | | ● | | | | ● |
| | 36 | 10 | | | | | | | | | | | | | | ● | | | | |
| | 38 | 8 | | | | | | | | | | | | | | ● | | | | ● |
| | 40 | 11 | | | | | | | | | | | | | | ● | | | | ● |
| | 42 | 5 | ● | | | | | | | | | | | | | ● | | | | |
| | 42 | 7 | | | | | | | | | | | | | | ● | | | | ● |
| | 42 | 10 | | | | | | | | | | | | | | ● | | | | ● |
| | 42 | 11 | | | | | | | | | | | | | | ● | | | | ● |
| | 23 | 35 | 6 | | | | | | | | | | | | | ● | | | | |
| 24 | 35 | 6 | | | | | | | | | | | | | ● | | | | | |
| | 35 | 7 | | | | | | | | | | | | | ● | | | | | |
| | 35 | 8 | | | | | | | | | | | | | ● | | | | | ● |
| | 38 | 5 | ● | | | | | | | | | | | | ● | | | | | |
| | 38 | 8 | | | | | | | | | | | | | ● | | | | | ● |
| | 38 | 10 | | | | | | | | | | | | | ● | | | | | |
| | 40 | 6 | ● | | | | | | | | | | | | ● | | | | | ● |
| | 40 | 8 | | | | | | | | | | | | | ● | | | | | ● |
| | 45 | 7 | | | | | | | | | | | | | ● | | | | | |
| | 45 | 10 | | | | | | | | | | | | | ● | | | | | |
| 25 | 32 | 4 | | | | | | | | | | | | | ● | | | | | |
| | 32 | 8 | | | | | | | | | | | | | ● | | | | | |
| | 33 | 4 | | | | | | | | | | | | | ● | | | | | |
| | 35 | 5 | ● | | ● | | | | | | | | | | ● | | | | | |
| | 35 | 6 | | | | | | | | | | | | | | | | | | ● |
| 35 | 7 | | | | | | | | | | | | | | | | | | ● | |

d_1 (25)~(28)

| | | | | Metal O.D wall | | | | Rubber O.D wall | | | | | | | | | | | | |
|-------------------------|-----|-----|---|----------------|---|-----|---|-----------------|---|------|---|----|---|-----|---|-----|---|------|---|--|
| | | | | | | | | | | | | | | | | | | | | |
| Boundary dimensions, mm | | | | HM | | HMA | | HMS | | HMSA | | MH | | MHA | | MHS | | MHSA | | |
| d_1 | D | b | | N | A | S | F | N | A | S | F | N | A | S | F | N | A | S | F | |
| 25 | 35 | 8 | | | | | | | | | | | | | | | | | | |
| | 38 | 5 | ● | | | ● | ● | | | | | | | | | | | | | |
| | 38 | 7 | | | | | | | | | | | | | | | | | | |
| | 38 | 8 | | | | | | | | | | | | | | | | | | |
| | 40 | 5 | ● | | | | ● | | | | | | | | | | | | | |
| | 40 | 6 | ● | | | | ● | | | | | | | | | | | | | |
| | 40 | 7 | | | | | | | | | | | | | | | | | | |
| | 40 | 8 | | | | | | | | | | | | | | | | | | |
| | 40 | 10 | | | | | | | | | | | | | | | | | | |
| | 42 | 5 | | | | | | | | | | | | | | | | | | |
| | 42 | 8 | | | | | | | | | | | | | | | | | | |
| | 42 | 11 | | | | | | | | | | | | | | | | | | |
| | 44 | 7 | | | | | | | | | | | | | | | | | | |
| | 45 | 5 | ● | | | | | | | | | | | | | | | | | |
| | 45 | 7 | | | | | | | | | | | | | | | | | | |
| | 45 | 8 | | | | | | | | | | | | | | | | | | |
| | 45 | 10 | | | | | | | | | | | | | | | | | | |
| | 45 | 11 | | | | | | | | | | | | | | | | | | |
| | 47 | 5 | ● | | | | | | | | | | | | | | | | | |
| | 47 | 6 | ● | | | | | | | | | | | | | | | | | |
| 47 | 7 | | | | | | | | | | | | | | | | | | | |
| 47 | 8 | | | | | | | | | | | | | | | | | | | |
| 48 | 8 | | | | | | | | | | | | | | | | | | | |
| 50 | 9 | | | | | | | | | | | | | | | | | | | |
| 50 | 12 | | | | | | | | | | | | | | | | | | | |
| 52 | 7 | | | | | | | | | | | | | | | | | | | |
| 52 | 10 | | | | | | | | | | | | | | | | | | | |
| 52 | 12 | | | | | | | | | | | | | | | | | | | |
| 62 | 11 | | | | | | | | | | | | | | | | | | | |
| 26 | 36 | 8 | | | | | | | | | | | | | | | | | | |
| | 38 | 8 | | | | | | | | | | | | | | | | | | |
| | 40 | 7 | | | | | | | | | | | | | | | | | | |
| | 40 | 8 | | | | | | | | | | | | | | | | | | |
| | 42 | 7 | | | | | | | | | | | | | | | | | | |
| | 42 | 8 | | | | | | | | | | | | | | | | | | |
| | 45 | 7 | | | | | | | | | | | | | | | | | | |
| | 48 | 11 | | | | | | | | | | | | | | | | | | |
| 27 | 40 | 8 | | | | | | | | | | | | | | | | | | |
| | 47 | 11 | | | | | | | | | | | | | | | | | | |
| 28 | 35 | 5 | | | | | | | | | | | | | | | | | | |
| | 37 | 6 | ● | | | | | | | | | | | | | | | | | |
| | 38 | 7 | | | | | | | | | | | | | | | | | | |
| | 38 | 8 | | | | | | | | | | | | | | | | | | |

YS type
d₁ 220~335

YS YSN YSA YSAN

Remarks

- 1) For seals marked ●, JTEKT owns molding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: YS32036018 (320×360×18 mm).
- 3) Seal number marked ●* have suffix -1.
- 4) Seals with spacer are available. Seal number with spacer is referred on right side page.
- 5) Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

d₁ 220~(310)

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|-------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 220 | 255 | 16 | | | | ● | | | | | | | | |
| 230 | 264 | 16 | | | | ● | | | | | | | | |
| 240 | 275 | 16 | | | | ● | | | | | | | | |
| 250 | 285 | 16 | | | | ● | | | | | | | | |
| 255 | 315 | 25 | ● | | | | | | | | | | | |
| 265 | 305 | 18 | ● | | | ● | | | | | | | | |
| 270 | 330 | 25 | ● | | | | | | | | | | | |
| 280 | 320 | 18 | ● | | | ● | | | | | | | | |
| | 330 | 20 | ●* | | | | | | | | | | | |
| | 340 | 25 | ● | | | ● | | | | | | | | |
| 290 | 330 | 18 | ● | | | | | | | | | | | |
| | 340 | 20 | ● | | | | | | | | | | | |
| | 350 | 25 | ● | | | | | | | | | | | |
| 300 | 350 | 28 | | | | | | | ● | | | | | |
| | 340 | 18 | ● | ● | | ● | ● | | | | | | | |
| | 340 | 20 | ● | | | | | | | | | | | |
| 304 | 340 | 25 | ● | | | | | | | | | | | |
| | 345 | 20 | ● | | | | | | | | | | | |
| | 345 | 22 | ● | | | | | | | | | | | |
| 304.8 | 350 | 20 | ●* | | | | | | | | | | | |
| | 350 | 25 | ● | | | | | | | | | | | |
| | 350 | 29 | ● | | | | | | ● | | | | | |
| 305 | 360 | 25 | ● | | | ● | | | | | | | | |
| | 360 | 28 | | | | | | | ● | | | | | |
| | 342.1 | 17.5 | ●* | | | | | | | | | | | |
| 310 | 342.9 | 17.5 | ●* | | | | | | | | | | | |
| | 355.6 | 20.6 | ● | | | | | | | | | | | |
| | 355.6 | 25.4 | ● | | | | | | | | | | | |

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

Example 1 **YS 320 360 18 D5** Spacer width: 5 mm

Example 2 **YS 320 360 18 2D5** Spacer width: 5 mm

d₁ (310)~335

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 310 | 350 | 19 | ● | | | | | | | | | | | |
| | 350 | 20 | ● | | | ● | | | | | | | | |
| | 360 | 20 | ● | | | | | | | | | | | |
| 315 | 360 | 25 | ● | | | | | | | | ● | | | |
| | 370 | 25 | ● | ● | | | | | | ● | ●* | | | |
| | 370 | 28 | ● | | | | | | | | ● | | | |
| | 355 | 20 | ● | | | | | | | | | | | |
| | 360 | 20 | ● | | | | | | | | | | | |
| 320 | 365 | 20 | ● | | | | | | | | | | | |
| | 375 | 25 | ● | | | | | | | | | | | |
| | 375 | 28 | ● | | | | | | | | ● | | | |
| 320.68 | 360 | 18 | ● | | | | | | | | | | | |
| | 360 | 20 | ● | | | | | | | | | | | |
| | 360 | 25 | ● | | | | | | | | ● | | | |
| | 370 | 20 | ● | | | | | | | | | | | |
| | 370 | 25 | ● | | | | | | | | | | | |
| 325 | 380 | 25 | ● | | | | | | | | | | | |
| | 380 | 28 | ● | | | | | | | | ● | ● | | |
| | 371.48 | 25.4 | ● | | | | | | | | | | | |
| 330 | 365 | 20 | ● | | | | | | | | | | | |
| | 375 | 25 | ● | | | | | | | | | | | |
| | 370 | 18 | ● | | | | | | | | | | | |
| 330.2 | 370 | 20 | ● | | | | | | | | | | | |
| | 370 | 25 | ● | | | | | | | | | | | |
| | 370 | 25 | ● | | | | | | | | | | | |
| 335 | 380 | 25 | ● | | | | | | | | | | | |
| | 390 | 25 | ● | | | | | | | | ● | | | |
| | 390 | 28 | ● | | | | | | | | ● | | | |

YS type

d_1 336.6~(400)

YS YSN YSA YSAN

Remarks

- 1) For seals marked ●, JTEKT owns molding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: YS32036018 (320×360×18 mm).
- 3) Seal number marked ●* have suffix -1.
- 4) Seals with spacer are available. Seal number with spacer is referred on right side page.
- 5) Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

d_1 336.6~365

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d_1 | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 336.6 | 374.65 | 17.5 | ●* | | | | | | | | | | | |
| 340 | 380 | 18 | ● | | | ● | | | | | | | | |
| | 380 | 20 | ● | ● | | | ● | | | | | | | |
| | 380 | 25 | ● | | | | | | | | | | | |
| | 384 | 20 | ● | | | | | | | | | | | |
| | 390 | 20 | ● | | | | | | | | | | | |
| | 390 | 25 | ● | | | | | | | | | | | |
| | 400 | 25 | ● | ● | | | ● | | | | ● | | | |
| 342.9 | 381 | 17.5 | ● | | | | | | | | | | | |
| | 393.7 | 20.6 | ● | | | | | | | | | | | |
| | 393.7 | 25.4 | ● | | | | | | | | | | | |
| 350 | 390 | 16 | | | | ● | | | | | | | | |
| | 390 | 18 | ● | | | | | | | | | | | |
| | 390 | 20 | ● | | | | | | | | | | | |
| | 400 | 17 | ● | | | | | | | | | | | |
| | 400 | 25 | ● | | | | | | | ● | | | | |
| | 410 | 25 | ● | | | | | | | | | | | |
| 355 | 405 | 25 | ● | | | | | | | | | | | |
| | 415 | 28 | | | | | | | | ● | | | | |
| 355.6 | 406.4 | 20.6 | ●* | | | | | | | | | | | |
| | 406.4 | 25.4 | ● | | | | | | | | | | | |
| 360 | 400 | 17 | ● | | | | | | | | | | | |
| | 400 | 18 | ● | | | | | | | | | | | |
| | 400 | 20 | ● | | | | | | | | | | | |
| | 400 | 25 | ● | | | | | | | | | | | |
| | 410 | 25 | ● | | | | | | | ● | | | | |
| | 420 | 25 | ● | | | | | | | | | | | |
| | 420 | 28 | | | | | | | | | ● | | | |
| 365 | 405 | 18 | ● | | | | | | | | | | | |

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

Example 1 **YS 320 360 18 D5**

Spacer width: 5 mm

Example 2 **YS 320 360 18 2D5**

Spacer width: 5 mm

d_1 370~(400)

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d_1 | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 370 | 410 | 18 | ● | ● | | | | | | | | | | |
| | 410 | 20 | ● | | | | | | | | | | | |
| | 410 | 25 | ● | | | | | | | | | | | |
| | 415 | 20 | ● | ● | | | | | | | | | | |
| | 420 | 20 | ● | | | | | | | | | | | |
| | 420 | 25 | ● | | | | | | | | ● | | | |
| | 430 | 25 | ● | | | | | | | | ● | | | |
| 430 | 28 | | | | | | | | | | | | | |
| 374.65 | 419.1 | 22.2 | ● | | | | | | | | | | | |
| 375 | 420 | 18 | ● | | | | | | | | | | | |
| | 420 | 20 | ● | | | | | | | | | | | |
| | 435 | 28 | | | | | | | | | ● | | | |
| 380 | 420 | 18 | ● | | | | | | | | | | | |
| | 420 | 20 | ● | | | | | | | | | | | |
| | 420 | 25 | ● | | | | | | | | | | | |
| | 430 | 25 | ● | | | | | | | | | | | |
| | 440 | 25 | ● | | | | | | | | | | | |
| | 440 | 28 | | | | | | | | | | ● | | |
| 381 | 419.1 | 17.5 | ● | | | | | | | | | | | |
| | 431.8 | 20.6 | ●* | | | | | | | | | | | |
| | 431.8 | 25.4 | ● | | | | | | | | | | | |
| 385 | 425 | 18 | ● | | | | | | | | | | | |
| 387.4 | 425.15 | 17.5 | ●* | | | | | | | | | | | |
| 390 | 430 | 18 | ● | | | | | | | | | | | |
| | 430 | 20 | ● | | | | | | | | | | | |
| | 440 | 20 | ● | | | | | | | | | | | |
| | 440 | 25 | ● | | | | | | | | | ● | | |
| | 450 | 25 | ● | | | | | | | | | ● | | |
| | 450 | 28 | | | | | | | | | | ● | | |
| 393.7 | 431.8 | 19 | ● | | | | | | | | | | | |
| 400 | 440 | 18 | ● | | | | | | | | | | | |

YS type
d₁ 463.6~550

YS YSN YSA YSAN

Remarks

- For seals marked ●, JTEKT owns molding dies for production.
- Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: YS32036018 (320×360×18 mm).
- Seal number marked ●* have suffix -1.
- Seals with spacer are available. Seal number with spacer is referred on right side page.
- Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

Example 1 **YS 320 360 18 D5** Spacer width: 5 mm

Example 2 **YS 320 360 18 2D5** Spacer width: 5 mm

d₁ 463.6~510

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 463.6 | 501.65 | 19.1 | ● | | | | | | | | | | | |
| 465 | 510 | 20 | ● | | | | | | | | | | | |
| | 515 | 25 | | | | | | | ● | | | | | |
| 467 | 510 | 20 | ● | | | | | | | | | | | |
| 469.9 | 520.7 | 23 | ● | | | | | | | | | | | |
| | 520.7 | 23.4 | ● | | | | | | | | | | | |
| 470 | 510 | 20 | ● | | | | | | | | | | | |
| | 520 | 18 | ●* | | | | | | | | | | | |
| | 520 | 20 | ● | | | ● | ● | | | | | | | |
| | 520 | 25 | | | | | | | ● | | | | | |
| | 530 | 25 | ● | | | | | | ● | | | | | |
| 480 | 530 | 28 | | | | | | | ● | | | | | |
| | 520 | 20 | ● | | | ● | | | | | | | | |
| | 530 | 20 | ● | | | | | | | | | | | |
| | 530 | 22 | ● | | | | | | | | | | | |
| | 530 | 25 | ● | | | | | | | | | | | |
| 482.6 | 540 | 25 | ● | ● | | | | | ● | | | | | |
| | 540 | 28 | | | | | | | ● | | | | | |
| 490 | 530 | 20 | ● | | | | | | | | | | | |
| | 540 | 25 | ● | | | | | | ● | | | | | |
| | 550 | 25 | ● | | | | | | | | | | | |
| 495.3 | 546.1 | 23.8 | ● | | | | | | | | | | | |
| 500 | 540 | 20 | ● | | | | | | | | | | | |
| | 550 | 20 | ● | | | | | | | | | | | |
| | 550 | 25 | ● | | | | | | | | | | | |
| | 560 | 25 | ● | | | | | | ● | | | | | |
| | 560 | 28 | | | | | | | ● | | | | | |
| 510 | 550 | 20 | ● | | | | | | | | | | | |
| | 560 | 25 | ● | ● | | ● | | | | | | | | |
| | 570 | 28 | | | | | | | ● | | | | | |

d₁ 514~550

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 514 | 565 | 25 | ● | | | | | | | | | | | |
| 514.4 | 565.15 | 22.2 | ● | | | | | | | | | | | |
| 520 | 560 | 20 | ● | ● | | | | | ● | | | | | |
| | 570 | 20 | ● | | | | | | | | | | | |
| | 580 | 20 | | | | | | | ● | | | | | |
| | 580 | 25 | ● | | | | | | | | ● | | | |
| 520.7 | 580 | 28 | | | | | | | | | ● | | | |
| | 558.8 | 19.1 | ●* | | | | | | | | | | | |
| 530 | 571.5 | 22.2 | ● | | | | | | | | | | | |
| | 570 | 20 | ● | | | | | | | | | | | |
| 539.8 | 580 | 20 | ● | | | | | | | | | | | |
| | 580 | 22 | ● | | | | | | | | | | | |
| | 590 | 28 | | | | | | | | | ● | | | |
| | 600 | 25 | ● | | | | | | | | | | | |
| | 590.55 | 22 | ●* | | | | | | | | | | | |
| 540 | 580 | 20 | ● | | | | | | | | | | | |
| | 580 | 25 | ● | | | | | | | | | | | |
| | 590 | 20 | ● | | | | | | | | | | | |
| | 590 | 25 | ● | | | | | | | | | | | |
| | 600 | 25 | ● | | | | | | | | ● | | | |
| 546.1 | 600 | 28 | | | | | | | | | ● | | | |
| | 610 | 25 | ● | | | | | | | | | | | |
| | 596.9 | 20.6 | ● | | | | | | | | | | | |
| | 596.9 | 22.2 | ● | | | | | | | | | | | |
| | 550 | 590 | 20 | ● | | | | | | | | | | |
| 550 | 600 | 20 | ● | | | | | | | | | | | |
| | 600 | 25 | ● | ● | | | | | | | | | | |
| | 600 | 25 | ● | | | | | | | | | | | |
| | 610 | 23 | ● | | | | | | | | | | | |
| | 610 | 25 | ● | | | | | | | | | | | |
| | 610 | 28 | | | | | | | | | ● | | | |
| | 620 | 25 | ● | ● | | | | | | | | | | |

Remarks

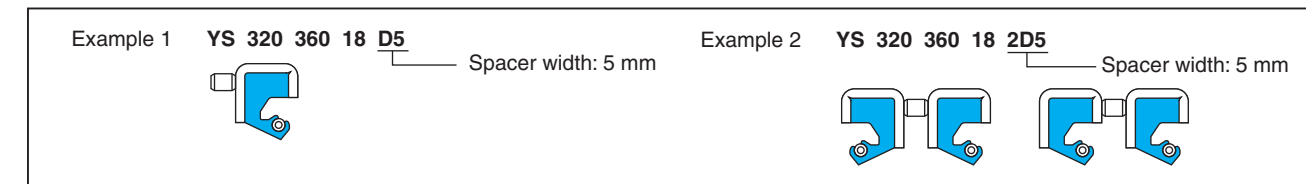
- 1) For seals marked ●, JTEKT owns molding dies for production.
 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
 Example: YS32036018 (320×360×18 mm).
 3) Seal number marked ●* have suffix -1.
 4) Seals with spacer are available. Seal number with spacer is referred on right side page.
 5) Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

 d_1 558~(600)

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|-------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| d_1 | D | b | YS | | | YSN | | | YSA | | YSAN | | | |
| | | | N | F | K | N | F | K | N | F | N | F | | |
| 558 | 618 | 25 | ● | | | | | | | | | | | |
| 558.8 | 596.9 | 19.1 | ●* | | | | | | | | | | | |
| | 609.6 | 22.2 | ● | | | | | | | | | | | |
| | 622.3 | 22.2 | ● | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 560 | 600 | 20 | ● | | | | | | | | | | | |
| | 610 | 20 | ● | | | ● | | | | | | | | |
| | 610 | 22 | ● | | | | | | | | | | | |
| | 610 | 23 | ● | | | | | | | | | | | |
| | 620 | 25 | ● | | | | | | | | | | | |
| | 620 | 28 | | | | | | | ● | | | | | |
| | 620 | 30 | | | | | | | ● | | | | | |
| 570 | 610 | 20 | ● | | | | | | | | | | | |
| | 620 | 22 | ● | | | | | | | | | | | |
| | 630 | 25 | ● | | | | | | | | | | | |
| 579.2 | 630 | 25.4 | ● | | | | | | | | | | | |
| 580 | 620 | 20 | ● | | | ● | | | | | | | | |
| | 630 | 20 | ● | | | | | | | | | | | |
| | 630 | 25 | ● | | | | | | | | | | | |
| | 640 | 25 | ● | | | | | | | | | | | |
| | 640 | 28 | | | | | | | ● | | | | | |
| | 640 | 30 | | | | | | | ● | | | | | |
| 584.2 | 622.3 | 19 | ● | | | | | | | | | | | |
| | 635 | 25.4 | ● | | | | | | | | | | | |
| 587 | 637 | 20 | ● | | | | | | | | | | | |
| 590 | 630 | 20 | ● | | | | | | | | | | | |
| | 640 | 20 | ● | | | | | | | | | | | |
| | 640 | 25 | ● | | | | | | | | | | | |
| | 650 | 28 | | | | | | | ● | | | | | |
| 600 | 640 | 19 | ● | | | | | | | | | | | |

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

 d_1 (600)~647.7

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|-------|------|-----------|---|---|-----|---|---|-----|---|------|---|---|---|
| d_1 | D | b | YS | | | YSN | | | YSA | | YSAN | | | |
| | | | N | F | K | N | F | K | N | F | N | F | | |
| 600 | 640 | 20 | ● | | | | | | | | | | | |
| | 650 | 25 | | | | | | | | | | | ● | |
| | 660 | 25 | ● | | | | | | | | | | | |
| | 660 | 28 | | | | | | | | | | | ● | |
| 609.6 | 660.4 | 22.2 | ● | | | | | | | | | | | |
| 610 | 660 | 25 | ● | | | | | | | | | | | |
| | 670 | 23 | ● | | | | | | | | | | | |
| | 670 | 25 | ● | | | | | | | | | | | |
| | 670 | 28 | | | | | | | | | | | ● | |
| 620 | 670 | 30 | | | | | | | | | | | ● | |
| | 660 | 20 | ● | | | | | | | | | | | |
| | 670 | 20 | ● | | | | | | | | | | | |
| | 670 | 25 | ● | | | | | | | | | | | |
| | 680 | 25 | ● | | | | | | | | | | | |
| 622.3 | 673.1 | 22.2 | ● | | | | | | | | | | | |
| | 630 | 670 | 20 | ● | | | | | | | | | | |
| | | 670 | 25 | ● | | | | | | | | | | |
| 680 | | 25 | ● | | | | | | | | | | | |
| 635 | 690 | 25 | ● | | | | | | | | | | | |
| | 690 | 30 | ● | | | | | | | | | | | |
| | 700 | 30 | | | | | | | | | | | | ● |
| | 673.1 | 19.1 | ● | | | | | | | | | | | |
| | 685 | 25 | ● | | | | | | | | | | | |
| | 695 | 25 | ● | | | | | | | | | | | |
| | 640 | 680 | 20 | ● | | | | | | | | | | |
| 690 | | 25 | ● | | | | | | | | | | | |
| 700 | | 25 | ● | | | | | | | | | | | |
| 700 | | 28 | | | | | | | | | | | | ● |
| 647.7 | 698.5 | 22.2 | ● | | | | | | | | | | | |

YS type
d₁ (810)~(1 000)

YS YSN YSA YSAN

Remarks

- 1) For seals marked ●, JTEKT owns molding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: YS32036018 (320×360×18 mm).
- 3) Seal number marked ●* have suffix -1.
- 4) Seals with spacer are available. Seal number with spacer is referred on right side page.
- 5) Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

d₁ (810)~(889)

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|--------|-------|-----------|------|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 810 | 874 | 22 | ● | | | | | | | | | | | |
| | 820 | 870 | 25 | ● | | | | | | | | | | |
| | | 880 | 25 | ● | | | | | | | | | | |
| | | 880 | 28 | | | | | | | ● | | | | |
| 825.5 | 876.3 | 22.2 | ● | ● | | | | | | | | | | |
| | | 830 | 880 | 25 | ● | | | | | | | | | |
| 830 | 900 | 25 | ● | | | | | | | | | | | |
| | | 838.2 | 879.5 | 19 | | | | | ● | | | | | |
| 838.2 | 889 | 22.2 | ● | | | | | | | | | | | |
| | | 840 | 890 | 22 | ● | | | | | | | | | |
| 840 | 890 | 25 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| 849 | 900 | 25 | | | | | | | | | | ● | | |
| | | 850 | 900 | 25 | ● | ● | | | | | | | | |
| 850 | 910 | 25 | ● | | | | | | | | | | | |
| | | 850.9 | 914.4 | 22.2 | ● | | | | | | | | | |
| 860 | 910 | 25 | ● | | | | | | | | | | | |
| | | 920 | 23 | ● | | | | | | | | | | |
| | | 920 | 25 | ● | | | | | | | | | | |
| 864 | 928 | 22 | ● | | | | | | | | | | | |
| 870 | 920 | 25 | ● | | | | | | | | | | | |
| 876.3 | 927.1 | 22.2 | ● | | | | | | | | | | | |
| 880 | 930 | 25 | ● | | | | | | | | | | | |
| | | 30 | | | | | | | | | ● | | | |
| | | 25 | ● | | | | | | | | | | | |
| | | 28 | | | | | | | | | | ● | | |
| 882.7 | 933.45 | 22.2 | ● | | | | | | | | | | | |
| 889 | 939.8 | 20.6 | ● | | | | | | | | | | | |
| | | 952.5 | 22.2 | ● | | | | | | | | | | |
| | | 952.5 | 25.4 | ● | | | | | | | | | | |

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

Example 1 **YS 320 360 18 D5** Spacer width: 5 mm

Example 2 **YS 320 360 18 2D5** Spacer width: 5 mm

d₁ (889)~(1 000)

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|----------|-------|-----------|------|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d ₁ | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 889 | 965.2 | 25.4 | ● | | | | | | | | | | | |
| | | 890 | 940 | 25 | ● | | | | | | | | | |
| 900 | 950 | 25 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| 914.4 | 977.9 | 25.4 | ● | | | | | | | | | | | |
| | | 920 | 970 | 20 | ● | | | | | | | | | |
| 920 | 970 | 25 | ● | | | | | | | | | | | |
| | | 927.1 | 977.9 | 22.2 | ● | | | | | | | | | |
| 940 | 990 | 25 | ● | | | | | | | | | | | |
| | | 23 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| 950 | 1 000 | 23 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| | | 30 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| 952.5 | 990.6 | 22.2 | | | | | | | | | | | | |
| | | 22.2 | ● | | | | | | | | | | | |
| | | 22.2 | ● | | | | | | | | | | | |
| 960 | 1 020 | 25 | ● | | | | | | | | | | | |
| 970 | 1 020 | 25 | ● | | | | | | | | | | | |
| | | 25 | ●* | | | | | | | | | | | |
| 971.5 | 1 035.05 | 19.05 | ● | | | | | | | | | | | |
| 971.6 | 1 035.05 | 25 | ● | | | | | | | | | | | |
| 977.9 | 1 041.4 | 25 | ●* | | | | | | | | | | | |
| 990 | 1 040 | 25 | ●* | | | | | | | | | | | |
| 990.6 | 1 041.4 | 22.2 | ● | | | | | | | | | | | |
| 1 000 | 1 050 | 22 | ● | | | | | | | | | | | |
| | | 23 | ● | | | | | | | | | | | |
| | | 25 | ● | | | | | | | | | | | |
| | | 30 | ● | | | | | | | | | | | |

YS type

d_1 (1 000)~1 640

YS YSN YSA YSAN

Remarks

- 1) For seals marked ●, JTEKT owns molding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: YS32036018 (320×360×18 mm).
- 3) Seal number marked ●* have suffix -1.
- 4) Seals with spacer are available. Seal number with spacer is referred on right side page.
- 5) Rubber code N represents nitrile rubber, F: fluorocarbon rubber, and K: hydrogenated nitrile rubber.

Example of seal number with spacer

(Various width spacers are available as like 10 mm.)

Example 1 **YS 320 360 18 D5**

Spacer width: 5 mm

Example 2 **YS 320 360 18 2D5**

Spacer width: 5 mm

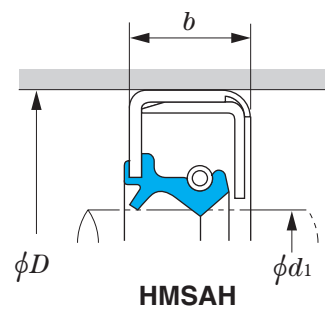
d_1 (1 000)~1 500

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|---------|------|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d_1 | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 1 000 | 1 060 | 25 | ● | | | | | | | | | | | |
| | 1 100 | 20 | | | | ● | | | | | | | | |
| 1 010 | 1 060 | 25 | | | ● | | | | | | | | | |
| 1 016 | 1 066.8 | 22.2 | ● | | | | | | | | | | | |
| 1 020 | 1 070 | 25 | ● | | | | | | | | | | | |
| 1 030 | 1 070 | 25 | ● | | | | | | | | | | | |
| 1 050 | 1 110 | 25 | ● | | | | | | | | | | | |
| 1 070 | 1 120 | 25 | ● | | | | | | | | | | | |
| | 1 130 | 25 | ● | | | | | | | | | | | |
| 1 079.5 | 1 143 | 22.2 | ● | | | | | | | | | | | |
| 1 080 | 1 130 | 25 | ●* | | | | | | | | | | | |
| 1 090 | 1 140 | 25 | ● | | | | | | | | | | | |
| | 1 150 | 25 | ● | | | | | | | | | | | |
| 1 092.2 | 1 155.7 | 25.4 | ● | | | | | | | | | | | |
| 1 104.9 | 1 155.7 | 22.2 | ● | | | | | | | | | | | |
| 1 105 | 1 155 | 15 | | | | ● | | | | | | | | |
| 1 110 | 1 160 | 25 | ● | | | | | | | | | | | |
| 1 117.6 | 1 181.1 | 22.2 | ● | | | | | | | | | | | |
| 1 130 | 1 180 | 25 | ● | | | | | | | | | | | |
| 1 136 | 1 186 | 25 | ● | | | | | | | | | | | |
| 1 140 | 1 200 | 25 | ● | | | | | | | | | | | |
| 1 200 | 1 264 | 25 | ● | | | | | | | | | | | |
| 1 210 | 1 270 | 25 | ● | | | | | | | | | | | |
| 1 320 | 1 380 | 30 | | | | | | | ● | ● | | | | |
| 1 340 | 1 390 | 25 | ● | | | | | | | | | | | |
| 1 360 | 1 410 | 25 | ● | | | | | | | | | | | |
| 1 400 | 1 460 | 25 | ● | | | | | | | | | | | |
| 1 460 | 1 510 | 25 | ● | | | | | | | | | | | |
| 1 480 | 1 530.8 | 22.2 | ● | | | | | | | | | | | |
| 1 498.6 | 1 549.4 | 22.2 | ● | | | | | | ● | | | | | |
| 1 500 | 1 550 | 25 | ● | | | | | | | | | | | |

d_1 1 640

| Boundary dimensions, mm | | | Seal type | | | | | | | | | | | |
|-------------------------|-------|-----|-----------|---|---|-----|---|---|-----|---|------|---|--|--|
| | | | YS | | | YSN | | | YSA | | YSAN | | | |
| d_1 | D | b | N | F | K | N | F | K | N | F | N | F | | |
| 1 640 | 1 690 | 25 | ●* | | | | | | | | | | | |

Seals with reinforcing inner metal ring

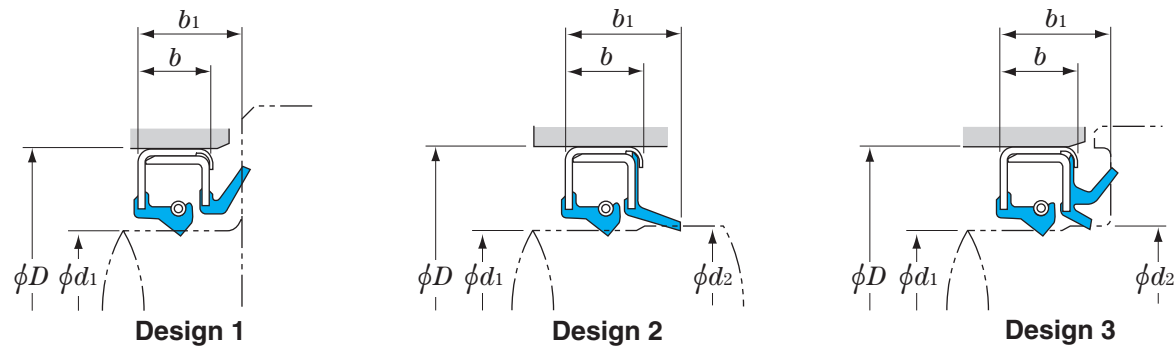


Remark) All seals use nitrile rubber

 d_1 68~340

| Boundary dimensions, mm | | | Seal No. |
|-------------------------|-----|-----|------------------|
| d_1 | D | b | |
| 68 | 88 | 10 | HMSAH 68 88 10 |
| | 90 | 10 | HMSAH 68 90 10 |
| 70 | 90 | 10 | HMSAH 70 90 10 |
| 90 | 118 | 12 | HMSAH 90 118 12 |
| | 135 | 15 | HMSAH 90 135 15 |
| 140 | 170 | 14 | HMSAH 140 170 14 |
| 150 | 180 | 16 | HMSAH 150 180 16 |
| 160 | 190 | 16 | HMSAH 160 190 16 |
| 164 | 194 | 16 | HMSAH 164 194 16 |
| 180 | 210 | 15 | HMSAH 180 210 15 |
| | 215 | 18 | HMSAH 180 215 18 |
| 190 | 225 | 18 | HMSAH 190 225 18 |
| 195 | 245 | 22 | HMSAH 195 245 22 |
| 200 | 235 | 18 | HMSAH 200 235 18 |
| 205 | 260 | 23 | HMSAH 205 260 23 |
| 210 | 260 | 25 | HMSAH 210 260 25 |
| | 265 | 23 | HMSAH 210 265 23 |
| 220 | 255 | 18 | HMSAH 220 255 18 |
| 240 | 270 | 16 | HMSAH 240 270 16 |
| | 275 | 18 | HMSAH 240 275 18 |
| | 300 | 28 | HMSAH 240 300 28 |
| 250 | 285 | 15 | HMSAH 250 285 15 |
| | 310 | 28 | HMSAH 250 310 28 |
| 260 | 290 | 16 | HMSAH 260 290 16 |
| | 290 | 18 | HMSAH 260 290 18 |
| | 300 | 22 | HMSAH 260 300 22 |
| 270 | 330 | 25 | HMSAH 270 330 25 |
| | 330 | 28 | HMSAH 270 330 28 |
| 280 | 320 | 18 | HMSAH 280 320 18 |
| | 320 | 22 | HMSAH 280 320 22 |
| | 340 | 28 | HMSAH 280 340 28 |
| 290 | 350 | 22 | HMSAH 290 350 22 |
| 300 | 340 | 22 | HMSAH 300 340 22 |
| 310 | 340 | 20 | HMSAH 310 340 20 |
| | 340 | 22 | HMSAH 310 340 22 |
| | 350 | 18 | HMSAH 310 350 18 |
| 340 | 400 | 25 | HMSAH 340 400 25 |

Seals with reinforcing inner metal ring



Remarks 1) All seals use nitrile rubber.
2) Consult JTEKT for drain-provided seals.

 d_1 117~254

| Boundary dimensions, mm | | | | | Seal No. | Design |
|-------------------------|-------|-----|------|-------|----------------------------|--------|
| d_1 | d_2 | D | b | b_1 | | |
| 117 | — | 140 | 10 | 14 | HMSH 117 140 10 – 14 J | 1 |
| 129 | — | 150 | 10 | 15 | HMSH 129 150 10 – 15 J | 1 |
| 130 | 132 | 150 | 10 | 14 | HMSH 130 150 10 – 14 J | 3 |
| 134 | — | 160 | 11 | 17 | HMSH 134 160 11 – 17 J | 1 |
| 137 | 139 | 160 | 11 | 14 | HMSH 137 160 11 – 14 J | 3 |
| 145 | — | 165 | 10 | 15 | HMSH 145 165 10 – 15 J | 1 |
| 155 | 158 | 180 | 13 | 17 | HMSH 155 180 13 – 17 J | 3 |
| 159 | — | 183 | 12 | 18 | HMSH 159 183 12 – 18 J | 1 |
| 166 | — | 190 | 12 | 18 | HMSH 166 190 12 – 18 J | 1 |
| 170 | — | 200 | 16 | 25 | HMSH 170 200 16 – 25 J | 1 |
| 174 | 177 | 200 | 14 | 19 | HMSH 174 200 14 – 19 J | 3 |
| 175 | — | 200 | 10 | 15.5 | HMSH 175 200 10 – 15.5 J | 1 |
| 180 | — | 220 | 16 | 25 | HMSH 180 220 16 – 25 J | 1 |
| 190 | — | 220 | 12 | 18 | HMSH 190 220 12 – 18 J | 1 |
| | 193 | 220 | 14 | 20 | HMSH 190 220 14 – 20 J | 3 |
| 200 | 203 | 230 | 14 | 20 | HMSH 200 230 14 – 20 J | 3 |
| | — | 235 | 16 | 23 | HMSH 200 235 16 – 23 J | 1 |
| 205 | — | 235 | 13 | 19 | HMSH 205 235 13 – 19 J | 1 |
| | — | 235 | 15 | 22 | HMSH 205 235 15 – 22 J | 1 |
| 210 | — | 240 | 12 | 21 | HMSH 210 240 12 – 21 J | 1 |
| 215 | — | 240 | 12 | 18 | HMSH 215 240 12 – 18 J | 1 |
| | — | 245 | 13 | 19 | HMSH 215 245 13 – 19 J | 1 |
| | 218 | 245 | 14 | 22 | HMSH 215 245 14 – 22 J | 3 |
| 220 | — | 245 | 13 | 21 | HMSH 220 245 13 – 21 J | 1 |
| | — | 260 | 16 | 23 | HMSH 220 260 16 – 23 J | 1 |
| 225 | — | 255 | 13 | 21 | HMSH 225 255 13 – 21 J | 1 |
| | 228 | 260 | 14 | 20 | HMSH 225 260 14 – 20 J | 3 |
| 230 | — | 260 | 15 | 23 | HMSH 230 260 15 – 23 J | 1 |
| 240 | 240 | 270 | 16 | 22 | HMSH 240 270 16 – 22 J | 2 |
| | — | 270 | 16 | 23 | HMSH 240 270 16 – 23 J | 1 |
| | 243 | 275 | 16 | 24 | HMSH 240 275 16 – 24 J | 3 |
| 245 | — | 275 | 13 | 21 | HMSH 245 275 13 – 21 J | 1 |
| 250 | — | 280 | 16 | 23 | HMSH 250 280 16 – 23 J | 1 |
| | — | 280 | 16 | 25 | HMSH 250 280 16 – 25 J | 1 |
| 254 | — | 285 | 11.5 | 18.4 | HMSH 254 285 11.5 – 18.4 J | 1 |

 d_1 260~405

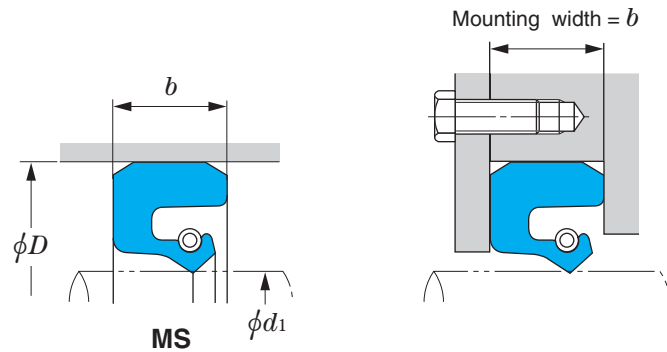
| Boundary dimensions, mm | | | | | Seal No. | Design |
|-------------------------|-------|-----|------|-------|----------------------------|--------|
| d_1 | d_2 | D | b | b_1 | | |
| 260 | 263 | 290 | 14 | 20 | HMSH 260 290 14 – 20 J | 3 |
| 270 | — | 300 | 16 | 25 | HMSH 270 300 16 – 25 J | 1 |
| 280 | — | 316 | 18 | 25 | HMSH 280 316 18 – 25 J | 1 |
| | — | 320 | 20 | 27 | HMSH 280 320 20 – 27 J | 1 |
| | 384 | 320 | 20 | 28 | HMSH 280 320 20 – 28 J | 3 |
| 290 | — | 330 | 18 | 28 | HMSH 290 330 18 – 28 J | 1 |
| 300 | 300 | 340 | 20 | 29 | HMSH 300 340 20 – 29 J | 3 |
| 310 | — | 350 | 18 | 28 | HMSH 310 350 18 – 28 J | 1 |
| | 313 | 350 | 20 | 28 | HMSH 310 350 20 – 28 J | 3 |
| 320 | — | 360 | 18 | 25 | HMSH 320 360 18 – 25 J | 1 |
| 330 | — | 380 | 18 | 25 | HMSH 330 380 18 – 25 J | 1 |
| 340 | — | 380 | 18 | 24 | HMSH 340 380 18 – 24 J | 1 |
| | — | 380 | 16 | 21.5 | HMSH 340 380 16 – 21.5 J | 1 |
| | 343 | 380 | 18 | 26 | HMSH 340 380 18 – 26 J | 3 |
| 350 | — | 390 | 18 | 25 | HMSH 350 390 18 – 25 J | 1 |
| 370 | — | 410 | 18 | 25 | HMSH 370 410 18 – 25 J | 1 |
| 375 | 378 | 420 | 20 | 28 | HMSH 375 420 20 – 28 J | 3 |
| 405 | — | 435 | 14.5 | 19.2 | HMSH 405 435 14.5 – 19.2 J | 1 |

Full rubber seals

d_1 1 040~3 530

MS

■ Mounting example



Remarks

- 1) All seals use nitrile rubber.
- 2) Mounting width deviation should be as specified in the table below:

Mounting width deviation (Unit : mm)

| Mounting width = b | Deviation |
|----------------------|-------------|
| — Up to 6 | -0.1 ~ -0.2 |
| Over 6 up to 10 | -0.1 ~ -0.3 |
| Over 10 up to 18 | -0.1 ~ -0.4 |
| Over 18 up to 30 | -0.1 ~ -0.5 |

d_1 1 040~2 420

d_1 2 538~3 530

| Boundary dimensions, mm | | | Seal No. |
|-------------------------|-------|-----|-----------------|
| d_1 | D | b | |
| 1 040 | 1 087 | 25 | MS 1040 1087 25 |
| | 1 110 | 30 | MS 1040 1110 30 |
| 1 045 | 1 095 | 25 | MS 1045 1095 25 |
| 1 090 | 1 137 | 25 | MS 1090 1137 25 |
| 1 100 | 1 150 | 30 | MS 1100 1150 30 |
| | 1 157 | 25 | MS 1100 1157 25 |
| | 1 170 | 30 | MS 1100 1170 30 |
| 1 110 | 1 157 | 25 | MS 1110 1157 25 |
| 1 170 | 1 217 | 25 | MS 1170 1217 25 |
| 1 200 | 1 250 | 24 | MS 1200 1250 24 |
| | 1 250 | 30 | MS 1200 1250 30 |
| | 1 270 | 30 | MS 1200 1270 30 |
| 1 210 | 1 267 | 25 | MS 1210 1267 25 |
| 1 220 | 1 267 | 25 | MS 1220 1267 25 |
| 1 230 | 1 290 | 30 | MS 1230 1290 30 |
| 1 310 | 1 357 | 25 | MS 1310 1357 25 |
| 1 390 | 1 450 | 30 | MS 1390 1450 30 |
| 1 400 | 1 456 | 25 | MS 1400 1456 25 |
| | 1 460 | 30 | MS 1400 1460 30 |
| 1 450 | 1 497 | 25 | MS 1450 1497 25 |
| 1 470 | 1 517 | 25 | MS 1470 1517 25 |
| 1 500 | 1 550 | 25 | MS 1500 1550 25 |
| 1 526 | 1 582 | 25 | MS 1526 1582 25 |
| 1 530 | 1 590 | 30 | MS 1530 1590 30 |
| 1 550 | 1 606 | 25 | MS 1550 1606 25 |
| 1 580 | 1 640 | 30 | MS 1580 1640 30 |
| 1 650 | 1 700 | 30 | MS 1650 1700 30 |
| 1 734 | 1 790 | 25 | MS 1734 1790 25 |
| 1 760 | 1 820 | 30 | MS 1760 1820 30 |
| 1 880 | 1 940 | 30 | MS 1880 1940 30 |
| 1 940 | 1 996 | 25 | MS 1940 1996 25 |
| 2 000 | 2 060 | 30 | MS 2000 2060 30 |
| 2 150 | 2 206 | 25 | MS 2150 2206 25 |
| 2 380 | 2 436 | 25 | MS 2380 2436 25 |
| 2 420 | 2 476 | 25 | MS 2420 2476 25 |

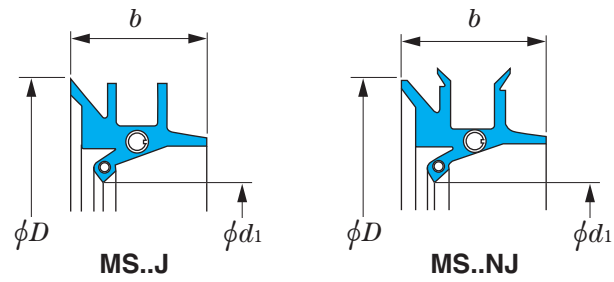
| Boundary dimensions, mm | | | Seal No. |
|-------------------------|-------|-----|-----------------|
| d_1 | D | b | |
| 2 538 | 2 594 | 25 | MS 2538 2594 25 |
| 2 915 | 2 970 | 25 | MS 2915 2970 25 |
| 3 530 | 3 585 | 25 | MS 3530 3585 25 |

MORGOIL seals

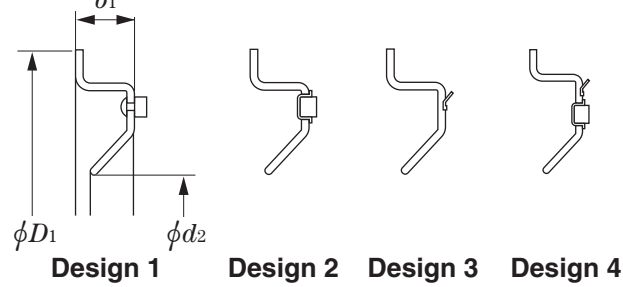
d_1 167~1 593

MS..J MS..NJ H..J H..JM H..PJ

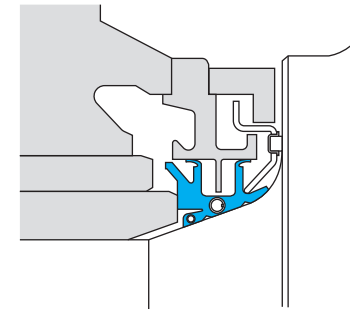
■ MORGOIL seals



■ Seal inner rings



■ Mounting example



Remark) All seals use nitrile rubber.

Note 1) Special type code B represents "with a steel band" and W represents "with a wire."

d_1 167~936

| MORGOIL seals | | | | Seal inner rings | | | | |
|-------------------------|-------|-----|------------------------|-------------------------|-------|-------|---------------------|--------|
| Boundary dimensions, mm | | | Seal No. ¹⁾ | Boundary dimensions, mm | | | Seal inner ring No. | Design |
| d_1 | D | b | | d_2 | D_1 | b_1 | | |
| 167 | 219 | 41 | MS 10 J | 194 | 238 | 16 | H 10 J | 1 |
| 236 | 295 | 49 | MS 14 J | 270 | 327 | 17.5 | H 14 J | 1 |
| 275 | 346 | 51 | MS 16 J | 308 | 372 | 21.5 | H 16 J | 1 |
| 323 | 402 | 54 | MS 18 J | 349 | 421 | 18 | H 18 J | 1 |
| 369 | 459 | 60 | MS 21 J | 406 | 490 | 19 | H 21 J | 1 |
| | | | MS 21 JBW | | | | | |
| 423 | 531 | 72 | MS 24 J | 475 | 567 | 27 | H 24 J | 1 |
| 677 | 798 | 84 | MS 38 J | 737 | 883 | 32 | H 38 J | 1 |
| | | | MS 38 JB | | | | | |
| | | | MS 38 NJBW | | | | | |
| 713 | 834 | 84 | MS 40 J | 772 | 940 | 36.5 | H 40 J | 1 |
| 754 | 907 | 95 | MS 42 J | 822 | 988 | 38 | H 42 J | 1 |
| | | | | | | | H 42 JM | 2 |
| 786 | 939 | 95 | MS 44 J | 854 | 1 029 | 38 | H 44 J | 1 |
| | | | MS 44 JB | | | | H 44 JM | 2 |
| | | | MS 44 NJBW | | | | H 44 PJ | 3 |
| 825 | 977 | 95 | MS 46 J | 892 | 1 061 | 38 | H 46 J | 1 |
| | | | | | | | H 46 JM | 2 |
| | | | MS 46 NJBW | 892 | 1 061 | 45 | H 46 NJM | 2 |
| 866 | 1 018 | 95 | MS 48 J | 933 | 1 124 | 44.5 | H 48 J | 1 |
| | | | MS 48 JB | | | | H 48 JM | 2 |
| | | | MS 48 JW | | | | | |
| | | | MS 48 NJBW | | | | | |
| 901 | 1 054 | 95 | MS 50 J | 968 | 1 162 | 44.5 | H 50 J | 1 |
| | | | MS 50 JB | 968 | 1 162 | 44.5 | H 50 J | 1 |
| | | | | | | | H 50 JM | 2 |
| | | | | | | | H 50 PJ | 3 |
| | | | MS 50 NJ | 968 | 1 150 | 43 | HM 50 NJP | 3 |
| | | | MS 50 NJB, NJBW | | | | | |
| 936 | 1 089 | 95 | MS 52 J | 1 003 | 1 200 | 48 | H 52 JM | 2 |

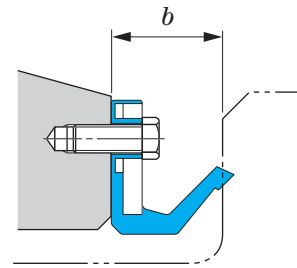
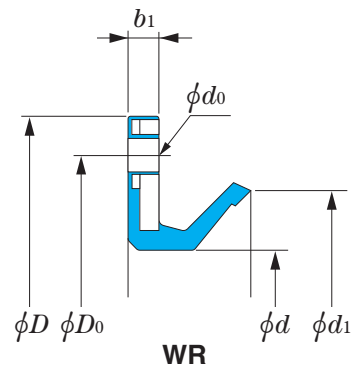
d_1 962~1 593

| MORGOIL seals | | | | Seal inner rings | | | | |
|-------------------------|-------|-----|------------------------|-------------------------|-------|-------|---------------------|--------|
| Boundary dimensions, mm | | | Seal No. ¹⁾ | Boundary dimensions, mm | | | Seal inner ring No. | Design |
| d_1 | D | b | | d_2 | D_1 | b_1 | | |
| 962 | 1 109 | 92 | MS 54 NJBW | 1 038 | 1 225 | 44.5 | H 54 NJP | 3 |
| 972 | 1 124 | 95 | MS 54 J | 1 038 | 1 238 | 44.5 | H 54 J | 2 |
| | | | MS 54 JB | | | | H 54 JM | 2 |
| | | | | | | | H 54 PJ | 3 |
| | | | | 1 052 | 1 252 | 72 | H 54 SNJP | 3 |
| 1 029 | 1 181 | 95 | MS 56 SJ | 1 098 | 1 289 | 38 | H 56 J | 1 |
| | | | MS 56 SJB | | | | H 56 JM | 2 |
| | | | | | | | H 56 PJ | 3 |
| | | | MS 56 NJ | 1 098 | 1 287 | 44 | H 56 NJP | 3 |
| | | | MS 56 NJBW | 1 098 | 1 287 | 44 | H 56 NJM | 2 |
| | | | | | | | H 56 NJP | 3 |
| 1 099 | 1 245 | 92 | MS 60 NJBW | 1 175 | 1 340 | 45 | H 60 NJP | 3 |
| 1 253 | 1 438 | 108 | MS 68 J | | | | | |
| 1 542 | 1 712 | 108 | MS 80 J | 1 630 | 1 885 | 55 | H 80 JMP | 4 |
| 1 593 | 1 782 | 108 | MS 82 J | 1 680 | 1 955 | 82 | H 82 JMP | 4 |

Scale seals

 d 195~1 595

WR



Remarks

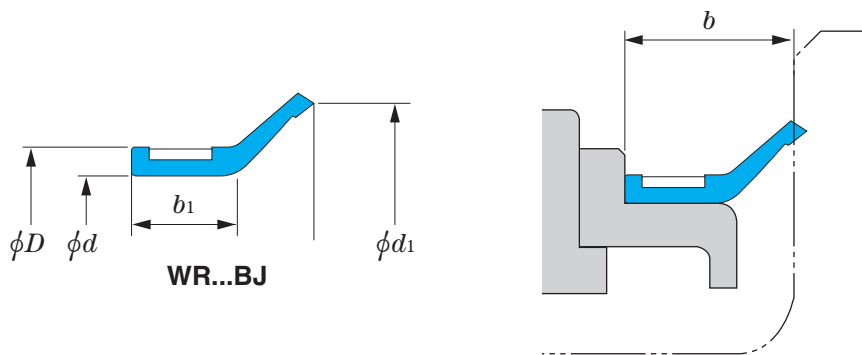
- 1) All seals use nitrile rubber.
- 2) Consult JTEKT for drain-provided seals.

 d 195~490

| Boundary dimensions, mm | | | | | Scale seal No. | Fixing holes | | |
|-------------------------|-----|------|-------|-------|-------------------|--------------|-------------|-------------------------------|
| d | D | b | b_1 | d_1 | | D_0 mm | d_0 mm | Hole Q'ty (equally spaced) |
| 195 | 250 | 26 | 5 | 222 | WR 195 250 26 | 234 | 9.5 | 6 |
| 200 | 250 | 26 | 5 | 229 | WR 200 250 26 | 234 | 9.5 | 6 |
| 210 | 265 | 19 | 4 | 231 | WR 210 265 19 | 245 | 9.5 | 8 |
| 240 | 300 | 26 | 5 | 269 | WR 240 300 26 | 280 | 9.5 | 6 |
| 255 | 315 | 23 | 5 | 280 | WR 255 315 23 | 295 | 9.5 | 8 |
| 275 | 335 | 30 | 5 | 311 | WR 275 335 30 | 315 | 9.5 | 8 |
| 280 | 340 | 25 | 5 | 304 | WR 280 340 25 | 320 | 9.5 | 6 |
| 290 | 348 | 23 | 5 | 320 | WR 290 348 23 | 330 | 9.5 | 8 |
| | 349 | 35 | 5 | 325 | WR 290 N1 | 330 | 9.5 | 8 |
| 310 | 455 | 42.5 | 11 | 354 | WR 310 455 42.5 | 400 | 17.5 | Special |
| 318 | 380 | 30 | 8 | 350 | WR 318 380 30 | 355 | 9.5 | 6 |
| 320 | 373 | 20 | 3.7 | 351 | WR 320 373 20 | 355 | 9.5 | 6 |
| 325 | 385 | 30 | 8 | 358 | WR 325 385 30 J | 360 | 9.5 | 6 |
| 330 | 400 | 35 | 5 | 370 | WR 330 400 35 | 380 | 9.5 | Special |
| 335 | 390 | 22 | 4.5 | 364 | WR 335 N1 | 370 | 9.5 | 6 |
| 340 | 410 | 26 | 5 | 369 | WR 340 410 26 | 390 | 9.5 | 6 |
| | 435 | 30 | 5 | 400 | WR 340 435 30 J | 415 | 9 | 8 |
| 350 | 414 | 35 | 5 | 386 | WR 350 414 35 | 395 | 10 | 8 |
| | 450 | 25 | 5 | 396 | WR 350 450 25 | 426 | 11 | 6 |
| 365 | 425 | 27.5 | 5 | 400 | WR 365 425 27.5 | 405 | 9.5 | 12 |
| 380 | 455 | 35 | 8 | 421 | WR 380 455 35 | 430 | 12 | Special |
| 383 | 450 | 24 | 5 | 409 | WR 383 450 24 | 430 | 9.5 | 12 |
| 405 | 485 | 32 | 8 | 442 | WR 405 485 32 | 460 | 9.5 | 8 |
| 420 | 480 | 26 | 5.5 | 444 | WR 420 N1 | 462 | 10 | 8 |
| 424 | 482 | 22.5 | 5 | 453 | WR 424 482 22.5 J | 465 | 9.5 | 12 |
| 430 | 490 | 26 | 8 | 456 | WR 430 490 26 | 472 | 10 | 12 |
| 435 | 489 | 25.4 | 7 | 460 | WR 435 489 25.4 | 470 | 10 | 8 |
| | 490 | 22.5 | 5 | 459 | WR 435 490 22.5 | 470 | 9.5 | 8 |
| 440 | 510 | 26 | 8 | 468 | WR 440 510 26 | 490 | 9 | 12 |
| | 514 | 35 | 5 | 464 | WR 440 514 35 | 490 | 12 | 8 |
| | 530 | 50 | 7 | 495 | WR 440 530 50 | 500 | 14 | 8 |
| 448 | 510 | 28.4 | 6 | 485 | WR 448 510 28.4 | 490 | 12 | Special |
| 458 | 540 | 26 | 6 | 485 | WR 458 N2 | 458 | 11.5 | 12 |
| 480 | 550 | 28 | 6 | 507 | WR 480 550 28 | 525 | 9.5 | 6 |
| 490 | 560 | 26 | 6 | 523 | WR 490 N1 | 535 | 9.5 | 8 |

 d 550~1 595

| Boundary dimensions, mm | | | | | Scale seal No. | Fixing holes | | |
|-------------------------|-------|------|-------|-------|-------------------|--------------|-------------|-------------------------------|
| d | D | b | b_1 | d_1 | | D_0 mm | d_0 mm | Hole Q'ty (equally spaced) |
| 550 | 610 | 22 | 6 | 578 | WR 550 610 22 | 590 | 9.5 | 8 |
| 566 | 622 | 25 | 4.7 | 594 | WR 566 622 25 | 603 | 12 | 6 |
| 580 | 650 | 51 | 8 | 632 | WR 580 650 51 | 626 | 12 | 12 |
| | 655 | 32 | 10 | 628 | WR 580 655 32 | 632 | Special | 8 |
| 645 | 719 | 30 | 4.5 | 684 | WR 645 N1 | 690 | 12 | 12 |
| 730 | 830 | 57 | 7 | 770 | WR 730 N1 | 790 | 13 | 12 |
| 734 | 830 | 21.1 | 4 | 770 | WR 734 830 21.1 | 800 | 12 | 8 |
| 740 | 840 | 55 | 9 | 786 | WR 740 840 55 | 800 | 12 | 12 |
| 760 | 835 | 33 | 6 | 802 | WR 760 N2 | 810 | 11 | 8 |
| 840 | 915 | 35 | 8 | 876 | WR 840 915 35 | 890 | 12 | 8 |
| 870 | 980 | 40 | 8 | 912 | WR 870 980 40 | 940 | 14 | 12 |
| 890 | 1 000 | 50 | 8 | 948 | WR 890 1000 50 | 950 | 18 | 12 |
| 992 | 1 064 | 26 | 6 | 1 020 | WR 992 1064 26 | 1 040 | 12 | Special |
| 1 000 | 1 108 | 38 | 8 | 1 040 | WR 1000 1108 38 | 1 065 | 14 | 12 |
| 1 025 | 1 080 | 45 | 9 | 1 053 | WR 1025 1080 45 | 1 060 | 9 | 12 |
| 1 105 | 1 180 | 40 | 6 | 1 145 | WR 1105 1180 40 | 1 156 | 14 | 16 |
| 1 200 | 1 270 | 38 | 8 | 1 242 | WR 1200 1270 38 | 1 242 | 12 | 16 |
| 1 202 | 1 300 | 50 | 7 | 1 246 | WR 1202 1300 50 | 1 260 | 14 | 16 |
| 1 595 | 1 750 | 48 | 7.6 | 1 663 | WR 1595 1750 48 J | 1 700 | 14 | 20 |

Scale seals*d* 280~1 340**WR...BJ**

Remarks

- 1) All seals use nitrile rubber.
- 2) Consult JTEKT for drain-provided seals.

d 280~1 340

| Boundary dimensions, mm | | | | | Scale seal No. |
|-------------------------|-----------------------|----------|-----------------------|----------|------------------------|
| <i>d</i> | <i>d</i> ₁ | <i>b</i> | <i>b</i> ₁ | <i>D</i> | |
| 280 | 292 | 27 | 22.5 | 288 | WR 280 288 27 BJ |
| 326 | 342.5 | 38 | 23 | 336 | WR 326 336 38 BJ |
| 337 | 352 | 38 | 28 | 347 | WR 337 347 38 BJ |
| 390 | 400 | 35 | 25 | 400 | WR 390 400 35 BJ |
| 395 | 405 | 38 | 25 | 405 | WR 395 405 38 BJ |
| 420 | 452 | 35 | 25 | 435 | WR 420 435 35 BJ |
| 445 | 461 | 35 | 25 | 461 | WR 445 461 35 BJ |
| | 478 | 35 | 25 | 470 | WR 445 470 35 BJ |
| 500 | 516 | 56.5 | 35 | 516 | WR 500 516 56.5 BJ – 1 |
| 533 | 546 | 31.5 | 22 | 543 | WR 533 543 31.5 BJ – 1 |
| 593 | 631 | 48 | 24 | 610 | WR 593 610 48 BJ |
| 595.3 | 611.3 | 29 | 22 | 611 | WR 595.3 611.3 29 BJ |
| 600 | 616 | 45 | 28 | 616 | WR 600 616 45 BJ |
| 625 | 671 | 35 | 22 | 641 | WR 625 641 35 BJ |
| 720 | 766 | 35 | 22 | 736 | WR 720 736 35 BJ |
| 750 | 792 | 45 | 25 | 766 | WR 750 766 45 BJ |
| 760 | 776 | 56.5 | 35 | 776 | WR 760 776 56.5 BJ |
| 800 | 854 | 56.5 | 35 | 816 | WR 800 816 56.5 BJ |
| 824 | 840 | 45 | 25 | 840 | WR 824 840 45 BJ |
| 900 | 942 | 45 | 25 | 916 | WR 900 916 45 BJ |
| 995 | 1 044 | 50 | 32 | 1 011 | WR 995 1011 50 BJ |
| 1 130 | 1 146 | 45 | 25 | 1 146 | WR 1130 1146 45 BJ |
| 1 193.8 | 1 231 | 40 | 20.5 | 1 209.8 | WR 1193.8 1209.8 40 BJ |
| 1 340 | 1 389 | 50 | 32 | 1 356 | WR 1340 1356 50 BJ |

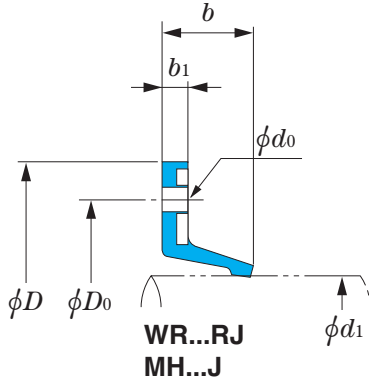
Scale seals

 d_1 210~1 203

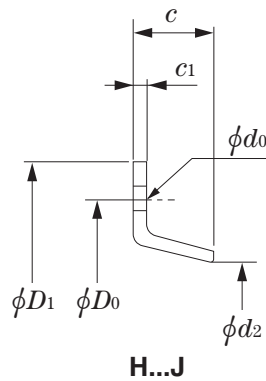
WR...RJ MH...J H...J

Koyo

■ Scale seal



■ Scale cover



Remarks

- 1) All seals use nitrile rubber.
- 2) Consult JTEKT for drain-provided seals.

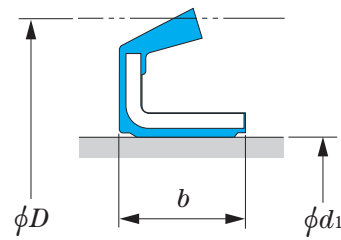
 d_1 210~1 203

| Boundary dimensions, mm | | | | Scale seal No. | Scale cover | | | | Fixing holes | | | |
|-------------------------|-------|------|-------|--------------------|-------------------------|-------|-----|-------|------------------|-------------|-------------|------------------------------|
| d_1 | D | b | b_1 | | Boundary dimensions, mm | | | | Scale cover No. | D_0 mm | d_0 mm | Hole Qty (equally spaced) |
| | | | | | d_2 | D_1 | c | c_1 | | | | |
| 210 | 300 | 16 | 4 | MH 210 300 4J | 218 | 300 | 18 | 2 | H 210 300 18 J | 275 | 10 | Special |
| 235 | 340 | 25 | 5 | WR 235 340 25 RJ | — | — | — | — | — | 300 | 11.5 | 5 |
| 300 | 380 | 26 | 6 | MH 300 380 6 J | — | — | — | — | — | 350 | 10 | 6 |
| 395 | 475 | 35 | 6 | MH 395 475 6 J | 409 | 475 | 33 | 5 | H 395 475 33 J | 455 | 10 | Special |
| 425 | 490 | 16.8 | 5 | MH 425 490 5 J | — | — | — | — | — | 470 | 9.5 | 8 |
| 510 | 580 | 25 | 5 | WR 510 580 25 RJ | 524 | 580 | 30 | 3.2 | H 510 580 30 J | 562 | 9.5 | 8 |
| 550 | 624 | 35 | 8 | MH 550 624 8 J | 556 | 624 | 40 | 5 | H 550 624 40 J | 605 | 10 | Special |
| 580 | 654 | 34 | 8 | WR 580 654 34 RJ | 589 | 654 | 40 | 5 | H 580 654 40 J | 635 | 10 | 12 |
| 584 | 685 | 25 | 5 | WR 584 685 25 RJ | — | — | — | — | — | 635 | 9 | 8 |
| 623 | 705 | 32 | 8 | MH 623 705 8 J | 635 | 705 | 30 | 5 | H 623 705 30 J | 685 | 12 | Special |
| 690 | 770 | 35 | 8 | MH 690 770 8 J | 700 | 770 | 40 | 5 | H 690 770 40 J | 745 | 10 | Special |
| | | | | | 695 | 770 | 55 | 5 | H 690 770 55 J | 745 | 10 | Special |
| 696 | 780 | 32 | 8 | MH 696 780 8 J | 705 | 780 | 30 | 5 | H 696 780 30 J | 750 | 14 | 8 |
| | 780 | 37 | 8 | WR 696 780 32 RJ | — | — | — | — | — | 750 | 10 | Special |
| 760 | 845 | 35 | 8 | MH 760 845 8 J | — | — | — | — | — | 820 | 10 | 12 |
| 805 | 885 | 35 | 8 | MH 805 885 8 J | 815 | 885 | 37 | 5 | H 805 885 37 J | 860 | 10 | 12 |
| 815 | 880 | 35 | 10 | MH 815 880 8 J | 828 | 880 | 27 | 5 | H 815 880 27 J | 865 | 9 | 12 |
| 820 | 925 | 35 | 8 | MH 820 925 8 J | 834 | 925 | 35 | 5 | H 820 925 35 J | 890 | 14 | Special |
| 850 | 925 | 30 | 8 | MH 850 925 8 J | 857 | 925 | 30 | 5 | H 850 925 30 J | 900 | 10 | Special |
| 920 | 995 | 35 | 8 | WR 920 995 35 RJ | — | — | — | — | — | 970 | 10 | 12 |
| 970 | 1 070 | 35 | 8 | WR 970 1070 35 RJ | — | — | — | — | — | 1 040 | 12 | 12 |
| 990 | 1 090 | 40 | 8 | WR 990 1090 40 RJ | — | — | — | — | — | 1 060 | 14 | 12 |
| 1 010 | 1 110 | 35 | 6 | WR 1010 1110 35 RJ | — | — | — | — | — | 1 080 | 14 | 12 |
| 1 030 | 1 120 | 40 | 8 | WR 1030 1120 40 RJ | — | — | — | — | — | 1 090 | 15 | 12 |
| 1 117 | 1 230 | 41.5 | 10 | WR 1117 1230 40 RJ | 1 137 | 1 230 | 45 | 5 | H 1117 1230 45 J | 1 200 | 14 | 18 |
| 1 120 | 1 220 | 35 | 10 | MH 1120 1220 10 J | 1 132 | 1 220 | 33 | 5 | H 1120 1220 33 J | 1 190 | 14 | 12 |
| 1 193 | 1 290 | 35 | 10 | MH 1193 1290 10 J | 1 206 | 1 290 | 33 | 5 | H 1193 1290 33 J | 1 260 | 13 | 12 |
| 1 203 | 1 300 | 35 | 10 | MH 1203 1300 10 J | 1 215 | 1 300 | 33 | 5 | H 1203 1300 33 J | 1 270 | 13 | Special |

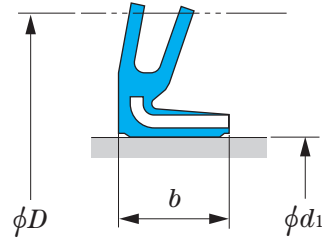
Water seals

d_1 219.2~1 460

XMH XM XMHE



XMH



**XM
XMHE**

Remarks

- 1) For seals marked ●, JTEKT owns moulding dies for production.
- 2) Seal number is constructed by combination of type code and dimensional numbers (bore diameter, outside diameter and width).
Example: XMHE77081029 (770×810×29 mm)
- 3) All seals use nitrile rubber.

d_1 219.2~800

| Boundary dimensions, mm | | | Seal type | | |
|-------------------------|-----|-----|-----------|----|------|
| d_1 | D | b | XMH | XM | XMHE |
| 219.2 | 240 | 6 | | ● | |
| 230 | 260 | 15 | ● | | |
| 245 | 275 | 12 | ● | | |
| 265 | 295 | 15 | ● | | |
| 274 | 304 | 13 | ● | | |
| 296 | 324 | 15 | ● | | |
| 345 | 375 | 15 | | | ● |
| 350 | 380 | 20 | ● | | |
| 360 | 390 | 20 | ● | | |
| | 400 | 20 | | | ● |
| 365 | 405 | 12 | ● | | |
| | 405 | 18 | ● | | |
| 400 | 440 | 20 | | | ● |
| 420 | 470 | 20 | | ● | |
| 440 | 480 | 20 | | ● | |
| 465 | 505 | 25 | | ● | |
| 485 | 525 | 25 | | ● | |
| 490 | 530 | 20 | | | ● |
| 520 | 560 | 20 | | | ● |
| 560 | 600 | 25 | | ● | |
| 580 | 624 | 25 | | ● | |
| 610 | 660 | 25 | | ● | |
| 620 | 660 | 25 | | | ● |
| 680 | 720 | 25 | | | ● |
| 720 | 770 | 25 | | | ● |
| 740 | 780 | 30 | | | ● |
| | 810 | 45 | | | ● |
| 750 | 800 | 25 | | | ● |
| 760 | 820 | 38 | | | ● |
| 800 | 840 | 20 | | | ● |

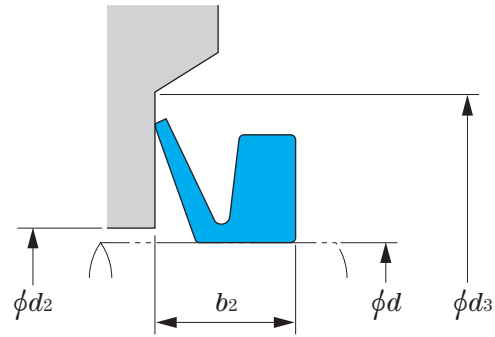
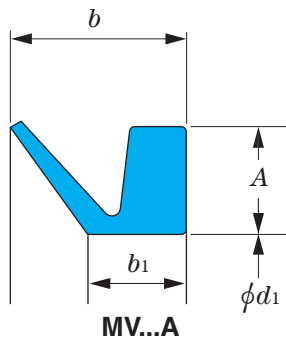
d_1 834~1 460

| Boundary dimensions, mm | | | Seal type | | |
|-------------------------|-------|-----|-----------|----|------|
| d_1 | D | b | XMH | XM | XMHE |
| 834 | 884 | 25 | | | ● |
| 850 | 900 | 30 | | | ● |
| 880 | 930 | 25 | | | ● |
| 905 | 955 | 25 | | | ● |
| 940 | 990 | 25 | | | ● |
| 980 | 1 030 | 25 | | | ● |
| 1 030 | 1 090 | 30 | | | ● |
| 1 040 | 1 090 | 25 | | | ● |
| 1 080 | 1 130 | 25 | | ● | |
| 1 090 | 1 150 | 25 | | ● | |
| 1 110 | 1 160 | 25 | | ● | |
| 1 200 | 1 250 | 30 | | | ● |
| 1 460 | 1 510 | 25 | | | ● |

V-rings

d 38~875

MV...A

*d* 38~875

Remark) All seals use nitrile rubber.

| V-ring No. | Shaft diameter | Boundary dimensions, mm | | | | Mounted dimensions, mm | | |
|------------|----------------------------|-------------------------|----------|----------|-----------------------|---------------------------------|---------------------------------|-----------------------|
| | <i>d</i> , mm (from~to) | <i>d</i> ₁ | <i>A</i> | <i>b</i> | <i>b</i> ₁ | <i>d</i> ₂ (max.) | <i>d</i> ₃ (min.) | <i>b</i> ₂ |
| MV 40 A | 38 ~ 43 | 36 | 5 | 9 | 5.5 | <i>d</i> + 3 | <i>d</i> + 15 | 7.0 ± 1.0 |
| MV 60 A | 58 ~ 63 | 54 | | | | | | |
| MV 90 A | 88 ~ 93 | 81 | 6 | 11 | 6.8 | <i>d</i> + 4 | <i>d</i> + 18 | 9.0 ± 1.2 |
| MV 100 A | 98 ~ 105 | 90 | | | | | | |
| MV 120 A | 115 ~ 125 | 108 | 7 | 12.8 | 7.9 | <i>d</i> + 4 | <i>d</i> + 21 | 10.5 ± 1.5 |
| MV 130 A | 125 ~ 135 | 117 | | | | | | |
| MV 140 A | 135 ~ 145 | 126 | | | | | | |
| MV 150 A | 145 ~ 155 | 135 | | | | | | |
| MV 170 A | 165 ~ 175 | 153 | 8 | 14.5 | 9 | <i>d</i> + 5 | <i>d</i> + 24 | 12.0 ± 1.8 |
| MV 199 A | 195 ~ 210 | 180 | | | | | | |
| MV 250 A | 235 ~ 265 | 225 | 15 | 25 | 14.3 | <i>d</i> + 10 | <i>d</i> + 45 | 20.0 ± 4.0 |
| MV 275 A | 265 ~ 290 | 247 | | | | | | |
| MV 325 A | 310 ~ 335 | 292 | | | | | | |
| MV 350 A | 335 ~ 365 | 315 | | | | | | |
| MV 375 A | 365 ~ 390 | 337 | | | | | | |
| MV 400 A | 390 ~ 430 | 360 | | | | | | |
| MV 450 A | 430 ~ 480 | 405 | | | | | | |
| MV 500 A | 480 ~ 530 | 450 | | | | | | |
| MV 550 A | 530 ~ 580 | 495 | | | | | | |
| MV 600 A | 580 ~ 630 | 540 | | | | | | |
| MV 650 A | 630 ~ 665 | 600 | | | | | | |
| MV 750 A | 745 ~ 785 | 705 | | | | | | |
| MV 800 A | 785 ~ 830 | 745 | | | | | | |
| MV 850 A | 830 ~ 875 | 785 | | | | | | |

2

O-Rings

| | |
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2.1 Classification of O-ring and backup ring

2.1 Classification of O-ring and backup ring

(1) O-ring classification and application guide

O-rings are used in a various machines as a compact sealing component. O-rings can generally be classified into dynamic applications ("packing") and static applications ("gaskets").

Other classification is according to their properties, such as oil resistance. O-rings are specified in the industrial standards listed in Table 2.1.1.

Table 2.1.1 O-ring classification and application guide

| Application | General industrial machines | | | | Automobiles | | Aircraft |
|----------------|--|---|-----------------------------|--|------------------------------------|---|---|
| Standard | JIS B 2401 | | | Old ISO 3601 | JASO F 404 | | AS 568 AS 28775A |
| Classification | JIS code | Remarks (hardness measured by type A durometer) | Old JIS identification code | Remarks | Material class | Remarks | Remarks |
| Material | NBR-70-1 | Mineral oil resistance (A70) | Class 1-A | For mineral-based fluids Class: JIS NBR-70-1 | Class 1-A | General mineral oil resistance | For mineral-based fluids Class: JIS NBR-70-1 NBR-90 FKM-70 |
| | NBR-90 | Mineral oil resistance (A90) | Class 1-B | | Class 2 | Gasoline resistance | |
| | NBR-70-2 | Gasoline resistance (A70) | Class 2 | | Class 3 | Animal oil, vegetable oil, and brake fluid resistance | |
| | EPDM-70 | Animal oil, vegetable oil, and brake fluid resistance (A70) | Class 3 | | — | — | |
| | EPDM-90 | Animal oil, vegetable oil, and brake fluid resistance (A90) | — | | — | — | |
| | VMQ-70 | High-temperature application resistance (A70) | Class 4-C | | Class 4-C | High-temperature application resistance | |
| | FKM-70 | High-temperature application resistance (A70) | Class 4-D | | Class 4-D | High-temperature application resistance | |
| | FKM-90 | High-temperature application resistance (A90) | — | | — | — | |
| | HNBR-70 | Mineral oil and high-temperature application resistance (A70) | — | | — | — | |
| | HNBR-90 | Mineral oil and high-temperature application resistance (A90) | — | | — | — | |
| | ACM-70 | High-temperature application and mineral oil resistance (A70) | — | | — | — | |
| | SBR-70* | Animal oil and vegetable oil resistance (A70) | Class 3 | | Class 3 | Coolant resistance | |
| Application | P: For dynamic use and static sealing V: For vacuum flanges G: For static sealing S: For slim static sealing (not standardized in the JIS) | | | For general industrial use | For dynamic use and static sealing | | For static sealing |

*: Not standardized in the JIS

(2) Backup ring types and material

Backup rings are used with O-rings to prevent O-ring protrusion from the groove.

Backup rings are used for dynamic sealing and for static sealing of cylindrical surface.

Table 2.1.2 shows backup ring types and material.

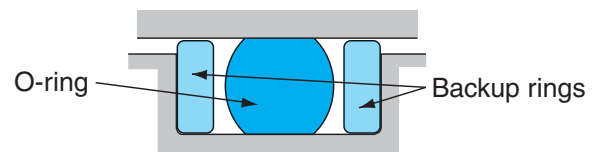


Fig. 2.1.1 O-ring installation with backup rings

Table 2.1.2 Backup ring types and material

| Applicable standard | JIS B 2407 | | |
|---------------------|---|-------------------|------------------|
| Type | T1: Spiral ring | T2: Bias-cut ring | T3: Endless ring |
| Shape | | | |
| Material | Tetrafluoroethylene resin | | |
| Applications | For dynamic sealing / static sealing of cylindrical surface | | |

2.2 Numbering systems of O-ring and backup ring

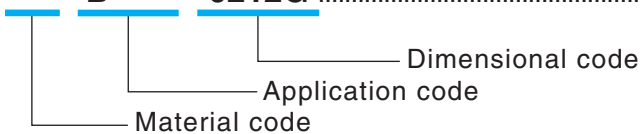
(1) O-ring designation numbers

O-ring designation number consists of material code, application code, and dimensional code.

Table 2.2.1 O-ring numbering system

Example

| | | | | |
|-----------|-------------|--------------|-------|----------------------------|
| | P | 26 | | JIS product ¹⁾ |
| 1B | G | 80 | | JIS product ¹⁾ |
| 2 | JASO | 1013 | | JASO product ²⁾ |
| | AS | 325 | | AS product ³⁾ |
| | B | 0212G | | ISO product ⁴⁾ |



- Notes
- 1) JIS: Japanese Industrial Standards
 - 2) JASO: Japanese Automobile Standard Organization
 - 3) AS: Aeronautical Standard
 - 4) ISO: International Organization for Standardization

1) Material codes

| Code | Standard (JIS B 2401) | Standard (JASO F 404) |
|-------------|-----------------------|-----------------------|
| None | NBR-70-1 | Class1-A |
| 1B | NBR-90 | — |
| 2 | NBR-70-2 | Class2 |
| 3 | SBR-70* | Class3 |
| 4C | VMQ-70 | Class4-C |
| 4D | FKM-70 | Class4-D |
| 4E | ACM-70 | Class4-E |
| 4F | FKM-90 | — |
| 5 | — | Class5 |
| 5A | EPDM-70 | — |
| 5B | EPDM-90 | — |
| 6A | HNBR-70 | — |
| 6B | HNBR-90 | — |

* : Not standardized in the JIS

2) Application codes

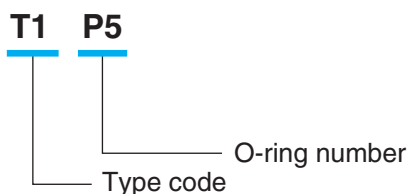
| Code | Standard | Remarks |
|--|--------------|------------------------------------|
| P | JIS B 2401-1 | For dynamic use and static sealing |
| G | | For static sealing |
| V | | For vacuum flanges |
| S | Slim series | For static sealing |
| JASO | JASO F 404 | For dynamic use and static sealing |
| AS | AS 568 | For static sealing |
| | AS 28775A | For dynamic use and static sealing |
| A B C D E | Old ISO 3601 | For general industrial use |

(2) Backup ring designation numbers

Backup ring designation number consists of type code and the O-ring number for which the backup ring is applied.

Table 2.2.2 Backup ring numbering system

Example



■ Type codes

| Code | Backup ring shape |
|-----------|-------------------|
| T1 | Spiral |
| T2 | Bias-cut |
| T3 | Endless |

Remark) Backup ring types and shapes are listed in Table 2.1.2.

2.3 Selection of O-ring

(1) O-ring materials

Materials conforming to JIS B 2401 or JASO F 404 standards are mainly used. Major rubber materials and their physical properties are listed in Table 2.3.1.

Consult JTEKT for special materials to suit a wide variety of applications.

Table 2.3.1 O-ring rubber materials and their physical properties

| Applicable standards | | Class | | | | | | | | | | | | | |
|---------------------------------------|--|--|----------------------|---|---|------------------------------------|---|--|---|-------------------------------------|-------------------------------------|-------------------------------------|---|----------------------------------|---|
| JIS B 2401 | | NBR-70-1 | NBR-90 | NBR-70-2 | HNBR-70 | HNBR-90 | | SBR-70 ³⁾ | VMQ-70 | FKM-70 | FKM-90 | ACM-70 | EPDM-70 | – | EPDM-90 |
| JASO F 404 | | Class 1-A | – | Class 2 | – | – | | Class 3 | Class 4-C | Class 4-D | – | Class 4-E | – | Class 5 | – |
| Rubber materials, Applications | | Nitrile rubber (NBR) | Nitrile rubber (NBR) | Nitrile rubber (NBR) | Hydrogenated nitrile rubber (HNBR) | Hydrogenated nitrile rubber (HNBR) | | Styrene-butadiene rubber (SBR) | Silicone rubber (VMQ) | Fluorocarbon rubber (FKM) | Fluorocarbon rubber (FKM) | Acrylic rubber (ACM) | Ethylene-propylene rubber (EPDM) | Ethylene-propylene rubber (EPDM) | Ethylene-propylene rubber (EPDM) |
| Test items | | Mineral oil resistance | | Gasoline resistance | Mineral oil and high-temperature application resistance | | | Animal oil and vegetable oil resistance | High-temperature application resistance | | | | Animal oil, vegetable oil, and brake fluid resistance | Coolant resistance | Animal oil, vegetable oil, and brake fluid resistance |
| Normal properties | Hardness by durometer type A ¹⁾ | A70 ± 5 | A90 ± 5 | A70 ± 5 | A70 ± 5 | A90 ± 5 | | A70 ± 5 | A70 ± 5 | A70 ± 5 | A90 ± 5 | A70 ± 5 | A70 ± 5 | A70 ± 5 | A90 ± 5 |
| | Tensile strength (MPa), min. | 10.0 | 14.0 | 10.0 | 16.0 | 16.0 | | 9.8 | 3.5 | 10.0 | 10.0 | 6.0 | 10.0 | 9.8 | 10.0 |
| | Elongation (%), min. | 250 | 100 | 200 | 180 | 100 | | 150 | 60 | 170 | 80 | 100 | 150 | 150 | 80 |
| | Tensile stress (MPa), min. (at 100 % elongation) | 2.5 | – | 2.5 | 2.5 | – | | 2.7 | – | 2.0 | – | – | – | 2.7 | – |
| Aging tests | Temperature and duration | 120 °C, 72h | | 100 °C, 72h | 150 °C, 72h | | | 100 °C, 70h | 230 °C, 72h | | 230 °C, 72h | 150 °C, 72h | 100 °C, 72h | 120 °C, 70h | 100 °C, 72h |
| | Change in hardness, max. | + 10 | + 10 | + 10 | + 15 | + 15 | | + 10 | + 10 | + 5 | + 5 | + 10 | + 10 | + 10 | + 10 |
| | Change in tensile strength (%), max. | – 15 | – 25 | – 15 | – 30 | – 30 | | – 15 | – 10 | – 10 | – 10 | – 30 | – 15 | – 20 | – 15 |
| | Change in elongation (%), max. | – 45 | – 55 | – 40 | – 40 | – 40 | | – 45 | – 25 | – 25 | – 25 | – 40 | – 45 | – 40 | – 45 |
| Compression set test | Temperature and duration | 120 °C, 72h | | 100 °C, 72h | 150 °C, 72h | | | 100 °C, 70h | 175 °C, 72h | 200 °C, 72h | 200 °C, 72h | 150 °C, 72h | 100 °C, 72h | 120 °C, 70h | 100 °C, 72h |
| | Compression set (%), max. | 40 | 40 | 25 | 40 | 40 | | 25 | 30 | 40 | 40 | 60 | 25 | 40 | 30 |
| Immersion test | Temperature, duration, and testing oil | 120 °C, 72h IRM901 ²⁾ | | 23 °C, 72h fuel oil No.1 ²⁾ | 150 °C, 72h IRM901 ²⁾ | | | 100 °C, 70h brake fluid ²⁾ | 175 °C, 72h IRM901 ²⁾ | | 175 °C, 72h IRM901 ²⁾ | 150 °C, 72h IRM901 ²⁾ | 100 °C, 72h brake fluid ²⁾ | 100 °C, 70h coolant | 100 °C, 72h brake fluid ²⁾ |
| | Change in hardness | – 5 ~ + 8 | – 5 ~ + 8 | – 8 ~ 0 | – 5 ~ + 10 | – 5 ~ + 10 | | – 15 ~ 0 | – 10 ~ + 5 | – 10 ~ + 5 | – 10 ~ + 5 | – 7 ~ + 10 | – 15 ~ 0 | – 5 ~ + 5 | – 15 ~ 0 |
| | Change in tensile strength (%), max. | – 15 | – 20 | – 15 | – 20 | – 20 | | – 40 | – 20 | – 20 | – 20 | – 30 | – 40 | – 40 | – 40 |
| | Change in elongation (%), max. | – 40 | – 40 | – 25 | – 40 | – 40 | | – 40 | – 20 | – 20 | – 20 | – 40 | – 40 | – 40 | – 40 |
| | Change in volume (%) | – 8 ~ + 5 | – 8 ~ + 5 | – 3 ~ + 5 | – 10 ~ + 5 | – 10 ~ + 5 | | 0 ~ + 12 | 0 ~ + 10 | – 5 ~ + 5 | – 5 ~ + 5 | – 5 ~ + 5 | 0 ~ + 12 | – 5 ~ + 5 | 0 ~ + 12 |
| | Temperature, duration, and testing oil | 120 °C, 72h IRM903 ²⁾ | | 23 °C, 72h fuel oil No.2 ²⁾ | 150 °C, 72h IRM903 ²⁾ | | | – | – | 175 °C, 72h IRM903 ²⁾ | 175 °C, 72h IRM903 ²⁾ | 150 °C, 72h IRM903 ²⁾ | – | – | – |
| | Change in hardness | – 15 ~ 0 | – 10 ~ + 5 | – 20 ~ 0 | – 15 ~ + 5 | – 15 ~ + 5 | | – | – | – 10 ~ + 5 | – 10 ~ + 5 | – 20 ~ 0 | – | – | – |
| | Change in tensile strength (%), max. | – 25 | – 35 | – 45 | – 30 | – 35 | | – | – | – 20 | – 20 | – 40 | – | – | – |
| Change in elongation (%), max. | – 35 | – 35 | – 45 | – 40 | – 40 | | – | – | – 20 | – 20 | – 40 | – | – | – | |
| Change in volume (%) | 0 ~ + 20 | 0 ~ + 20 | 0 ~ + 30 | 0 ~ + 30 | 0 ~ + 25 | | – | – | – 5 ~ + 5 | – 5 ~ + 5 | 0 ~ + 30 | – | – | – | |
| Low-temperature brittleness test | Brittleness limit temperature (°C), max. | – 13 | – | – 10 | – | – | | – 40 | – 50 | – 15 | – | – 1 | – | – 40 | – |
| Low-temperature elastic recovery test | TR10 value (°C), max. | – 15 | – 15 | – 10 | – 15 | – 15 | | – | – 30 | – 10 | – 10 | – 10 | – 30 | – | – 25 |
| Corrosion test | Temperature and duration | 70 ± 1 °C, 24h | | | | | | | | | | | | | |
| | Appearance | The rubber shall not corrode the metal with which it is in contact nor shall the rubber become sticky. However, changes in metal surface color shall not be judged as corrosion. | | | | | | | | | | | | | |

Notes 1) Instantaneous values have been used.

2) For details, see the appendix of JIS B 2401-1.

3) Not standardized in the JIS.

(2) Selection of O-ring material

O-rings have contact with substances to be sealed. Therefore, material should be chemically stable to such substances.

Table 2.3.2 below lists the substances with which each rubber material can remain stable. Consult JTEKT for further details.

- ◎ : Resistant to the substance
- : Resistant to the substance except under extreme conditions
- △ : Not resistant to the substance except under specific favorable conditions
- × : Not resistant to the substance

Table 2.3.2 O-ring rubber materials and their stability to fluids

| Applicable standard | | Class | | | | | | | | | | | | | |
|---|--|----------------------|----------------------|----------------------|------------------------------------|------------------------------------|--------------------------------|-----------------------|---------------------------|---|---------------------------|----------------------|----------------------------------|---------|----------------------------------|
| JIS B 2401 | | NBR-70-1 | NBR-90 | NBR-70-2 | HNBR-70 | HNBR-90 | SBR-70* | VMQ-70 | FKM-70 | | FKM-90 | ACM-70 | EPDM-70 | — | EPDM-90 |
| JASO F 404 | | Class 1-A | — | Class 2 | — | — | Class 3 | Class 4-C | Class 4-D | | — | Class 4-E | — | Class 5 | — |
| Rubber materials | | Nitrile rubber (NBR) | Nitrile rubber (NBR) | Nitrile rubber (NBR) | Hydrogenated nitrile rubber (HNBR) | Hydrogenated nitrile rubber (HNBR) | Styrene-butadiene rubber (SBR) | Silicone rubber (VMQ) | Fluorocarbon rubber (FKM) | | Fluorocarbon rubber (FKM) | Acrylic rubber (ACM) | Ethylene-propylene rubber (EPDM) | | Ethylene-propylene rubber (EPDM) |
| Operating temperature range (°C) (Guidance) | | − 30 ~ 100 | − 25 ~ 100 | − 25 ~ 80 | − 30 ~ 140 | − 25 ~ 140 | − 50 ~ 80 | − 50 ~ 200 | − 15 ~ 200 | | − 10 ~ 200 | − 15 ~ 130 | − 45 ~ 130 | | − 40 ~ 130 |
| Weatherability | Ozone resistance | △ | | △ | | ○ | △ | ◎ | ◎ | | ◎ | ◎ | | ◎ | |
| | Flame resistance | × | | × | × | × | × | ○ | ◎ | | ◎ | × | | × | |
| Resistance to lubrication oils | Radiation resistance | △ | | △ | △ | △ | ○ | △ | △ | | △ | × | | ○ | |
| | Coal gas | ○ | | ◎ | ○ | ○ | △ | △ | ◎ | | ◎ | ○ | | △ | |
| | Liquefied petroleum gas | ○ | | ◎ | ○ | ○ | × | × | ◎ | | ◎ | △ | | × | |
| | Gear oil | ◎ | | ○ | ◎ | ◎ | × | × | ◎ | | ◎ | ◎ | | × | |
| | Engine oil | ◎ | | ○ | ◎ | ◎ | × | △ | ◎ | | ◎ | ◎ | | × | |
| Resistance to hydraulic fluids | Machine oil | ◎ | | ◎ | ◎ | ◎ | × | ○ | ◎ | | ◎ | ◎ | | × | |
| | Spindle oil | ○ | | ◎ | ◎ | ◎ | × | △ | ◎ | | ◎ | ○ | | × | |
| | Lithium grease | ◎ | | ◎ | ◎ | ◎ | × | ◎ | ◎ | | ◎ | ◎ | | × | |
| | Silicone grease | ◎ | | ◎ | ◎ | ◎ | ○ | × | ◎ | | ◎ | ◎ | | ◎ | |
| | Cup grease | ◎ | | ◎ | ◎ | ◎ | × | △ | ◎ | | ◎ | ○ | | × | |
| Resistance to fuel oils and water | Refrigeration oil (mineral oil) | ○ | | ◎ | ○ | ○ | × | △ | ◎ | | ◎ | ○ | | × | |
| | Turbine oil | ◎ | | ◎ | ◎ | ◎ | × | ○ | ◎ | | ◎ | ◎ | | × | |
| | Torque-converter oil | △ | | ◎ | △ | △ | × | △ | ◎ | | ◎ | ◎ | | × | |
| | Brake fluid | △ | | △ | △ | △ | ◎ | ○ | △ | | △ | × | | ◎ | |
| | Silicone oil | ◎ | | ◎ | ◎ | ◎ | ○ | × | ◎ | | ◎ | ◎ | | ◎ | |
| | Phosphoric ester | × | | × | × | × | × | ○ | △ | | △ | × | | ◎ | |
| | Water + glycol | ○ | | ○ | ○ | ○ | ○ | △ | ○ | | ○ | × | | ◎ | |
| Chemical resistance | Oil + water emulsion | ◎ | | ◎ | ◎ | ◎ | △ | △ | ◎ | | ○ | × | | △ | |
| | Gasoline | △ | | ○ | ○ | ○ | × | × | ◎ | | ◎ | △ | | × | |
| | Light oil and kerosene | ○ | | ◎ | ◎ | ◎ | × | △ | ◎ | | ◎ | △ | | × | |
| | Heavy oil | △ | | ○ | △ | △ | × | × | ◎ | | ◎ | × | | × | |
| | Cold water and warm water | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | × | | ◎ | |
| Features | Steam and hot water | ○ | | ○ | ○ | ○ | ○ | △ | △ | | △ | × | | ◎ | |
| | Water including antifreeze fluid | ○ | | ○ | ○ | ○ | △ | △ | ○ | | ○ | × | | ◎ | |
| | Water-based cutting oil | ○ | | ○ | ○ | ○ | △ | △ | ○ | | ○ | × | | △ | |
| | Trichloroethylene | × | | × | × | × | × | × | △ | | △ | × | | × | |
| | Alcohol | ○ | | ○ | ○ | ○ | ◎ | ○ | ○ | | ○ | × | | ◎ | |
| | Benzene | × | | × | × | × | × | × | △ | | △ | × | | × | |
| | Ethylene glycol | ◎ | | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | | ◎ | △ | | ◎ | |
| | Acetone | × | | × | × | × | △ | △ | × | | × | × | | ○ | |
| | Hydrochloric acid 20 % | △ | | △ | △ | △ | ○ | △ | ◎ | | ◎ | △ | | ◎ | |
| | Sulfuric acid 30 % | ○ | | ○ | ○ | ○ | ○ | ○ | ◎ | | ◎ | △ | | ◎ | |
| Nitric acid 10 % | × | | × | × | × | × | × | ◎ | | ◎ | × | | ○ | | |
| Caustic soda 30 % | ○ | | ○ | ○ | ○ | ◎ | △ | × | | × | × | | ◎ | | |
| Features | <ul style="list-style-type: none"> • The most common material • High resistance to oil, abrasion and heat • Hardness: A70 <ul style="list-style-type: none"> • Harder and higher pressureresistance than NBR-70-1 (Class 1-A rubber) • Same properties as NBR-70-1 (Class 1-A rubber) in other respects • Hardness: A90 <ul style="list-style-type: none"> • High resistance to fuel oils, such as gasoline, light oil and kerosene <ul style="list-style-type: none"> • Superior to the NBR-70-1 in terms of ozone resistance, oil resistance, and heat resistance • Hardness: A70 <ul style="list-style-type: none"> • Superior to the HNBR-70 in terms of hardness and resistance to pressure • Same properties as the HNBR-70 in other respects • Hardness: A90 <ul style="list-style-type: none"> • Highest resistance to animal oil and vegetable oil, such as brake fluid <ul style="list-style-type: none"> • High resistance to high and low temperature • Excellent self-restoration after compression, under a wide temperature range <ul style="list-style-type: none"> • Highest resistance to oils, chemicals, and heat • Useful over a wide temperature range • Hardness: A70 <ul style="list-style-type: none"> • Harder and higher pressureresistance than FKM-70 (Class 4-D rubber) • Same properties as FKM-70 (Class 4-D rubber) in other respects • Hardness: A90 <ul style="list-style-type: none"> • Superior to nitrile rubber in terms of heat resistance and oil resistance • Especially resistant to high-temperature oil <ul style="list-style-type: none"> • Superior in ozone resistance, heat resistance and electrical insulation resistance • Hardness: A70 <ul style="list-style-type: none"> • Harder and higher pressureresistance than EPDM-70 (Class 5 rubber) • Same properties as EPDM-70 (Class 5 rubber) in other respects • Hardness: A90 | | | | | | | | | | | | | | |

* Not standardized in the JIS.

(3) Selection of cross section diameter

When sealing fluid with O-ring, design the O-ring so that the depth of groove for fitting it is smaller than the thickness of the O-ring to compress (squeeze) it (provide compression amount). Determine this compression carefully, because O-rings may become permanently deformed if squeezed excessively, thus deteriorating sealing performance.

Generally, the compression rate of an O-ring should be between 8 % and 30 % in ring cross section diameter (the lower limit of 8 % for sufficient sealing performance and the upper limit of 30 % for limited compression set.).

Fig. 2.3.1 shows the relation between O-ring cross section diameter and compression set.

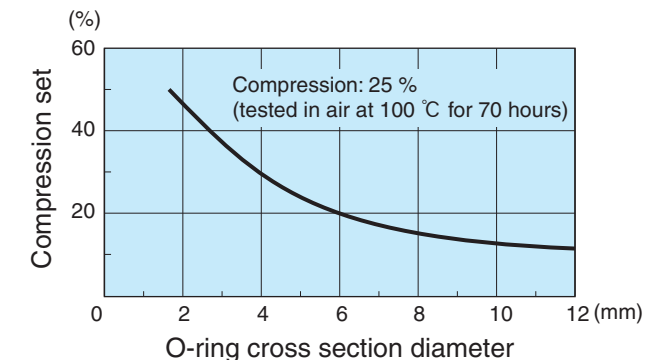


Fig. 2.3.1 Relation between O-ring cross section diameter and compression set

Larger cross section diameter offers more stable sealing performance. As shown in Fig. 2.3.1, when the O-ring compression rate is constant (25 % in the figure), the larger cross section diameter shows the smaller the compression set. Larger cross section diameter is advantageous in that it can accommodate errors in installation dimensions as well.

In dynamic-sealing applications, larger cross section diameter is less likely to twist during service or during installation. The largest cross section diameter possible should be selected providing it can fit in the available space.

2.4 O-ring technical principles

(1) Sealing mechanism

Fig. 2.4.1 shows how O-ring can be deformed under pressure.

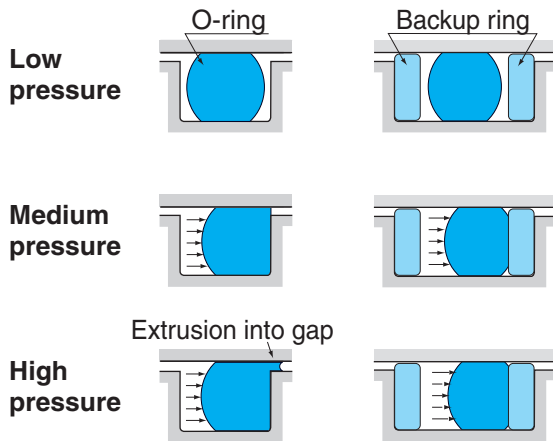


Fig. 2.4.1 O-ring deformation under pressure

O-ring installed in a groove with compression (compression rate) of 8 % to 30 % provides a self-seal by its elasticity when the pressure is low.

When operation pressure is higher, the O-ring is pressed against one side of the groove, providing better sealing. However, under extremely high pressure, the O-ring partially is pressed out from groove into the gap and may be damaged, and deteriorated sealing performance.

For such high-pressure applications, one or two backup rings should be applied to prevent extrusion into gap.

(2) Backup ring

Backup rings are used for dynamic sealing and for static sealing of cylindrical surface.

Two backup rings should be installed on both sides of O-ring when high pressure is put on the O-ring in two directions. One backup ring is installed on low pressure side of O-ring when high pressure is applied in one direction.

Even when extrusion into gap does not occur under low pressure, backup rings are recommended because they can extend O-ring service life by preventing O-ring tearing or damage, which are the most common causes of O-ring failures.

One each backup ring is installed on both sides of O-ring normally (total is two backup rings). However, if space does not allow this, one backup ring should be installed on the lower-pressure side.

The O-ring extrusion varies depending on applied pressure, O-ring hardness and gap amount on the cylindrical surface. Refer to Fig. 2.5.2, "O-ring extrusion limit values," when using backup rings.

Backup rings of endless design (T3) are the most advantageous in the prevention of extrusion into the gap. However, those of spiral design (T1) and bias-cut design (T2) can be more easily installed.

Backup rings of spiral design are most commonly used.

Use backup rings of spiral design with a pressure between 10 MPa and 20 MPa. If the operating temperature exceeds 100°C, use backup rings of spiral design with a pressure of less than 10 MPa.

Backup rings of bias-cut design excel at protecting O-rings at pressures ranging from 15 MPa to 20 MPa and above.

Backup rings of endless design are suited to use with pressures exceeding 25 MPa and temperatures exceeding 135°C.

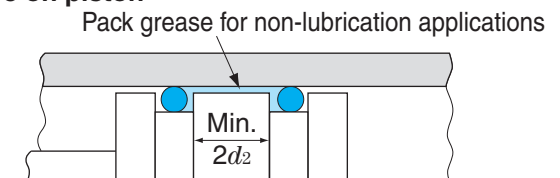
All Koyo backup rings are made from tetrafluoroethylene (PTFE) resin, which is chemically stable to all media under a wide range of temperatures and is resistant to corrosion.

(3) O-rings for dynamic sealing (Reciprocal movement)

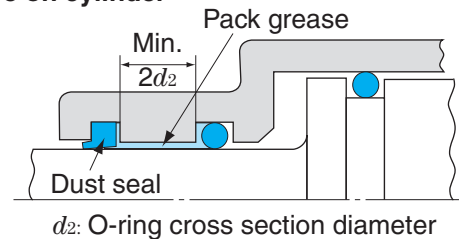
When fitting groove is provided on the piston, use two O-rings to ensure improved service life and sealing performance (Fig. 2.4.2). Pack grease between the two O-rings in a non-lubrication application. Recommended grease is lithium soap base with NLGI No. 2.

When fitting groove is provided on the cylinder, use a dust seal as well and pack grease between the O-ring and dust seal.

Groove on piston



Groove on cylinder



d_2 : O-ring cross section diameter

Fig. 2.4.2 Typical installation of O-ring for dynamic sealing

For the installation of O-rings on cast cylinders or for low-friction dynamic-sealing applications, consult JTEKT.

(4) O-rings for static sealing of cylindrical surface

When O-ring is used under low pressure with the compression rate close to the minimal of 8 %, the fitting groove accuracy affects sealing performance so much, so that the groove accuracy should be controlled at the same level as the fitting groove of dynamic sealing.

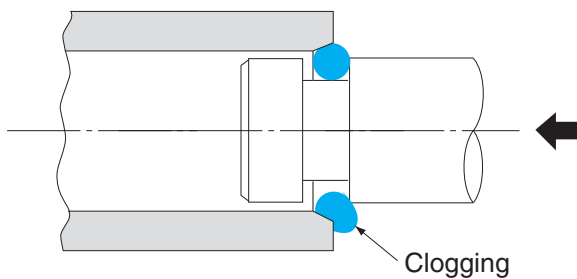


Fig. 2.4.3 O-ring slack and clogging

Even when an O-ring is selected in accordance with the dimensional table values and groove dimensions, the O-ring may become slack due to dimensional deviation and installation method, which may be caused by the reason why the O-ring is unduly caught between the groove and housing (Fig. 2.4.3).

Especially large size O-rings must be installed with care to avoid ring slack.

To prevent ring slack for the ring size of 150 mm or more, a slightly smaller size O-ring may be used rather than one that exactly fits the groove dimensions after determining the O-ring compression amount carefully.

Consult JTEKT for this method.

(5) O-rings for static sealing of flat surface

Determine the O-ring compression amount to be slightly larger than in other applications.

If the O-ring is exposed to internal pressure, the O-ring outside diameter should be determined, according to groove diameter ϕd_7 . When the O-ring is exposed to external pressure, O-ring bore diameter should be determined according to groove diameter ϕd_8 (see Fig. 2.4.4 (a) and (b)).

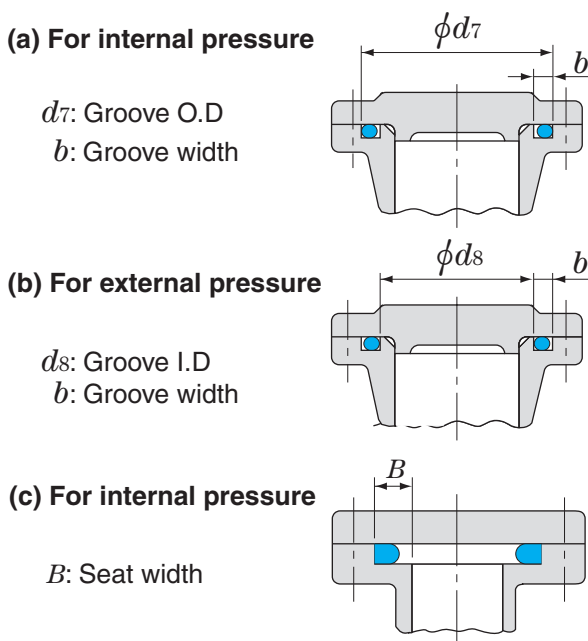


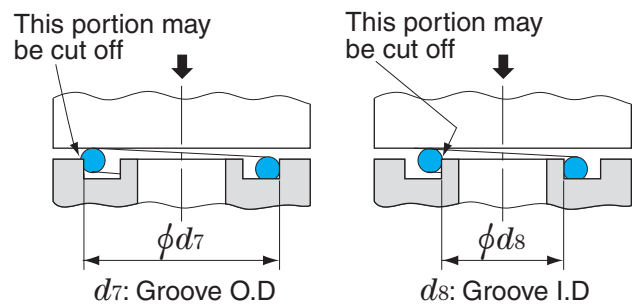
Fig. 2.4.4 Fitting groove for static sealing of flat surface

If the O-ring is exposed to pressure in one direction, the groove side face on the high-pressure side can be eliminated for easy machining (Fig. 2.4.4 (c)).

In this case, dimension B should be greater than the minimum of the groove width b (Fig. 2.4.4(a)) used in flat surface static-sealing application.

In the case of internal-pressure applications and O-ring size is small (30 mm or less), groove outside diameter ϕd_7 should be 0.2 to 0.3 mm larger to ensure correct O-ring installation.

In the case of thin O-ring (cross section diameter 3 mm or less) of large size (150 mm or more), it may be installed on the groove incorrectly and partially protruding from the groove, which results in cutting off of O-ring. Such a situation must be avoided. Use thicker O-ring to prevent such a protrusion (Fig. 2.4.5).



For internal pressure For external pressure

Fig. 2.4.5 O-ring protrusion

(6) O-rings for vacuum flanges

In vacuum applications, O-rings are used to seal in gases. Therefore, fitting groove surfaces should be carefully machined and finished.

To select a suitable rubber material to meet vacuum grade, consult JTEKT.

(7) Installation in triangular groove

When O-ring is installed on the interior angle on a shaft or flange, the A dimension of the triangular groove should be 1.3 to 1.4 times of the O-ring cross section diameter (Fig. 2.4.6).

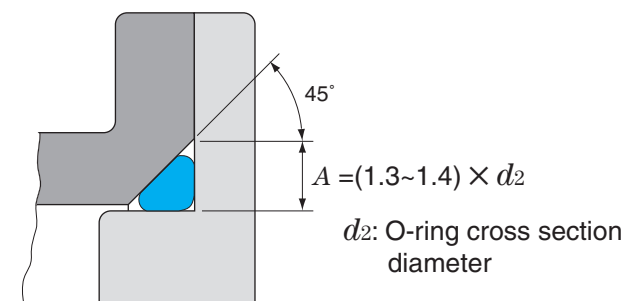


Fig. 2.4.6 Triangular-groove dimensions

2.5 Fitting groove design for O-ring

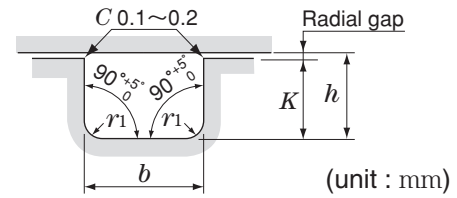
(1) Compression amount and compression rate

Table 2.5.1 lists the JIS-standard of O-ring Compression amount and compression rate.

See dimension table for each groove dimensions corresponding to O-ring number.

Compression amounts of standards other than JIS are shown in respective dimensional tables.

Fig.2.5.1 shows the details of relation between the shape of groove and the compression amount and compression rate.



- 1) Groove depth K
Determine dimension h to obtain O-ring compression rate between 8 % and 30%.
Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

$$\text{Compression amount} = d_2 - h$$

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%)$$

d_2 : O-ring cross section diameter

- 2) Groove width b
Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2 / 2)^2}{b \times h} \times 100 (\%)$$

Fig. 2.5.1 Relation between shape of groove and compression amount (rate)

Table 2.5.1 O-ring compression amount and compression rate

| O-ring number | O-ring dimensions, mm | | Compression amount and compression rate | | | | | | | |
|---------------|------------------------------|---------------------|--|------|-------|------|------------------------------------|------|------|------|
| | | | For dynamic sealing /static sealing of cylindrical surface | | | | For static sealing of flat surface | | | |
| | Cross section diameter d_2 | Bore diameter d_1 | mm | | % | | mm | | % | |
| | | | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| P3 ~ P10 | 1.9 ±0.08 | 2.8 ~ 9.8 | 0.48 | 0.27 | 24.2 | 14.8 | 0.63 | 0.37 | 31.8 | 20.3 |
| P10A ~ P18 | 2.4 ±0.09 | 9.8 ~ 17.8 | 0.49 | 0.25 | 19.7 | 10.8 | 0.74 | 0.46 | 29.7 | 19.9 |
| P20 ~ P22 | | 19.8 ~ 21.8 | | | | | | | | |
| P22A ~ P40 | 3.5 ±0.1 | 21.7 ~ 39.7 | 0.60 | 0.32 | 16.7 | 9.4 | 0.95 | 0.65 | 26.4 | 19.1 |
| P41 ~ P50 | | 40.7 ~ 49.7 | | | | | | | | |
| P48A ~ P70 | 5.7 ±0.13 | 47.6 ~ 69.6 | 0.83 | 0.47 | 14.2 | 8.4 | 1.28 | 0.92 | 22.0 | 16.5 |
| P71 ~ P125 | | 70.6 ~ 124.6 | | | | | | | | |
| P130 ~ P150 | | 129.6 ~ 149.6 | | | | | | | | |
| P150A~ P180 | 8.4 ±0.15 | 149.5 ~ 179.5 | 1.05 | 0.65 | 12.3 | 7.9 | 1.70 | 1.30 | 19.9 | 15.8 |
| P185 ~ P300 | | 184.5 ~ 299.5 | | | | | | | | |
| P315 ~ P400 | | 314.5 ~ 399.5 | | | | | | | | |
| G25 ~ G40 | 3.1 ±0.1 | 24.4 ~ 39.4 | 0.70 | 0.40 | 21.85 | 13.3 | 0.85 | 0.55 | 26.6 | 18.3 |
| G45 ~ G70 | | 44.4 ~ 69.4 | | | | | | | | |
| G75 ~ G125 | | 74.4 ~ 124.4 | | | | | | | | |
| G130 ~ G145 | | 129.4 ~ 144.4 | | | | | | | | |
| G150 ~ G180 | 5.7 ±0.13 | 149.3 ~ 179.3 | 0.83 | 0.47 | 14.2 | 8.4 | 1.28 | 0.92 | 22.0 | 16.5 |
| G185 ~ G300 | | 184.3 ~ 299.3 | | | | | | | | |

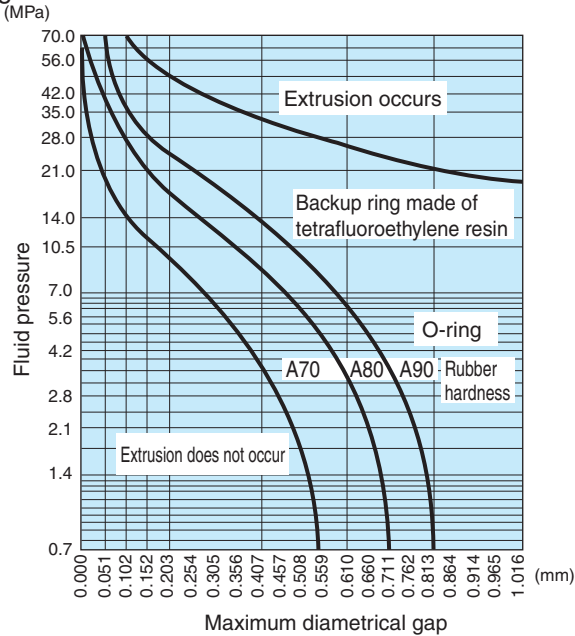
Tolerances of O-ring bore diameter d_1 are given in the dimensional table of the O-rings.

(2) Extrusion into gap from fitting groove

The O-ring and backup ring extrusion into the gap from the fitting groove on cylindrical surfaces is mainly related to the gap amount of the cylindrical surface.

Pressure of fluid to be sealed or O-ring hardness also influence.

Fig. 2.5.2 shows the relation between these factors.



<O-ring test conditions>

1. Without backup ring
2. Expansion of cylinder inner diameter due to internal pressure of cylinder is not included.
3. These results were obtained after 100 thousand cycles at 2.5 Hz between zero pressure to the pressure specified in the diagram.

Fig. 2.5.2 O-ring and backup ring extrusion limit values

Expansion of cylinder inner diameter due to internal pressure of cylinder is not taken into consideration for the gap in the diagram above. If any expansion of the cylinder inner diameter may occur, the gap should be 75% of the values shown in the diagram, taking expansion of the gap into consideration.

Also, if an O-ring exceeds the values of the gaps in the figure above, use a backup ring.

(3) Fitting groove surface roughness

Fitting groove surface should be finished as specified in Table 2.5.2 below for the O-ring to have sufficient sealing performance and long service life, and to minimize frictional resistance.

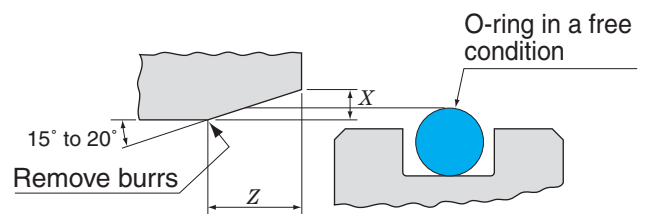
Table 2.5.2 O-ring fitting groove surface roughness

| Location | Purpose | Type of pressure | | Surface roughness | |
|-------------------------------|-------------------|---------------------|-------------------------------------|-------------------|------------------|
| | | Constant | Flat surface Cylindrical surface | $\mu\text{m Ra}$ | $\mu\text{m Rz}$ |
| Groove side and bottom | Static sealing | Constant | Flat surface | 3.2 | 12.5 |
| | | | Cylindrical surface | 3.2 | 12.5 |
| | Pulsating | 1.6 | 6.3 | | |
| Dynamic sealing | With backup rings | Without backup ring | 0.8 | 3.2 | |
| | | Constant | 1.6 | 6.3 | |
| O-ring sealed contact surface | Dynamic sealing | Constant | 0.8 | 3.2 | |
| | | Pulsating | 0.8 | 3.2 | |
| Chamfer area | | | | 0.4 | 1.6 |
| | | | | 3.2 | 12.5 |

(4) Chamfer of installation location

Provide chamfers on all edges of the cylinder and piston rod to prevent O-ring damage during installation, as shown in Table 2.5.3.

Table 2.5.3 Chamfer of O-ring installed area



unit : mm

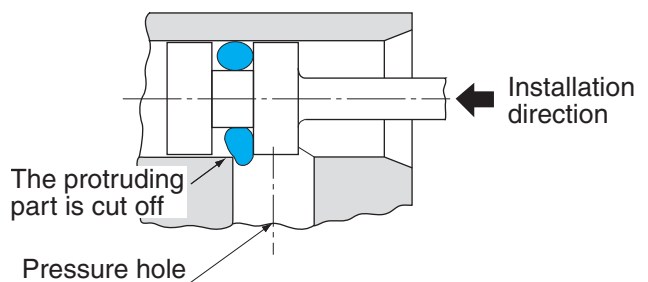
| O-ring cross section diameter | | X (min.) | Z ¹⁾ | |
|-------------------------------|-------|----------|-----------------|--------|
| Over | Up to | | At 15° | At 20° |
| — | 2.4 | 0.9 | 3.4 | 2.5 |
| 2.4 | 3.5 | 1.1 | 4.1 | 3 |
| 3.5 | 5.7 | 1.3 | 4.9 | 3.6 |
| 5.7 | 8.4 | 1.5 | 5.6 | 4.1 |

Note 1) Dimension Z is shown when dimension X is minimum.

When O-ring is used on piston seal, do not provide a pressure hole on the area on which the O-ring slides.

If the pressure hole must be installed in the area the O-ring is slid, chamfer the pressure hole (Fig.2.5.3). For the chamfering amount, see the Table 2.5.3.

When the pressure hole is not chamfered:



When the pressure hole is chamfered:

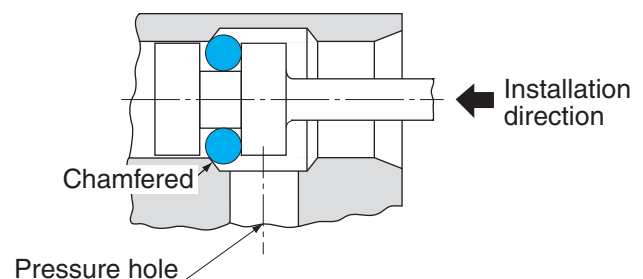


Fig. 2.5.3 Chamfer of pressure-hole edges

(5) Material and surface finishing of fitting groove parts

Cylinder material for dynamic-sealing application should be steel. The most suitable piston rod material is hardened steel.

Soft materials such as aluminum, brass, bronze, Monel metal and soft stainless steel are not suitable as a sliding surface material because of inferior in abrasion resistance.

For static-sealing applications, materials should have sufficient strength to normal operation pressure and should also be resistant to pulsating pressure.

Surface finishing methods to minimize friction are honing, varnishing (roller varnishing), and polishing after hard nickel plating.

Hard-nickel plating is preferable for the application which requires heat resistance, abrasion resistance and low-friction.

Table 2.5.4 shows materials for fitting groove parts and their compatibility

Table 2.5.4 Groove materials and compatibility

| Metal | Corrosion resistance | Abrasion resistance | Contamination resistance | Metal protection | O-ring | |
|---------|--|---------------------|--------------------------|------------------|--------------------------------------|-----------------|
| | | | | | Static sealing | Dynamic sealing |
| Cadmium | × | × | × | ⊙ | ○ | ○ |
| Chrome | ⊙ | ⊙ | ⊙ | × | ○ | ○ |
| Copper | ○ | △ | × | ○ | × | × |
| Gold | ⊙ | △ | ⊙ | △ | ○ | × |
| Iron | × | ○ | × | ○ | ○ | ○ |
| Lead | ○ | × | × | △ | ○ | × |
| Nickel | ○ | ○ | △ | ○ | ○ | ○ |
| Rhodium | ⊙ | ⊙ | ⊙ | △ | ○ | ○ |
| Silver | ○ | △ | △ | △ | ○ | × |
| Tin | ○ | × | ○ | △ | ○ | × |
| Zinc | × | × | × | ⊙ | ○ | × |
| Remarks | ⊙ : Excellent △ : Acceptable ○ : Good × : No good | | | | ○ : Compatible × : Not compatible | |

2.6 Handling of O-ring

(1) Storage

The following practices are advisable to keep O-ring quality for a long time.

- Do not store where exposed to direct sunlight.
- Store enclosed indoors where temperature is less than 30 °C and humidity is less than 65 %.
- Keep O-rings away from heat or ozone sources.
- O-rings should be sealed completely in packages when stored.
- Do not hang or suspend O-rings on hooks, wires, or strings.

(2) Handling

For good performance of O-ring, pay attention to the points shown below.

- Avoid reuse of used O-rings.
- When installing an O-ring, apply sealing medium (lubricant) to the O-ring and contact surface.
- Install an O-ring in the groove without twisting it.
- Do not clean O-ring equipped machine with cleaning oil or gasoline and protect O-ring from cleaning oil. Otherwise, it may be swollen, causing poor sealing performance.
- If an O-ring passes along the threaded surface or sharp edges on it during installation, provide any mechanism to prevent the O-ring from being damaged.

When fitting an O-ring, insert the cap onto the threaded surface as shown in Fig.2.6.1.

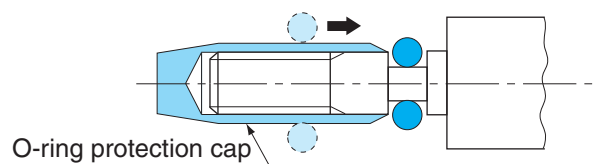


Fig. 2.6.1 O-ring installation jig

2.7 Typical O-ring failures, causes and countermeasures

When leakage is observed, investigate the causes and implement proper countermeasures.

To identify the causes, it is critical to observe the O-ring closely and evaluate the failure in all respects, such as cylinder, piston, and medium to be sealed.

Table 2.7.1 O-ring failures, causes and countermeasures

Ⓓ : Dynamic sealing Ⓔ : Static sealing

| Phenomenon | Appearance | | Major causes | Countermeasures |
|---|---|--|---|---|
| | Condition | | | |
| Ⓓ Twist | Twisted and deformed | | <ol style="list-style-type: none"> Excessive speed Eccentric movements Poor surface finish on sliding face Twisted installation | <ul style="list-style-type: none"> Replace with V-packing Improve accuracy of equipment Improve sliding surface finish Install with care (Coat grease.) |
| Ⓓ Chipping | Partially chipped | | <ul style="list-style-type: none"> Chipped by the bore edge, threads, or sharp corner at installation | <ul style="list-style-type: none"> Round all sharp edges Use an installation jig |
| Ⓓ and Ⓔ Permanent set | Deformed into the groove's shape | | <ol style="list-style-type: none"> Exposure to repeated drastic temperature changes Improper adjustment of temperature, compression, and fluid | <ul style="list-style-type: none"> Study alternative rubber materials Study groove dimensions |
| Ⓓ Abrasion around the circumference | Worn all round the circumference | | <ol style="list-style-type: none"> Poor sliding surface finish Poor lubrication Entry of dust or other foreign materials | <ul style="list-style-type: none"> Improve sliding surface finish Supply sufficient lubrication Clean thoroughly and use filter etc |
| Ⓓ and Ⓔ Partial abrasion | Sliding surface is partially worn | | <ul style="list-style-type: none"> There are damages on sliding surface | <ul style="list-style-type: none"> Remove damages on sliding surface and improve surface finish |
| Ⓔ Hardening | Hardened and cracked when bent | | <ul style="list-style-type: none"> Operating temperature is higher than the rubber's heat resistance limit | <ul style="list-style-type: none"> Study alternative rubber materials |
| Ⓔ Swelling | Softened and swollen | | <ol style="list-style-type: none"> Improper rubber material Cleaned with fuel oil or other incompatible cleanser | <ul style="list-style-type: none"> Study alternative rubber materials Clean with kerosene |
| Ⓔ Scratch | Scratch marks are observed | | <ul style="list-style-type: none"> Scratched by a thread or sharp edge at installation | <ul style="list-style-type: none"> Use an installation jig |
| Ⓔ Protrusion | The outside or inside of the ring is cut off partially or around the entire circumference | | <ol style="list-style-type: none"> Inappropriate determination of pressure, gap and hardness Due to swelling | <ul style="list-style-type: none"> Restudy pressure, gap and hardness Apply backup rings Study alternative rubber materials |
| Ⓔ Tearing | The squeezed portion is cut off or chipped | | <ol style="list-style-type: none"> Poor chamfer Groove depth is not sufficient | <ul style="list-style-type: none"> Improve chamfer Restudy groove depth |
| Ⓔ Crack by ozone | Cracks are observed on all over the ring | | <ul style="list-style-type: none"> Left in the air in a stretched condition | <ul style="list-style-type: none"> Do not stretch the ring Coat grease or oil to the O-ring to avoid contact with air Study alternative rubber materials |

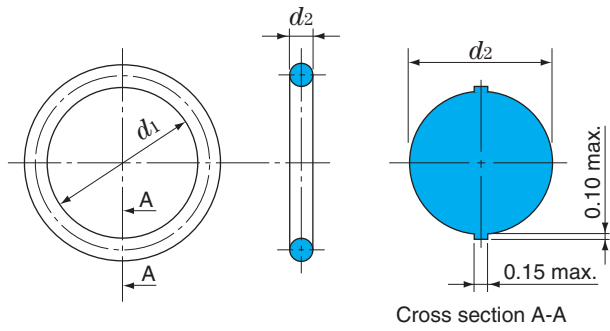
Remark) Dotted line shows original O-ring shape or size.

2.8 O-ring dimensional tables (Contents)

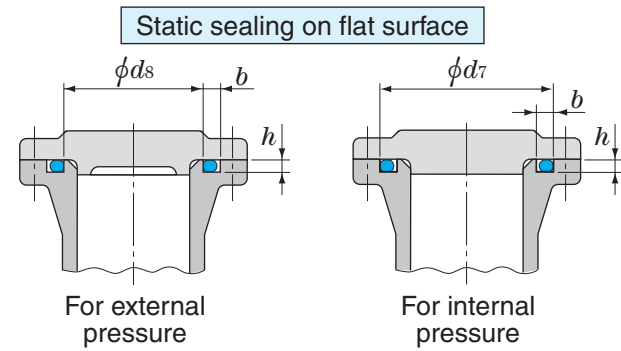
| Code | O-ring dimensions (Unit mm) | Application | Page |
|------------------------------|-----------------------------|---|------|
| JIS P | | General industrial machines Dynamic/static sealing | 108 |
| JIS G | | General industrial machines Static sealing | 116 |
| S | | General industrial machines Static sealing | 118 |
| Old ISO A, B, C, D, E | | General industrial machines | 120 |
| JASO | | Automobiles Dynamic/static sealing | 124 |
| AS | | Aircraft Static sealing and Dynamic/static sealing | 130 |
| BACKUP RING | | For dynamic / static sealing of cylindrical surface | 138 |
| JIS V | | General industrial machines For Vacuum flanges | 142 |

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HNBR-70, HNBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

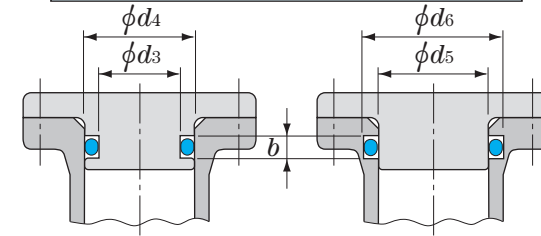
O-ring shape and dimensions (unit : mm)



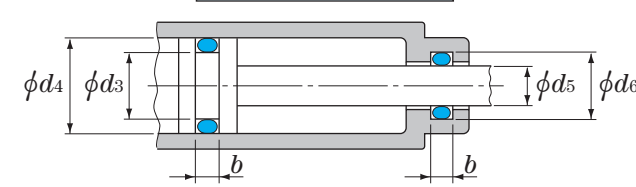
Fitting groove dimensions



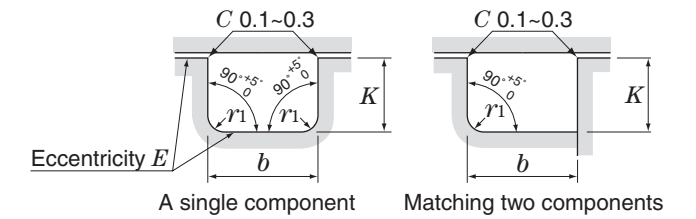
For static sealing on cylindrical surface



For dynamic sealing

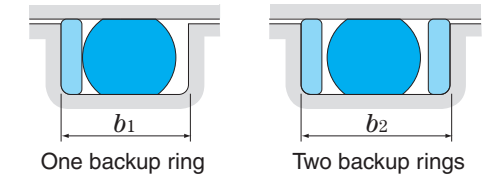


Fitting groove design (unit : mm)



Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



unit : mm

P 3~35

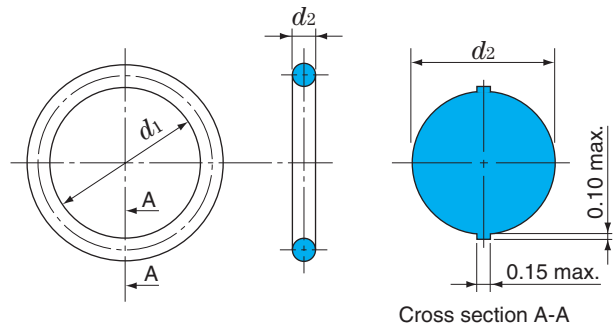
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | | O-ring No. | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-----------------------------|---|---|--|-----------------|--------------|---------------|-------------|---|---|------------|--------------|--|---|--|---------------------------|---------------|-----|-----|-----|------------------|----|------------------|------------|-----|-----|-----|------|-----|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_s ²⁾ (for external pressure) | d_7 ²⁾ (for internal pressure) | $b + 0.25$ 0 | $h \pm 0.05$ | r_1 max. | | d_3, d_5 | Reference fitting codes corresponding to d_3 and d_5 tolerances | d_4, d_6 | Fitting code | $b + 0.25$ 0 Without backup ring | $b_1 + 0.25$ 0 With one backup ring | $b_2 + 0.25$ 0 With two backup rings | E ⁴⁾ max. | r_1 max. | | | | | | | | | | | | |
| 2.8 | ± 0.14 | P 3 P 4 P 5 P 6 P 7 P 8 P 9 P 10 | 3 | 6.2 | 2.5 | 1.4 | 0.4 | 3 4 5 | e9 | 6 7 8 | +0.05 0 | 2.5 | 3.9 | 5.4 | 0.05 | 0.4 | | | | | | | | | | | | | |
| 3.8 | ± 0.14 | | 4 | 7.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.8 | ± 0.15 | | 5 | 8.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.8 | ± 0.15 | | 6 | 9.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6.8 | ± 0.16 | | 7 | 10.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.8 | ± 0.16 | | 8 | 11.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.8 | ± 0.17 | | 9 | 12.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.8 | ± 0.17 | | 10 | 13.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.8 | ± 0.17 | | P 10A P 11 P 11.2 P 12 P 12.5 P 14 P 15 P 16 P 18 | 10 | | | | | | | | | | | | | 14 | 3.2 | 1.8 | 0.4 | 10 11 11.2 | e8 | 14 15 15.2 | +0.06 0 | 3.2 | 4.4 | 6.0 | 0.05 | 0.4 |
| 10.8 | ± 0.18 | | | 11 | | | | | | | | | | | | | 15 | | | | | | | | | | | | |
| 11.0 | ± 0.18 | 11.2 | | 15.2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.8 | ± 0.19 | 12 | | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.3 | ± 0.19 | 12.5 | | 16.5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13.8 | ± 0.19 | 14 | | 18 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14.8 | ± 0.20 | 15 | | 19 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15.8 | ± 0.20 | 16 | | 20 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17.8 | ± 0.21 | 18 | | 22 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19.8 | ± 0.22 | P 20 P 21 P 22 P 22A P 22.4 P 24 P 25 P 25.5 P 26 P 28 P 29 P 29.5 P 30 P 31 P 31.5 P 32 P 34 P 35 | | 20 | 24 | 4.7 | 2.7 | 0.8 | 20 21 22 | h9 | f8 | e7 | 24 25 26 | H9 | 4.7 | 6.0 | 7.8 | | | | | | | | | | | | |
| 20.8 | ± 0.23 | | 21 | 25 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21.8 | ± 0.24 | | 22 | 26 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21.7 | ± 0.24 | | 22 | 28 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22.1 | ± 0.24 | | 22.4 | 28.4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23.7 | ± 0.24 | | 24 | 30 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24.7 | ± 0.25 | | 25 | 31 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25.2 | ± 0.25 | | 25.5 | 31.5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25.7 | ± 0.26 | | 26 | 32 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27.7 | ± 0.28 | | 28 | 34 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28.7 | ± 0.29 | 29 | 35 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29.2 | ± 0.29 | 29.5 | 35.5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29.7 | ± 0.29 | 30 | 36 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30.7 | ± 0.30 | 31 | 37 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31.2 | ± 0.31 | 31.5 | 37.5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31.7 | ± 0.31 | 32 | 38 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33.7 | ± 0.33 | 34 | 40 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34.7 | ± 0.34 | 35 | 41 | | | | | | | | | | | | | | | | | | | | | | | | | | |

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products.
For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

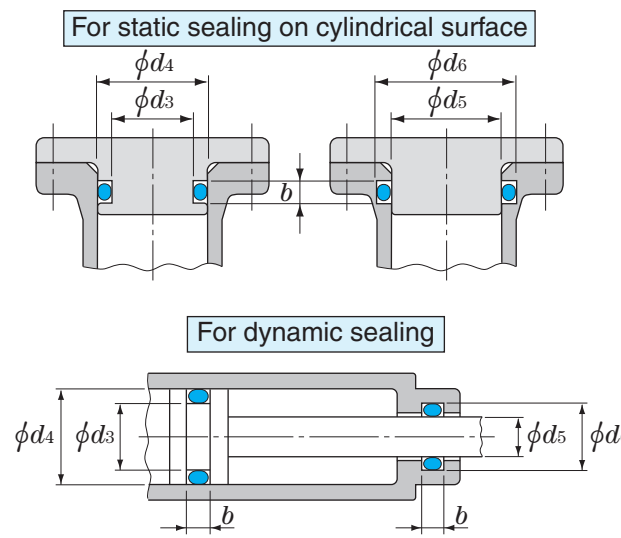
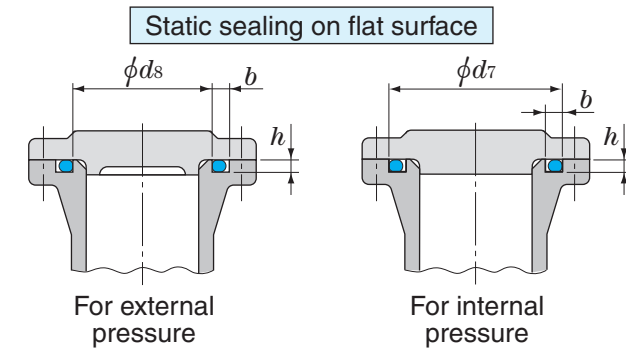
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HNBR-70, HNBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

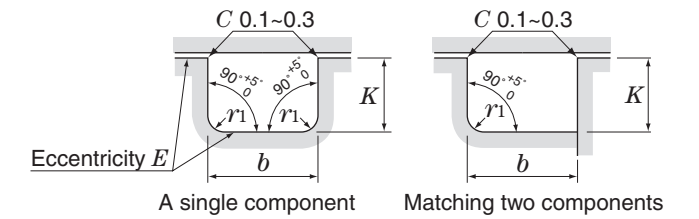
■ O-ring shape and dimensions (unit : mm)



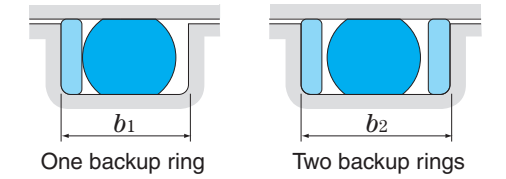
■ Fitting groove dimensions



■ Fitting groove design (unit : mm)



■ Backup rings (For dynamic sealing and static sealing on cylindrical surface)



P 35.5~105

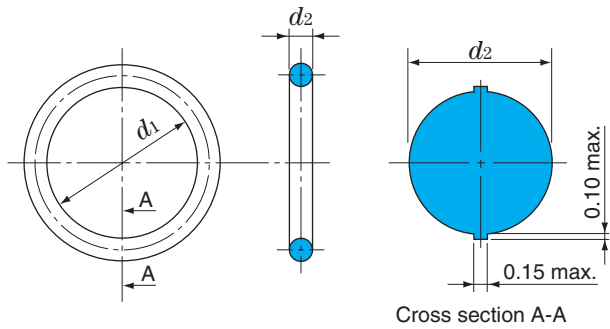
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | | O-ring No. | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | | | | | | | |
|-------------------------------|--------------------------|------------|--|--|-------------------------------------|----------------|------------|------------|---|---|------------|--------------|--|---|--|------------------------|------------|------|------|----|-------|---|------|-----|-------|-----|-----|------|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_s ²⁾ (for external pressure) | d_t ²⁾ (for internal pressure) | b ^{+0.25} / ₀ | h ± 0.05 | r_1 max. | | d_3, d_5 | Reference fitting codes corresponding to d_3 and d_5 tolerances | d_4, d_6 | Fitting code | b ^{+0.25} / ₀ Without backup ring | b_1 ^{+0.25} / ₀ With one backup ring | b_2 ^{+0.25} / ₀ With two backup rings | E ⁴⁾ max. | r_1 max. | | | | | | | | | | | |
| 35.2 ± 0.34 | 3.5 ± 0.1 | P 35.5 | 35.5 | 41.5 | 4.7 | 2.7 | 0.8 | 35.5 | h9 | f8 | H9 | 4.7 | 6.0 | 7.8 | 0.08 | 0.8 | P 35.5 | 35.5 | 41.5 | e7 | +0.08 | 0 | 0.08 | 0.8 | | | | |
| 35.7 ± 0.34 | | P 36 | 36 | 42 | | | | | | | | | | | | | | | | | | | | | P 36 | 36 | 42 | 41.5 |
| 37.7 ± 0.37 | | P 38 | 38 | 44 | | | | | | | | | | | | | | | | | | | | | P 38 | 38 | 44 | 42 |
| 38.7 ± 0.37 | | P 39 | 39 | 45 | | | | | | | | | | | | | | | | | | | | | P 39 | 39 | 45 | 44 |
| 39.7 ± 0.37 | | P 40 | 40 | 46 | | | | | | | | | | | | | | | | | | | | | P 40 | 40 | 46 | 45 |
| 40.7 ± 0.38 | | P 41 | 41 | 47 | | | | | | | | | | | | | | | | | | | | | P 41 | 41 | 47 | 46 |
| 41.7 ± 0.39 | | P 42 | 42 | 48 | | | | | | | | | | | | | | | | | | | | | P 42 | 42 | 48 | 47 |
| 43.7 ± 0.41 | | P 44 | 44 | 50 | | | | | | | | | | | | | | | | | | | | | P 44 | 44 | 50 | 48 |
| 44.7 ± 0.41 | | P 45 | 45 | 51 | | | | | | | | | | | | | | | | | | | | | P 45 | 45 | 51 | 50 |
| 45.7 ± 0.42 | | P 46 | 46 | 52 | | | | | | | | | | | | | | | | | | | | | P 46 | 46 | 52 | 51 |
| 47.7 ± 0.44 | 5.7 ± 0.13 | P 48 | 48 | 54 | 7.5 | 4.6 | 0.8 | 48 | h9 | f8 | H9 | 7.5 | 9.0 | 11.5 | 0.10 | 0.8 | P 48A | 48 | 58 | e7 | +0.10 | 0 | 0.10 | 0.8 | | | | |
| 47.7 ± 0.44 | | P 50A | 50 | 60 | | | | | | | | | | | | | | | | | | | | | P 50A | 50 | 60 | 58 |
| 48.7 ± 0.45 | | P 52 | 52 | 62 | | | | | | | | | | | | | | | | | | | | | P 52 | 52 | 62 | 60 |
| 49.7 ± 0.45 | | P 53 | 53 | 63 | | | | | | | | | | | | | | | | | | | | | P 53 | 53 | 63 | 62 |
| 49.7 ± 0.45 | | P 55 | 55 | 65 | | | | | | | | | | | | | | | | | | | | | P 55 | 55 | 65 | 63 |
| 49.7 ± 0.45 | | P 56 | 56 | 66 | | | | | | | | | | | | | | | | | | | | | P 56 | 56 | 66 | 65 |
| 49.7 ± 0.45 | | P 58 | 58 | 68 | | | | | | | | | | | | | | | | | | | | | P 58 | 58 | 68 | 66 |
| 49.7 ± 0.45 | | P 60 | 60 | 70 | | | | | | | | | | | | | | | | | | | | | P 60 | 60 | 70 | 68 |
| 49.7 ± 0.45 | | P 62 | 62 | 72 | | | | | | | | | | | | | | | | | | | | | P 62 | 62 | 72 | 70 |
| 49.7 ± 0.45 | | P 63 | 63 | 73 | | | | | | | | | | | | | | | | | | | | | P 63 | 63 | 73 | 72 |
| 47.6 ± 0.44 | 5.7 ± 0.13 | P 65 | 65 | 75 | 7.5 | 4.6 | 0.8 | 63 | h9 | f8 | H9 | 7.5 | 9.0 | 11.5 | 0.10 | 0.8 | P 65 | 65 | 75 | e7 | +0.10 | 0 | 0.10 | 0.8 | | | | |
| 49.6 ± 0.45 | | P 67 | 67 | 77 | | | | | | | | | | | | | | | | | | | | | P 67 | 67 | 77 | 73 |
| 51.6 ± 0.47 | | P 70 | 70 | 80 | | | | | | | | | | | | | | | | | | | | | P 70 | 70 | 80 | 75 |
| 52.6 ± 0.48 | | P 71 | 71 | 81 | | | | | | | | | | | | | | | | | | | | | P 71 | 71 | 81 | 77 |
| 54.6 ± 0.49 | | P 75 | 75 | 85 | | | | | | | | | | | | | | | | | | | | | P 75 | 75 | 85 | 80 |
| 55.6 ± 0.50 | | P 80 | 80 | 90 | | | | | | | | | | | | | | | | | | | | | P 80 | 80 | 90 | 81 |
| 57.6 ± 0.52 | | P 85 | 85 | 95 | | | | | | | | | | | | | | | | | | | | | P 85 | 85 | 95 | 85 |
| 59.6 ± 0.53 | | P 90 | 90 | 100 | | | | | | | | | | | | | | | | | | | | | P 90 | 90 | 100 | 90 |
| 61.6 ± 0.55 | | P 95 | 95 | 105 | | | | | | | | | | | | | | | | | | | | | P 95 | 95 | 105 | 95 |
| 62.6 ± 0.56 | | P 100 | 100 | 110 | | | | | | | | | | | | | | | | | | | | | P 100 | 100 | 110 | 100 |
| 64.6 ± 0.57 | 5.7 ± 0.13 | P 102 | 102 | 112 | 7.5 | 4.6 | 0.8 | 105 | h9 | f8 | H9 | 7.5 | 9.0 | 11.5 | 0.10 | 0.8 | P 102 | 102 | 112 | e6 | +0.10 | 0 | 0.10 | 0.8 | | | | |
| 66.6 ± 0.59 | | P 105 | 105 | 115 | | | | | | | | | | | | | | | | | | | | | P 105 | 105 | 115 | 105 |
| 69.6 ± 0.61 | | P 100 | 100 | 110 | | | | | | | | | | | | | | | | | | | | | P 100 | 100 | 110 | 110 |
| 70.6 ± 0.62 | | P 102 | 102 | 112 | | | | | | | | | | | | | | | | | | | | | P 102 | 102 | 112 | 110 |
| 74.6 ± 0.65 | | P 105 | 105 | 115 | | | | | | | | | | | | | | | | | | | | | P 105 | 105 | 115 | 110 |
| 79.6 ± 0.69 | | P 100 | 100 | 110 | | | | | | | | | | | | | | | | | | | | | P 100 | 100 | 110 | 112 |
| 84.6 ± 0.73 | | P 102 | 102 | 112 | | | | | | | | | | | | | | | | | | | | | P 102 | 102 | 112 | 112 |
| 89.6 ± 0.77 | | P 105 | 105 | 115 | | | | | | | | | | | | | | | | | | | | | P 105 | 105 | 115 | 112 |
| 94.6 ± 0.81 | | P 105 | 105 | 115 | | | | | | | | | | | | | | | | | | | | | P 105 | 105 | 115 | 115 |
| 99.6 ± 0.84 | | P 105 | 105 | 115 | | | | | | | | | | | | | | | | | | | | | P 105 | 105 | 115 | 115 |

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products.
For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_t for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

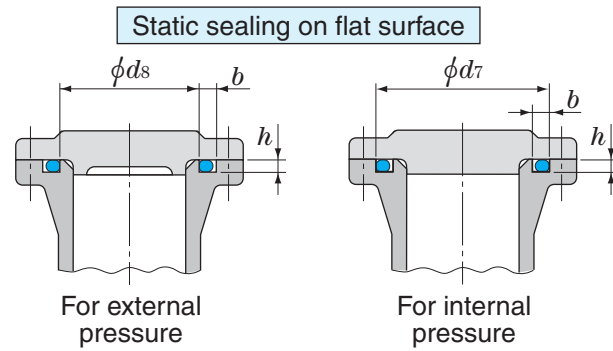
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HNBR-70, HNBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

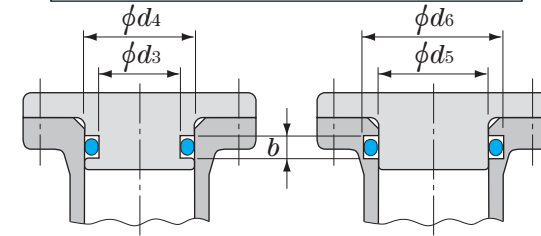
O-ring shape and dimensions (unit : mm)



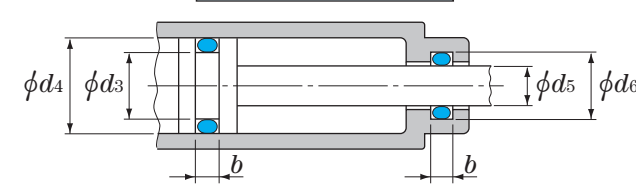
Fitting groove dimensions



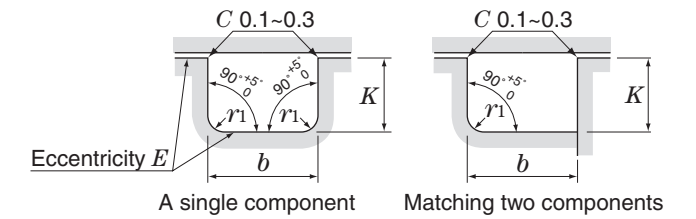
For static sealing on cylindrical surface



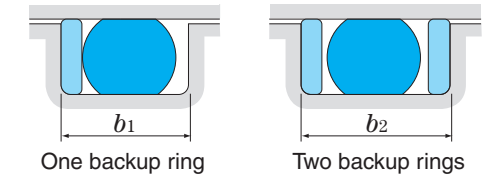
For dynamic sealing



Fitting groove design (unit : mm)



Backup rings (For dynamic sealing and static sealing on cylindrical surface)



P 110~260

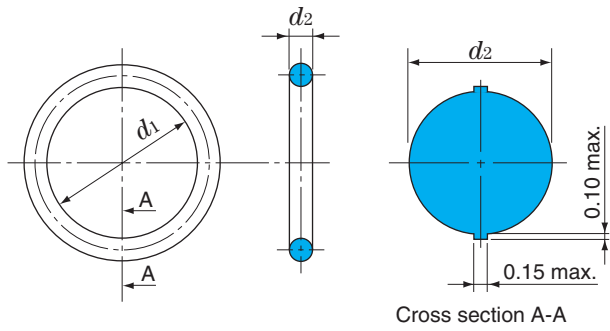
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | | O-ring No. | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | |
|-------------------------------|--------------------------|--------------------------|--|--|-------------------------------------|----------------|------------|-------------------|---|---|------------|----------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------|------------|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_s ²⁾ (for external pressure) | d_7 ²⁾ (for internal pressure) | b ^{+0.25} / ₀ | h ± 0.05 | r_1 max. | | d_3, d_5 | Reference fitting codes corresponding to d_3 and d_5 tolerances | d_4, d_6 | Fitting code ³⁾ | b ^{+0.25} / ₀ | b_1 ^{+0.25} / ₀ | b_2 ^{+0.25} / ₀ | E ⁴⁾ max. | r_1 max. |
| 109.6 | ± 0.91 | P 110 P 112 P 115 | 110 | 120 | 7.5 | 4.6 | 0.8 | 110 112 115 | f8 | e6 | H9 | 7.5 | 9.0 | 11.5 | 0.10 | 0.8 | |
| 111.6 | ± 0.92 | | | | | | | | | | | | | | | | |
| 114.6 | ± 0.94 | | | | | | | | | | | | | | | | |
| 119.6 | ± 0.98 | | P 120 P 125 P 130 | 120 | | | | | | | | | | | | | 130 |
| 124.6 | ± 1.01 | | | | | | | | | | | | | | | | |
| 129.6 | ± 1.05 | | | | | | | | | | | | | | | | |
| 131.6 | ± 1.06 | | | | | | | | | | | | | | | | |
| 134.6 | ± 1.09 | | | | | | | | | | | | | | | | |
| 139.6 | ± 1.12 | | P 132 P 135 P 140 | 132 | | | | | | | | | | | | | 142 |
| 144.6 | ± 1.16 | | | | | | | | | | | | | | | | |
| 149.6 | ± 1.19 | | | | | | | | | | | | | | | | |
| 149.5 | ± 1.19 | P 145 P 150 | | 145 | 155 | | | | | | | | | | | | |
| 154.5 | ± 1.23 | | | | | | | | | | | | | | | | |
| 159.5 | ± 1.26 | | | | | | | | | | | | | | | | |
| 164.5 | ± 1.30 | | | | | | | | | | | | | | | | |
| 169.5 | ± 1.33 | | | | | | | | | | | | | | | | |
| 174.5 | ± 1.37 | P 150A P 155 P 160 | 150 | 165 | | | | | | | | | | | | | |
| 179.5 | ± 1.40 | | | | | | | | | | | | | | | | |
| 184.5 | ± 1.44 | | | | | | | | | | | | | | | | |
| 189.5 | ± 1.48 | | | | | | | | | | | | | | | | |
| 194.5 | ± 1.51 | | P 165 P 170 P 175 | 165 | 180 | | | | | | | | | | | | |
| 199.5 | ± 1.55 | | | | | | | | | | | | | | | | |
| 204.5 | ± 1.58 | | | | | | | | | | | | | | | | |
| 208.5 | ± 1.61 | | | | | | | | | | | | | | | | |
| 209.5 | ± 1.62 | | | | | | | | | | | | | | | | |
| 214.5 | ± 1.65 | P 180 P 185 P 190 | 180 | 195 | | | | | | | | | | | | | |
| 219.5 | ± 1.68 | | | | | | | | | | | | | | | | |
| 224.5 | ± 1.71 | | | | | | | | | | | | | | | | |
| 229.5 | ± 1.75 | | | | | | | | | | | | | | | | |
| 234.5 | ± 1.78 | | P 195 P 200 P 205 | 195 | 210 | | | | | | | | | | | | |
| 239.5 | ± 1.81 | | | | | | | | | | | | | | | | |
| 244.5 | ± 1.84 | | | | | | | | | | | | | | | | |
| 249.5 | ± 1.88 | | | | | | | | | | | | | | | | |
| 254.5 | ± 1.91 | P 209 P 210 P 215 | | 209 | 224 | | | | | | | | | | | | |
| 259.5 | ± 1.94 | | | | | | | | | | | | | | | | |
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| | | P 220 P 225 P 230 | 220 | 235 | | | | | | | | | | | | | |
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| | | P 235 P 240 P 245 | 235 | 250 | | | | | | | | | | | | | |
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| | | P 240 P 245 P 250 | 240 | 255 | | | | | | | | | | | | | |
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| | | P 250 P 255 P 260 | 250 | 265 | | | | | | | | | | | | | |
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Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products.
For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

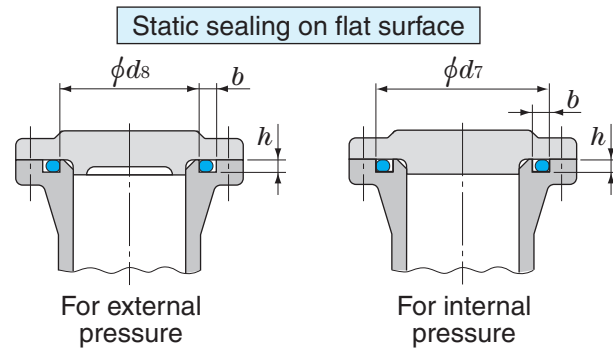
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HNBR-70, HNBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

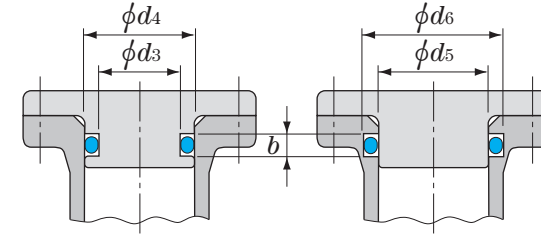
O-ring shape and dimensions (unit : mm)



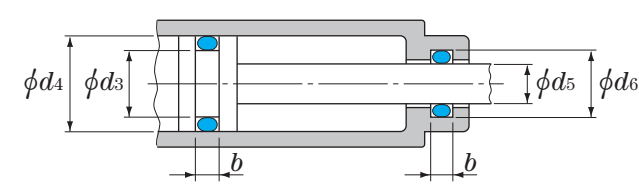
Fitting groove dimensions



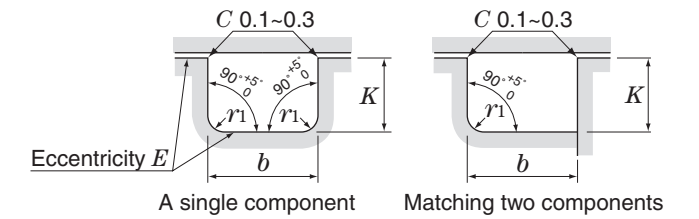
For static sealing on cylindrical surface



For dynamic sealing

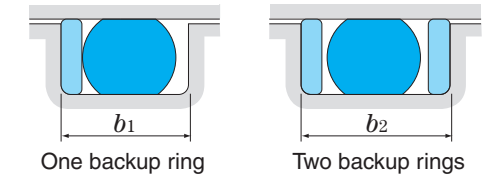


Fitting groove design (unit : mm)



Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



unit : mm

P 265~400

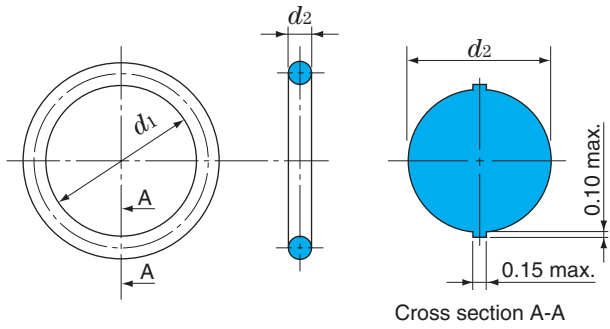
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | | O-ring No. | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | | | | | | | |
|-------------------------------|--------------------------|-------------------------|--|--|--|--------------|------------|-------------------|---|---|------------|----------------------------|---|--|---|------------------------|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_s ²⁾ (for external pressure) | d_7 ²⁾ (for internal pressure) | b $\begin{smallmatrix} +0.25 \\ 0 \end{smallmatrix}$ | $h \pm 0.05$ | r_1 max. | | d_3, d_5 | Reference fitting codes corresponding to d_3 and d_5 tolerances | d_4, d_6 | Fitting code ³⁾ | b $\begin{smallmatrix} +0.25 \\ 0 \end{smallmatrix}$ Without backup ring | b_1 $\begin{smallmatrix} +0.25 \\ 0 \end{smallmatrix}$ With one backup ring | b_2 $\begin{smallmatrix} +0.25 \\ 0 \end{smallmatrix}$ With two backup rings | E ⁴⁾ max. | r_1 max. | | | | | | | | | | | |
| 264.5 | ± 1.97 | P 265 P 270 P 275 | 265 | 280 | 11.0 | 6.9 | 1.2 | 265 270 275 | h8 | f6 | +0.10 0 | H8 | 11.0 | 13.0 | 17.0 | 0.12 | 1.2 | | | | | | | | | | | |
| 269.5 | ± 2.01 | | 270 | 285 | | | | | | | | | | | | | | 280 | 295 | 280 | 295 | 280 | 295 | 280 | 295 | 280 | 295 | |
| 274.5 | ± 2.04 | | 275 | 290 | | | | | | | | | | | | | | 285 | 300 | 285 | 300 | 285 | 300 | 285 | 300 | 285 | 300 | |
| 279.5 | ± 2.07 | P 280 P 285 P 290 | 280 | 295 | | | | | | | | | | | | | | 290 | 305 | 290 | 305 | 290 | 305 | 290 | 305 | 290 | 305 | |
| 284.5 | ± 2.10 | | 285 | 300 | | | | | | | | | | | | | | 295 | 310 | 295 | 310 | 295 | 310 | 295 | 310 | 295 | 310 | |
| 289.5 | ± 2.14 | | 290 | 305 | | | | | | | | | | | | | | 300 | 315 | 300 | 315 | 300 | 315 | 300 | 315 | 300 | 315 | |
| 294.5 | ± 2.17 | P 295 P 300 P 315 | 295 | 310 | | | | | | | | | | | | | | 315 | 330 | 295 | 310 | 315 | 315 | 330 | 295 | 310 | 315 | 330 |
| 299.5 | ± 2.20 | | 300 | 315 | | | | | | | | | | | | | | 320 | 335 | 300 | 315 | 320 | 335 | 300 | 315 | 320 | 335 | |
| 314.5 | ± 2.30 | | 315 | 330 | | | | | | | | | | | | | | 335 | 350 | 315 | 330 | 335 | 350 | 315 | 330 | 335 | 350 | |
| 319.5 | ± 2.33 | P 320 P 335 P 340 | 320 | 335 | | | | | | | | | | | | | | 340 | 355 | 320 | 335 | 340 | 355 | 320 | 335 | 340 | 355 | |
| 334.5 | ± 2.42 | | 335 | 350 | | | | | | | | | | | | | | 355 | 370 | 335 | 350 | 355 | 370 | 335 | 350 | 355 | 370 | |
| 339.5 | ± 2.45 | | 340 | 355 | | | | | | | | | | | | | | 370 | 375 | 340 | 355 | 370 | 375 | 340 | 355 | 370 | 375 | |
| 354.5 | ± 2.54 | P 355 P 360 P 375 | 355 | 370 | | | | | | | | | | | | | | 375 | 390 | 355 | 370 | 375 | 390 | 355 | 370 | 375 | 390 | |
| 359.5 | ± 2.57 | | 360 | 375 | | | | | | | | | | | | | | 385 | 400 | 360 | 375 | 385 | 400 | 360 | 375 | 385 | 400 | |
| 374.5 | ± 2.67 | | 375 | 390 | | | | | | | | | | | | | | 400 | 415 | 375 | 390 | 400 | 415 | 375 | 390 | 400 | 415 | |
| 384.5 | ± 2.73 | P 385 P 400 | 385 | 400 | 400 | 415 | 385 | 400 | 400 | 415 | 385 | 400 | 400 | 415 | | | | | | | | | | | | | | |
| 399.5 | ± 2.82 | | 400 | 415 | 415 | 415 | 400 | 415 | 415 | 415 | 400 | 415 | 415 | 415 | | | | | | | | | | | | | | |

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products. For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

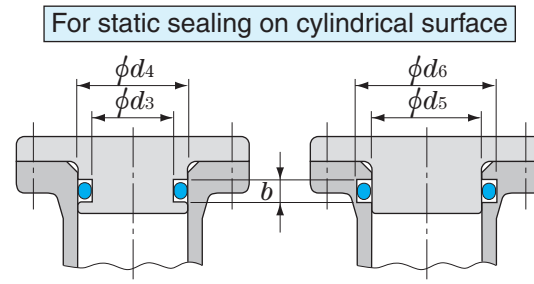
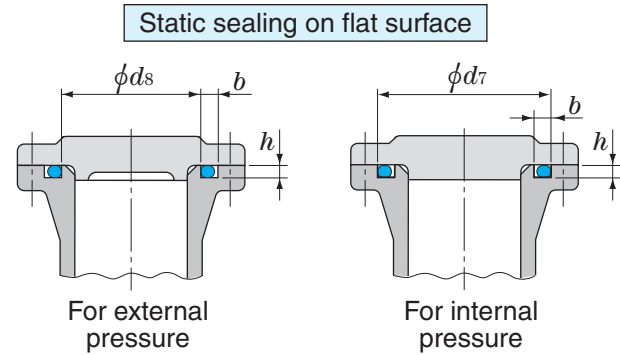
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HMBR-70, HMBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

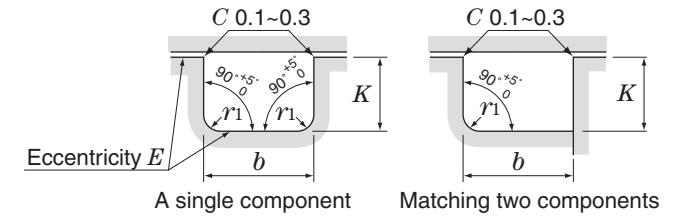
■ O-ring shape and dimensions (unit : mm)



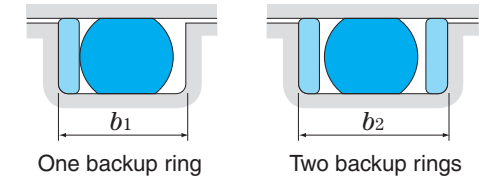
■ Fitting groove dimensions



■ Fitting groove design (unit : mm)



■ Backup rings (For static sealing on cylindrical surface)



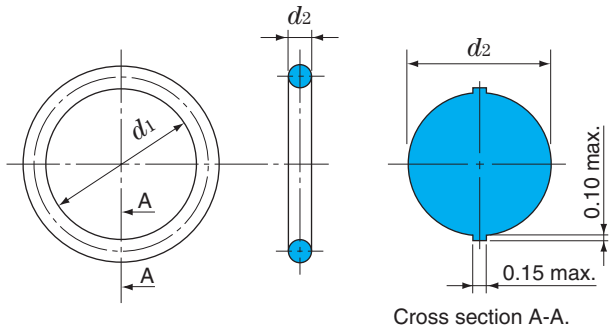
G 25~300

| O-ring dimensions | | | Groove dimensions for static sealing on flat surface | | | | | | Groove dimensions for static sealing on cylindrical surface | | | | | | | | | | | | |
|----------------------------------|-----------------------------|------------|--|--|-----------------|--------------|---------------|------------|---|--------------|---|--------------|--------------|--------------|----|--------------|--|---|--|---------------------------|---------------|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | O-ring No. | d_s ²⁾ (for external pressure) | d_t ²⁾ (for internal pressure) | $b + 0.25$ 0 | $h \pm 0.05$ | r_1 max. | O-ring No. | d_3, d_5 | | Reference fitting codes corresponding to d_3 and d_5 tolerances | | | d_4, d_6 | | Fitting code | $b + 0.25$ 0 Without backup ring | $b_1 + 0.25$ 0 With one backup ring | $b_2 + 0.25$ 0 With two backup rings | E ⁴⁾ max. | r_1 max. |
| | | | | | | | | | Fitting code | Fitting code | Fitting code | Fitting code | Fitting code | Fitting code | | | | | | | |
| 24.4 | ± 0.25 | G 25 | 25 | 30 | 4.1 | 2.4 | 0.7 | G 25 | | | | | | | 25 | h9 | f8 | e9 | 30 | H10 | 4.1 |
| 29.4 | ± 0.29 | G 30 | 30 | 35 | | | | | | | | | | | | | | | | | |
| 34.4 | ± 0.33 | G 35 | 35 | 40 | | | | | | | | | | | | | | | | | |
| 39.4 | ± 0.37 | G 40 | 40 | 45 | | | | | | | | | | | | | | | | | |
| 44.4 | ± 0.41 | G 45 | 45 | 50 | | | | | | | | | | | | | | | | | |
| 49.4 | ± 0.45 | G 50 | 50 | 55 | | | | | | | | | | | | | | | | | |
| 54.4 | ± 0.49 | G 55 | 55 | 60 | | | | | | | | | | | | | | | | | |
| 59.4 | ± 0.53 | G 60 | 60 | 65 | | | | | | | | | | | | | | | | | |
| 64.4 | ± 0.57 | G 65 | 65 | 70 | | | | | | | | | | | | | | | | | |
| 69.4 | ± 0.61 | G 70 | 70 | 75 | | | | | | | | | | | | | | | | | |
| 74.4 | ± 0.65 | G 75 | 75 | 80 | | | | | | | | | | | | | | | | | |
| 79.4 | ± 0.69 | G 80 | 80 | 85 | | | | | | | | | | | | | | | | | |
| 84.4 | ± 0.73 | G 85 | 85 | 90 | | | | | | | | | | | | | | | | | |
| 89.4 | ± 0.77 | G 90 | 90 | 95 | | | | | | | | | | | | | | | | | |
| 94.4 | ± 0.81 | G 95 | 95 | 100 | | | | | | | | | | | | | | | | | |
| 99.4 | ± 0.85 | G 100 | 100 | 105 | | | | | | | | | | | | | | | | | |
| 104.4 | ± 0.87 | G 105 | 105 | 110 | | | | | | | | | | | | | | | | | |
| 109.4 | ± 0.91 | G 110 | 110 | 115 | | | | | | | | | | | | | | | | | |
| 114.4 | ± 0.94 | G 115 | 115 | 120 | | | | | | | | | | | | | | | | | |
| 119.4 | ± 0.98 | G 120 | 120 | 125 | | | | | | | | | | | | | | | | | |
| 124.4 | ± 1.01 | G 125 | 125 | 130 | | | | | | | | | | | | | | | | | |
| 129.4 | ± 1.05 | G 130 | 130 | 135 | | | | | | | | | | | | | | | | | |
| 134.4 | ± 1.08 | G 135 | 135 | 140 | | | | | | | | | | | | | | | | | |
| 139.4 | ± 1.12 | G 140 | 140 | 145 | | | | | | | | | | | | | | | | | |
| 144.4 | ± 1.16 | G 145 | 145 | 150 | | | | | | | | | | | | | | | | | |
| 149.3 | ± 1.19 | G 150 | 150 | 160 | | | | | | | | | | | | | | | | | |
| 154.3 | ± 1.23 | G 155 | 155 | 165 | | | | | | | | | | | | | | | | | |
| 159.3 | ± 1.26 | G 160 | 160 | 170 | | | | | | | | | | | | | | | | | |
| 164.3 | ± 1.30 | G 165 | 165 | 175 | | | | | | | | | | | | | | | | | |
| 169.3 | ± 1.33 | G 170 | 170 | 180 | | | | | | | | | | | | | | | | | |
| 174.3 | ± 1.37 | G 175 | 175 | 185 | | | | | | | | | | | | | | | | | |
| 179.3 | ± 1.40 | G 180 | 180 | 190 | | | | | | | | | | | | | | | | | |
| 184.3 | ± 1.44 | G 185 | 185 | 195 | | | | | | | | | | | | | | | | | |
| 189.3 | ± 1.47 | G 190 | 190 | 200 | | | | | | | | | | | | | | | | | |
| 194.3 | ± 1.51 | G 195 | 195 | 205 | | | | | | | | | | | | | | | | | |
| 199.3 | ± 1.55 | G 200 | 200 | 210 | | | | | | | | | | | | | | | | | |
| 209.3 | ± 1.61 | G 210 | 210 | 220 | | | | | | | | | | | | | | | | | |
| 219.3 | ± 1.68 | G 220 | 220 | 230 | | | | | | | | | | | | | | | | | |
| 229.3 | ± 1.73 | G 230 | 230 | 240 | | | | | | | | | | | | | | | | | |
| 239.3 | ± 1.81 | G 240 | 240 | 250 | | | | | | | | | | | | | | | | | |
| 249.3 | ± 1.88 | G 250 | 250 | 260 | | | | | | | | | | | | | | | | | |
| 259.3 | ± 1.94 | G 260 | 260 | 270 | | | | | | | | | | | | | | | | | |
| 269.3 | ± 2.01 | G 270 | 270 | 280 | | | | | | | | | | | | | | | | | |
| 279.3 | ± 2.07 | G 280 | 280 | 290 | | | | | | | | | | | | | | | | | |
| 289.3 | ± 2.14 | G 290 | 290 | 300 | | | | | | | | | | | | | | | | | |
| 299.3 | ± 2.20 | G 300 | 300 | 310 | | | | | | | | | | | | | | | | | |

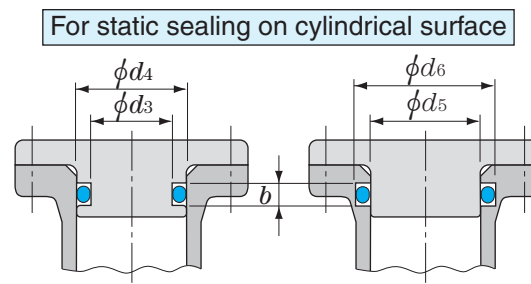
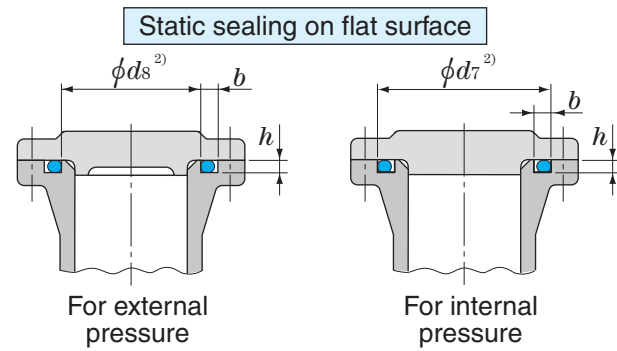
Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products.
For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_t for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

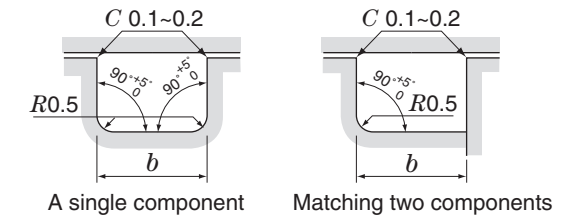
■ O-ring shape and dimensions (unit : mm)



■ Fitting groove dimensions



■ Fitting groove design (unit : mm)



S 3~40

unit : mm

| O-ring dimensions | | O-ring No. | Groove dimensions | | | | |
|----------------------------------|-----------------------------|------------|--|-----------------------|---------------------|----------------|---------------|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_3, d_5, d_8 ²⁾ 0 -0.05 | d_4, d_6 +0.05 0 | d_7 ²⁾ | b +0.25 0 | h 0 -0.1 |
| 2.5 | 1.5 ± 0.1 | S 3 | 3 | 5 | 5.3 | 2.5 | 1.0 |
| 3.5 | | S 4 | 4 | 6 | 6.3 | | |
| 4.5 | | S 5 | 5 | 7 | 7.3 | | |
| 5.5 | | S 6 | 6 | 8 | 8.3 | | |
| 6.5 | | S 7 | 7 | 9 | 9.3 | | |
| 7.5 | | S 8 | 8 | 10 | 10.3 | | |
| 8.5 | | S 9 | 9 | 11 | 11.3 | | |
| 9.5 | | S 10 | 10 | 12 | 12.3 | | |
| 10.7 | | S 11.2 | 11.2 | 13.2 | 13.5 | | |
| 11.5 | | S 12 | 12 | 14 | 14.3 | | |
| 12.0 | | S 12.5 | 12.5 | 14.5 | 14.8 | | |
| 13.5 | | S 14 | 14 | 16 | 16.3 | | |
| 14.5 | | S 15 | 15 | 17 | 17.3 | | |
| 15.5 | | S 16 | 16 | 18 | 18.3 | | |
| 17.5 | S 18 | 18 | 20 | 20.3 | | | |
| 19.5 | ± 0.15 | S 20 | 20 | 22 | 22.3 | 2.7 | 1.5 |
| 21.5 | | S 22 | 22 | 24 | 24.3 | | |
| 21.9 | | S 22.4 | 22.4 | 25.4 | 25.9 | | |
| 23.5 | | S 24 | 24 | 27 | 27.5 | | |
| 24.5 | | S 25 | 25 | 28 | 28.5 | | |
| 25.5 | | S 26 | 26 | 29 | 29.5 | | |
| 27.5 | | S 28 | 28 | 31 | 31.5 | | |
| 28.5 | | S 29 | 29 | 32 | 32.5 | | |
| 29.5 | | S 30 | 30 | 33 | 33.5 | | |
| 31.0 | | S 31.5 | 31.5 | 34.5 | 35 | | |
| 31.5 | | S 32 | 32 | 35 | 35.5 | | |
| 33.5 | | S 34 | 34 | 37 | 37.5 | | |
| 34.5 | | S 35 | 35 | 38 | 38.5 | | |
| 35.0 | | S 35.5 | 35.5 | 38.5 | 39 | | |
| 35.5 | | S 36 | 36 | 39 | 39.5 | | |
| 37.5 | | S 38 | 38 | 41 | 41.5 | | |
| 38.5 | S 39 | 39 | 42 | 42.5 | | | |
| 39.5 | S 40 | 40 | 43 | 43.5 | | | |

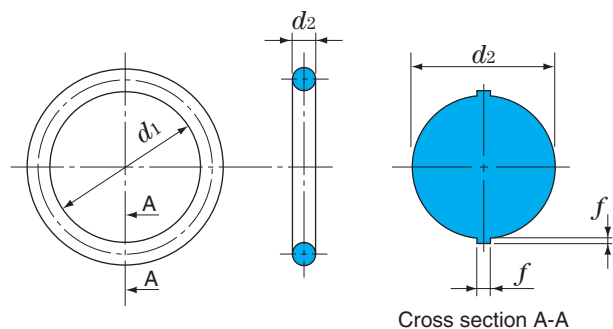
- Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, products. For FKM-70 products, the tolerance is 2 times these values.
2) For a static sealing application on a flat surface, design the groove according to dimension d_8 for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.

S 42~150

unit : mm

| O-ring dimensions | | O-ring No. | Groove dimensions | | | | |
|----------------------------------|-----------------------------|------------|--|-----------------------|---------------------|----------------|---------------|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | d_3, d_5, d_8 ²⁾ 0 -0.05 | d_4, d_6 +0.05 0 | d_7 ²⁾ | b +0.25 0 | h 0 -0.1 |
| 41.5 | ± 0.25 | S 42 | 42 | 45 | 45.5 | 2.7 | 1.5 |
| 43.5 | | S 44 | 44 | 47 | 47.5 | | |
| 44.5 | | S 45 | 45 | 48 | 48.5 | | |
| 45.5 | | S 46 | 46 | 49 | 49.5 | | |
| 47.5 | | S 48 | 48 | 51 | 51 | | |
| 49.5 | | S 50 | 50 | 53 | 53 | | |
| 52.5 | | S 53 | 53 | 56 | 56 | | |
| 54.5 | | S 55 | 55 | 58 | 58 | | |
| 55.5 | | S 56 | 56 | 59 | 59 | | |
| 59.5 | | S 60 | 60 | 63 | 63 | | |
| 62.5 | | S 63 | 63 | 66 | 66 | | |
| 64.5 | | S 65 | 65 | 68 | 68 | | |
| 66.5 | | S 67 | 67 | 70 | 70 | | |
| 69.5 | | S 70 | 70 | 73 | 73 | | |
| 70.5 | | S 71 | 71 | 74 | 74 | | |
| 74.5 | | S 75 | 75 | 78 | 78 | | |
| 79.5 | | S 80 | 80 | 83 | 83 | | |
| 84.5 | | S 85 | 85 | 88 | 88 | | |
| 89.5 | | S 90 | 90 | 93 | 93 | | |
| 94.5 | | S 95 | 95 | 98 | 98 | | |
| 99.5 | S 100 | 100 | 103 | 103 | | | |
| 104.5 | S 105 | 105 | 108 | 108 | | | |
| 109.5 | S 110 | 110 | 113 | 113 | | | |
| 111.5 | S 112 | 112 | 115 | 115 | | | |
| 114.5 | S 115 | 115 | 118 | 118 | | | |
| 119.5 | S 120 | 120 | 123 | 123 | | | |
| 124.5 | S 125 | 125 | 128 | 128 | | | |
| 129.5 | S 130 | 130 | 133 | 133 | | | |
| 131.5 | S 132 | 132 | 135 | 135 | | | |
| 134.5 | S 135 | 135 | 138 | 138 | | | |
| 139.5 | S 140 | 140 | 143 | 143 | | | |
| 144.5 | S 145 | 145 | 148 | 148 | | | |
| 149.5 | S 150 | 150 | 153 | 153 | | | |

■ O-ring shape and dimensions (unit : mm)



Cross section A-A

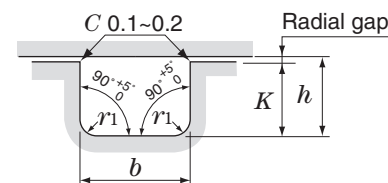
d₁ 1.8~20

unit : mm

| Cross section dia. d ₂ | 1.80 ± 0.08 | 2.65 ± 0.09 | 3.55 ± 0.10 | 5.30 ± 0.13 | 7.00 ± 0.15 |
|-----------------------------------|---|-------------|-------------|-------------|-------------|
| Dike width and height f | Up to 0.1 Up to 0.12 Up to 0.14 Up to 0.16 Up to 0.18 | | | | |
| Bore dia. d ₁ | Tolerance | O-ring No. | | | |
| 1.80 | ± 0.13 | A0018G | | | |
| 2.00 | | A0020G | | | |
| 2.24 | | A0022G | | | |
| 2.50 | | A0025G | | | |
| 2.80 | ± 0.14 | A0028G | | | |
| 3.15 | | A0031G | | | |
| 3.55 | | A0035G | | | |
| 3.75 | | A0037G | | | |
| 4.00 | | A0040G | | | |
| 4.50 | A0045G | | | | |
| 4.87 | ± 0.15 | A0048G | | | |
| 5.00 | | A0050G | | | |
| 5.15 | | A0051G | | | |
| 5.30 | | A0053G | | | |
| 5.60 | A0056G | | | | |
| 6.00 | A0060G | | | | |
| 6.30 | A0063G | | | | |
| 6.70 | ± 0.16 | A0067G | | | |
| 6.90 | | A0069G | | | |
| 7.10 | | A0071G | | | |
| 7.50 | | A0075G | | | |
| 8.00 | | A0080G | | | |
| 8.50 | A0085G | | | | |
| 8.75 | ± 0.17 | A0087G | | | |
| 9.00 | | A0090G | | | |
| 9.50 | | A0095G | | | |
| 10.0 | | A0100G | | | |
| 10.6 | ± 0.18 | A0106G | | | |
| 11.2 | | A0112G | | | |
| 11.8 | ± 0.19 | A0118G | | | |
| 12.5 | | A0125G | | | |
| 13.2 | | A0132G | | | |
| 14.0 | | A0140G | B0140G | | |
| 15.0 | ± 0.20 | A0150G | B0150G | | |
| 16.0 | | A0160G | B0160G | | |
| 17.0 | ± 0.21 | A0170G | B0170G | | |
| 18.0 | | | B0180G | C0180G | |
| 19.0 | ± 0.22 | | B0190G | C0190G | |
| 20.0 | | | B0200G | C0200G | |

* Old ISO: Applies to the ISO series of the old JIS standard

■ Fitting groove dimensions (unit : mm)



| Cross section dia. d ₂ | Corner radius r ₁ |
|-----------------------------------|------------------------------|
| 1.80 | 0.3 ± 0.1 |
| 2.65 | |
| 3.55 | 0.6 ± 0.2 |
| 5.30 | |
| 7.00 | 1.0 ± 0.2 |

d₁ 21.2~75

unit : mm

| Cross section dia. d ₂ | 1.80 ± 0.08 | 2.65 ± 0.09 | 3.55 ± 0.10 | 5.30 ± 0.13 | 7.00 ± 0.15 |
|-----------------------------------|---|-------------|-------------|-------------|-------------|
| Dike width and height f | Up to 0.1 Up to 0.12 Up to 0.14 Up to 0.16 Up to 0.18 | | | | |
| Bore dia. d ₁ | Tolerance | O-ring No. | | | |
| 21.2 | ± 0.23 | B0212G | C0212G | | |
| 22.4 | ± 0.24 | B0224G | C0224G | | |
| 23.6 | | B0236G | C0236G | | |
| 25.0 | ± 0.25 | B0250G | C0250G | | |
| 25.8 | ± 0.26 | B0258G | C0258G | | |
| 26.5 | | B0265G | C0265G | | |
| 28.0 | ± 0.28 | B0280G | C0280G | | |
| 30.0 | ± 0.29 | B0300G | C0300G | | |
| 31.5 | ± 0.31 | B0315G | C0315G | | |
| 32.5 | ± 0.32 | B0325G | C0325G | | |
| 33.5 | ± 0.32 | B0335G | C0335G | | |
| 34.5 | ± 0.33 | B0345G | C0345G | | |
| 35.5 | ± 0.34 | B0355G | C0355G | | |
| 36.5 | ± 0.35 | B0365G | C0365G | | |
| 37.5 | ± 0.36 | B0375G | C0375G | | |
| 38.7 | ± 0.37 | B0387G | C0387G | | |
| 40.0 | ± 0.38 | | C0400G | D0400G | |
| 41.2 | ± 0.39 | | C0412G | D0412G | |
| 42.5 | ± 0.40 | | C0425G | D0425G | |
| 43.7 | ± 0.41 | | C0437G | D0437G | |
| 45.0 | ± 0.42 | | C0450G | D0450G | |
| 46.2 | ± 0.43 | | C0462G | D0462G | |
| 47.5 | ± 0.44 | | C0475G | D0475G | |
| 48.7 | ± 0.45 | | C0487G | D0487G | |
| 50.0 | ± 0.46 | | C0500G | D0500G | |
| 51.5 | ± 0.47 | | C0515G | D0515G | |
| 53.0 | ± 0.48 | | C0530G | D0530G | |
| 54.5 | ± 0.50 | | C0545G | D0545G | |
| 56.0 | ± 0.51 | | C0560G | D0560G | |
| 58.0 | ± 0.52 | | C0580G | D0580G | |
| 60.0 | ± 0.54 | | C0600G | D0600G | |
| 61.5 | ± 0.55 | | C0615G | D0615G | |
| 63.0 | ± 0.56 | | C0630G | D0630G | |
| 65.0 | ± 0.58 | | C0650G | D0650G | |
| 67.0 | ± 0.59 | | C0670G | D0670G | |
| 69.0 | ± 0.61 | | C0690G | D0690G | |
| 71.0 | ± 0.63 | | C0710G | D0710G | |
| 73.0 | ± 0.64 | | C0730G | D0730G | |
| 75.0 | ± 0.66 | | C0750G | D0750G | |

1) Groove depth K

Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

Therefore: $K = h - \text{gap in radial}$

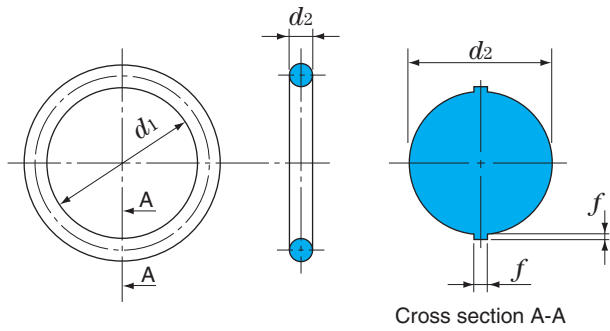
d₂: O-ring cross section diameter

2) Groove width b

Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

■ O-ring shape and dimensions (unit : mm)



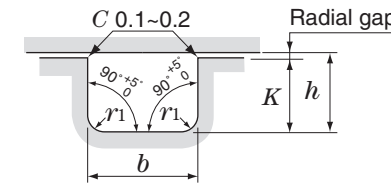
d₁ 77.5~230

unit : mm

| Cross section dia. d ₂ | 1.80 ± 0.08 | 2.65 ± 0.09 | 3.55 ± 0.10 | 5.30 ± 0.13 | 7.00 ± 0.15 |
|-----------------------------------|---|-------------|-------------|-------------|-------------|
| Dike width and height f | Up to 0.1 Up to 0.12 Up to 0.14 Up to 0.16 Up to 0.18 | | | | |
| Bore dia. d ₁ | Tolerance | O-ring No. | | | |
| 77.5 | ± 0.67 | | C0775G | D0775G | |
| 80.0 | ± 0.69 | | C0800G | D0800G | |
| 82.5 | ± 0.71 | | C0825G | D0825G | |
| 85.0 | ± 0.73 | | C0850G | D0850G | |
| 87.5 | ± 0.75 | | C0875G | D0875G | |
| 90.0 | ± 0.77 | | C0900G | D0900G | |
| 92.5 | ± 0.79 | | C0925G | D0925G | |
| 95.0 | ± 0.81 | | C0950G | D0950G | |
| 97.5 | ± 0.83 | | C0975G | D0975G | |
| 100 | ± 0.84 | | C1000G | D1000G | |
| 103 | ± 0.87 | | C1030G | D1030G | |
| 106 | ± 0.89 | | C1060G | D1060G | |
| 109 | ± 0.91 | | C1090G | D1090G | E1090G |
| 112 | ± 0.93 | | C1120G | D1120G | E1120G |
| 115 | ± 0.95 | | C1150G | D1150G | E1150G |
| 118 | ± 0.97 | | C1180G | D1180G | E1180G |
| 122 | ± 1.00 | | C1220G | D1220G | E1220G |
| 125 | ± 1.03 | | C1250G | D1250G | E1250G |
| 128 | ± 1.05 | | C1280G | D1280G | E1280G |
| 132 | ± 1.08 | | C1320G | D1320G | E1320G |
| 136 | ± 1.10 | | C1360G | D1360G | E1360G |
| 140 | ± 1.13 | | C1400G | D1400G | E1400G |
| 145 | ± 1.17 | | C1450G | D1450G | E1450G |
| 150 | ± 1.20 | | C1500G | D1500G | E1500G |
| 155 | ± 1.24 | | C1550G | D1550G | E1550G |
| 160 | ± 1.27 | | C1600G | D1600G | E1600G |
| 165 | ± 1.31 | | C1650G | D1650G | E1650G |
| 170 | ± 1.34 | | C1700G | D1700G | E1700G |
| 175 | ± 1.38 | | C1750G | D1750G | E1750G |
| 180 | ± 1.41 | | C1800G | D1800G | E1800G |
| 185 | ± 1.44 | | C1850G | D1850G | E1850G |
| 190 | ± 1.48 | | C1900G | D1900G | E1900G |
| 195 | ± 1.51 | | C1950G | D1950G | E1950G |
| 200 | ± 1.55 | | C2000G | D2000G | E2000G |
| 206 | ± 1.59 | | | D2060G | E2060G |
| 212 | ± 1.63 | | | D2120G | E2120G |
| 218 | ± 1.67 | | | D2180G | E2180G |
| 224 | ± 1.71 | | | D2240G | E2240G |
| 230 | ± 1.75 | | | D2300G | E2300G |

* Old ISO: Applies to the ISO series of the old JIS standard

■ Fitting groove dimensions (unit : mm)



| Cross section dia. d ₂ | Corner radius r ₁ |
|-----------------------------------|------------------------------|
| 1.80 | 0.3 ± 0.1 |
| 2.65 | |
| 3.55 | 0.6 ± 0.2 |
| 5.30 | |
| 7.00 | 1.0 ± 0.2 |

d₁ 236~670

unit : mm

| Cross section dia. d ₂ | 1.80 ± 0.08 | 2.65 ± 0.09 | 3.55 ± 0.10 | 5.30 ± 0.13 | 7.00 ± 0.15 |
|-----------------------------------|---|-------------|-------------|-------------|-------------|
| Dike width and height f | Up to 0.1 Up to 0.12 Up to 0.14 Up to 0.16 Up to 0.18 | | | | |
| Bore dia. d ₁ | Tolerance | O-ring No. | | | |
| 236 | ± 1.79 | | | D2360G | E2360G |
| 243 | ± 1.83 | | | D2430G | E2430G |
| 250 | ± 1.88 | | | D2500G | E2500G |
| 258 | ± 1.93 | | | D2580G | E2580G |
| 265 | ± 1.98 | | | D2650G | E2650G |
| 272 | ± 2.02 | | | D2720G | E2720G |
| 280 | ± 2.08 | | | D2800G | E2800G |
| 290 | ± 2.14 | | | D2900G | E2900G |
| 300 | ± 2.21 | | | D3000G | E3000G |
| 307 | ± 2.25 | | | D3070G | E3070G |
| 315 | ± 2.30 | | | D3150G | E3150G |
| 325 | ± 2.37 | | | D3250G | E3250G |
| 335 | ± 2.43 | | | D3350G | E3350G |
| 345 | ± 2.49 | | | D3450G | E3450G |
| 355 | ± 2.56 | | | D3550G | E3550G |
| 365 | ± 2.62 | | | D3650G | E3650G |
| 375 | ± 2.68 | | | D3750G | E3750G |
| 387 | ± 2.76 | | | D3870G | E3870G |
| 400 | ± 2.84 | | | D4000G | E4000G |
| 412 | ± 2.91 | | | | E4120G |
| 425 | ± 2.99 | | | | E4250G |
| 437 | ± 3.07 | | | | E4370G |
| 450 | ± 3.15 | | | | E4500G |
| 462 | ± 3.22 | | | | E4620G |
| 475 | ± 3.30 | | | | E4750G |
| 487 | ± 3.37 | | | | E4870G |
| 500 | ± 3.45 | | | | E5000G |
| 515 | ± 3.54 | | | | E5150G |
| 530 | ± 3.63 | | | | E5300G |
| 545 | ± 3.72 | | | | E5450G |
| 560 | ± 3.81 | | | | E5600G |
| 580 | ± 3.93 | | | | E5800G |
| 600 | ± 4.05 | | | | E6000G |
| 615 | ± 4.13 | | | | E6150G |
| 630 | ± 4.22 | | | | E6300G |
| 650 | ± 4.34 | | | | E6500G |
| 670 | ± 4.46 | | | | E6700G |

1) Groove depth K

Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

$$\text{Therefore: } K = h - \text{gap in radial}$$

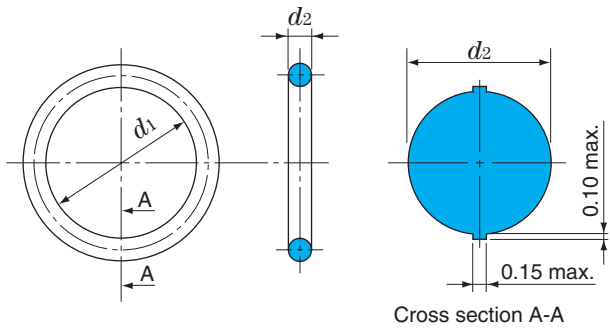
d₂: O-ring cross section diameter

2) Groove width b

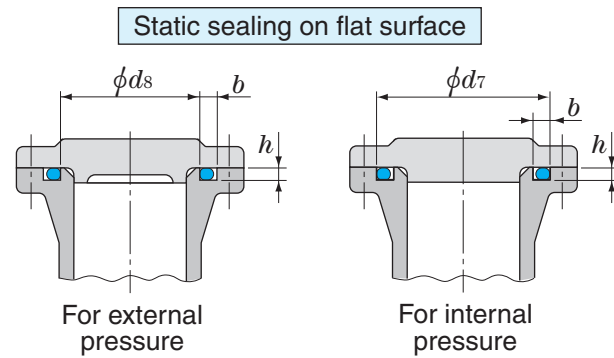
Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

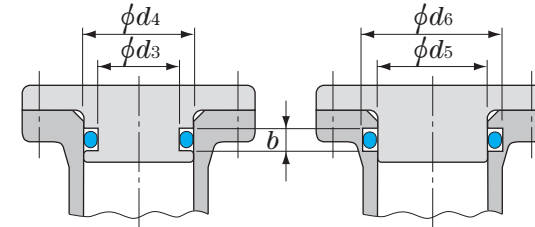
■ O-ring shape and dimensions (unit : mm)



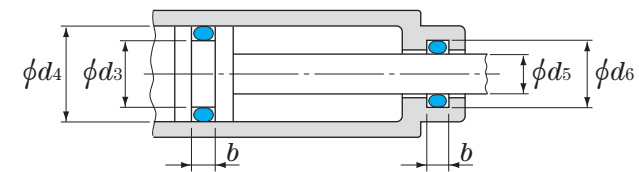
■ Fitting groove dimensions



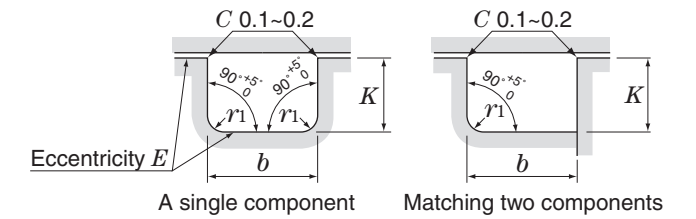
For static sealing on cylindrical surface



For dynamic sealing

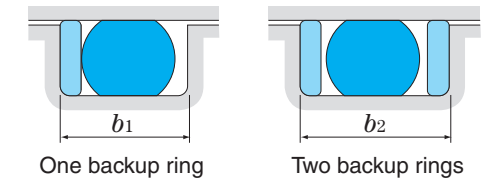


■ Fitting groove design (unit : mm)



■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)

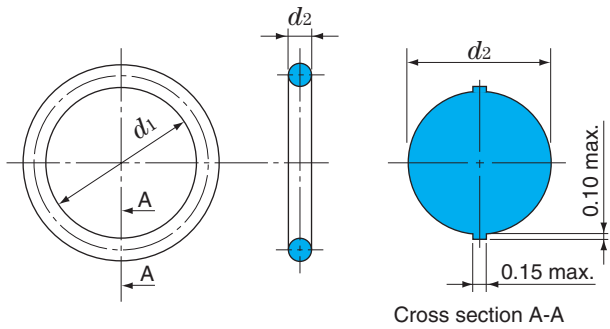


d_2 1.9

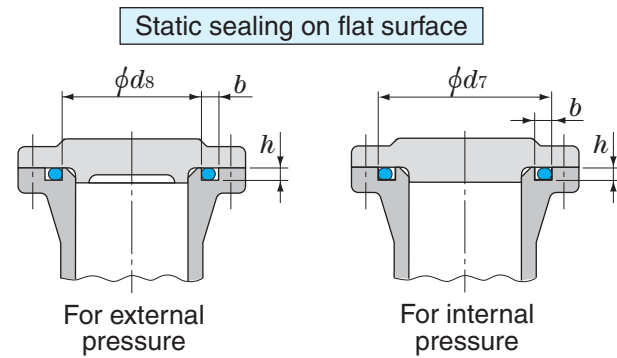
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | |
|--------------------|----------------------------------|----------------------------------|--|--|-----------------|--------------|---|------------|-----------|-------|-------------------------------|-------|-------|-------------------------------|--|---|--|---------------------------|---------------|------|
| Bore dia. d_1 | Cross section dia. d_2 | | d_8 ¹⁾ (for external pressure) | d_7 ¹⁾ (for internal pressure) | $b + 0.25$ 0 | $h \pm 0.05$ | r_1 max. | O-ring No. | d_3 | d_5 | Tolerances of d_3 and d_5 | d_4 | d_6 | Tolerances of d_4 and d_6 | $b + 0.25$ 0 Without backup ring | $b_1 + 0.25$ 0 With one backup ring | $b_2 + 0.25$ 0 With two backup rings | E ²⁾ max. | r_1 max. | |
| 2.8 | 1.9 ± 0.07 | JASO 1003 | 3 | 6.3 | 2.5 | 1.4 | 0.4 | JASO 1003 | 3.1 | 3 | 0 -0.05 | 6 | 5.9 | +0.05 0 | 2.5 | 3.9 | 5.4 | 0.05 | 0.4 | |
| 3.8 | | JASO 1004 | 4 | 7.3 | | | | JASO 1004 | 4.1 | 4 | | 7 | 6.9 | | | | | | | |
| 4.8 | | JASO 1005 | 5 | 8.3 | | | | JASO 1005 | 5.1 | 5 | | 8 | 7.9 | | | | | | | |
| 5.8 | | Classes 1-A and 2 ± 0.12 | JASO 1006 | 6 | | | | 9.3 | JASO 1006 | 6.1 | | 6 | 9 | | | | | | | 8.9 |
| 6.8 | | | JASO 1007 | 7 | | | | 10.3 | JASO 1007 | 7.1 | | 7 | 10 | | | | | | | 9.9 |
| 7.8 | | | JASO 1008 | 8 | | | | 11.3 | JASO 1008 | 8.1 | | 8 | 11 | | | | | | | 10.9 |
| 8.8 | | Classes 3 and 4-D ± 0.24 | JASO 1009 | 9 | | | | 12.3 | JASO 1009 | 9.1 | | 9 | 12 | | | | | | | 11.9 |
| 9.8 | | | JASO 1010 | 10 | | | | 13.3 | JASO 1010 | 10.1 | | 10 | 13 | | | | | | | 12.9 |
| 11.0 | | | JASO 1011 | 11.2 | | | | 14.4 | JASO 1011 | 11.3 | | 11.2 | 14.2 | | | | | | | 14.1 |
| 12.3 | | Classes 4-C, 4-E and 5 ± 0.36 | JASO 1012 | 12.5 | | | | 15.7 | JASO 1012 | 12.6 | | 12.5 | 15.5 | | | | | | | 15.4 |
| 13.0 | | | JASO 1013 | 13.2 | | | | 16.4 | JASO 1013 | 13.3 | | 13.2 | 16.2 | | | | | | | 16.1 |
| 13.8 | | | JASO 1014 | 14 | | | | 17.2 | JASO 1014 | 14.1 | | 14 | 17 | | | | | | | 16.9 |
| 14.8 | | | JASO 1015 | 15 | | | | 18.2 | JASO 1015 | 15.1 | | 15 | 18 | | | | | | | 17.9 |
| 15.8 | | | JASO 1016 | 16 | | | | 19.2 | JASO 1016 | 16.1 | | 16 | 19 | | | | | | | 18.9 |
| 16.8 | JASO 1017 | | 17 | 20.2 | JASO 1017 | 17.1 | 17 | 20 | 19.2 | | | | | | | | | | | |
| 17.8 | Classes 1-A and 2 ± 0.15 | JASO 1018 | 18 | 21.2 | JASO 1018 | 18.1 | 18 | 21 | 20.9 | | | | | | | | | | | |
| 18.8 | | JASO 1019 | 19 | 22.2 | JASO 1019 | 19.1 | 19 | 22 | 21.9 | | | | | | | | | | | |
| 19.8 | | JASO 1020 | 20 | 23.2 | JASO 1020 | 20.1 | 20 | 23 | 22.9 | | | | | | | | | | | |
| 21.0 | | JASO 1021 | 21.2 | 24.4 | JASO 1021 | 21.3 | 21.2 | 24.2 | 24.1 | | | | | | | | | | | |
| 22.1 | | JASO 1022 | 22.4 | 25.5 | JASO 1022 | 22.5 | 22.4 | 25.4 | 25.3 | | | | | | | | | | | |
| 23.3 | | JASO 1023 | 23.6 | 26.7 | JASO 1023 | 23.7 | 23.6 | 26.6 | 26.5 | | | | | | | | | | | |
| 24.7 | Classes 3 and 4-D ± 0.3 | JASO 1025 | 25 | 28.1 | JASO 1025 | 25.1 | 25 | 28 | 27.9 | | | | | | | | | | | |
| 26.2 | | JASO 1026 | 26.5 | 29.6 | JASO 1026 | 26.6 | 26.5 | 29.5 | 29.4 | | | | | | | | | | | |
| 27.7 | | JASO 1028 | 28 | 31.1 | JASO 1028 | 28.1 | 28 | 31 | 30.9 | | | | | | | | | | | |
| 29.7 | Classes 4-C, 4-E and 5 ± 0.45 | JASO 1030 | 30 | 33.1 | JASO 1030 | 30.1 | 30 | 33 | 32.9 | | | | | | | | | | | |
| 31.2 | | JASO 1031 | 31.5 | 34.6 | JASO 1031 | 31.6 | 31.5 | 34.5 | 34.4 | | | | | | | | | | | |
| 33.2 | | JASO 1033 | 33.5 | 36.6 | JASO 1033 | 33.6 | 33.5 | 36.5 | 36.4 | | | | | | | | | | | |
| 35.2 | | JASO 1035 | 35.5 | 38.6 | JASO 1035 | 35.6 | 35.5 | 38.5 | 38.4 | | | | | | | | | | | |

Notes 1) For a static sealing application on a flat surface, design the groove according to dimension d_8 for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.
2) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

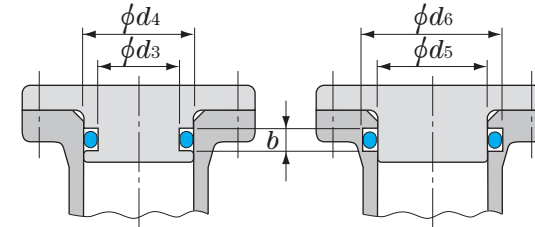
■ O-ring shape and dimensions (unit : mm)



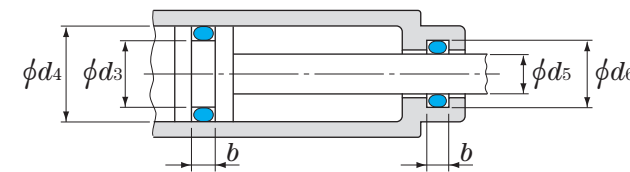
■ Fitting groove dimensions



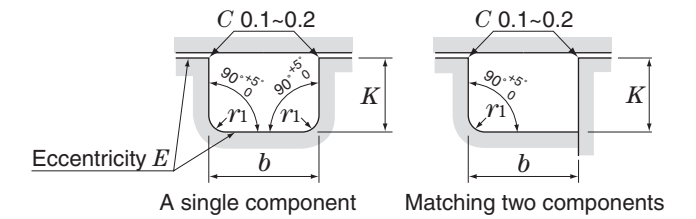
For static sealing on cylindrical surface



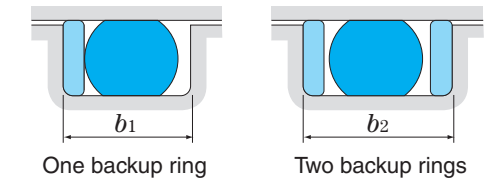
For dynamic sealing



■ Fitting groove design (unit : mm)



■ Backup rings
(For dynamic sealing and static sealing on cylindrical surface)

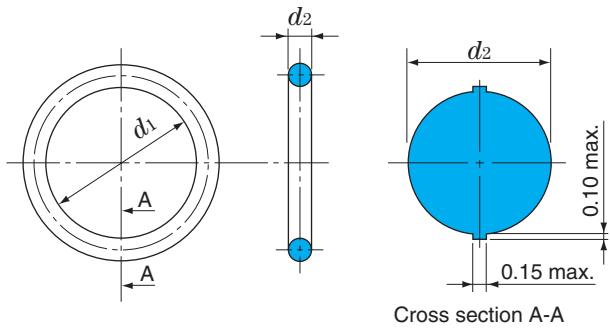


d_2 2.4

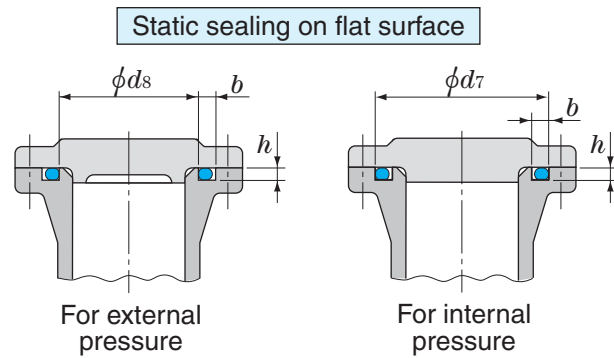
| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | | |
|----------------------|--------------------------|--|--|--|-----------------|--------------|---|------------|-----------|-----------|-------------------------------|------------|-------|-------------------------------|--|---|--|---------------------------|---------------|-----|------|
| Bore dia. d_1 | Cross section dia. d_2 | | d_8 ¹⁾ (for external pressure) | d_7 ¹⁾ (for internal pressure) | $b + 0.25$ 0 | $h \pm 0.05$ | r_1 max. | O-ring No. | d_3 | d_5 | Tolerances of d_3 and d_5 | d_4 | d_6 | Tolerances of d_4 and d_6 | b ^{+0.25} ₀ Without backup ring | b_1 ^{+0.25} ₀ With one backup ring | b_2 ^{+0.25} ₀ With two backup rings | E ²⁾ max. | r_1 max. | | |
| 9.8 11.0 12.3 | 2.4 ± 0.07 | Classes 1-A and 2 ± 0.12 | JASO 2010 | 10 | 14.1 | 3.2 | 1.8 | 0.4 | JASO 2010 | 10.2 | 10 | 0 -0.06 | 14 | 13.8 | + 0.06 0 | 3.2 | 4.4 | 6.0 | 0.05 | 0.4 | |
| 13.0 13.8 14.8 | | | Classes 3 and 4-D ± 0.24 | JASO 2011 | 11.2 | | | | 15.3 | JASO 2011 | 11.4 | | 11.2 | 15.2 | | | | | | | 15 |
| 15.8 16.8 17.8 | | | | Classes 4-C, 4-E and 5 ± 0.36 | JASO 2012 | | | | 12.5 | 16.6 | JASO 2012 | | 12.7 | 12.5 | | | | | | | 16.5 |
| 18.8 19.8 20.8 | | JASO 2013 | | | 13.2 | | | | 17.3 | JASO 2013 | 13.4 | | 13.2 | 17.2 | | | | | | | 17 |
| 22.1 23.3 24.7 | | Classes 1-A and 2 ± 0.15 | JASO 2014 | | 14 | | | | 18.1 | JASO 2014 | 14.2 | | 14 | 18 | | | | | | | 17.8 |
| 26.2 27.7 29.7 | | | Classes 3 and 4-D ± 0.30 | JASO 2015 | 15 | | | | 19.1 | JASO 2015 | 15.2 | | 15 | 19 | | | | | | | 18.8 |
| 31.2 33.2 35.2 | | | | Classes 4-C, 4-E and 5 ± 0.45 | JASO 2016 | | | | 16 | 20.1 | JASO 2016 | | 16.2 | 16 | | | | | | | 20 |
| 37.2 39.7 | | JASO 2017 | | | 17 | | | | 21.1 | JASO 2017 | 17.2 | | 17 | 21 | | | | | | | 20.8 |
| 42.2 44.7 47.2 | | Classes 1-A and 2 ± 0.25 | JASO 2018 | | 18 | | | | 22.1 | JASO 2018 | 18.2 | | 18 | 22 | | | | | | | 21.8 |
| 49.7 52.6 55.6 | | | Classes 3 and 4-D ± 0.50 | JASO 2019 | 19 | | | | 23.1 | JASO 2019 | 19.2 | | 19 | 23 | | | | | | | 22.8 |
| 59.6 62.6 66.6 | | | | Classes 4-C, 4-E and 5 ± 0.75 | JASO 2020 | | | | 20 | 24.1 | JASO 2020 | | 20.2 | 20 | | | | | | | 24 |
| 70.6 | | Classes 1-A and 2 ± 0.40 Classes 3 and 4-D ± 0.80 Classes 4-C, 4-E and 5 ± 1.20 | | | JASO 2021 | | | | 21 | 25.1 | JASO 2021 | | 21.2 | 21 | | | | | | | 25 |
| | JASO 2022 | | 22.4 | | 26.4 | JASO 2022 | 22.6 | 22.4 | 26.4 | 26.2 | + 0.08 0 | | | | | | | | | | |
| | JASO 2023 | | 23.6 | 27.6 | JASO 2023 | 23.8 | 23.6 | 27.6 | 27.4 | | | | | | | | | | | | |
| | JASO 2025 | 25 | 29 | JASO 2025 | 25.2 | 25 | 29 | 28.8 | | | | | | | | | | | | | |
| | JASO 2026 | 26.5 | 30.5 | JASO 2026 | 26.7 | 26.5 | 30.5 | 30.3 | | | | | | | | | | | | | |
| | JASO 2028 | 28 | 32 | JASO 2028 | 28.2 | 28 | 32 | 31.8 | | | | | | | | | | | | | |
| | JASO 2030 | 30 | 34 | JASO 2030 | 30.2 | 30 | 34 | 33.8 | | | | | | | | | | | | | |
| | JASO 2031 | 31.5 | 35.5 | JASO 2031 | 31.7 | 31.5 | 35.5 | 35.3 | | | | | | | | | | | | | |
| | JASO 2033 | 33.5 | 37.5 | JASO 2033 | 33.7 | 33.5 | 37.5 | 37.3 | | | | | | | | | | | | | |
| | JASO 2035 | 35.5 | 39.5 | JASO 2035 | 35.7 | 35.5 | 39.5 | 39.3 | | | | | | | | | | | | | |
| | JASO 2037 | 37.5 | 41.5 | JASO 2037 | 37.7 | 37.5 | 41.5 | 41.3 | | | | | | | | | | | | | |
| | JASO 2040 | 40 | 44 | JASO 2040 | 40.2 | 40 | 44 | 43.8 | | | | | | | | | | | | | |
| | JASO 2042 | 42.5 | 46.5 | JASO 2042 | 42.7 | 42.5 | 46.5 | 46.3 | | | | | | | | | | | | | |
| | JASO 2045 | 45 | 49 | JASO 2045 | 45.2 | 45 | 49 | 48.8 | | | | | | | | | | | | | |
| | JASO 2047 | 47.5 | 51.5 | JASO 2047 | 47.7 | 47.5 | 51.5 | 51.3 | | | | | | | | | | | | | |
| | JASO 2050 | 50 | 54 | JASO 2050 | 50.2 | 50 | 54 | 53.8 | | | | | | | | | | | | | |
| | JASO 2053 | 53 | 57 | JASO 2053 | 53.2 | 53 | 57 | 56.8 | | | | | | | | | | | | | |
| | JASO 2056 | 56 | 60 | JASO 2056 | 56.2 | 56 | 60 | 59.8 | | | | | | | | | | | | | |
| | JASO 2060 | 60 | 64 | JASO 2060 | 60.2 | 60 | 64 | 63.8 | | | | | | | | | | | | | |
| | JASO 2063 | 63 | 67 | JASO 2063 | 63.2 | 63 | 67 | 66.8 | | | | | | | | | | | | | |
| | JASO 2067 | 67 | 71 | JASO 2067 | 67.2 | 67 | 71 | 70.8 | | | | | | | | | | | | | |
| | JASO 2071 | 71 | 75 | JASO 2071 | 71.2 | 71 | 75 | 74.8 | | | | | | | | | | | | | |

Notes 1) For a static sealing application on a flat surface, design the groove according to dimension d_8 for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.
2) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

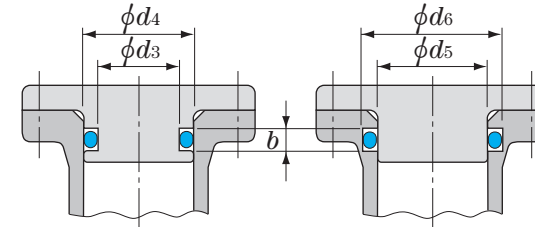
■ O-ring shape and dimensions (unit : mm)



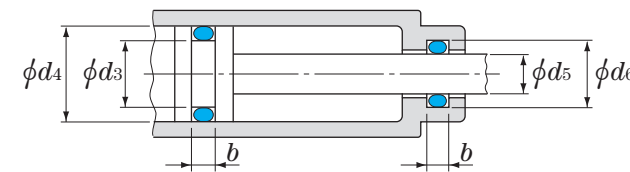
■ Fitting groove dimensions



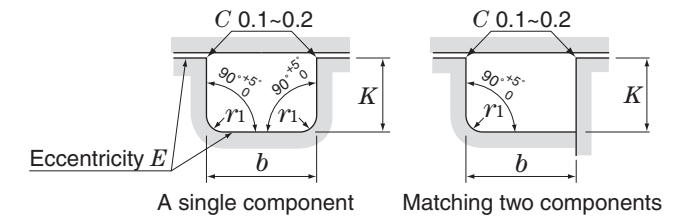
For static sealing on cylindrical surface



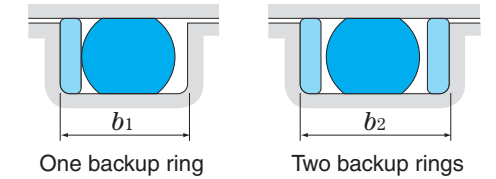
For dynamic sealing



■ Fitting groove design (unit : mm)



■ Backup rings
(For dynamic sealing and static sealing on cylindrical surface)



unit : mm

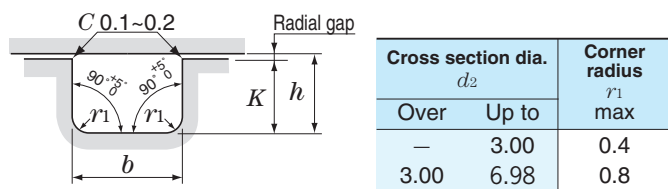
d_2 3.5

| O-ring dimensions | | O-ring No. | Groove dimensions for static sealing on flat surface | | | | Groove dimensions for dynamic sealing and static sealing on cylindrical surface | | | | | | | | | | | | | |
|--------------------|--------------------------------------|--------------------------------------|--|--|-----------------|--------------|---|------------|-----------|-------|-------------------------------|-------|-------|-------------------------------|--|---|--|---------------------------|---------------|------|
| Bore dia. d_1 | Cross section dia. d_2 | | d_s ¹⁾ (for external pressure) | d_7 ¹⁾ (for internal pressure) | $b + 0.25$ 0 | $h \pm 0.05$ | r_1 max. | O-ring No. | d_3 | d_5 | Tolerances of d_3 and d_5 | d_4 | d_6 | Tolerances of d_4 and d_6 | b ^{+0.25} ₀ Without backup ring | b_1 ^{+0.25} ₀ With one backup ring | b_2 ^{+0.25} ₀ With two backup rings | E ²⁾ max. | r_1 max. | |
| 22.1 | Classes 1-A and 2 ± 0.15 | JASO 3022 | 22.4 | 28.4 | 4.7 | 2.7 | 0.7 | JASO 3022 | 22.7 | 22.4 | 0 -0.08 | 28.4 | 28.1 | +0.08 0 | 4.7 | 6.0 | 7.8 | 0.08 | 0.7 | |
| 23.7 | | JASO 3024 | 24 | 30 | | | | JASO 3024 | 24.3 | 24 | | 30 | 29.7 | | | | | | | |
| 24.7 | | JASO 3025 | 25 | 31 | | | | JASO 3025 | 25.3 | 25 | | 31 | 30.7 | | | | | | | |
| 25.7 | | JASO 3026 | 26 | 32 | | | | JASO 3026 | 26.3 | 26 | | 32 | 31.7 | | | | | | | |
| 27.7 | | Classes 3 and 4-D ± 0.30 | JASO 3028 | 28 | | | | 34 | JASO 3028 | 28.3 | | 28 | 34 | | | | | | | 33.7 |
| 29.7 | | | JASO 3030 | 30 | | | | 36 | JASO 3030 | 30.3 | | 30 | 36 | | | | | | | 35.7 |
| 31.2 | | | JASO 3031 | 31.5 | | | | 37.5 | JASO 3031 | 31.8 | | 31.5 | 37.5 | | | | | | | 37.2 |
| 33.7 | | Classes 4-C, 4-E and 5 ± 0.45 | JASO 3034 | 34 | | | | 40 | JASO 3034 | 34.3 | | 34 | 40 | | | | | | | 39.7 |
| 35.2 | | | JASO 3035 | 35.5 | | | | 41.5 | JASO 3035 | 35.8 | | 35.5 | 41.5 | | | | | | | 41.2 |
| 37.7 | | | JASO 3038 | 38 | | | | 44 | JASO 3038 | 38.3 | | 38 | 44 | | | | | | | 43.7 |
| 38.7 | | | JASO 3039 | 39 | | | | 45 | JASO 3039 | 39.3 | | 39 | 45 | | | | | | | 44.7 |
| 39.7 | | | JASO 3040 | 40 | | | | 46 | JASO 3040 | 40.3 | | 40 | 46 | | | | | | | 45.7 |
| 41.7 | | Classes 1-A and 2 ± 0.25 | JASO 3042 | 42 | | | | 48 | JASO 3042 | 42.3 | | 42 | 48 | | | | | | | 47.7 |
| 43.7 | | | JASO 3044 | 44 | | | | 50 | JASO 3044 | 44.3 | | 44 | 50 | | | | | | | 49.7 |
| 44.7 | | | JASO 3045 | 45 | | | | 51 | JASO 3045 | 45.3 | | 45 | 51 | | | | | | | 50.7 |
| 47.7 | | Classes 3 and 4-D ± 0.50 | JASO 3048 | 48 | | | | 54 | JASO 3048 | 48.3 | | 48 | 54 | | | | | | | 53.7 |
| 49.7 | | | JASO 3050 | 50 | | | | 56 | JASO 3050 | 50.3 | | 50 | 56 | | | | | | | 55.7 |
| 52.6 | | | JASO 3053 | 53 | | | | 59 | JASO 3053 | 53.3 | | 53 | 59 | | | | | | | 58.7 |
| 55.6 | Classes 4-C, 4-E and 5 ± 0.75 | JASO 3056 | 56 | 62 | JASO 3056 | 56.3 | 56 | 62 | 61.7 | | | | | | | | | | | |
| 59.6 | | JASO 3060 | 60 | 66 | JASO 3060 | 60.3 | 60 | 66 | 65.7 | | | | | | | | | | | |
| 62.6 | | JASO 3063 | 63 | 69 | JASO 3063 | 63.3 | 63 | 69 | 68.7 | | | | | | | | | | | |
| 66.6 | | JASO 3067 | 67 | 73 | JASO 3067 | 67.3 | 67 | 73 | 72.7 | | | | | | | | | | | |
| 70.6 | | Classes 1-A and 2 ± 0.40 | JASO 3071 | 71 | 77 | JASO 3071 | 71.3 | 71 | 77 | 76.7 | | | | | | | | | | |
| 74.6 | JASO 3075 | | 75 | 81 | JASO 3075 | 75.3 | 75 | 81 | 80.7 | | | | | | | | | | | |
| 79.6 | JASO 3080 | | 80 | 86 | JASO 3080 | 80.3 | 80 | 86 | 85.7 | | | | | | | | | | | |
| 84.6 | JASO 3085 | | 85 | 91 | JASO 3085 | 85.3 | 85 | 91 | 90.7 | | | | | | | | | | | |
| 89.6 | Classes 3 and 4-D ± 0.80 | JASO 3090 | 90 | 96 | JASO 3090 | 90.3 | 90 | 96 | 95.7 | | | | | | | | | | | |
| 94.6 | | JASO 3095 | 95 | 101 | JASO 3095 | 95.3 | 95 | 101 | 100.7 | | | | | | | | | | | |
| 99.6 | | JASO 3100 | 100 | 106 | JASO 3100 | 100.3 | 100 | 106 | 105.7 | | | | | | | | | | | |
| 105.6 | Classes 4-C, 4-E and 5 ± 1.20 | JASO 3106 | 106 | 112 | JASO 3106 | 106.3 | 106 | 112 | 111.7 | | | | | | | | | | | |
| 111.6 | | JASO 3112 | 112 | 118 | JASO 3112 | 112.3 | 112 | 118 | 117.7 | | | | | | | | | | | |
| 117.6 | | JASO 3118 | 118 | 124 | JASO 3118 | 118.3 | 118 | 124 | 123.7 | | | | | | | | | | | |
| 124.6 | | JASO 3125 | 125 | 131 | JASO 3125 | 125.3 | 125 | 131 | 130.7 | | | | | | | | | | | |
| 131.6 | | Classes 1-A and 2 ± 0.60 | JASO 3132 | 132 | 138 | JASO 3132 | 132.3 | 132 | 138 | 137.7 | | | | | | | | | | |
| 139.6 | JASO 3140 | | 140 | 146 | JASO 3140 | 140.3 | 140 | 146 | 145.7 | | | | | | | | | | | |
| 149.6 | JASO 3150 | | 150 | 156 | JASO 3150 | 150.3 | 150 | 156 | 155.7 | | | | | | | | | | | |

Notes 1) For a static sealing application on a flat surface, design the groove according to dimension d_s for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the inner wall of the groove during use. Likewise an O-ring for use under internal pressure can thus have its circumferential surface in close contact with the outer wall of the groove.
2) Eccentricity E means the difference between the maximum value and minimum value of dimension K . The eccentricity can also be defined as double the coaxiality measurement.

Material : JIS NBR-70-1, NBR-90 and FKM-70

Fitting groove dimensions (unit : mm)



1) Groove depth K
Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

Therefore: $K = h - \text{gap in radial}$

d_2 : O-ring cross section diameter

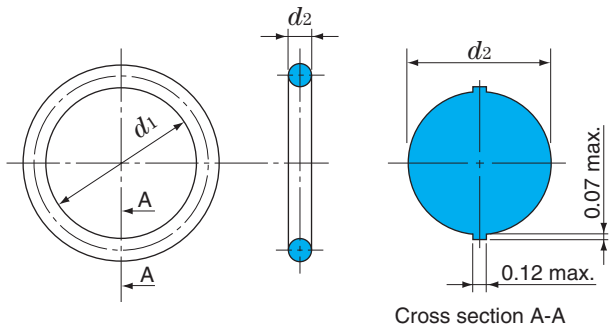
2) Groove width b

Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

unit : mm

O-ring shape and dimensions (unit : mm)



d_2 1.02~(1.78)

| O-ring dimensions | | | O-ring No. | Reference No. AS 28775A |
|--------------------------|-------------------------------|--------|------------|----------------------------|
| Cross section dia. d_2 | Bore dia. d_1 ¹⁾ | | | |
| 1.02 ± 0.07 | 0.74 | ± 0.10 | AS 001 | |
| 1.27 ± 0.07 | 1.07 | | AS 002 | |
| 1.42 ± 0.07 | 4.70 | ± 0.12 | AS 901 | |
| 1.52 ± 0.07 | 1.42 | | AS 003 | |
| 1.63 ± 0.07 | 6.07 | ± 0.12 | AS 902 | |
| | 7.64 | | AS 903 | |
| 1.78 ± 0.07 | 1.78 | ± 0.12 | AS 004 | |
| | 2.57 | | AS 005 | |
| | 2.90 | | AS 006 | |
| | 3.68 | | AS 007 | |
| | 4.47 | | AS 008 | |
| | 5.28 | | AS 009 | |
| | 6.07 | | AS 010 | |
| | 7.65 | | AS 011 | |
| | 9.25 | | AS 012 | |
| | 10.82 | | AS 013 | |
| | 12.42 | | AS 014 | |
| | 14.00 | | AS 015 | |
| | 15.60 | | AS 016 | |
| | 17.17 | | AS 017 | |
| | 18.77 | | AS 018 | |
| 1.78 ± 0.07 | 20.35 | ± 0.15 | AS 019 | |
| | 21.95 | | AS 020 | |
| | 23.52 | | AS 021 | |
| | 25.12 | | AS 022 | |
| | 26.70 | | AS 023 | |
| | 28.30 | | AS 024 | |
| | 29.87 | | AS 025 | |
| | 31.47 | | AS 026 | |
| | 33.05 | | AS 027 | |
| | 34.65 | | AS 028 | |
| 1.78 ± 0.07 | 37.82 | ± 0.25 | AS 029 | |
| | 41.00 | | AS 030 | |
| | 44.17 | | AS 031 | |
| | 47.35 | | AS 032 | |
| | 50.52 | | AS 033 | |
| | 53.70 | | AS 034 | |
| | 56.87 | | AS 035 | |
| | 60.05 | | AS 036 | |
| | 63.22 | | AS 037 | |

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1 and NBR-90 products. For FKM-70 products, consult JTEKT.

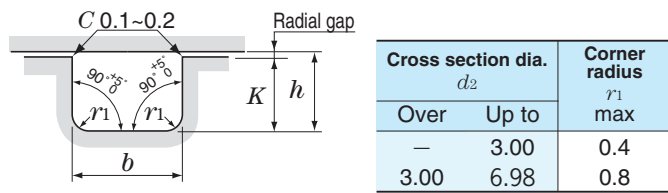
d_2 (1.78)~(2.62)

unit : mm

| O-ring dimensions | | O-ring No. | Reference No. AS 28775A | |
|--------------------------|-------------------------------|------------|----------------------------|--------|
| Cross section dia. d_2 | Bore dia. d_1 ¹⁾ | | | |
| 1.78 ± 0.07 | 66.40 | ± 0.25 | AS 038 | |
| | 69.57 | ± 0.38 | AS 039 | |
| | 72.75 | | AS 040 | |
| | 75.92 | | AS 041 | |
| | 82.27 | | AS 042 | |
| | 88.62 | | AS 043 | |
| | 94.97 | AS 044 | | |
| | 101.32 | ± 0.58 | AS 045 | |
| | 107.67 | | AS 046 | |
| | 114.02 | | AS 047 | |
| | 120.37 | | AS 048 | |
| | 126.72 | | AS 049 | |
| | 133.07 | AS 050 | | |
| | 1.83 ± 0.07 | 8.92 | ± 0.12 | AS 904 |
| | | 10.52 | | AS 905 |
| 1.98 ± 0.07 | 11.89 | AS 906 | | |
| 2.08 ± 0.07 | 13.46 | AS 907 | | |
| 2.21 ± 0.07 | 16.36 | AS 908 | | |
| 2.46 ± 0.07 | 17.93 | AS 909 | | |
| | 19.18 | AS 910 | | |
| 2.62 ± 0.07 | 1.24 | ± 0.12 | AS 102 | |
| | 2.06 | | AS 103 | |
| | 2.84 | | AS 104 | |
| | 3.63 | | AS 105 | |
| | 4.42 | | AS 106 | |
| | 5.23 | | AS 107 | |
| | 6.02 | | AS 108 | |
| | 7.59 | | AS 109 | |
| | 9.19 | | AS 110 | |
| | 10.77 | | AS 111 | |
| | 12.37 | | AS 112 | |
| | 13.94 | | AS 113 | |
| | 15.54 | | AS 114 | |
| | 17.12 | | AS 115 | |
| | 18.72 | | AS 116 | |
| | 20.29 | AS 117 | | |
| | 21.89 | AS 118 | | |
| | 23.47 | AS 119 | | |
| | 25.07 | AS 120 | | |
| | 26.64 | AS 121 | | |
| 28.24 | AS 122 | | | |
| 2.62 ± 0.07 | 29.82 | ± 0.15 | AS 123 | |
| | 31.42 | | AS 124 | |
| | 32.99 | | AS 125 | |
| | 34.59 | | AS 126 | |
| | 36.17 | | AS 127 | |
| | 37.77 | AS 128 | | |
| | 39.34 | ± 0.25 | AS 129 | |
| | 40.94 | | AS 130 | |
| | 42.52 | | AS 131 | |
| | 44.12 | | AS 132 | |
| | 45.69 | | AS 133 | |
| | 47.29 | AS 134 | | |
| | 48.90 | AS 135 | | |
| 50.47 | AS 136 | | | |
| 52.07 | AS 137 | | | |
| 53.64 | AS 138 | | | |

Material : JIS NBR-70-1, NBR-90 and FKM-70

■ Fitting groove dimensions (unit : mm)



1) Groove depth K
Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

Therefore: $K = h - \text{gap in radial}$

d_2 : O-ring cross section diameter

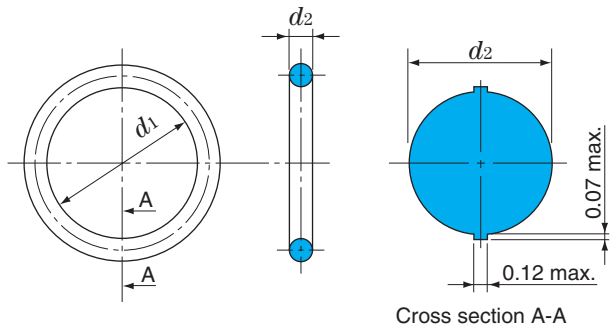
2) Groove width b

Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

unit : mm

■ O-ring shape and dimensions (unit : mm)



d_2 (2.62)

| O-ring dimensions | | O-ring No. | Reference No. |
|--------------------------|----------------------|------------|---------------|
| Cross section dia. d_2 | Bore dia. $d_1^{1)}$ | | |
| 2.62 ± 0.07 | ± 0.25 | AS 139 | AS 28775A |
| | | AS 140 | |
| | | AS 141 | |
| | | AS 142 | |
| | | AS 143 | |
| | | AS 144 | |
| | ± 0.38 | AS 145 | |
| | | AS 146 | |
| | | AS 147 | |
| | | AS 148 | |
| | | AS 149 | |
| | | AS 150 | |
| | | AS 151 | |
| | | AS 152 | |
| | | AS 153 | |
| | | AS 154 | |
| | ± 0.58 | AS 155 | |
| | | AS 156 | |
| | | AS 157 | |
| | | AS 158 | |
| | | AS 159 | |
| | | AS 160 | |
| | | AS 161 | |
| | | AS 162 | |
| | | AS 163 | |
| | | AS 164 | |
| | ± 0.76 | AS 165 | |
| | | AS 166 | |
| | | AS 167 | |
| | | AS 168 | |
| | | AS 169 | |
| | | AS 170 | |
| | | AS 171 | |
| | | AS 172 | |
| AS 173 | | | |
| AS 174 | | | |
| AS 175 | | | |
| AS 176 | | | |
| AS 177 | | | |
| AS 178 | | | |

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1 and NBR-90 products. For FKM-70 products, consult JTEKT.

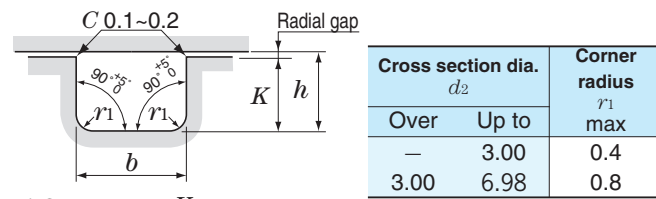
d_2 2.95~(3.53)

unit : mm

| O-ring dimensions | | O-ring No. | Reference No. |
|--------------------------|----------------------|------------|---------------|
| Cross section dia. d_2 | Bore dia. $d_1^{1)}$ | | |
| 2.95 ± 0.10 | ± 0.12 | AS 911 | AS 28775A |
| | | AS 912 | |
| | | AS 913 | |
| | ± 0.15 | AS 914 | |
| | | AS 916 | |
| | | AS 918 | |
| 3.00 ± 0.10 | ± 0.25 | AS 920 | |
| | | AS 924 | |
| | | AS 928 | |
| | | AS 932 | |
| | | AS 932 | |
| | | AS 932 | |
| 3.53 ± 0.10 | ± 0.12 | AS 201 | |
| | | AS 202 | |
| | | AS 203 | |
| | | AS 204 | |
| | | AS 205 | |
| | | AS 206 | |
| | ± 0.15 | AS 207 | |
| | | AS 208 | |
| | | AS 209 | |
| | | AS 210 | |
| | | AS 211 | |
| | | AS 212 | |
| | | AS 213 | |
| | | AS 214 | |
| | | AS 215 | |
| | | AS 216 | |
| | | AS 217 | |
| | | AS 218 | |
| | ± 0.25 | AS 219 | |
| | | AS 220 | |
| | | AS 221 | |
| | | AS 222 | |
| | | AS 223 | |
| | | AS 224 | |
| ± 0.38 | AS 225 | | |
| | AS 226 | | |
| | AS 227 | | |
| | AS 228 | | |
| | AS 229 | | |
| | AS 230 | | |
| AS 231 | | | |
| AS 232 | | | |
| AS 233 | | | |
| AS 234 | | | |
| AS 235 | | | |
| AS 236 | | | |
| AS 237 | | | |
| AS 238 | | | |
| AS 239 | | | |
| AS 240 | | | |
| AS 241 | | | |
| AS 242 | | | |
| AS 243 | | | |
| AS 244 | | | |
| AS 245 | | | |
| AS 246 | | | |
| AS 247 | | | |

Material : JIS NBR-70-1, NBR-90 and FKM-70

■ Fitting groove dimensions (unit : mm)



1) Groove depth K
Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

Therefore: $K = h - \text{gap in radial}$

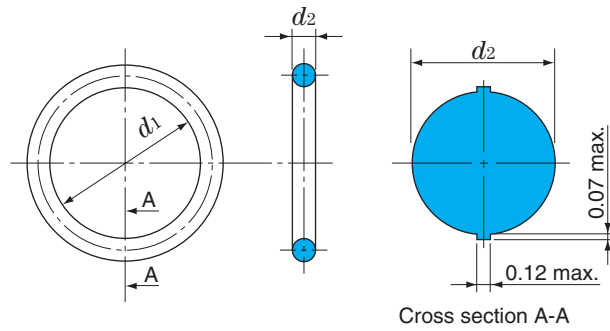
d_2 : O-ring cross section diameter

2) Groove width b

Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

■ O-ring shape and dimensions (unit : mm)



d_2 (3.53)~(5.33)

unit : mm

| O-ring dimensions | | O-ring No. | Reference No. | |
|--------------------------|----------------------|------------|---------------|-----|
| Cross section dia. d_2 | Bore dia. $d_1^{1)}$ | | | |
| 3.53 ± 0.10 | ± 0.38 | AS 248 | 248 | |
| | | AS 249 | 249 | |
| | | AS 250 | 250 | |
| | ± 0.58 | ± 0.58 | AS 251 | 251 |
| | | | AS 252 | 252 |
| | | | AS 253 | 253 |
| | | | AS 254 | 254 |
| | | | AS 255 | 255 |
| | | | AS 256 | 256 |
| | | | AS 257 | 257 |
| | | | AS 258 | 258 |
| | | | AS 259 | 259 |
| | | | AS 260 | 260 |
| | ± 0.76 | ± 0.76 | AS 261 | 261 |
| | | | AS 262 | 262 |
| | | | AS 263 | 263 |
| | | | AS 264 | 264 |
| | | | AS 265 | 265 |
| | | | AS 266 | 266 |
| | | | AS 267 | 267 |
| | | | AS 268 | 268 |
| | | | AS 269 | 269 |
| | | | AS 270 | 270 |
| | ± 1.14 | ± 1.14 | AS 271 | 271 |
| | | | AS 272 | 272 |
| | | | AS 273 | 273 |
| | | | AS 274 | 274 |
| | | | AS 275 | 275 |
| | | | AS 276 | 276 |
| | | | AS 277 | 277 |
| | | | AS 278 | 278 |
| | 5.33 ± 0.12 | ± 0.12 | AS 279 | 279 |
| AS 280 | | | 280 | |
| AS 281 | | | 281 | |
| AS 282 | | | 282 | |
| AS 283 | | | 283 | |
| AS 284 | AS 284 | AS 309 | 309 | |
| | | AS 310 | 310 | |
| | | AS 311 | 311 | |
| | | AS 311 | 311 | |

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1 and NBR-90 products. For FKM-70 products, consult JTEKT.

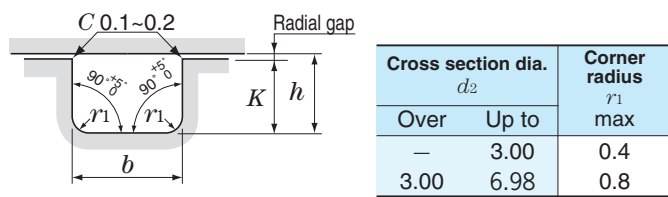
d_2 (5.33)

unit : mm

| Cross section dia. d_2 | O-ring dimensions | | O-ring No. | Reference No. |
|--------------------------|----------------------|--------|------------|---------------|
| | Bore dia. $d_1^{1)}$ | | | |
| 5.33 ± 0.12 | ± 0.12 | AS 312 | AS 28775A | |
| | | AS 313 | | |
| | | AS 314 | | |
| | ± 0.15 | ± 0.15 | AS 315 | |
| | | | AS 316 | |
| | | | AS 317 | |
| | | | AS 318 | |
| | | | AS 319 | |
| | | | AS 320 | |
| | | | AS 321 | |
| | | | AS 322 | |
| | | | AS 323 | |
| | | | AS 324 | |
| | ± 0.25 | ± 0.25 | AS 325 | |
| | | | AS 326 | |
| | | | AS 327 | |
| | | | AS 328 | |
| | | | AS 329 | |
| | | | AS 330 | |
| | | | AS 331 | |
| | | | AS 332 | |
| | | | AS 333 | |
| | | | AS 334 | |
| | ± 0.38 | ± 0.38 | AS 335 | |
| | | | AS 336 | |
| | | | AS 337 | |
| | | | AS 338 | |
| | | | AS 339 | |
| | | | AS 340 | |
| | | | AS 341 | |
| | | | AS 342 | |
| | | | AS 343 | |
| AS 344 | | | | |
| ± 0.58 | ± 0.58 | AS 345 | | |
| | | AS 346 | | |
| | | AS 347 | | |
| | | AS 348 | | |
| | | AS 349 | | |
| | | AS 350 | | |
| | | AS 351 | | |
| | | AS 352 | | |
| | | AS 353 | | |
| | | AS 354 | | |
| ± 0.76 | ± 0.76 | AS 355 | | |
| | | AS 356 | | |
| | | AS 357 | | |
| | | AS 358 | | |
| | | AS 359 | | |
| AS 360 | AS 360 | AS 360 | | |
| | | AS 361 | | |
| | | AS 362 | | |
| | | AS 363 | | |
| AS 364 | AS 364 | AS 364 | | |
| | | AS 365 | | |
| | | AS 366 | | |
| | | AS 367 | | |
| AS 368 | AS 368 | AS 368 | | |
| | | AS 368 | | |

Material : JIS NBR-70-1, NBR-90 and FKM-70

■ Fitting groove dimensions (unit : mm)



1) Groove depth K
Determine dimension h to obtain O-ring compression rate between 8 % and 30 %.

$$\text{Compression rate} = \frac{d_2 - h}{d_2} \times 100 (\%) = 8\% \sim 30\%$$

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.2.

Therefore: $K = h - \text{gap in radial}$

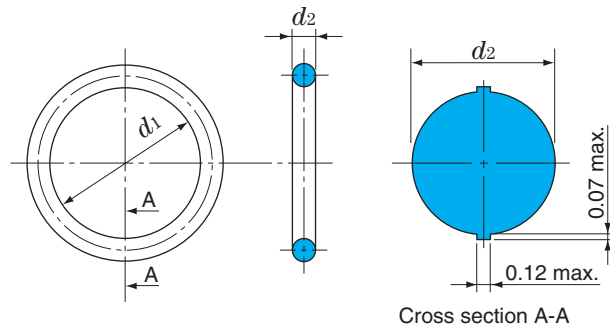
d_2 : O-ring cross section diameter

2) Groove width b

Determine groove width by the consideration that O-ring should not occupy more than 90 % of the groove space.

$$\text{Occupancy percentage} = \frac{\pi \times (d_2/2)^2}{b \times h} \times 100 (\%) < 90\%$$

■ O-ring shape and dimensions (unit : mm)



d_2 (5.33)~(6.98)

unit : mm

| O-ring dimensions | | O-ring No. | Reference No. |
|--------------------------|----------------------|------------|---------------|
| Cross section dia. d_2 | Bore dia. $d_1^{1)}$ | | |
| 5.33 ± 0.12 | ± 0.76 | AS 369 | AS 28775A |
| | | AS 370 | |
| | | AS 371 | |
| | | AS 372 | |
| | | AS 373 | |
| | | AS 374 | |
| | ± 1.14 | AS 375 | |
| | | AS 376 | |
| | | AS 377 | |
| | | AS 378 | |
| | | AS 379 | |
| | | AS 380 | |
| | ± 1.52 | AS 381 | |
| | | AS 382 | |
| | | AS 383 | |
| | | AS 384 | |
| | | AS 385 | |
| | | AS 386 | |
| | | AS 387 | |
| | | AS 388 | |
| 6.98 ± 0.15 | ± 0.38 | AS 389 | |
| | | AS 390 | |
| | | AS 391 | |
| | ± 0.58 | AS 392 | |
| | | AS 393 | |
| | | AS 394 | |
| | | AS 395 | |
| | | AS 425 | |
| | | AS 426 | |
| | | AS 427 | |
| ± 0.58 | ± 0.38 | AS 428 | |
| | | AS 429 | |
| | | AS 430 | |
| | ± 0.58 | AS 431 | |
| | | AS 432 | |
| | | AS 433 | |
| | | AS 434 | |
| | | AS 435 | |
| | | AS 436 | |
| | | AS 437 | |

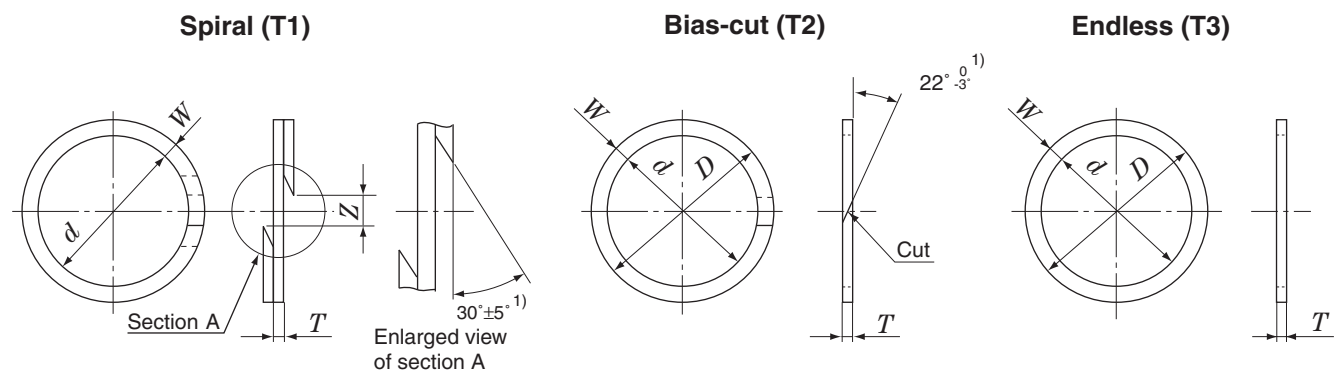
Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1 and NBR-90 products. For FKM-70 products, consult JTEKT.

d_2 (6.98)

unit : mm

| O-ring dimensions | | O-ring No. | Reference No. |
|--------------------------|----------------------|------------|---------------|
| Cross section dia. d_2 | Bore dia. $d_1^{1)}$ | | |
| 6.98 ± 0.15 | ± 0.58 | AS 438 | AS 28775A |
| | | AS 439 | |
| | | AS 440 | |
| | | AS 441 | |
| | ± 0.76 | AS 442 | |
| | | AS 443 | |
| | | AS 444 | |
| | | AS 445 | |
| | | AS 446 | |
| | | AS 447 | |
| | | AS 448 | |
| | | AS 449 | |
| | | AS 450 | |
| | | AS 451 | |
| | | AS 452 | |
| | | AS 453 | |
| | ± 1.14 | AS 454 | |
| | | AS 455 | |
| | | AS 456 | |
| | | AS 457 | |
| | | AS 458 | |
| | | AS 459 | |
| | | AS 460 | |
| | | AS 461 | |
| | | AS 462 | |
| | | AS 463 | |
| | | AS 464 | |
| | | AS 465 | |
| | | AS 466 | |
| | | AS 467 | |
| | ± 1.52 | AS 468 | |
| | | AS 469 | |
| | | AS 470 | |
| | | AS 471 | |
| | | AS 472 | |
| | | AS 473 | |
| | AS 474 | | |
| | AS 475 | | |

■ Backup ring shape and dimensions



Remark) All rings material is tetrafluoroethylene resin.

P 3~34 unit : mm

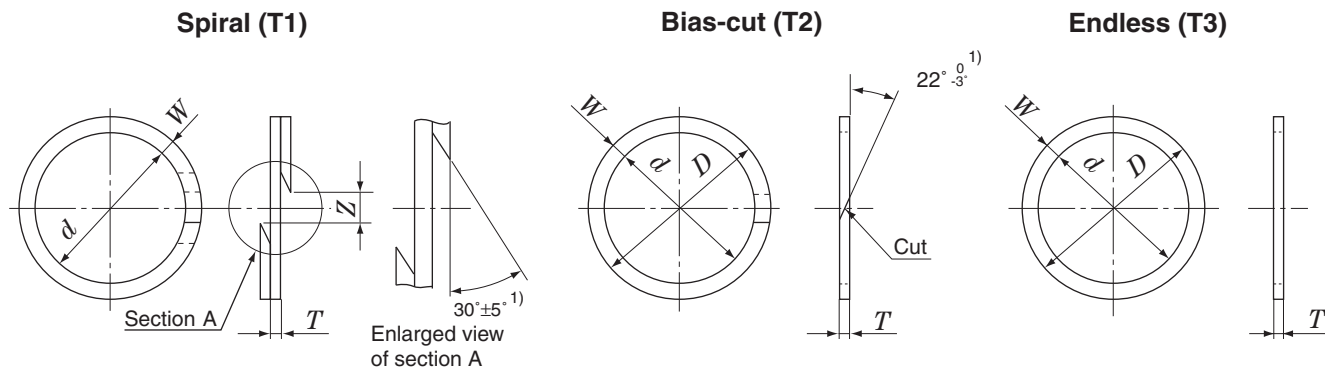
| Applied O-ring No. | Backup ring No. | Spiral ring | | | | Bias-cut and Endless ring ²⁾ | | | | | |
|--------------------|-----------------|-------------|---------------------------------------|------------|-----------------|---|-----------|------------|-------------|------------|------------|
| | | d | W ³⁾ | T | Z ⁴⁾ | Backup ring No. | | Dimensions | | | |
| | | | | | | Bias-cut | Endless | d | D | T | |
| P 3 | T1 P 3 | 3 | 1.5 ^{+0.03} _{-0.06} | 0.7 ± 0.05 | 1.2 ± 0.4 | T2 P 3 | T3 P 3 | 3 | + 0.15 0 | 0 -0.15 | 1.25 ± 0.1 |
| P 4 | T1 P 4 | 4 | | | | T2 P 4 | T3 P 4 | 4 | | | |
| P 5 | T1 P 5 | 5 | | | | T2 P 5 | T3 P 5 | 5 | | | |
| P 6 | T1 P 6 | 6 | | | | T2 P 6 | T3 P 6 | 6 | | | |
| P 7 | T1 P 7 | 7 | T2 P 7 | T3 P 7 | 7 | | | | | | |
| P 8 | T1 P 8 | 8 | T2 P 8 | T3 P 8 | 8 | | | | | | |
| P 9 | T1 P 9 | 9 | T2 P 9 | T3 P 9 | 9 | | | | | | |
| P 10 | T1 P 10 | 10 | T2 P 10 | T3 P 10 | 10 | | | | | | |
| P 10A | T1 P 10A | 10 | T2 P 10A | T3 P 10A | 10 | | | | | | |
| P 11 | T1 P 11 | 11 | T2 P 11 | T3 P 11 | 11 | | | | | | |
| P 11.2 | T1 P 11.2 | 11.2 | T2 P 11.2 | T3 P 11.2 | 11.2 | | | | | | |
| P 12 | T1 P 12 | 12 | T2 P 12 | T3 P 12 | 12 | | | | | | |
| P 12.5 | T1 P 12.5 | 12.5 | T2 P 12.5 | T3 P 12.5 | 12.5 | | | | | | |
| P 14 | T1 P 14 | 14 | T2 P 14 | T3 P 14 | 14 | | | | | | |
| P 15 | T1 P 15 | 15 | 2.0 ^{+0.03} _{-0.06} | 0.7 ± 0.05 | 1.4 ± 0.8 | T2 P 15 | T3 P 15 | 15 | | | |
| P 16 | T1 P 16 | 16 | | | | T2 P 16 | T3 P 16 | 16 | | | |
| P 18 | T1 P 18 | 18 | | | | T2 P 18 | T3 P 18 | 18 | | | |
| P 20 | T1 P 20 | 20 | | | | T2 P 20 | T3 P 20 | 20 | | | |
| P 21 | T1 P 21 | 21 | | | | T2 P 21 | T3 P 21 | 21 | | | |
| P 22 | T1 P 22 | 22 | | | | T2 P 22 | T3 P 22 | 22 | | | |
| P 22A | T1 P 22A | 22 | | | | T2 P 22A | T3 P 22A | 22 | | | |
| P 22.4 | T1 P 22.4 | 22.4 | | | | T2 P 22.4 | T3 P 22.4 | 22.4 | | | |
| P 24 | T1 P 24 | 24 | T2 P 24 | T3 P 24 | 24 | | | | | | |
| P 25 | T1 P 25 | 25 | T2 P 25 | T3 P 25 | 25 | | | | | | |
| P 25.5 | T1 P 25.5 | 25.5 | T2 P 25.5 | T3 P 25.5 | 25.5 | | | | | | |
| P 26 | T1 P 26 | 26 | T2 P 26 | T3 P 26 | 26 | | | | | | |
| P 28 | T1 P 28 | 28 | 3.0 ^{+0.03} _{-0.06} | 0.7 ± 0.05 | 2.5 ± 1.5 | T2 P 28 | T3 P 28 | 28 | | | |
| P 29 | T1 P 29 | 29 | | | | T2 P 29 | T3 P 29 | 29 | | | |
| P 29.5 | T1 P 29.5 | 29.5 | | | | T2 P 29.5 | T3 P 29.5 | 29.5 | | | |
| P 30 | T1 P 30 | 30 | | | | T2 P 30 | T3 P 30 | 30 | | | |
| P 31 | T1 P 31 | 31 | | | | T2 P 31 | T3 P 31 | 31 | | | |
| P 31.5 | T1 P 31.5 | 31.5 | | | | T2 P 31.5 | T3 P 31.5 | 31.5 | | | |
| P 32 | T1 P 32 | 32 | T2 P 32 | T3 P 32 | 32 | | | | | | |
| P 34 | T1 P 34 | 34 | T2 P 34 | T3 P 34 | 34 | | | | | | |

- Notes 1) The cut angle for P3 to P10 is 35°~40°.
 2) The dimensions shown in the "Bias-cut and Endless ring" column are the dimensions of endless rings. Bias-cut rings are produced by cutting endless rings.
 3) In the case of bias-cut and endless ring, the deviation of ring thickness W (within one piece) shall be 0.05 mm max.
 4) The clearance Z is shown when the backup ring is installed on a shaft toleranced to 0 mm / - 0.05 mm.

P 35~165 unit : mm

| Applied O-ring No. | Backup ring No. | Spiral ring | | | | Bias-cut and Endless ring ²⁾ | | | | | | | | | | | |
|--------------------|-----------------|-------------|---------------------------------------|------------|-----------------|---|------------|------------|-------------|------------|------------|----------|----------|-----|-------------|------------|-------------|
| | | d | W ³⁾ | T | Z ⁴⁾ | Backup ring No. | | Dimensions | | | | | | | | | |
| | | | | | | Bias-cut | Endless | d | D | T | | | | | | | |
| P 35 | T1 P 35 | 35 | 3.0 ^{+0.03} _{-0.06} | 0.7 ± 0.05 | 2.5 ± 1.5 | T2 P 35 | T3 P 35 | 35 | + 0.20 0 | 0 -0.20 | 1.25 ± 0.1 | | | | | | |
| P 35.5 | T1 P 35.5 | 35.5 | | | | T2 P 35.5 | T3 P 35.5 | 35.5 | | | | | | | | | |
| P 36 | T1 P 36 | 36 | | | | T2 P 36 | T3 P 36 | 36 | | | | | | | | | |
| P 38 | T1 P 38 | 38 | | | | T2 P 38 | T3 P 38 | 38 | | | | | | | | | |
| P 39 | T1 P 39 | 39 | | | | T2 P 39 | T3 P 39 | 39 | | | | | | | | | |
| P 40 | T1 P 40 | 40 | | | | T2 P 40 | T3 P 40 | 40 | | | | | | | | | |
| P 41 | T1 P 41 | 41 | | | | T2 P 41 | T3 P 41 | 41 | | | | | | | | | |
| P 42 | T1 P 42 | 42 | | | | T2 P 42 | T3 P 42 | 42 | | | | | | | | | |
| P 44 | T1 P 44 | 44 | | | | T2 P 44 | T3 P 44 | 44 | | | | | | | | | |
| P 45 | T1 P 45 | 45 | | | | T2 P 45 | T3 P 45 | 45 | | | | | | | | | |
| P 46 | T1 P 46 | 46 | | | | T2 P 46 | T3 P 46 | 46 | | | | | | | | | |
| P 48 | T1 P 48 | 48 | | | | T2 P 48 | T3 P 48 | 48 | | | | | | | | | |
| P 49 | T1 P 49 | 49 | | | | T2 P 49 | T3 P 49 | 49 | | | | | | | | | |
| P 50 | T1 P 50 | 50 | | | | T2 P 50 | T3 P 50 | 50 | | | | | | | | | |
| P 48A | T1 P 48A | 48 | | | | T2 P 48A | T3 P 48A | 48 | | | | | | | | | |
| P 50A | T1 P 50A | 50 | | | | T2 P 50A | T3 P 50A | 50 | | | | | | | | | |
| P 52 | T1 P 52 | 52 | T2 P 52 | T3 P 52 | 52 | | | | | | | | | | | | |
| P 53 | T1 P 53 | 53 | T2 P 53 | T3 P 53 | 53 | | | | | | | | | | | | |
| P 55 | T1 P 55 | 55 | T2 P 55 | T3 P 55 | 55 | | | | | | | | | | | | |
| P 56 | T1 P 56 | 56 | T2 P 56 | T3 P 56 | 56 | | | | | | | | | | | | |
| P 58 | T1 P 58 | 58 | T2 P 58 | T3 P 58 | 58 | | | | | | | | | | | | |
| P 60 | T1 P 60 | 60 | T2 P 60 | T3 P 60 | 60 | | | | | | | | | | | | |
| P 62 | T1 P 62 | 62 | T2 P 62 | T3 P 62 | 62 | | | | | | | | | | | | |
| P 63 | T1 P 63 | 63 | T2 P 63 | T3 P 63 | 63 | | | | | | | | | | | | |
| P 65 | T1 P 65 | 65 | T2 P 65 | T3 P 65 | 65 | | | | | | | | | | | | |
| P 67 | T1 P 67 | 67 | T2 P 67 | T3 P 67 | 67 | | | | | | | | | | | | |
| P 70 | T1 P 70 | 70 | 5.0 ^{+0.03} _{-0.06} | 0.9 ± 0.06 | 4.5 ± 1.5 | T2 P 70 | T3 P 70 | 70 | + 0.25 0 | 0 -0.25 | 1.9 ± 0.13 | | | | | | |
| P 71 | T1 P 71 | 71 | | | | T2 P 71 | T3 P 71 | 71 | | | | | | | | | |
| P 75 | T1 P 75 | 75 | | | | T2 P 75 | T3 P 75 | 75 | | | | | | | | | |
| P 80 | T1 P 80 | 80 | | | | T2 P 80 | T3 P 80 | 80 | | | | | | | | | |
| P 85 | T1 P 85 | 85 | | | | T2 P 85 | T3 P 85 | 85 | | | | | | | | | |
| P 90 | T1 P 90 | 90 | | | | T2 P 90 | T3 P 90 | 90 | | | | | | | | | |
| P 95 | T1 P 95 | 95 | | | | T2 P 95 | T3 P 95 | 95 | | | | | | | | | |
| P 100 | T1 P 100 | 100 | | | | T2 P 100 | T3 P 100 | 100 | | | | | | | | | |
| P 102 | T1 P 102 | 102 | | | | T2 P 102 | T3 P 102 | 102 | | | | | | | | | |
| P 105 | T1 P 105 | 105 | | | | T2 P 105 | T3 P 105 | 105 | | | | | | | | | |
| P 110 | T1 P 110 | 110 | | | | T2 P 110 | T3 P 110 | 110 | | | | | | | | | |
| P 112 | T1 P 112 | 112 | | | | T2 P 112 | T3 P 112 | 112 | | | | | | | | | |
| P 115 | T1 P 115 | 115 | | | | T2 P 115 | T3 P 115 | 115 | | | | | | | | | |
| P 120 | T1 P 120 | 120 | | | | T2 P 120 | T3 P 120 | 120 | | | | | | | | | |
| P 125 | T1 P 125 | 125 | | | | T2 P 125 | T3 P 125 | 125 | | | | | | | | | |
| P 130 | T1 P 130 | 130 | | | | T2 P 130 | T3 P 130 | 130 | | | | | | | | | |
| P 132 | T1 P 132 | 132 | | | | T2 P 132 | T3 P 132 | 132 | | | | | | | | | |
| P 135 | T1 P 135 | 135 | | | | T2 P 135 | T3 P 135 | 135 | | | | | | | | | |
| P 140 | T1 P 140 | 140 | | | | T2 P 140 | T3 P 140 | 140 | | | | | | | | | |
| P 145 | T1 P 145 | 145 | | | | T2 P 145 | T3 P 145 | 145 | | | | | | | | | |
| P 150 | T1 P 150 | 150 | | | | T2 P 150 | T3 P 150 | 150 | | | | | | | | | |
| P 150A | T1 P 150A | 150 | | | | T2 P 150A | T3 P 150A | 150 | | | | | | | | | |
| P 155 | T1 P 155 | 155 | | | | 7.5 ^{+0.03} _{-0.06} | 1.4 ± 0.08 | 6.0 ± 2.0 | | | | T2 P 155 | T3 P 155 | 155 | + 0.30 0 | 0 -0.30 | 2.75 ± 0.15 |
| P 160 | T1 P 160 | 160 | | | | | | | | | | T2 P 160 | T3 P 160 | 160 | | | |
| P 165 | T1 P 165 | 165 | | | | | | | | | | T2 P 165 | T3 P 165 | 165 | | | |

■ Backup ring shape and dimensions



Remark) All rings material is tetrafluoroethylene resin.

P 170~360

unit : mm

| Applied O-ring No. | Spiral ring | | | | Bias-cut and Endless ring ²⁾ | | | | | | |
|--------------------|-----------------|------------|-------------------------------|------------|---|----------|------------|-----|-------------|------------|-------------|
| | Backup ring No. | Dimensions | | | Backup ring No. | | Dimensions | | | T | |
| | | d | W ³⁾ | T | Z ⁴⁾ | Bias-cut | Endless | d | D | | |
| P 170 | T1 P170 | 170 | 7.5 ^{+0.03} -0.06 | 1.4 ± 0.08 | 6.0 ± 2.0 | T2 P 170 | T3 P 170 | 170 | + 0.30 0 | 0 -0.30 | 2.75 ± 0.15 |
| P 175 | T1 P175 | 175 | | | | T2 P 175 | T3 P 175 | 175 | | | |
| P 180 | T1 P180 | 180 | | | | T2 P 180 | T3 P 180 | 180 | | | |
| P 185 | T1 P185 | 185 | | | | T2 P 185 | T3 P 185 | 185 | | | |
| P 190 | T1 P190 | 190 | | | | T2 P 190 | T3 P 190 | 190 | | | |
| P 195 | T1 P195 | 195 | | | | T2 P 195 | T3 P 195 | 195 | | | |
| P 200 | T1 P200 | 200 | | | | T2 P 200 | T3 P 200 | 200 | | | |
| P 205 | T1 P205 | 205 | | | | T2 P 205 | T3 P 205 | 205 | | | |
| P 209 | T1 P209 | 209 | | | | T2 P 209 | T3 P 209 | 209 | | | |
| P 210 | T1 P210 | 210 | | | | T2 P 210 | T3 P 210 | 210 | | | |
| P 215 | T1 P215 | 215 | | | | T2 P 215 | T3 P 215 | 215 | | | |
| P 220 | T1 P220 | 220 | | | | T2 P 220 | T3 P 220 | 220 | | | |
| P 225 | T1 P225 | 225 | | | | T2 P 225 | T3 P 225 | 225 | | | |
| P 230 | T1 P230 | 230 | | | | T2 P 230 | T3 P 230 | 230 | | | |
| P 235 | T1 P235 | 235 | | | | T2 P 235 | T3 P 235 | 235 | | | |
| P 240 | T1 P240 | 240 | | | | T2 P 240 | T3 P 240 | 240 | | | |
| P 245 | T1 P245 | 245 | | | | T2 P 245 | T3 P 245 | 245 | | | |
| P 250 | T1 P250 | 250 | | | | T2 P 250 | T3 P 250 | 250 | | | |
| P 255 | T1 P255 | 255 | | | | T2 P 255 | T3 P 255 | 255 | | | |
| P 260 | T1 P260 | 260 | | | | T2 P 260 | T3 P 260 | 260 | | | |
| P 265 | T1 P265 | 265 | | | | T2 P 265 | T3 P 265 | 265 | | | |
| P 270 | T1 P270 | 270 | | | | T2 P 270 | T3 P 270 | 270 | | | |
| P 275 | T1 P275 | 275 | | | | T2 P 275 | T3 P 275 | 275 | | | |
| P 280 | T1 P280 | 280 | | | | T2 P 280 | T3 P 280 | 280 | | | |
| P 285 | T1 P285 | 285 | | | | T2 P 285 | T3 P 285 | 285 | | | |
| P 290 | T1 P290 | 290 | | | | T2 P 290 | T3 P 290 | 290 | | | |
| P 295 | T1 P295 | 295 | | | | T2 P 295 | T3 P 295 | 295 | | | |
| P 300 | T1 P300 | 300 | | | | T2 P 300 | T3 P 300 | 300 | | | |
| P 315 | T1 P315 | 315 | | | | T2 P 315 | T3 P 315 | 315 | | | |
| P 320 | T1 P320 | 320 | | | | T2 P 320 | T3 P 320 | 320 | | | |
| P 335 | T1 P335 | 335 | | | | T2 P 335 | T3 P 335 | 335 | | | |
| P 340 | T1 P340 | 340 | | | | T2 P 340 | T3 P 340 | 340 | | | |
| P 355 | T1 P355 | 355 | T2 P 355 | T3 P 355 | 355 | | | | | | |
| P 360 | T1 P360 | 360 | T2 P 360 | T3 P 360 | 360 | | | | | | |

- Notes
- 1) The cut angle for P3 to P10 is 35°~ 40°.
 - 2) The dimensions shown in the "Bias-cut and Endless ring" column are the dimensions of endless rings. Bias-cut rings are produced by cutting endless rings.
 - 3) In the case of bias-cut and endless ring, the deviation of ring thickness W (within one piece) shall be 0.05 mm max.
 - 4) The clearance Z is shown when the backup ring is installed on a shaft toleranced to 0 mm / - 0.05 mm.

P 375~400
G 25~300

unit : mm

| Applied O-ring No. | Spiral ring | | | | | Bias-cut and Endless ring ²⁾ | | | | | | |
|--------------------|-----------------|------------|-------------------------------|------------|-----------------|---|----------|------------|-------------|---|---------------------|--------------------------|
| | Backup ring No. | Dimensions | | | Z ⁴⁾ | Backup ring No. | | Dimensions | | | | |
| | | d | W ³⁾ | T | | Bias-cut | Endless | d | D | T | | |
| P 375 | T1 P 375 | 375 | 7.5 ^{+0.03} -0.06 | 1.4 ± 0.08 | 6.0 ± 2.0 | T2 P 375 | T3 P 375 | 375 | + 0.30 0 | 390 400 415 | 0 -0.30 | 2.75 ± 0.15 |
| P 385 | T1 P 385 | 385 | | | | T2 P 385 | T3 P 385 | 385 | | | | |
| P 400 | T1 P 400 | 400 | | | | T2 P 400 | T3 P 400 | 400 | | | | |
| G 25 | T1 G 25 | 25 | 2.5 ^{+0.03} -0.06 | 0.7 ± 0.05 | 4.5 ± 1.5 | T2 G 25 | T3 G 25 | 25 | + 0.25 0 | 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 | 0 -0.20 -0.25 | 1.25 ± 0.1 1.25 ± 0.1 |
| G 30 | T1 G 30 | 30 | | | | T2 G 30 | T3 G 30 | 30 | | | | |
| G 35 | T1 G 35 | 35 | | | | T2 G 35 | T3 G 35 | 35 | | | | |
| G 40 | T1 G 40 | 40 | | | | T2 G 40 | T3 G 40 | 40 | | | | |
| G 45 | T1 G 45 | 45 | | | | T2 G 45 | T3 G 45 | 45 | | | | |
| G 50 | T1 G 50 | 50 | | | | T2 G 50 | T3 G 50 | 50 | | | | |
| G 55 | T1 G 55 | 55 | | | | T2 G 55 | T3 G 55 | 55 | | | | |
| G 60 | T1 G 60 | 60 | | | | T2 G 60 | T3 G 60 | 60 | | | | |
| G 65 | T1 G 65 | 65 | | | | T2 G 65 | T3 G 65 | 65 | | | | |
| G 70 | T1 G 70 | 70 | | | | T2 G 70 | T3 G 70 | 70 | | | | |
| G 75 | T1 G 75 | 75 | | | | T2 G 75 | T3 G 75 | 75 | | | | |
| G 80 | T1 G 80 | 80 | | | | T2 G 80 | T3 G 80 | 80 | | | | |
| G 85 | T1 G 85 | 85 | | | | T2 G 85 | T3 G 85 | 85 | | | | |
| G 90 | T1 G 90 | 90 | | | | T2 G 90 | T3 G 90 | 90 | | | | |
| G 95 | T1 G 95 | 95 | | | | T2 G 95 | T3 G 95 | 95 | | | | |
| G 100 | T1 G 100 | 100 | T2 G 100 | T3 G 100 | 100 | | | | | | | |
| G 105 | T1 G 105 | 105 | T2 G 105 | T3 G 105 | 105 | | | | | | | |
| G 110 | T1 G 110 | 110 | T2 G 110 | T3 G 110 | 110 | | | | | | | |
| G 115 | T1 G 115 | 115 | T2 G 115 | T3 G 115 | 115 | | | | | | | |
| G 120 | T1 G 120 | 120 | T2 G 120 | T3 G 120 | 120 | | | | | | | |
| G 125 | T1 G 125 | 125 | T2 G 125 | T3 G 125 | 125 | | | | | | | |
| G 130 | T1 G 130 | 130 | T2 G 130 | T3 G 130 | 130 | | | | | | | |
| G 135 | T1 G 135 | 135 | T2 G 135 | T3 G 135 | 135 | | | | | | | |
| G 140 | T1 G 140 | 140 | T2 G 140 | T3 G 140 | 140 | | | | | | | |
| G 145 | T1 G 145 | 145 | T2 G 145 | T3 G 145 | 145 | | | | | | | |
| G 150 | T1 G 150 | 150 | 5.0 ^{+0.03} -0.06 | 0.9 ± 0.06 | 6.0 ± 2.0 | T2 G 150 | T3 G 150 | 150 | + 0.30 0 | 160 165 170 175 180 185 190 195 200 205 210 220 230 240 250 260 270 280 290 300 310 | 0 -0.30 | 1.9 ± 0.13 |
| G 155 | T1 G 155 | 155 | | | | T2 G 155 | T3 G 155 | 155 | | | | |
| G 160 | T1 G 160 | 160 | | | | T2 G 160 | T3 G 160 | 160 | | | | |
| G 165 | T1 G 165 | 165 | | | | T2 G 165 | T3 G 165 | 165 | | | | |
| G 170 | T1 G 170 | 170 | | | | T2 G 170 | T3 G 170 | 170 | | | | |
| G 175 | T1 G 175 | 175 | | | | T2 G 175 | T3 G 175 | 175 | | | | |
| G 180 | T1 G 180 | 180 | | | | T2 G 180 | T3 G 180 | 180 | | | | |
| G 185 | T1 G 185 | 185 | | | | T2 G 185 | T3 G 185 | 185 | | | | |
| G 190 | T1 G 190 | 190 | | | | T2 G 190 | T3 G 190 | 190 | | | | |
| G 195 | T1 G 195 | 195 | | | | T2 G 195 | T3 G 195 | 195 | | | | |
| G 200 | T1 G 200 | 200 | | | | T2 G 200 | T3 G 200 | 200 | | | | |
| G 210 | T1 G 210 | 210 | | | | T2 G 210 | T3 G 210 | 210 | | | | |
| G 220 | T1 G 220 | 220 | | | | T2 G 220 | T3 G 220 | 220 | | | | |
| G 230 | T1 G 230 | 230 | | | | T2 G 230 | T3 G 230 | 230 | | | | |
| G 240 | T1 G 240 | 240 | | | | T2 G 240 | T3 G 240 | 240 | | | | |
| G 250 | T1 G 250 | 250 | T2 G 250 | T3 G 250 | 250 | | | | | | | |
| G 260 | T1 G 260 | 260 | T2 G 260 | T3 G 260 | 260 | | | | | | | |
| G 270 | T1 G 270 | 270 | T2 G 270 | T3 G 270 | 270 | | | | | | | |
| G 280 | T1 G 280 | 280 | T2 G 280 | T3 G 280 | 280 | | | | | | | |
| G 290 | T1 G 290 | 290 | T2 G 290 | T3 G 290 | 290 | | | | | | | |
| G 300 | T1 G 300 | 300 | T2 G 300 | T3 G 300 | 300 | | | | | | | |

V

15~1 055

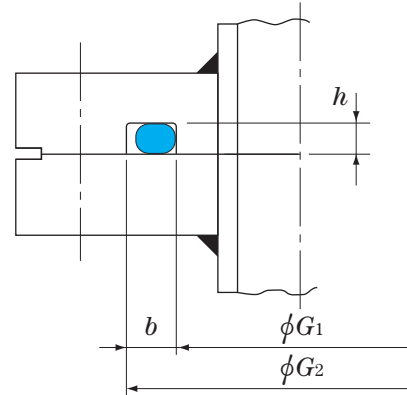
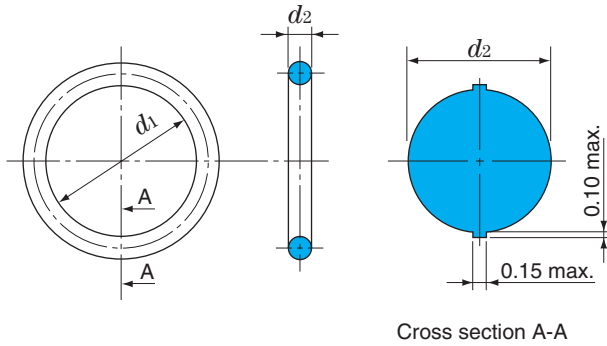
JIS B 2401

V (for Vacuum Flanges)

Material : JIS NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90, VMQ-70, FKM-70, FKM-90, HNBR-70, HNBR-90, ACM-70 and SBR-70 (Not standardized in the JIS)

■ O-ring shape and dimensions (unit : mm)

■ Fitting groove dimensions



V 15~1 055

unit : mm

| O-ring dimensions | | O-ring No. | Groove dimensions | | | | | | | |
|----------------------------------|-----------------------------|------------|-------------------|------------|------------|----------------------------------|----------------------------------|-----|-----|-----|
| Bore dia. d_1 ¹⁾ | Cross section dia. d_2 | | G_1 | | G_2 | b ^{+0.1} ₀ | h ⁰ _{-0.2} | | | |
| 14.5 | ± 0.20 | V 15 | 15 | + 1.0 0 | 25 | 5.0 | 3.0 | | | |
| 23.5 | ± 0.24 | V 24 | 24 | | | | | | | |
| 33.5 | ± 0.33 | V 34 | 34 | | | | | | | |
| 39.5 | ± 0.37 | V 40 | 40 | | | | | | | |
| 54.5 | ± 0.49 | V 55 | 55 | | | | | | | |
| 69.0 | ± 0.61 | V 70 | 70 | | | | | | | |
| 84.0 | ± 0.72 | V 85 | 85 | | | | | | | |
| 99.0 | ± 0.83 | V 100 | 100 | | | | | | | |
| 119.0 | ± 0.97 | V 120 | 120 | | | | | | | |
| 148.5 | ± 1.18 | V 150 | 150 | | | | | | | |
| 173.0 | ± 1.36 | V 175 | 175 | | | | | | | |
| 222.5 | ± 1.70 | V 225 | 225 | | + 1.5 0 | | | 241 | 8.0 | 4.5 |
| 272.0 | ± 2.02 | V 275 | 275 | | | | | | | |
| 321.5 | ± 2.34 | V 325 | 325 | | | | | | | |
| 376.0 | ± 2.68 | V 380 | 380 | | | | | | | |
| 425.5 | ± 2.99 | V 430 | 430 | | | | | | | |
| 475.0 | ± 3.30 | V 480 | 480 | | | | | | | |
| 524.5 | ± 3.60 | V 530 | 530 | + 2.0 0 | 504 | 12.0 | 7.0 | | | |
| 579.0 | ± 3.92 | V 585 | 585 | | | | | | | |
| 633.5 | ± 4.24 | V 640 | 640 | | | | | | | |
| 683.0 | ± 4.54 | V 690 | 690 | | | | | | | |
| 732.5 | ± 4.83 | V 740 | 740 | | | | | | | |
| 782.0 | ± 5.12 | V 790 | 790 | | | | | | | |
| 836.5 | ± 5.44 | V 845 | 845 | 1 079 | 814 | | | | | |
| 940.5 | ± 6.06 | V 950 | 950 | | 869 | | | | | |
| 1 044.0 | ± 6.67 | V 1 055 | 1 055 | | 974 | | | | | |

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for NBR-70-1, NBR-90, NBR-70-2, EPDM-70, EPDM-90 and SBR-70 (Not standardized in the JIS) products.
For VMQ-70 and ACM-70 products, the tolerance is 1.5 times these values, and for FKM-70, FKM-90, HNBR-70 and HNBR-90 products, 1.2 times.

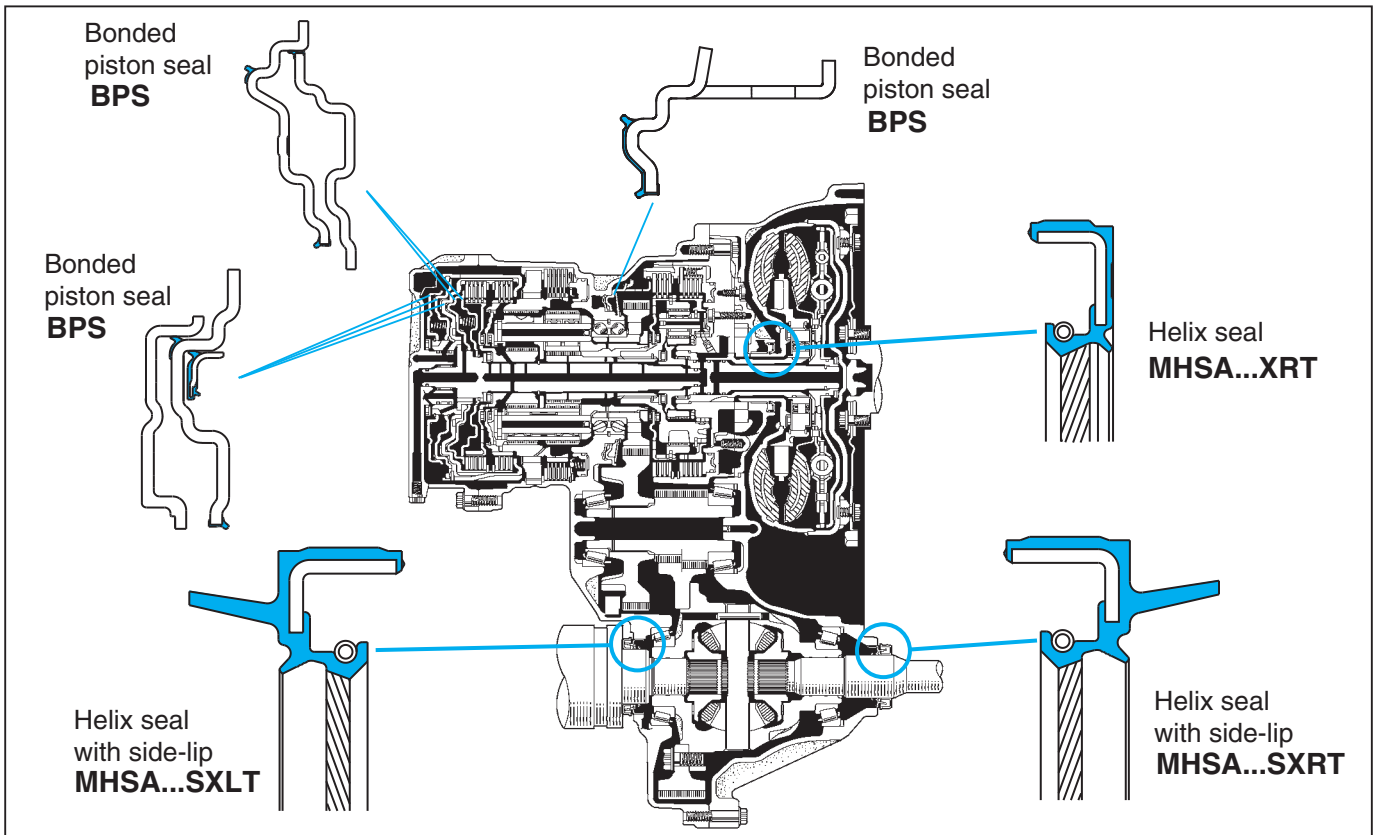
3

Application Examples of Oil Seals and O-Rings

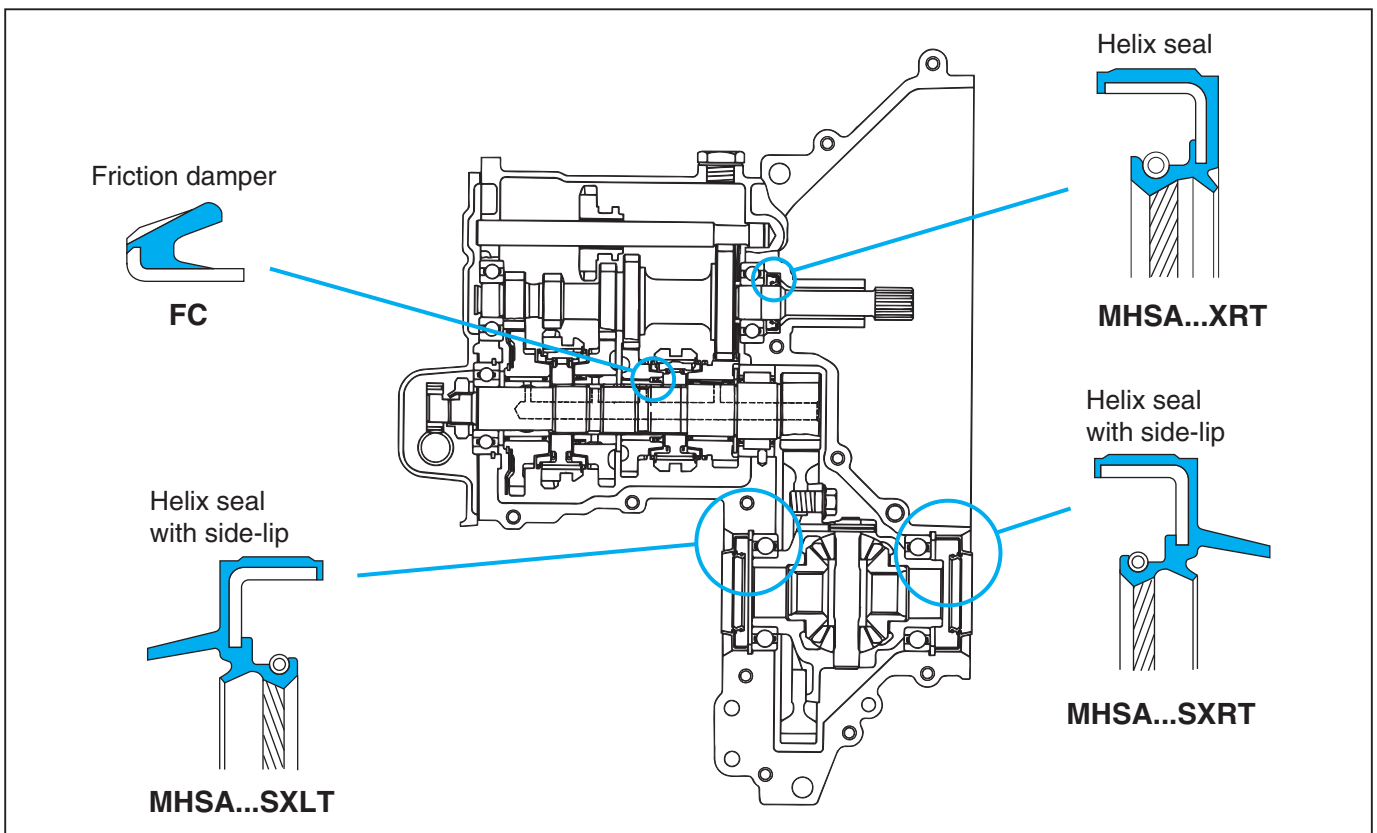
| | |
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| ■ Manual transaxle | |
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| ■ Electric power steering | |
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3.1 Automobile

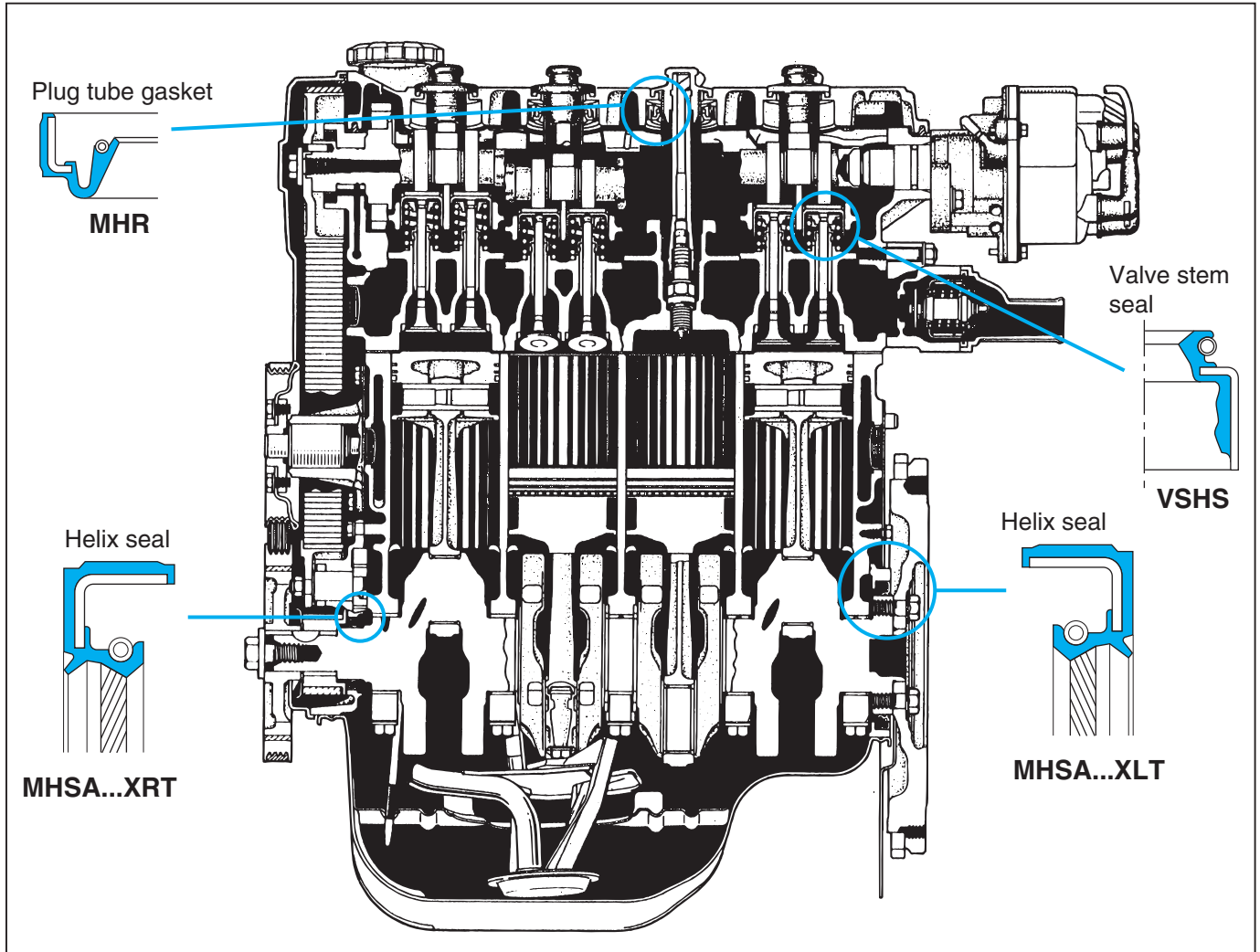
Automatic transaxle



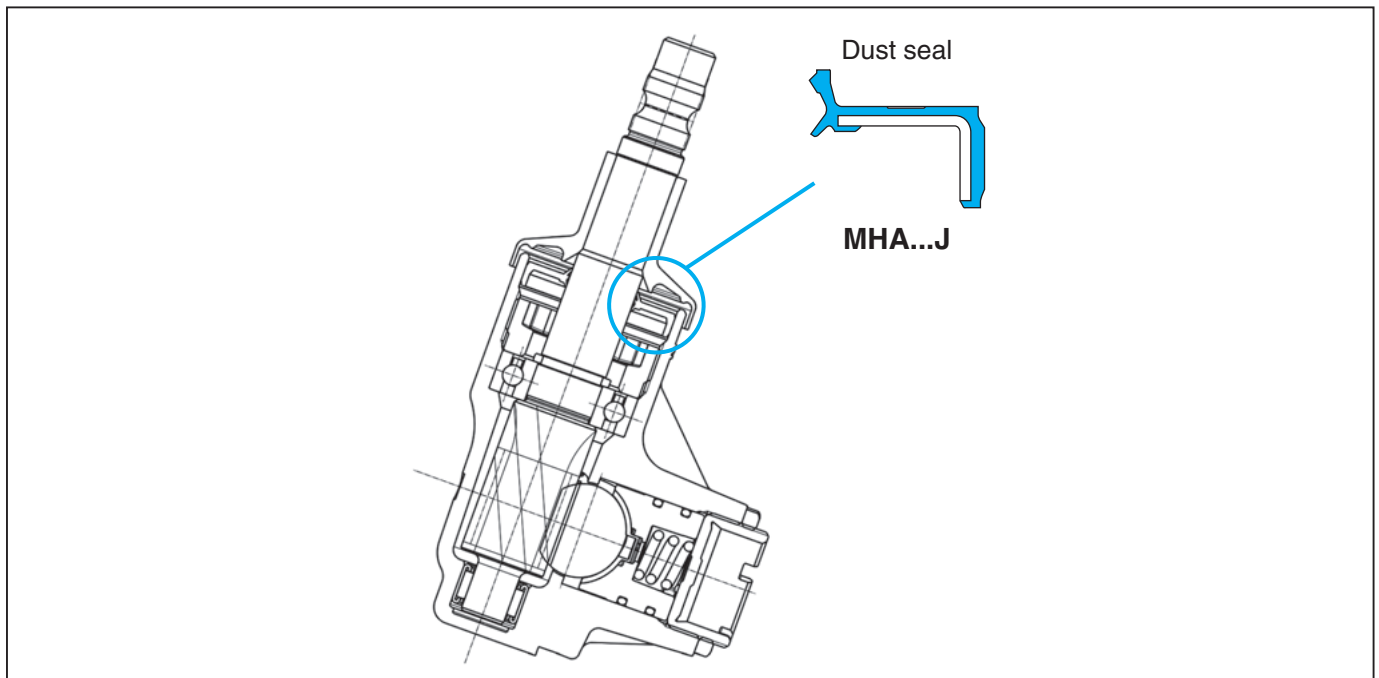
Manual transaxle



■ Engine

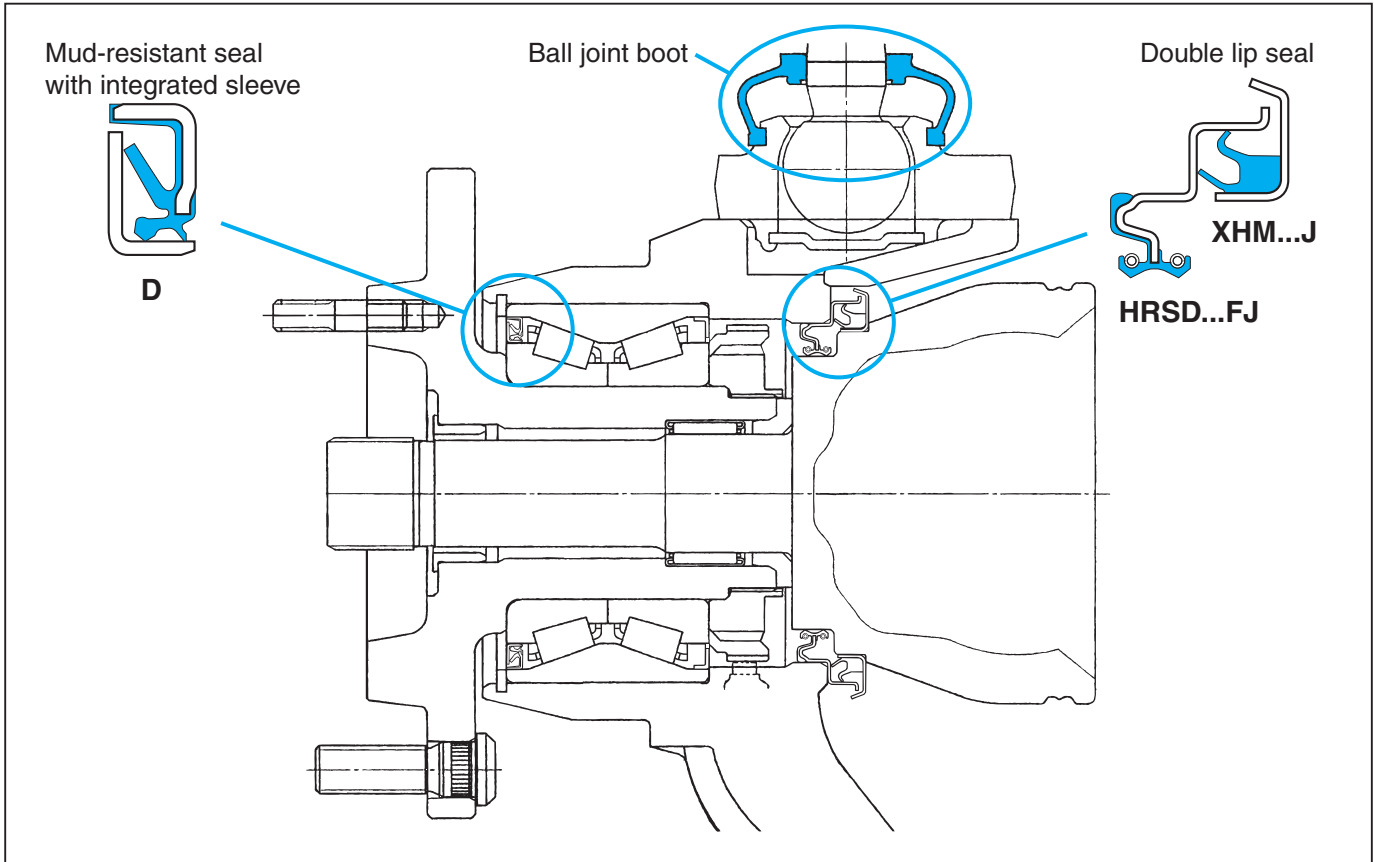


■ Electric power steering

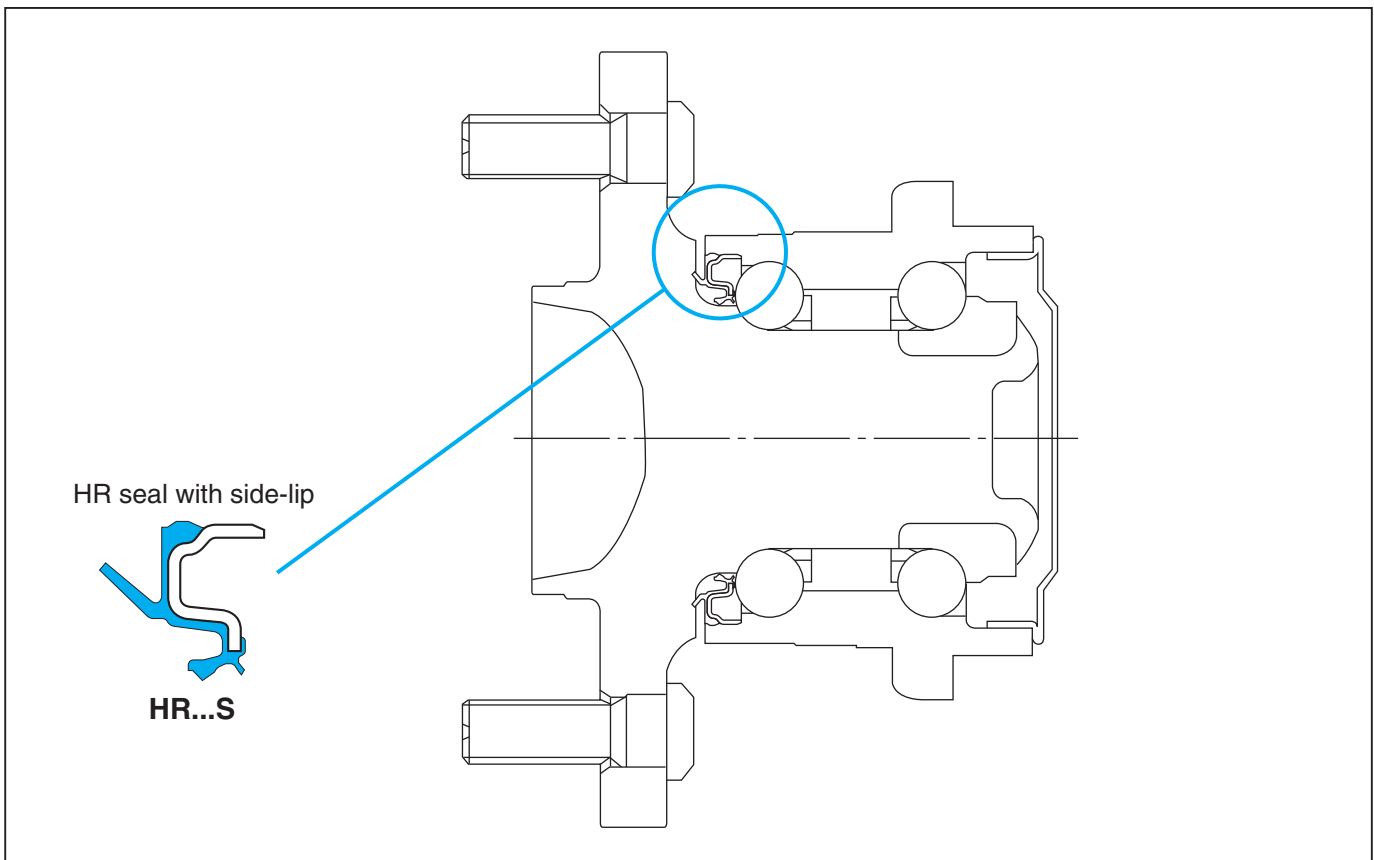


3. Application Examples of Oil Seals and O-Rings

■ Driving wheel

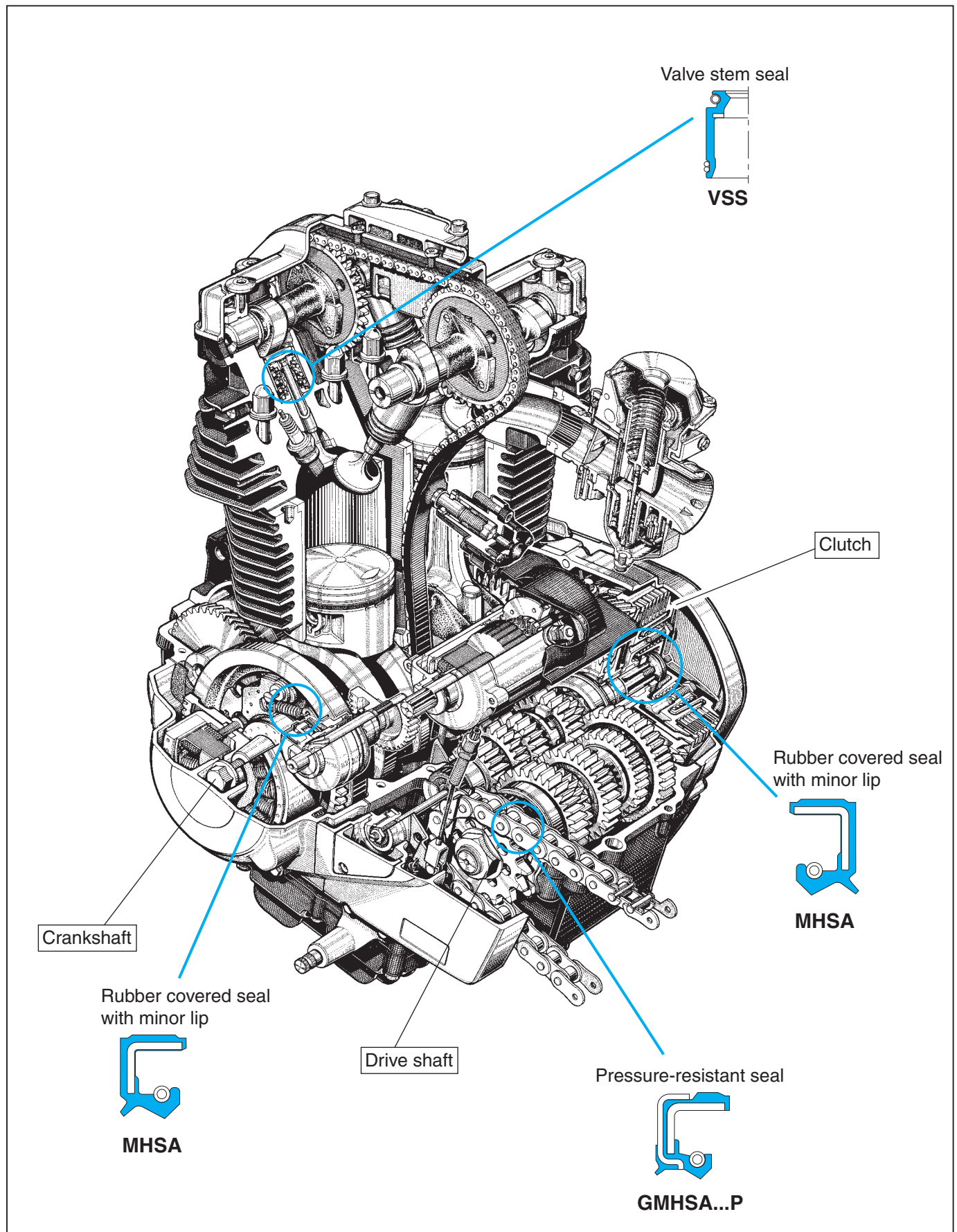


■ Driven wheel



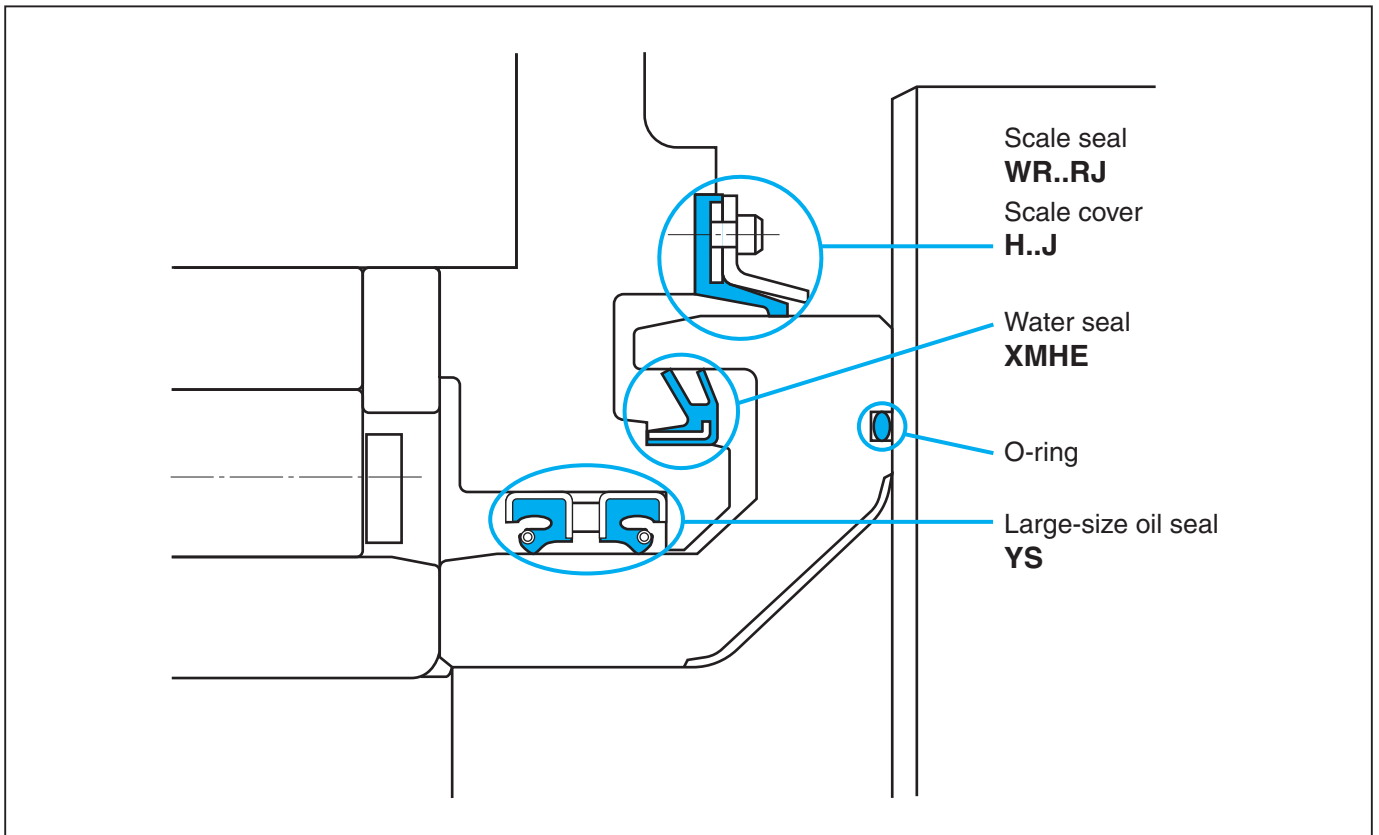
3.2 Motorcycle

■ Engine

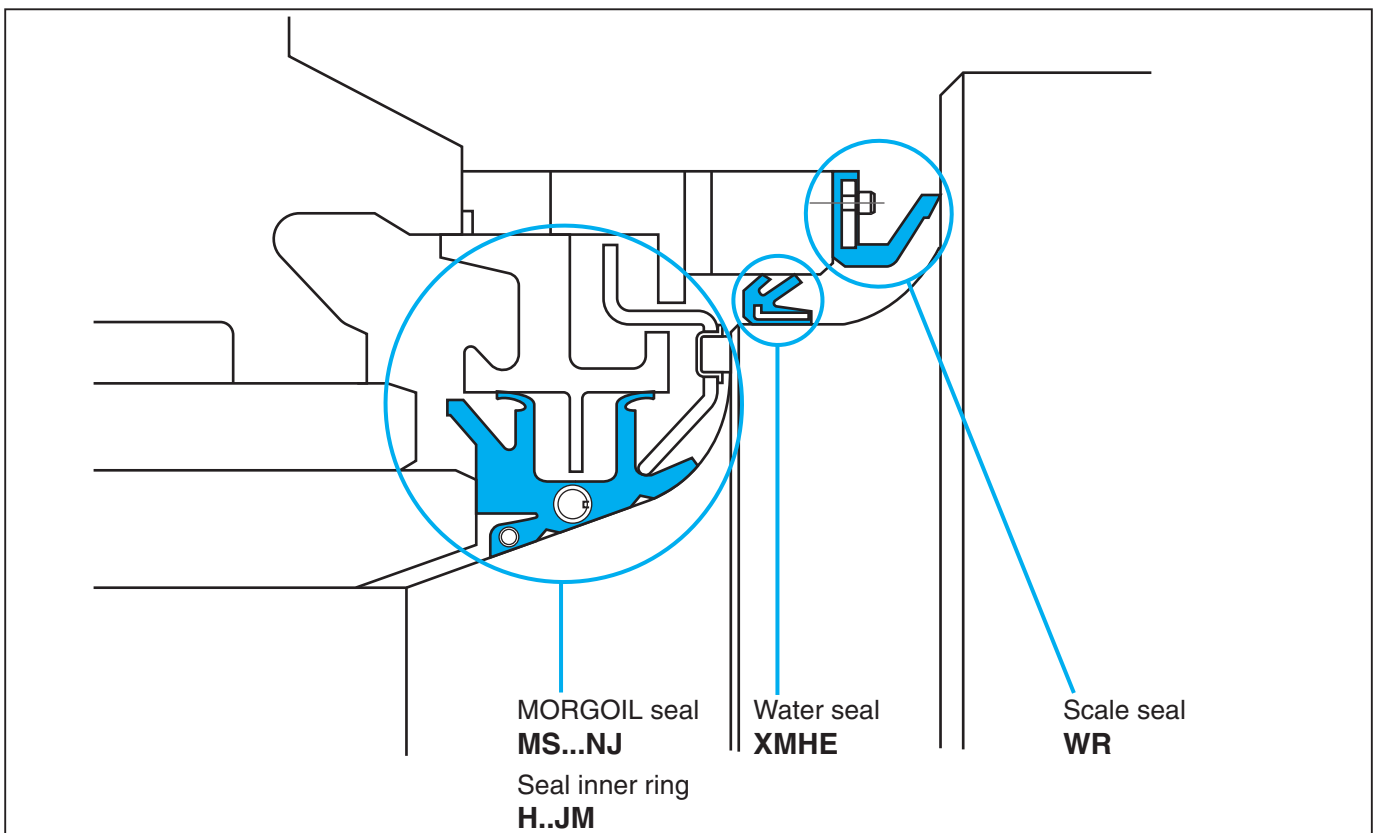


3.3 Rolling mill roll necks

Rolling bearing

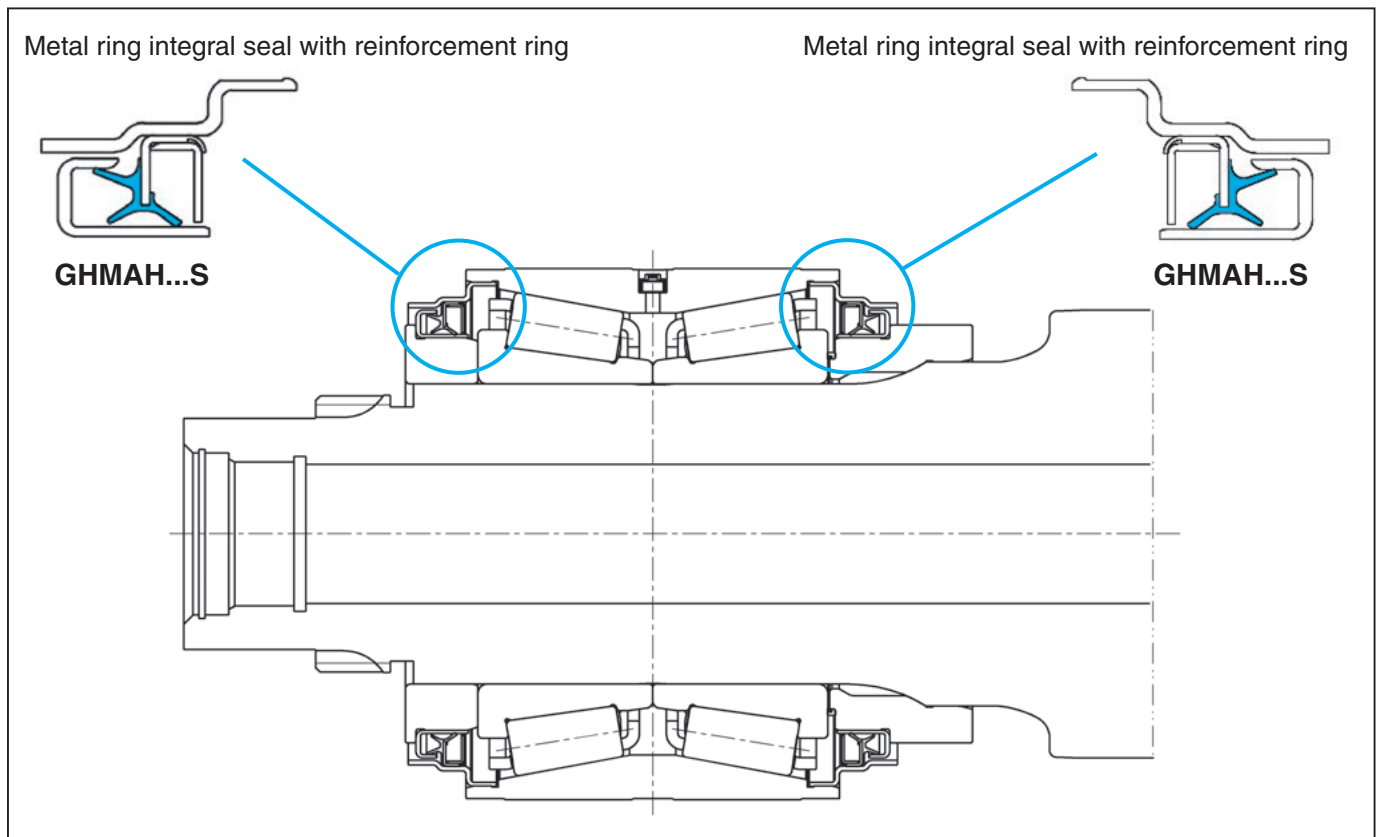


Oil-film bearing

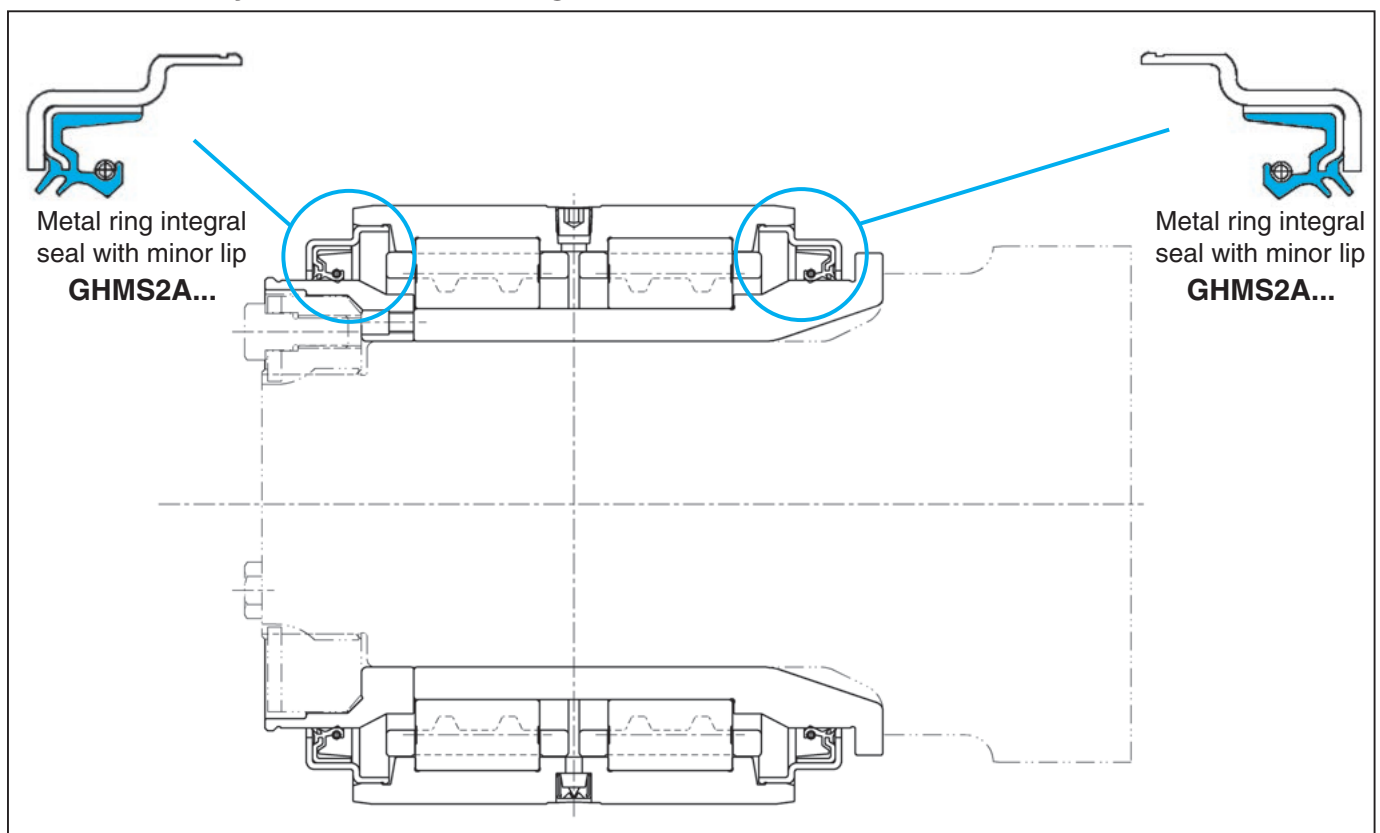


3.4 Rolling stock axles

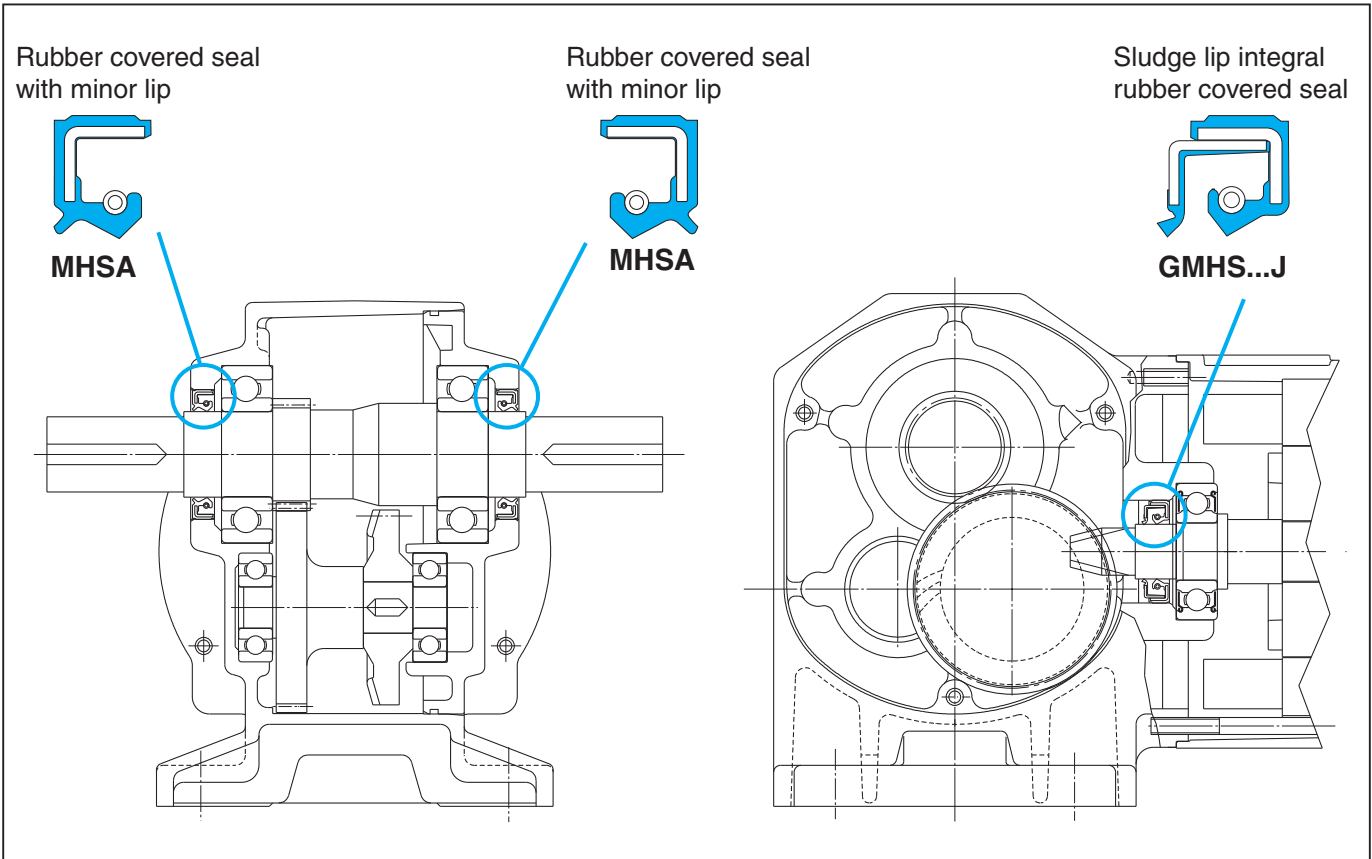
■ Double row tapered roller bearing



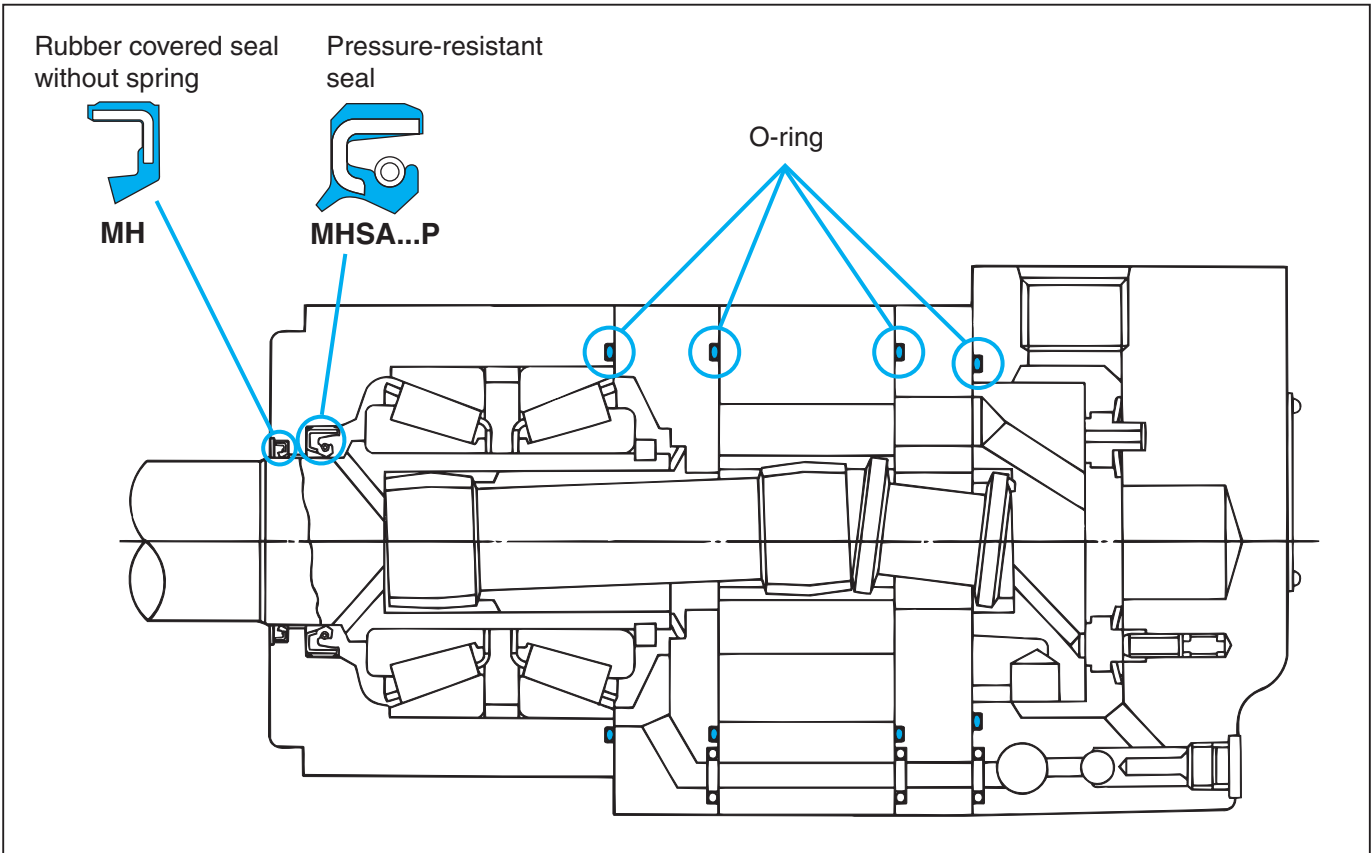
■ Double row cylindrical roller bearing



3.5 Geared motor



3.6 Hydraulic motor



4

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5

Request Forms for Oil Seal Design and Production

..... 166

4.1 Rubber-material varieties and properties

This table compares the properties of all available rubber materials, including those that are not suitable for oil seals and O-rings.

⊙ : Resistant to the substance.
 ○ : Resistant to the substance except under extreme conditions.
 △ : Not resistant to the substance except under specific favorable conditions.
 × : Not resistant to the substance.

| Kind of rubber (ASTM code) | | Nitrile rubber (NBR) | Hydrogenated nitrile rubber (HNBR) | Acrylic rubber (ACM and ANM) | Silicone rubber (VMQ) | Fluorocarbon rubber (FKM) | Chloroprene rubber (CR) | Ethylene-propylene rubber (EPM and EPDM) | Styrene-butadiene rubber (SBR) | Urethane rubber (U) | Natural rubber and isoprene rubber (NR and IR) | Butadiene rubber (BR) | Butyl rubber (IIR) | Chlorosulfonated polyethylene rubber (CSM) |
|--|---|--|--|---|---|--|--|--|--|---|--|---|---|---|
| Chemical structure | | Acrylonitrile-butadiene copolymer | Hydrogenated acrylonitrile-butadiene copolymer | Acrylic-ester copolymer | Organopolysiloxane | Hexafluoropropylene-vinylidene-fluoride copolymer | Polychloroprene | Ethylene-propylene copolymer | Styrene-butadiene copolymer | Polyurethane | Polyisoprene | Polybutadiene | Isobutylene-isoprene copolymer | Chlorosulfonated polyethylene |
| Raw-rubber properties | Specific gravity | 0.96 ~ 1.02 | 0.98 ~ 1.00 | 1.09 ~ 1.10 | 0.95 ~ 0.98 | 1.80 ~ 1.82 | 1.15 ~ 1.25 | 0.86 ~ 0.87 | 0.92 ~ 0.97 | 1.00 ~ 1.30 | 0.92 | 0.91 ~ 0.94 | 0.91 ~ 0.93 | 1.11 ~ 1.18 |
| | Mooney viscosity ML ₁₊₄ (100 °C) | 30 ~ 130 | 65 ~ 85 | 45 ~ 60 | Liquid | 35 ~ 160 | 45 ~ 120 | 40 ~ 100 | 30 ~ 70 | 25 ~ 60 (or liquid) | 45 ~ 150 | 35 ~ 55 | 45 ~ 80 | 30 ~ 115 |
| Compounded-rubber physical and resistance properties | Applicable JIS hardness range ¹⁾ | 20 ~ 100 | 40 ~ 100 | 40 ~ 90 | 30 ~ 90 | 50 ~ 90 | 10 ~ 90 | 30 ~ 90 | 30 ~ 100 | 60 ~ 100 | 10 ~ 100 | 30 ~ 100 | 20 ~ 90 | 50 ~ 90 |
| | Tensile strength (MPa) | 5 ~ 25 | 5 ~ 30 | 7 ~ 12 | 3 ~ 12 | 7 ~ 20 | 5 ~ 25 | 5 ~ 20 | 2 ~ 30 | 20 ~ 45 | 3 ~ 35 | 2 ~ 20 | 5 ~ 20 | 7 ~ 20 |
| | Elongation (%) | 800 ~ 100 | 800 ~ 100 | 600 ~ 100 | 500 ~ 50 | 500 ~ 100 | 1 000 ~ 100 | 800 ~ 100 | 800 ~ 100 | 800 ~ 300 | 1 000 ~ 100 | 800 ~ 100 | 800 ~ 100 | 500 ~ 100 |
| | Impact resilience | ○ | ○ | △ | ⊙ | △ | ⊙ | ○ | ○ | ⊙ | ⊙ | ⊙ | △ | ○ |
| | Tear strength | ○ | ○ | △ | × ~ △ | ○ | ○ | △ | △ | ⊙ | ⊙ | ○ | ○ | ○ |
| | Abrasion resistance | ⊙ | ⊙ | ○ | × ~ △ | ⊙ | ○ ~ ⊙ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ○ | ⊙ |
| | Flex crack resistance | ○ | ○ | ○ | × ~ ○ | ○ | ○ | ○ | ○ | ⊙ | ⊙ | △ | ⊙ | ○ |
| | Servisable temperature range (°C) | -50 ~ 120 | -40 ~ 160 | -30 ~ 180 | -80 ~ 250 | -30 ~ 250 | -60 ~ 120 | -60 ~ 150 | -60 ~ 70 | -60 ~ 80 | -75 ~ 90 | -100 ~ 100 | -60 ~ 150 | -60 ~ 150 |
| | Aging resistance | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ○ | ○ | ○ | ○ | ⊙ | ⊙ |
| | Resistance to weather | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | ○ | ⊙ | ○ | ○ | ⊙ | ⊙ |
| | Ozone resistance | × | ○ | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | × | ⊙ | × | × | ⊙ | ⊙ |
| Flame resistance | × ~ △ | × ~ △ | × ~ △ | × ~ ○ | ⊙ | ○ | × | × | × ~ △ | × | × | × | ○ | |
| Electrical insulation (Ω · cm) (volume resistivity) | 10 ² ~ 10 ¹¹ | — | 10 ⁸ ~ 10 ¹⁰ | 10 ¹¹ ~ 10 ¹⁶ | 10 ¹⁰ ~ 10 ¹⁴ | 10 ¹⁰ ~ 10 ¹² | 10 ¹² ~ 10 ¹⁶ | 10 ¹⁰ ~ 10 ¹⁵ | 10 ⁹ ~ 10 ¹² | 10 ¹⁰ ~ 10 ¹⁵ | 10 ¹⁴ ~ 10 ¹⁵ | 10 ¹⁶ ~ 10 ¹⁸ | 10 ¹² ~ 10 ¹⁴ | |
| Gas permeability (10 ⁻¹⁶ m ⁴ /N · s) | 0.03 ~ 0.35 | — | 1 | 40 | 0.1 | 0.3 | 1.5 | 1.2 | 0.2 | 1.8 | 1.3 ~ 5 | 0.09 ~ 0.1 | 0.3 | |
| Radiation resistance | △ ~ ○ | △ ~ ○ | × ~ ○ | △ ~ ⊙ | △ ~ ○ | △ ~ ○ | × | ○ | ○ | △ ~ ○ | × | × | △ ~ ○ | |
| Compound-rubber chemical resistance | Gasoline and light oil | ⊙ | ⊙ | ⊙ | × ~ △ | ⊙ | ○ | × | × | ⊙ | × | × | × | △ |
| | Benzene and toluene | × ~ △ | × ~ △ | × | × ~ △ | ⊙ | × | △ | × | × ~ △ | × | × | △ ~ ○ | × ~ △ |
| | Alcohol | ⊙ | ⊙ | × | ⊙ | ⊙ | ⊙ | ⊙ | ⊙ | △ | ⊙ | ⊙ | ⊙ | ⊙ |
| | Ether | × ~ △ | × ~ △ | × | × ~ △ | × | × | ○ | × | × | × | × | △ ~ ○ | × |
| | Ketone (MEK) | × | × | × | ○ | × | △ ~ ○ | ⊙ | △ ~ ○ | × | △ ~ ○ | △ ~ ○ | ⊙ | △ ~ ○ |
| | Ethyl acetate | × ~ △ | × ~ △ | × | △ ~ ⊙ | × | × | ⊙ | × | △ | × | × | ⊙ | × |
| | Water | ⊙ | ⊙ | △ | ○ | ⊙ | ⊙ | ⊙ | ⊙ | △ | ⊙ | ⊙ | ⊙ | ⊙ |
| | Organic acid | × ~ △ | × ~ △ | × | ○ | × | × | × | × | × | × | × | △ ~ ○ | △ |
| | Concentrate inorganic acid solution | ○ | ○ | △ | △ | ⊙ | ○ | ○ | △ | × | △ | △ | ⊙ | ⊙ |
| | Dilute inorganic acid solution | ○ | ○ | ○ | ○ | ⊙ | ⊙ | ⊙ | ○ | △ | ○ | ○ | ⊙ | ⊙ |
| | Concentrate inorganic alkaline solution | ○ | ○ | △ | ⊙ | × | ⊙ | ⊙ | ○ | × | ○ | ○ | ⊙ | ⊙ |
| Dilute inorganic alkaline solution | ○ | ○ | ○ | ⊙ | △ | ⊙ | ⊙ | ○ | × | ○ | ○ | ⊙ | ⊙ | |
| Typical properties and major applications | | The most common oil-resistant rubber material. Good resistance to abrasion. Widely used for oil seals and O-rings. | Excellent heat resistance and mechanical strength, in addition to having properties of nitrile rubber. An optimal material for oil seals for high-temperature or hydraulic applications. | Compared with nitrile rubber, superior in aging resistance. Suitable for sealing hydraulic fluids. Commonly used in automotive applications such as transmission, crankshaft, and valve stem. | Siloxane-based, excellent heat resistance and low-temperature resistance. Suitable for extreme-temperature environments and food processing applications. | Most excellent in resistance against various severe conditions. Optimal for use in proximity to engines. | Well-balanced in resistance to weather, oil and heat. Commonly used to isolate vibration and to coat wires. Some cases used for oil seals and O-rings. | Excellent weatherproof and water-proof. It is used for clad automobiles and wires. | Compared with natural rubber, superior in resistance to abrasion and aging. Used as the material of tires and belts. | Superior mechanical strength and oil resistance, however relatively low heat resistance and water-proofness. Used in applications where heat resistance is not essential. | Excellent resilience and superior abrasion resistance. Oil resistance is relatively low. Used for tires and shoes. | Excellent in resilience and mechanical strength. But inferior in resistance to oil and to pressure. Used for produce tires and sport goods. | Low gas permeability and inferior in resilience. Commonly used for tubes and vibration isolators. | Superior aging resistance and chemical resistance. Used for hoses and cladding. |

Note 1) Hardness measured by durometer.

References : Japanese Standards Association. Shinban Gomu Zairyo Sentaku no Pointo ("Rubber Material Selection Guidelines, Rev."). Society of Rubber Industry, Japan. Gomu Kogyo Binran ("Rubber Industry Handbook"), 4th ed.

4.2 SI units and conversion factors

SI units and conversion factors (1)

| Mass | SI units | Other Units ¹⁾ | Conversion into SI units | Conversion from SI units |
|-----------------------------|---------------------|---|---|---|
| Angle | rad [radian(s)] | ° [degree(s)] * ' [minute(s)] * " [second(s)] * | 1° = π / 180 rad 1' = π / 10 800 rad 1" = π / 648 000 rad | 1 rad = 57.295 78° |
| Length | m [meter(s)] | Å [Angstrom unit] μ [micron(s)] in [inch(es)] ft [foot(feet)] yd [yard(s)] mile [mile(s)] | 1Å = 10 ⁻¹⁰ m = 0.1 nm = 100 pm 1μ = 1μm 1 in = 25.4 mm 1 ft = 12 in = 0.304 8 m 1 yd = 3 ft = 0.914 4 m 1 mile = 5 280 ft = 1 609.344 m | 1 m = 10 ¹⁰ Å 1 m = 39.37 in 1 m = 3.280 8 ft 1 m = 1.093 6 yd 1 km = 0.621 4 mile |
| Area | m ² | a [are(s)] ha [hectare(s)] acre [acre(s)] | 1 a = 100 m ² 1 ha = 10 ⁴ m ² 1 acre = 4 840 yd ² = 4 046.86 m ² | 1 km ² = 247.1 acre |
| Volume | m ³ | ℓ , L [liter(s)] * cc [cubic centimeters] gal (US) [gallon(s)] floz (US) [fluid ounce(s)] barrel (US) [barrels(US)] | 1 ℓ = 1 dm ³ = 10 ⁻³ m ³ 1 cc = 1 cm ³ = 10 ⁻⁶ m ³ 1 gal (US) = 231 in ³ = 3.785 41 dm ³ 1 floz (US) = 29.573 5 cm ³ 1 barrel (US) = 158.987 dm ³ | 1 m ³ = 10 ³ ℓ 1 m ³ = 10 ⁶ cc 1 m ³ = 264.17 gal 1 m ³ = 33 814 floz 1 m ³ = 6.289 8 barrel |
| Time | s [second(s)] | min [minute(s)] * h [hour(s)] * d [day(s)] * | | |
| Angular velocity | rad/s | | | |
| Velocity | m/s | kn [knot(s)] * m/h * | 1 kn = 1 852 m/h | 1 km/h = 0.539 96 kn |
| Acceleration | m/s ² | G | 1 G = 9.806 65 m/s ² | 1 m/s ² = 0.101 97 G |
| Frequency | Hz [hertz] | c/s [cycle(s)/second] | 1 c/s = 1 s ⁻¹ = 1 Hz | |
| Rotational frequency | s ⁻¹ | rpm [revolutions per minute] min ⁻¹ * r/min | 1 rpm = 1/60 s ⁻¹ | 1 s ⁻¹ = 60 rpm |
| Mass | kg [kilogram(s)] | t [ton(s)] * lb [pound(s)] gr [grain(s)] oz [ounce(s)] ton (UK) [ton(s) (UK)] ton (US) [ton(s) (US)] car [carat(s)] | 1 t = 10 ³ kg 1 lb = 0.453 592 37 kg 1 gr = 64.798 91 mg 1 oz = 1/16 lb = 28.349 5 g 1 ton (UK) = 1 016.05 kg 1 ton (US) = 907.185 kg 1 car = 200 mg | 1 kg = 2.204 6 lb 1 g = 15.432 4 gr 1 kg = 35.274 0 oz 1 t = 0.984 2 ton (UK) 1 t = 1.102 3 ton (US) 1 g = 5 car |

Note 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

SI units and conversion factors (2)

| Mass | SI units | Other Units ¹⁾ | Conversion into SI units | Conversion from SI units |
|---|--|---|--|---|
| Density | kg/m ³ | | | |
| Linear density | kg/m | | | |
| Momentum | kg · m/s | | | |
| Moment of momentum, Angular momentum | } kg · m ² /s | | | |
| Moment of inertia | | kg · m ² | | |
| Force | N [newton(s)] | dyn [dyne(s)] kgf [kilogram-force] gf [gram-force] tf [ton-force] lbf [pound-force] | 1 dyn = 10 ⁻⁵ N 1 kgf = 9.806 65 N 1 gf = 9.806 65 × 10 ⁻³ N 1 tf = 9.806 65 × 10 ³ N 1 lbf = 4.448 22 N | 1 N = 10 ⁵ dyn 1 N = 0.101 97 kgf 1 N = 0.224 809 lbf |
| Moment of force | N · m [newton meter(s)] | gf · cm kgf · cm kgf · m tf · m lbf · ft | 1 gf · cm = 9.806 65 × 10 ⁻⁵ N · m 1 kgf · cm = 9.806 65 × 10 ⁻² N · m 1 kgf · m = 9.806 65 N · m 1 tf · m = 9.806 65 × 10 ³ N · m 1 lbf · ft = 1.355 82 N · m | 1 N · m = 0.101 97 kgf · m 1 N · m = 0.737 56 lbf · ft |
| Pressure, Normal stress | Pa [pascal(s)] or N/m ² {1 Pa = 1 N/m ² } | gf/cm ² kgf/mm ² kgf/m ² lbf/in ² bar [bar(s)] at [engineering air pressure] mH ₂ O, mAq [meter water column] atm [atmosphere] mHg [meter mercury column] Torr [torr] | 1 gf/cm ² = 9.806 65 × 10 Pa 1 kgf/mm ² = 9.806 65 × 10 ⁶ Pa 1 kgf/m ² = 9.806 65 Pa 1 lbf/in ² = 6 894.76 Pa 1 bar = 10 ⁵ Pa 1 at = 1kgf/cm ² = 9.806 65 × 10 ⁴ Pa 1 mH ₂ O = 9.806 65 × 10 ³ Pa 1 atm = 101 325 Pa 1 mHg = $\frac{101\ 325}{0.76}$ Pa 1 Torr = 1mmHg = 133.322 Pa | 1 MPa = 0.101 97 kgf/mm ² 1 Pa = 0.101 97 kgf/m ² 1 Pa = 0.145 × 10 ⁻³ lbf/in ² 1 Pa = 10 ⁻² mbar 1 Pa = 7.500 6 × 10 ⁻³ Torr |
| Viscosity | Pa · s [pascal second] | P [poise] kgf · s/m ² | 10 ⁻² P = 1 cP = 1 mPa · s 1 kgf · s/m ² = 9.806 65 Pa · s | 1 Pa · s = 0.101 97 kgf · s/m ² |
| Kinematic viscosity | m ² /s | St [stokes] | 10 ⁻² St = 1 cSt = 1 mm ² /s | |
| Surface tension | N/m | | | |

SI units and conversion factors (3)

| Mass | SI units | Other Units ¹⁾ | Conversion into SI units | Conversion from SI units |
|---|--|---|---|--|
| Work, energy | J [joule(s)] {1 J = 1 N · m} | eV [electron volt(s)] * erg [erg(s)] kgf · m lbf · ft | 1 eV = (1.602 189 2±0.000 004 6)×10 ⁻¹⁹ J 1 erg = 10 ⁻⁷ J 1 kgf · m = 9.806 65 J 1 lbf · ft = 1.355 82 J | 1 J = 10 ⁷ erg 1 J = 0.101 97 kgf · m 1 J = 0.737 56 lbf · ft |
| Power | W [watt(s)] | erg/s [ergs per second] kgf · m/s PS [French horse-power] HP [horse-power (British)] lbf · ft/s | 1 erg/s = 10 ⁻⁷ W 1 kgf · m/s = 9.806 65 W 1 PS = 75 kgf · m/s = 735.5 W 1 HP = 550 lbf · ft/s = 745.7 W 1 lbf · ft/s = 1.355 82 W | 1 W = 0.101 97 kgf · m/s 1 W = 0.001 36 PS 1 W = 0.001 34 HP |
| Thermo-dynamic temperature | K [kelvin(s)] | | | |
| Celsius temperature | °C [celsius(s)] {t°C = (t+273.15) K} | °F [degree(s) Fahrenheit] | t°F = $\frac{5}{9}(t - 32)°C$ | t°C = $(\frac{9}{5}t + 32)°F$ |
| Linear expansion coefficient | K ⁻¹ | °C ⁻¹ [per degree] | | |
| Heat | J [joule(s)] {1 J = 1 N · m} | erg [erg(s)] kgf · m cal _{IT} [I. T. calories] | 1 erg = 10 ⁻⁷ J 1 cal _{IT} = 4.186 8 J 1 Mcal _{IT} = 1.163 kW · h | 1 J = 10 ⁷ erg 1 J = 0.238 85 cal _{IT} 1 kW · h = 0.86 × 10 ⁶ cal _{IT} |
| Thermal conductivity | W/ (m · K) | W/ (m · °C) cal/ (s · m · °C) | 1 W/ (m · °C) = 1 W/ (m · K) 1 cal/ (s · m · °C) = 4.186 05 W/ (m · K) | |
| Coefficient of heat transfer | W/ (m ² · K) | W/ (m ² · °C) cal/ (s · m ² · °C) | 1 W/ (m ² · °C) = 1 W/ (m ² · K) 1 cal/ (s · m ² · °C) = 4.186 05 W/ (m ² · K) | |
| Heat capacity | J/K | J/°C | 1 J/°C = 1 J/K | |
| Massic heat capacity | J/ (kg · K) | J/ (kg · °C) | | |

Note 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

SI units and conversion factors (4)

| Mass | SI units | Other Units ¹⁾ | Conversion into SI units | Conversion from SI units |
|---|--|---------------------------------------|--|--|
| Electric current | A [ampere(s)] | | | |
| Electric charge, quantity of electricity | C [coulomb(s)] {1 C = 1 A · s} | A · h * | 1 A · h = 3.6 kC | |
| Tension, electric potential | V [volt(s)] {1 V = 1 W/A} | | | |
| Capacitance | F [farad(s)] {1 F = 1 C/V} | | | |
| Magnetic field strength | A/m | Oe [oersted(s)] | $1 \text{ Oe} = \frac{10^3}{4\pi} \text{ A/m}$ | $1 \text{ A/m} = 4\pi \times 10^{-3} \text{ Oe}$ |
| Magnetic flux density | T [tesla(s)] { $1 \text{ T} = 1 \text{ N}/(\text{A} \cdot \text{m})$ $= 1 \text{ Wb}/\text{m}^2$ $= 1 \text{ V} \cdot \text{s}/\text{m}^2$ } | Gs [gauss(es)] γ [gamma(s)] | $1 \text{ Gs} = 10^{-4} \text{ T}$ $1 \gamma = 10^{-9} \text{ T}$ | $1 \text{ T} = 10^4 \text{ Gs}$ $1 \text{ T} = 10^9 \gamma$ |
| Magnetic flux | Wb [weber(s)] {1 Wb = 1 V · s} | Mx [maxwell(s)] | $1 \text{ Mx} = 10^{-8} \text{ Wb}$ | $1 \text{ Wb} = 10^8 \text{ Mx}$ |
| Self inductance | H [henry (– ries)] {1 H = 1 Wb/A} | | | |
| Resistance (to direct current) | Ω [ohm(s)] {1 Ω = 1 V/A} | | | |
| Conductance (to direct current) | S [siemens] {1 S = 1 A/V} | | | |
| Active power | W { $1 \text{ W} = 1 \text{ J/s}$ $= 1 \text{ A} \cdot \text{V}$ } | | | |

4.3 Shaft tolerance

unit μm

| Nominal shaft diameter mm | | Deviation classes of shaft diameter | | | | | | | | | | | | | | | | | | | | Nominal shaft diameter mm | | | | | | | | | | | | | | | |
|------------------------------|-------|-------------------------------------|-------|------|------|------|------|------|------|-----|-----|-----|-----|-----|------|------|------|----|-----|--------|--------|------------------------------|-----|------|------|------|------|------|------|-------|------|-------|-------|-------|-------|-----|-------|
| | | over | up to | d6 | e6 | e7 | e8 | e9 | f6 | f7 | f8 | g5 | g6 | h5 | h6 | h7 | h8 | h9 | h10 | js5 | js6 | | | js7 | j5 | j6 | k5 | k6 | k7 | m5 | m6 | m7 | n5 | n6 | p6 | r6 | r7 |
| - | 3 | -20 | -14 | -14 | -14 | -14 | -6 | -6 | -6 | -2 | -2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 2 | ± 3 | ± 5 | ± 2 | + 4 | + 4 | + 6 | + 10 | + 6 | + 8 | + 12 | + 8 | + 10 | + 10 | + 16 | + 20 | - | 3 |
| 3 | 6 | -30 | -20 | -20 | -20 | -20 | -10 | -10 | -10 | -4 | -4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 2.5 | ± 4 | ± 6 | + 3 | + 6 | + 6 | + 9 | + 13 | + 9 | + 12 | + 16 | + 13 | + 16 | + 20 | + 23 | + 27 | 3 | 6 |
| 6 | 10 | -40 | -25 | -25 | -25 | -25 | -13 | -13 | -13 | -5 | -5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 3 | ± 4.5 | ± 7.5 | + 4 | + 7 | + 7 | + 10 | + 16 | + 12 | + 15 | + 21 | + 16 | + 19 | + 24 | + 28 | + 34 | 6 | 10 |
| 10 | 18 | -50 | -32 | -32 | -32 | -32 | -16 | -16 | -16 | -6 | -6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 4 | ± 5.5 | ± 9 | + 5 | + 8 | + 9 | + 12 | + 19 | + 15 | + 18 | + 25 | + 20 | + 23 | + 29 | + 34 | + 41 | 10 | 18 |
| 18 | 30 | -65 | -40 | -40 | -40 | -40 | -20 | -20 | -20 | -7 | -7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 4.5 | ± 6.5 | ± 10.5 | + 5 | + 9 | + 11 | + 15 | + 23 | + 17 | + 21 | + 29 | + 24 | + 28 | + 35 | + 41 | + 49 | 18 | 30 |
| 30 | 50 | -80 | -50 | -50 | -50 | -50 | -25 | -25 | -25 | -9 | -9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 5.5 | ± 8 | ± 12.5 | + 6 | + 11 | + 13 | + 18 | + 27 | + 20 | + 25 | + 34 | + 28 | + 33 | + 42 | + 50 | + 59 | 30 | 50 |
| 50 | 80 | -100 | -60 | -60 | -60 | -60 | -30 | -30 | -30 | -10 | -10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 6.5 | ± 9.5 | ± 15 | + 6 | + 12 | + 15 | + 21 | + 32 | + 24 | + 30 | + 41 | + 33 | + 39 | + 51 | + 60 | + 71 | 50 | 80 |
| 80 | 120 | -120 | -72 | -72 | -72 | -72 | -36 | -36 | -36 | -12 | -12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 7.5 | ± 11 | ± 17.5 | + 6 | + 13 | + 18 | + 25 | + 38 | + 28 | + 35 | + 48 | + 38 | + 45 | + 59 | + 62 | + 73 | 80 | 120 |
| 120 | 180 | -145 | -85 | -85 | -85 | -85 | -43 | -43 | -43 | -14 | -14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 9 | ± 12.5 | ± 20 | + 7 | + 14 | + 21 | + 28 | + 43 | + 33 | + 40 | + 55 | + 45 | + 52 | + 68 | + 88 | + 103 | 120 | 180 |
| 180 | 250 | -170 | -100 | -100 | -100 | -100 | -50 | -50 | -50 | -15 | -15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 10 | ± 14.5 | ± 23 | + 7 | + 16 | + 24 | + 33 | + 50 | + 37 | + 46 | + 63 | + 51 | + 60 | + 79 | + 106 | + 123 | 180 | 250 |
| 250 | 315 | -190 | -110 | -110 | -110 | -110 | -56 | -56 | -56 | -17 | -17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 11.5 | ± 16 | ± 26 | + 7 | ± 16 | + 27 | + 36 | + 56 | + 43 | + 52 | + 72 | + 57 | + 66 | + 88 | + 126 | + 146 | 250 | 315 |
| 315 | 400 | -210 | -125 | -125 | -125 | -125 | -62 | -62 | -62 | -18 | -18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 12.5 | ± 18 | ± 28.5 | + 7 | ± 18 | + 29 | + 40 | + 61 | + 46 | + 57 | + 78 | + 62 | + 73 | + 98 | + 144 | + 165 | 315 | 400 |
| 400 | 500 | -230 | -135 | -135 | -135 | -135 | -68 | -68 | -68 | -20 | -20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 13.5 | ± 20 | ± 31.5 | + 7 | ± 20 | + 32 | + 45 | + 68 | + 50 | + 63 | + 86 | + 67 | + 80 | + 108 | + 166 | + 189 | 400 | 500 |
| 500 | 630 | -260 | -145 | -145 | -145 | -145 | -76 | -76 | -76 | -22 | -22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 16 | ± 22 | ± 35 | - | - | + 32 | + 44 | + 70 | + 58 | + 70 | + 96 | + 76 | + 88 | + 122 | + 194 | + 220 | 500 | 630 |
| 630 | 800 | -290 | -160 | -160 | -160 | -160 | -80 | -80 | -80 | -24 | -24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 18 | ± 25 | ± 40 | - | - | + 36 | + 50 | + 80 | + 66 | + 80 | + 110 | + 86 | + 100 | + 138 | + 225 | + 255 | 630 | 800 |
| 800 | 1 000 | -320 | -170 | -170 | -170 | -170 | -86 | -86 | -86 | -26 | -26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ± 20 | ± 28 | ± 45 | - | - | + 40 | + 56 | + 90 | + 74 | + 90 | + 124 | + 96 | + 112 | + 156 | + 266 | + 300 | 800 | 900 |
| | | -376 | -226 | -260 | -310 | -400 | -142 | -176 | -226 | -66 | -82 | -40 | -56 | -90 | -140 | -230 | -360 | | | | | | | | | | | | | | | | | | | 900 | 1 000 |

4.4 Housing bore tolerance

unit μm

| Nominal bore diameter mm | | Deviation classes of housing bore diameter | | | | | | | | | | | | | | | | | | | | Nominal bore diameter mm | | | | | | | | |
|-----------------------------|-------|--|-------------|-------------|------------|-------------|----------|-----------|-----------|-----------|-----------|------------|------------|------------|-----------|------------|-----------|-----------|------------|------------|-------------|-----------------------------|-------------|-------------|-------------|--------------|--------------|--------------|-------|-------|
| over | up to | E6 | F6 | F7 | G6 | G7 | H6 | H7 | H8 | H9 | H10 | JS5 | JS6 | JS7 | J6 | J7 | K5 | K6 | K7 | M5 | M6 | M7 | N5 | N6 | N7 | P6 | P7 | R7 | over | up to |
| 3 | 6 | +28 +20 | +18 +10 | +22 +10 | +12 +4 | +16 +4 | +8 0 | +12 0 | +18 0 | +30 0 | +48 0 | ± 2.5 | ± 4 | ± 6 | +5 -3 | ± 6 | 0 -5 | +2 -6 | +3 -9 | -3 -8 | -1 -9 | 0 -12 | -7 -12 | -5 -13 | -4 -16 | -9 -17 | -8 -20 | -11 -23 | 3 | 6 |
| 6 | 10 | +34 +25 | +22 +13 | +28 +13 | +14 +5 | +20 +5 | +9 0 | +15 0 | +22 0 | +36 0 | +58 0 | ± 3 | ± 4.5 | ± 7.5 | +5 -4 | +8 -7 | +1 -5 | +2 -7 | +5 -10 | -4 -10 | -3 -12 | 0 -15 | -8 -14 | -7 -16 | -4 -19 | -12 -21 | -9 -24 | -13 -28 | 6 | 10 |
| 10 | 18 | +43 +32 | +27 +16 | +34 +16 | +17 +6 | +24 +6 | +11 0 | +18 0 | +27 0 | +43 0 | +70 0 | ± 4 | ± 5.5 | ± 9 | +6 -5 | +10 -8 | +2 -6 | +2 -9 | +6 -12 | -4 -12 | -4 -15 | 0 -18 | -9 -17 | -9 -20 | -5 -23 | -15 -26 | -11 -29 | -16 -34 | 10 | 18 |
| 18 | 30 | +53 +40 | +33 +20 | +41 +20 | +20 +7 | +28 +7 | +13 0 | +21 0 | +33 0 | +52 0 | +84 0 | ± 4.5 | ± 6.5 | ± 10.5 | +8 -5 | +12 -9 | +1 -8 | +2 -11 | +6 -15 | -5 -14 | -4 -17 | 0 -21 | -12 -21 | -11 -24 | -7 -28 | -18 -31 | -14 -35 | -20 -41 | 18 | 30 |
| 30 | 50 | +66 +50 | +41 +25 | +50 +25 | +25 +9 | +34 +9 | +16 0 | +25 0 | +39 0 | +62 0 | +100 0 | ± 5.5 | ± 8 | ± 12.5 | +10 -6 | +14 -11 | +2 -9 | +3 -13 | +7 -18 | -5 -16 | -4 -20 | 0 -25 | -13 -24 | -12 -28 | -8 -33 | -21 -37 | -17 -42 | -25 -50 | 30 | 50 |
| 50 | 80 | +79 +60 | +49 +30 | +60 +30 | +29 +10 | +40 +10 | +19 0 | +30 0 | +46 0 | +74 0 | +120 0 | ± 6.5 | ± 9.5 | ± 15 | +13 -6 | +18 -12 | +3 -10 | +4 -15 | +9 -21 | -6 -19 | -5 -24 | 0 -30 | -15 -28 | -14 -33 | -9 -39 | -26 -45 | -21 -51 | -30 -62 | 50 | 80 |
| 80 | 120 | +94 +72 | +58 +36 | +71 +36 | +34 +12 | +47 +12 | +22 0 | +35 0 | +54 0 | +87 0 | +140 0 | ± 7.5 | ± 11 | ± 17.5 | +16 -6 | +22 -13 | +2 -13 | +4 -18 | +10 -25 | -8 -23 | -6 -28 | 0 -35 | -18 -33 | -16 -38 | -10 -45 | -30 -52 | -24 -59 | -38 -76 | 80 | 120 |
| 120 | 180 | +110 +85 | +68 +43 | +83 +43 | +39 +14 | +54 +14 | +25 0 | +40 0 | +63 0 | +100 0 | +160 0 | ± 9 | ± 12.5 | ± 20 | +18 -7 | +26 -14 | +3 -15 | +4 -21 | +12 -28 | -9 -27 | -8 -33 | 0 -40 | -21 -39 | -20 -45 | -12 -52 | -36 -61 | -28 -68 | -48 -90 | 120 | 180 |
| 180 | 250 | +129 +100 | +79 +50 | +96 +50 | +44 +15 | +61 +15 | +29 0 | +46 0 | +72 0 | +115 0 | +185 0 | ± 10 | ± 14.5 | ± 23 | +22 -7 | +30 -16 | +2 -18 | +5 -24 | +13 -33 | -11 -31 | -8 -37 | 0 -46 | -25 -45 | -22 -51 | -14 -60 | -41 -70 | -33 -79 | -60 -109 | 180 | 250 |
| 250 | 315 | +142 +110 | +88 +56 | +108 +56 | +49 +17 | +69 +17 | +32 0 | +52 0 | +81 0 | +130 0 | +210 0 | ± 11.5 | ± 16 | ± 26 | +25 -7 | +36 -16 | +3 -20 | +5 -27 | +16 -36 | -13 -36 | -9 -41 | 0 -52 | -27 -50 | -25 -57 | -14 -66 | -47 -79 | -36 -88 | -74 -130 | 250 | 315 |
| 315 | 400 | +161 +125 | +98 +62 | +119 +62 | +54 +18 | +75 +18 | +36 0 | +57 0 | +89 0 | +140 0 | +230 0 | ± 12.5 | ± 18 | ± 28.5 | +29 -7 | +39 -18 | +3 -22 | +7 -29 | +17 -40 | -14 -39 | -10 -46 | 0 -57 | -30 -55 | -26 -62 | -16 -73 | -51 -87 | -41 -98 | -87 -144 | 315 | 400 |
| 400 | 500 | +175 +135 | +108 +68 | +131 +68 | +60 +20 | +83 +20 | +40 0 | +63 0 | +97 0 | +155 0 | +250 0 | ± 13.5 | ± 20 | ± 31.5 | +33 -7 | +43 -20 | +2 -25 | +8 -32 | +18 -45 | -16 -43 | -10 -50 | 0 -63 | -33 -60 | -27 -67 | -17 -80 | -55 -95 | -45 -108 | -103 -172 | 400 | 500 |
| 500 | 630 | +189 +145 | +120 +76 | +146 +76 | +66 +22 | +92 +22 | +44 0 | +70 0 | +110 0 | +175 0 | +280 0 | ± 16 | ± 22 | ± 35 | - | - | 0 -32 | 0 -44 | 0 -70 | -26 -58 | -26 -70 | -26 -96 | -44 -76 | -44 -88 | -44 -114 | -78 -122 | -78 -148 | -150 -225 | 500 | 630 |
| 630 | 800 | +210 +160 | +130 +80 | +160 +80 | +74 +24 | +104 +24 | +50 0 | +80 0 | +125 0 | +200 0 | +320 0 | ± 18 | ± 25 | ± 40 | - | - | 0 -36 | 0 -50 | 0 -80 | -30 -66 | -30 -80 | -30 -110 | -50 -86 | -50 -100 | -50 -130 | -88 -138 | -88 -168 | -175 -265 | 630 | 800 |
| 800 | 1 000 | +226 +170 | +142 +86 | +176 +86 | +82 +26 | +116 +26 | +56 0 | +90 0 | +140 0 | +230 0 | +360 0 | ± 20 | ± 28 | ± 45 | - | - | 0 -40 | 0 -56 | 0 -90 | -34 -74 | -34 -90 | -34 -124 | -56 -96 | -56 -112 | -56 -146 | -100 -156 | -100 -190 | -210 -310 | 800 | 1 000 |
| 1 000 | 1 250 | +261 +195 | +164 +98 | +203 +98 | +94 +28 | +133 +28 | +66 0 | +105 0 | +165 0 | +260 0 | +420 0 | ± 23.5 | ± 33 | ± 52.5 | - | - | 0 -47 | 0 -66 | 0 -105 | -40 -87 | -40 -106 | -40 -145 | -66 -113 | -66 -132 | -66 -171 | -120 -186 | -120 -225 | -250 -365 | 1 000 | 1 250 |

4.5 °C - °F temperature conversion table

4.5 °C - °F temperature conversion table

| °C | | °F | °C | | °F | °C | | °F | °C | | °F |
|--------|--------------|-------|-------|-----------|-------|------|-----------|-------|------|--------------|-------|
| - 73 | - 100 | - 148 | - 1.6 | 29 | 84.2 | 17.7 | 64 | 147.2 | 37.1 | 99 | 210.2 |
| - 62 | - 80 | - 112 | - 1.1 | 30 | 86.0 | 18.2 | 65 | 149.0 | 37.7 | 100 | 212 |
| - 51 | - 60 | - 76 | - 0.6 | 31 | 87.8 | 18.8 | 66 | 150.8 | 40.6 | 105 | 221 |
| - 40 | - 40 | - 40 | 0 | 32 | 89.6 | 19.3 | 67 | 152.6 | 43 | 110 | 230 |
| - 29 | - 20 | - 4 | 0.5 | 33 | 91.4 | 19.9 | 68 | 154.4 | 49 | 120 | 248 |
| - 23.3 | - 10 | 14 | 1.1 | 34 | 93.2 | 20.4 | 69 | 156.2 | 54 | 130 | 266 |
| - 17.7 | 0 | 32 | 1.6 | 35 | 95.0 | 21.0 | 70 | 158.0 | 60 | 140 | 284 |
| - 17.2 | 1 | 33.8 | 2.2 | 36 | 96.8 | 21.5 | 71 | 159.8 | 65 | 150 | 302 |
| - 16.6 | 2 | 35.6 | 2.7 | 37 | 98.6 | 22.2 | 72 | 161.6 | 71 | 160 | 320 |
| - 16.1 | 3 | 37.4 | 3.3 | 38 | 100.4 | 22.7 | 73 | 163.4 | 76 | 170 | 338 |
| - 15.5 | 4 | 39.2 | 3.8 | 39 | 102.2 | 23.3 | 74 | 165.2 | 83 | 180 | 356 |
| - 15.0 | 5 | 41.0 | 4.4 | 40 | 104.0 | 23.8 | 75 | 167.0 | 88 | 190 | 374 |
| - 14.4 | 6 | 42.8 | 4.9 | 41 | 105.8 | 24.4 | 76 | 168.8 | 93 | 200 | 392 |
| - 13.9 | 7 | 44.6 | 5.4 | 42 | 107.6 | 25.0 | 77 | 170.6 | 121 | 250 | 482 |
| - 13.3 | 8 | 46.4 | 6.0 | 43 | 109.4 | 25.5 | 78 | 172.4 | 149 | 300 | 572 |
| - 12.7 | 9 | 48.2 | 6.6 | 44 | 111.2 | 26.2 | 79 | 174.2 | 177 | 350 | 662 |
| - 12.2 | 10 | 50.0 | 7.1 | 45 | 113.0 | 26.8 | 80 | 176.0 | 204 | 400 | 752 |
| - 11.6 | 11 | 51.8 | 7.7 | 46 | 114.8 | 27.3 | 81 | 177.8 | 232 | 450 | 842 |
| - 11.1 | 12 | 53.6 | 8.2 | 47 | 116.6 | 27.7 | 82 | 179.6 | 260 | 500 | 932 |
| - 10.5 | 13 | 55.4 | 8.8 | 48 | 118.4 | 28.2 | 83 | 181.4 | 288 | 550 | 1 022 |
| - 10.0 | 14 | 57.2 | 9.3 | 49 | 120.2 | 28.8 | 84 | 183.2 | 315 | 600 | 1 112 |
| - 9.4 | 15 | 59.0 | 9.9 | 50 | 122.0 | 29.3 | 85 | 185.0 | 343 | 650 | 1 202 |
| - 8.8 | 16 | 61.8 | 10.4 | 51 | 123.8 | 29.9 | 86 | 186.8 | 371 | 700 | 1 292 |
| - 8.3 | 17 | 63.6 | 11.1 | 52 | 125.6 | 30.4 | 87 | 188.6 | 399 | 750 | 1 382 |
| - 7.7 | 18 | 65.4 | 11.5 | 53 | 127.4 | 31.0 | 88 | 190.4 | 426 | 800 | 1 472 |
| - 7.2 | 19 | 67.2 | 12.1 | 54 | 129.2 | 31.5 | 89 | 192.2 | 454 | 850 | 1 562 |
| - 6.6 | 20 | 68.0 | 12.6 | 55 | 131.0 | 32.1 | 90 | 194.0 | 482 | 900 | 1 652 |
| - 6.1 | 21 | 69.8 | 13.2 | 56 | 132.8 | 32.6 | 91 | 195.8 | 510 | 950 | 1 742 |
| - 5.5 | 22 | 71.6 | 13.7 | 57 | 134.6 | 33.3 | 92 | 197.6 | 538 | 1 000 | 1 832 |
| - 5.0 | 23 | 73.4 | 14.3 | 58 | 136.4 | 33.8 | 93 | 199.4 | 593 | 1 100 | 2 012 |
| - 4.4 | 24 | 75.2 | 14.8 | 59 | 138.2 | 34.4 | 94 | 201.2 | 648 | 1 200 | 2 192 |
| - 3.9 | 25 | 77.0 | 15.6 | 60 | 140.0 | 34.9 | 95 | 203.0 | 704 | 1 300 | 2 372 |
| - 3.3 | 26 | 78.8 | 16.1 | 61 | 141.8 | 35.5 | 96 | 204.8 | 760 | 1 400 | 2 552 |
| - 2.8 | 27 | 80.6 | 16.6 | 62 | 143.6 | 36.1 | 97 | 206.6 | 815 | 1 500 | 2 732 |
| - 2.2 | 28 | 82.4 | 17.1 | 63 | 145.4 | 36.6 | 98 | 208.4 | 871 | 1 600 | 2 937 |

Example

The center columns of numbers is the temperature in either degrees Centigrade (°C) or Fahrenheit (°F) whichever is desired to convert into the other. If degrees Fahrenheit is given, read degrees Centigrade to the left. If degrees Centigrade is given, read degrees Fahrenheit to the right.

$$C = \frac{5}{9}(F - 32)$$

$$F = \frac{9}{5}C + 32$$

4.6 Steel hardness conversion table

| Rockwell | Vicker's | Brinell | | Rockwell | | Shore |
|-------------------------------|----------|---------------|--------------------------|-----------------------------|------------------------------|-------|
| C-scale 1471.0 N {150 kgf} | | Standard ball | Tungsten carbide ball | A-scale 588.4 N {60 kgf} | B-scale 980.7 N {100 kgf} | |
| 68 | 940 | | | 85.6 | | 97 |
| 67 | 900 | | | 85.0 | | 95 |
| 66 | 865 | | | 84.5 | | 92 |
| 65 | 832 | | 739 | 83.9 | | 91 |
| 64 | 800 | | 722 | 83.4 | | 88 |
| 63 | 772 | | 705 | 82.8 | | 87 |
| 62 | 746 | | 688 | 82.3 | | 85 |
| 61 | 720 | | 670 | 81.8 | | 83 |
| 60 | 697 | | 654 | 81.2 | | 81 |
| 59 | 674 | | 634 | 80.7 | | 80 |
| 58 | 653 | | 615 | 80.1 | | 78 |
| 57 | 633 | | 595 | 79.6 | | 76 |
| 56 | 613 | | 577 | 79.0 | | 75 |
| 55 | 595 | — | 560 | 78.5 | | 74 |
| 54 | 577 | — | 543 | 78.0 | | 72 |
| 53 | 560 | — | 525 | 77.4 | | 71 |
| 52 | 544 | 500 | 512 | 76.8 | | 69 |
| 51 | 528 | 487 | 496 | 76.3 | | 68 |
| 50 | 513 | 475 | 481 | 75.9 | | 67 |
| 49 | 498 | 464 | 469 | 75.2 | | 66 |
| 48 | 484 | 451 | 455 | 74.7 | | 64 |
| 47 | 471 | 442 | 443 | 74.1 | | 63 |
| 46 | 458 | 432 | 432 | 73.6 | | 62 |
| 45 | 446 | | 421 | 73.1 | | 60 |
| 44 | 434 | | 409 | 72.5 | | 58 |
| 43 | 423 | | 400 | 72.0 | | 57 |
| 42 | 412 | | 390 | 71.5 | | 56 |
| 41 | 402 | | 381 | 70.9 | | 55 |
| 40 | 392 | | 371 | 70.4 | — | 54 |
| 39 | 382 | | 362 | 69.9 | — | 52 |
| 38 | 372 | | 353 | 69.4 | — | 51 |
| 37 | 363 | | 344 | 68.9 | — | 50 |
| 36 | 354 | | 336 | 68.4 | (109.0) | 49 |
| 35 | 345 | | 327 | 67.9 | (108.5) | 48 |
| 34 | 336 | | 319 | 67.4 | (108.0) | 47 |
| 33 | 327 | | 311 | 66.8 | (107.5) | 46 |
| 32 | 318 | | 301 | 66.3 | (107.0) | 44 |
| 31 | 310 | | 294 | 65.8 | (106.0) | 43 |
| 30 | 302 | | 286 | 65.3 | (105.5) | 42 |
| 29 | 294 | | 279 | 64.7 | (104.5) | 41 |
| 28 | 286 | | 271 | 64.3 | (104.0) | 41 |
| 27 | 279 | | 264 | 63.8 | (103.0) | 40 |
| 26 | 272 | | 258 | 63.3 | (102.5) | 38 |
| 25 | 266 | | 253 | 62.8 | (101.5) | 38 |
| 24 | 260 | | 247 | 62.4 | (101.0) | 37 |
| 23 | 254 | | 243 | 62.0 | 100.0 | 36 |
| 22 | 248 | | 237 | 61.5 | 99.0 | 35 |
| 21 | 243 | | 231 | 61.0 | 98.5 | 35 |
| 20 | 238 | | 226 | 60.5 | 97.8 | 34 |
| (18) | 230 | | 219 | — | 96.7 | 33 |
| (16) | 222 | | 212 | — | 95.5 | 32 |
| (14) | 213 | | 203 | — | 93.9 | 31 |
| (12) | 204 | | 194 | — | 92.3 | 29 |
| (10) | 196 | | 187 | | 90.7 | 28 |
| (8) | 188 | | 179 | | 89.5 | 27 |
| (6) | 180 | | 171 | | 87.1 | 26 |
| (4) | 173 | | 165 | | 85.5 | 25 |
| (2) | 166 | | 158 | | 83.5 | 24 |
| (0) | 160 | | 152 | | 81.7 | 24 |

4.7 Viscosity conversion table

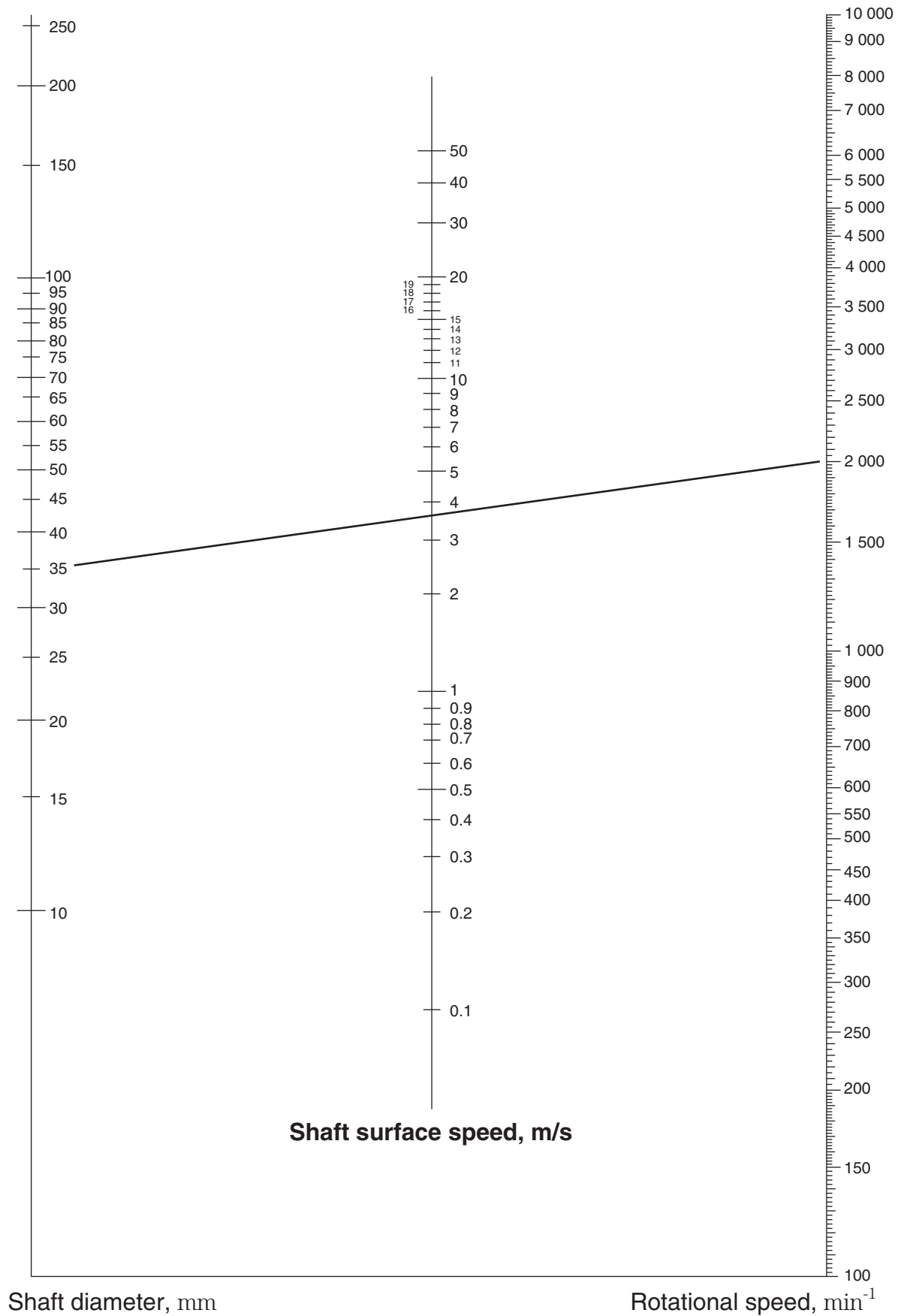
4.7 Viscosity conversion table

| Kinematic viscosity mm ² /s | Saybolt SUS (second) | | Redwood R (second) | | Engler E (degree) |
|---|-------------------------|--------|-----------------------|--------|----------------------|
| | 100 °F | 210 °F | 50 °C | 100 °C | |
| 2 | 32.6 | 32.8 | 30.8 | 31.2 | 1.14 |
| 3 | 36.0 | 36.3 | 33.3 | 33.7 | 1.22 |
| 4 | 39.1 | 39.4 | 35.9 | 36.5 | 1.31 |
| 5 | 42.3 | 42.6 | 38.5 | 39.1 | 1.40 |
| 6 | 45.5 | 45.8 | 41.1 | 41.7 | 1.48 |
| 7 | 48.7 | 49.0 | 43.7 | 44.3 | 1.56 |
| 8 | 52.0 | 52.4 | 46.3 | 47.0 | 1.65 |
| 9 | 55.4 | 55.8 | 49.1 | 50.0 | 1.75 |
| 10 | 58.8 | 59.2 | 52.1 | 52.9 | 1.84 |
| 11 | 62.3 | 62.7 | 55.1 | 56.0 | 1.93 |
| 12 | 65.9 | 66.4 | 58.2 | 59.1 | 2.02 |
| 13 | 69.6 | 70.1 | 61.4 | 62.3 | 2.12 |
| 14 | 73.4 | 73.9 | 64.7 | 65.6 | 2.22 |
| 15 | 77.2 | 77.7 | 68.0 | 69.1 | 2.32 |
| 16 | 81.1 | 81.7 | 71.5 | 72.6 | 2.43 |
| 17 | 85.1 | 85.7 | 75.0 | 76.1 | 2.54 |
| 18 | 89.2 | 89.8 | 78.6 | 79.7 | 2.64 |
| 19 | 93.3 | 94.0 | 82.1 | 83.6 | 2.76 |
| 20 | 97.5 | 98.2 | 85.8 | 87.4 | 2.87 |
| 21 | 102 | 102 | 89.5 | 91.3 | 2.98 |
| 22 | 106 | 107 | 93.3 | 95.1 | 3.10 |
| 23 | 110 | 111 | 97.1 | 98.9 | 3.22 |
| 24 | 115 | 115 | 101 | 103 | 3.34 |
| 25 | 119 | 120 | 105 | 107 | 3.46 |
| 26 | 123 | 124 | 109 | 111 | 3.58 |
| 27 | 128 | 129 | 112 | 115 | 3.70 |
| 28 | 132 | 133 | 116 | 119 | 3.82 |
| 29 | 137 | 138 | 120 | 123 | 3.95 |
| 30 | 141 | 142 | 124 | 127 | 4.07 |
| 31 | 145 | 146 | 128 | 131 | 4.20 |
| 32 | 150 | 150 | 132 | 135 | 4.32 |
| 33 | 154 | 155 | 136 | 139 | 4.45 |
| 34 | 159 | 160 | 140 | 143 | 4.57 |

| Kinematic viscosity mm ² /s | Saybolt SUS (second) | | Redwood R (second) | | Engler E (degree) |
|---|-------------------------|--------|-----------------------|--------|----------------------|
| | 100 °F | 210 °F | 50 °C | 100 °C | |
| 35 | 163 | 164 | 144 | 147 | 4.70 |
| 36 | 168 | 170 | 148 | 151 | 4.83 |
| 37 | 172 | 173 | 153 | 155 | 4.96 |
| 38 | 177 | 178 | 156 | 159 | 5.08 |
| 39 | 181 | 183 | 160 | 164 | 5.21 |
| 40 | 186 | 187 | 164 | 168 | 5.34 |
| 41 | 190 | 192 | 168 | 172 | 5.47 |
| 42 | 195 | 196 | 172 | 176 | 5.59 |
| 43 | 199 | 201 | 176 | 180 | 5.72 |
| 44 | 204 | 205 | 180 | 185 | 5.85 |
| 45 | 208 | 210 | 184 | 189 | 5.98 |
| 46 | 213 | 215 | 188 | 193 | 6.11 |
| 47 | 218 | 219 | 193 | 197 | 6.24 |
| 48 | 222 | 224 | 197 | 202 | 6.37 |
| 49 | 227 | 228 | 201 | 206 | 6.50 |
| 50 | 231 | 233 | 205 | 210 | 6.63 |
| 55 | 254 | 256 | 225 | 231 | 7.24 |
| 60 | 277 | 279 | 245 | 252 | 7.90 |
| 65 | 300 | 302 | 266 | 273 | 8.55 |
| 70 | 323 | 326 | 286 | 294 | 9.21 |
| 75 | 346 | 349 | 306 | 315 | 9.89 |
| 80 | 371 | 373 | 326 | 336 | 10.5 |
| 85 | 394 | 397 | 347 | 357 | 11.2 |
| 90 | 417 | 420 | 367 | 378 | 11.8 |
| 95 | 440 | 443 | 387 | 399 | 12.5 |
| 100 | 464 | 467 | 408 | 420 | 13.2 |
| 120 | 556 | 560 | 490 | 504 | 15.8 |
| 140 | 649 | 653 | 571 | 588 | 18.4 |
| 160 | 742 | 747 | 653 | 672 | 21.1 |
| 180 | 834 | 840 | 734 | 757 | 23.7 |
| 200 | 927 | 933 | 816 | 841 | 26.3 |
| 250 | 1 159 | 1 167 | 1 020 | 1 051 | 32.9 |
| 300 | 1 391 | 1 400 | 1 224 | 1 241 | 39.5 |

Remark) 1 mm²/s=1 cSt (centi stokes)

4.8 Shaft surface speed – Quick reference diagram –



5. Request Forms for Oil Seal Design and Production

Fill in the Request Forms for Oil Seal Design and Production (1) and (2) and send them by fax to your

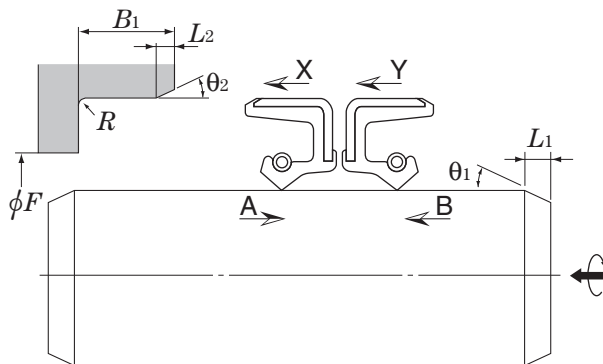
nearest JTEKT office when you need oil seal selection or when you have any requests or questions.

Request Form for Oil Seal Design and Production (1)

| | | | |
|-----------------|--|-----|--|
| Your name | | TEL | |
| Company / Dept. | | FAX | |
| Address | | | |

| | | | | | | | | | |
|--------------------------|--------------------------------|---|--------------------------------------|--------------------------------|------------------------|--|------------|----------|----------|
| Applied position | | Machine name | | | | | | | |
| Shaft | Outside diameter and tolerance | Housing | Bore diameter and tolerance | | | | | | |
| | Chamfer | | L_1 | θ_1 | Width and tolerance | | | | |
| | Motion type | | Rotary / Reciprocating / Oscillatory | | Chamfer | L_2 | θ_2 | | |
| | Direction of motion | Horizontal / Vertical | | Material and surface roughness | | | | | |
| | | Other () | | Housing bore eccentricity | mm TIR | | | | |
| | Motion frequency | Continuous | | Sealed medium | Substance to be sealed | Inside | | | |
| | | Intermittent | | | Level | Outside | | | |
| | | Other (rapid acceleration / deceleration) | | Temperature | Normal | °C Max. | °C | | |
| | Rotational speed | Normal: | Max.: | min ⁻¹ | Pressure | Internal | Normal | kPa Max. | kPa |
| | Sliding frequency | Hz | mm | | | | External | Normal | kPa Max. |
| | Oscillation frequency | Hz | ° | | Bearing Number | | | | |
| | Shaft runout | mm TIR | | | Lubricant oil name | | | | |
| | Material and hardness | Bearing | | Lubrication method | | Oil bath / Circulation / Splash / Drip / Other () | | | |
| Surface finishing method | | | | | | | | | |
| Surface roughness | | | | | | | | | |

Mounting specification



- Housing shoulder diameter F :
- Housing bore depth B_1 :
- Housing bore radius R :
- Seal mounting direction into housing: X/Y
- Seal mounting direction onto shaft: A/B
- Shaft rotational direction: Right/Left/Bi-direction
 (Right: Clockwise when viewed from oil seal back face
 Left: Counterclockwise when viewed from oil seal back face)

☆ Please specify as many items as possible to enable correct product design and selection.

<Manufacture>**KOYO SEALING TECHNO CO., LTD.**

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