ECOSEAL CO.,LTD.

Flow and Sealing Technology

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O-RING

O-RING SPECIFICATION

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GAPI™

1.1 O-ring classification and application guide

(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 1.1.1

Table 1.1.1 O-ring classification and application guide

Application	General industrial machines			Automobiles		Aircraft
Applicable standards	JIS B 2401		ISO 3601	JASO F 404		AS 568 AN 6227 AN 6230
Classification	Class	Remarks	Remarks	Class	Remarks	Remarks
Material	Class 1-A Class 1-B Class 2 Class 3 Class 4-C Class 4-D	For mineral oil (A70)* For mineral oil (A90)* For gasoline For animal oil and vegetable oil For high temperature applications For high temperature applications	For mineral-base fluids Class: JIS Class 1-A (A 70)*	Class 1-A Class 2 Class 3 Class 4-C Class 4-D Class 4-E Class 5	For general mineral oil For gasoline For brake fluid For high temperature applications For high temperature applications For high temperature applications For coolant	For mineral-base fluids Class: JIS Class 1-A (A 70)* JIS Class 1-B (A 90)* JIS Class 4-D
Remarks	P: For dynamic / static sealing G: For static sealing V: For vacuum flanges S: For static sealing (not standardized in the JIS)		For general industrial use	For dynamic / static sealing		AS 568 : For static sealing AN 6227 : For dynamic / static sealing AN 6230 : For static sealing

*: Hardness measured by durometer type A

(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.

Table1.1.2 shows backup ring types and material.

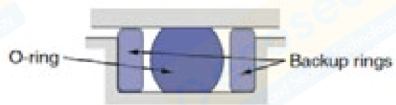
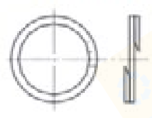
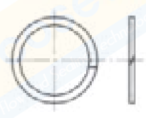
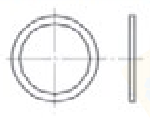


Fig. 1.1.1 O-ring installation with backup rings

Table 1.1.2 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		

1.2 Designation numbers

(1) O-ring designation numbers

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

Table 1.2.1 O-ring numbering system

Example

Material code	Application code	Dimensional code	
	P	26	JIS product [1]
1B	G	80	JIS product
2	JASO	1013	JASO product [2]
4C	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	Basic standard	Remarks
None	JIS B 2401 Class 1-A	Nitrile rubber (A70)*
1B	JIS B 2401 Class 1-B	Nitrile rubber (A90)*
2	JIS B 2401 Class 2	Nitrile rubber (gasoline-resistant)
3	JIS B 2401 Class 3	Styrene-butadiene rubber
4C	JIS B 2401 Class 4-C	Silicone rubber
4D	JIS B 2401 Class 4-D	Fluorocarbon rubber
4E	JASO F 404 Class 4-E	Acrylic rubber
5	JASO F 404 Class 5	Ethylene propylene rubber

*: Hardness measured by durometer type A

2) Application codes

Code	Basic standard	Remarks
P	JIS B 2401 P	For dynamic sealing / static sealing of cylindrical or flat surface
G	JIS B 2401 G	For static sealing of cylindrical or flat surface
V	JIS B 2401 V	For vacuum flange
S	Slim series	For static sealing of cylindrical or flat surface
JASO	JASO F 404	For dynamic sealing / static sealing of cylindrical or flat surface
AS	AS 568	For static sealing of cylindrical or flat surface
	AN 6227	For dynamic sealing / static sealing of cylindrical surface
	AN 6230	For static sealing of cylindrical surface
A B C D E	ISO 3601	For general industrial machines

(2) Backup ring designation numbers

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

Table 1.2.2 Backup ring numbering system

Example

T1 P5

T1: Type code
P5: O-ring number

■ Type codes

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

Remark) Backup ring types and shapes are listed in Table 1.1.2

1.3 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 1.3.1

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

Table 1.3.1 O-ring rubber materials and their physical properties

Applicable standards		JIS B 2401							–	–
		JASO F 404	–	JASO F 404						
Class		Class 1-A	Class 1-B	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)	Styrene-butadiene rubber (SBR)		Silicone rubber (VMQ)	Fluorocarbon rubber (FKM)	Acrylic rubber (ACM)	Ethylene-propylene rubber (EPDM)
Test items	Applications	For mineral oil		For gasoline	For animal oil and vegetable oil		For high temperature applications			For coolant
Normal properties	Hardness by durometer type A	A70/S ± 5	A90/S ± 5	A70/S ± 5	A70/S ± 5		A70/S ± 5	A70/S ± 5	A70/S ± 5	A70/S ± 5
	Tensile strength (MPa), min.	9.8	14	9.8	9.8		3.4	9.8	5.9	9.8
	Elongation (%), min.	250	100	200	150		60	200	100	150
	Tensile stress (MPa), min. (at 100 % elongation)	2.7	–	2.7	2.7		–	1.9	–	2.7
Aging tests	Temperature and duration	120 °C, 70 hours		100 °C, 70 hours			230 °C, 24 hours		150 °C, 70 hours	120 °C, 70 hours
	Change in hardness, max.	+ 10	+ 10	+ 10	+ 10		+ 10	+ 5	+ 10	+ 10
	Change in tensile strength (%), max.	− 15	− 25	− 15	− 15		− 10	− 10	− 30	− 20
	Change in elongation (%), max.	− 45	− 55	− 40	− 45		− 25	− 25	− 40	− 40
Compression set test	Temperature and duration	120 °C, 70 hours		100 °C, 70 hours			175 °C, 22 hours		150 °C, 70 hours	120 °C, 70 hours
	Compression set (%), max.	40	40	25	25		30	40	60	40
Immersion test	Temperature, duration, and testing oil	120 °C, 70 hours, ASTM No.1 oil		23 °C, 70 hours, fuel oil No.1	100 °C, 70 hours, brake fluid		175 °C, 70 hours, ASTM No.1 oil		150 °C, 70 hours, ASTM No.1 oil	100 °C, 70 hours, coolant
	Change in hardness	− 5 ~ + 8	− 5 ~ + 8	− 8 ~ 0	− 15 ~ 0		− 10 ~ + 5	− 10 ~ + 5	− 7 ~ + 10	− 5 ~ + 5
	Change in tensile strength (%), max.	− 15	− 20	− 15	− 40		− 20	− 20	− 30	− 30
	Change in elongation (%), max.	− 40	− 40	− 25	− 40		− 20	− 20	− 40	− 30
	Change in volume (%)	− 8 ~ + 5	− 8 ~ + 5	− 3 ~ + 5	0 ~ + 12		0 ~ + 10	− 5 ~ + 5	− 5 ~ + 5	− 5 ~ + 10
	Temperature, duration, and testing oil	120 °C, 70 hours, IRM903 oil		23 °C, 70 hours, fuel oil No.2	–		–	175 °C, 70 hours, IRM903 oil	150 °C, 70 hours, IRM903 oil	–
	Change in hardness	− 15 ~ 0	− 10 ~ + 5	− 20 ~ 0				− 10 ~ + 5	− 20 ~ 0	
	Change in tensile strength (%), max.	− 25	− 35	− 45				− 20	− 40	
	Change in elongation (%), max.	− 35	− 35	− 45				− 20	− 40	
	Change in volume (%)	0 ~ + 20	0 ~ + 20	0 ~ + 30				− 5 ~ + 5	0 ~ + 30	
Low temperature brittleness test	Non-destructive temperature (°C)	− 13	–	− 10	− 40		− 50	− 15	− 1	− 40
Low temperature bending test	Temperature and duration	− 30 °C ~ − 35 °C, 5 hours								
	Appearance	Test two pieces firstly for checking any crack. If one does have a crack, test again on another two pieces from the same lot and re-check and confirm that there is no crack.								
Corrosion test and stickiness test	Temperature and duration	70 ± 1 °C, 24 hours								
	Appearance	The rubber should not corrode the metal with which it is in contact nor should it become sticky. However, metal surface decoloration should not be jedged as corrosion.								

(2) Selection of O-ring material

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

Table1.3.2 below lists the substances with which each rubber material can remain stable. Consult GAPI 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 1.3.2 O-ring rubber materials and their stability to fluids

	Applicable standard	JIS B 2401 / JASO F 404	JIS B 2401 / –	JIS B 2401 / JASO F 404	JIS B 2401 / JASO F 404	JIS B 2401 / JASO F 404	JIS B 2401 / JASO F 404	JIS B 2401 / JASO F 404	–	–
	Class	Class 1-A	Class 1-B	Class 2	Class 3	Class 4-C	Class 4-D	Class 4-E	Class 5
	Rubber material	Nitrile rubber (NBR)	Nitrile rubber (NBR)	Nitrile rubber (NBR)	Styrene-butadiene rubber (SBR)	Silicone rubber (VMQ)	Fluorocarbon rubber (FKM)	Acrylic rubber (ACM)	Ethylene-propylene rubber (EPDM)
	Operating temperature range (°C) (Guidance)	−30 ~ 100	−25 ~ 100	−25 ~ 80	−50 ~ 80	−50 ~ 200	−15 ~ 200	−15 ~ 130	−45 ~ 130
Weatherability	Ozone resistance	△		△	△	◎	◎	◎	◎
	Flame resistance	×		×	×	○	◎	×	×
	Radiation resistance	△		△	○	△	△	×	○
	Coal gas	○		◎	△	△	◎	○	△
	Liquefied petroleum gas	○		◎	×	×	◎	△	×
Resistance to lubrication oils	Gear oil	◎		○	×	△	◎	◎	×
	Engine oil	◎		○	×	△	◎	◎	×
	Machine oil	◎		◎	×	○	◎	◎	×
	Spindle oil	◎		◎	×	△	◎	○	×
	Lithium grease	◎		◎	×	◎	◎	◎	×
	Silicone grease	◎		◎	○	×	◎	◎	◎
	Cup grease	◎		◎	×	△	◎	○	×
	Refrigeration oil(mineral oil)	○		◎	×	△	◎	○	×
Resistance to hydraulic fluids	Turbine oil	◎		◎	×	○	◎	◎	×
	Torque-converter oil	△		◎	×	△	◎	◎	×
	Brake fluid	△		△	◎	○	△	×	◎
	Silicone oil	◎		◎	○	×	◎	◎	◎
	Phosphoric ester	×		×	×	○	◎	×	◎
	Water + glycol	○		○	○	△	○	×	◎
	Oil + water emulsion	◎		◎	△	△	○	×	△
Resistance to fuel oils and water	Gasoline	△		○	×	×	◎	×	×
	Light oil and kerosene	△		◎	×	×	◎	×	×
	Heavy oil	△		○	×	×	◎	×	×
	Cold water and warm water	○		○	○	○	○	×	◎
	Steam and hot water	○		○	○	△	△	×	◎
	Water including antifreeze fluid	○		○	△	△	○	×	◎
	Water-based cutting oil	○		○	△	△	○	×	△
Chemical resistance	Trichloroethylene	×		×	×	×	△	×	×
	Alcohol	○		○	◎	○	○	×	◎
	Benzene	×		×	×	×	△	×	×
	Ethylene glycol	◎		◎	◎	◎	◎	△	◎
	Acetone	×		×	△	△	×	×	○
	Hydrochloric acid 20 %	△		△	○	△	◎	△	◎
	Sulfuric-acid 30 %	○		○	○	○	◎	△	◎
	Nitric-acid 10 %	×		×	×	×	◎	×	○
	Caustic soda 30 %	◎		◎	◎	×	×	×	◎
	Features	• The most common material • High resistance to oil, abrasion and heat • Hardness: A70	• Harder and higher pressure-resistance than Class 1-A rubber • Same properties as Class 1-A rubber in other respects • Hardness: A90	• High resistance to fuel oils, such as gasoline, light oil and kerosene	• High resistance to animal oil and vegetable oil, such as brake fluid	• High resistance to high and low temperature • Excellent self-restoration after compression, under a wide temperature range	• Highest resistance to oils, chemicals, and heat • Useful over a wide temperature range	• Superior to nitrile rubber in terms of heat resistance and oil resistance • Especially resistant to high temperature oil	• Superior in ozone resistance, heat resistance and electrical insulation resistance

(Class 1-A and Class 1-B share one merged cell for each fluid rating.)

(3) Selection of O-ring cross section diameter

The groove into which an O-ring is installed is designed to compress (squeeze) the cross section diameter. Determine this compression carefully, because O-rings may become permanently deformed if squeezed excessively, thus deteriorating sealing performance.

Generally, the compression 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.1.3.1 shows the relation between O-ring cross section diameter and compression set.

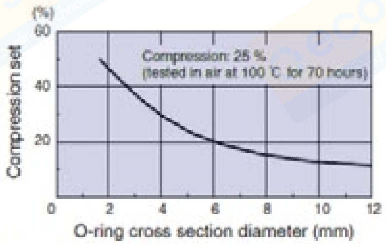


Fig. 1.3.1 Relation between O-ring cross section diameter and compression set

Larger cross section diameter offers more stable sealing performance. As shown in Fig.1.3.1, 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.

1.4 O-ring technical principles

(1) Sealing mechanism

Fig.1.4.1 shows how O-ring can be deformed under pressure.

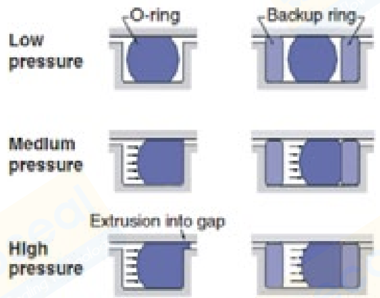


Fig. 1.4.1 O-ring deformation under pressure

O-ring installed in a groove with compression 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 when high pressure is put on the O-ring in two directions. One backup ring is installed 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.1.5.1. "O-ring extrusion limit values," when using backup rings.

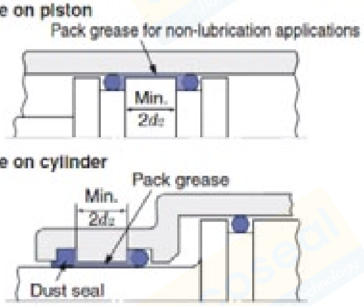
Backup rings of endless design (T3) are the most advantageous in the prevention of extrusion into the gap. However, those of spiral design (T1) and bias-cut design (T2) can be more easily installed.

All GAPI 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.1.4.2). 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.



d_2: O-ring cross section diameter

Fig. 1.4.2 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 GAPI.

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

When O-ring is used under low pressure with the compression 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.

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.1.4.3).

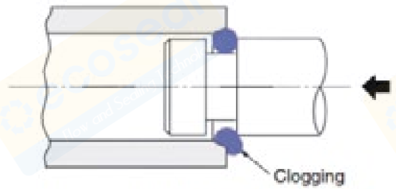


Fig. 1.4.3 O-ring slack and clogging

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 GAPI 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 d_7. When the O-ring is exposed to external pressure, O-ring bore diameter should be determined according to groove diameter d_8 (see Fig.1.4.4(a) and (b)).

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.1.4.4 (c)).

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

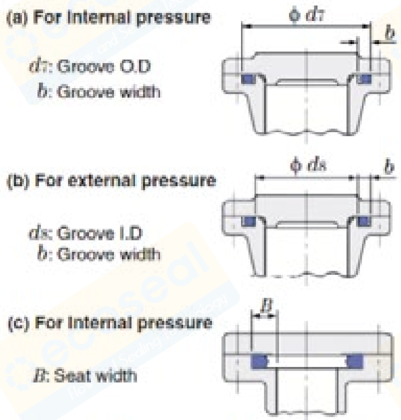


Fig. 1.4.4 Fitting groove for static sealing of flat surface

In the case of internal-pressure applications and O-ring size is small (30 mm or less), the d_7 dimension 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.1.4.5).

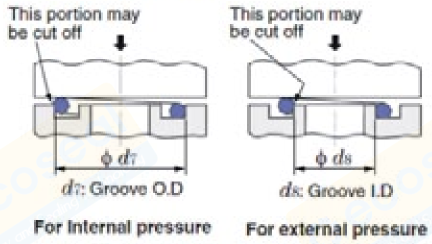


Fig. 1.4.5 O-ring protrusion

(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 GAPI.

(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.1.4.6).

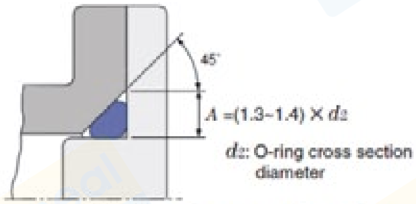


Fig. 1.4.6 Triangular-groove dimensions

1.5 Fitting groove design for O-ring

(1) Compression amount

Table 1.5.1 lists the JIS-standard of O-ring compression amount.

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

Table 1.5.1 O-ring compression amount

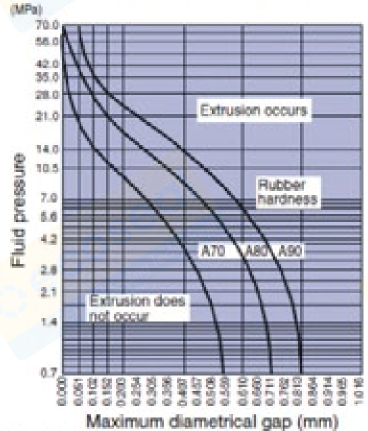
O-ring number	O-ring dimensions, mm		Compression amount							
			For dynamic sealing /static sealing of cylindrical surface				For static sealing of flat surface			
			mm		%		mm		%	
	Cross section diameter d_2	Bore diameter d_1	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
P3 ~ P10	1.9 ±0.08	2.8 ~ 9.8	0.48	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

O-ring extrusion into gap from fitting groove on cylindrical surface is related to the gap amount of the cylindrical surface. Pressure of fluid to be sealed or O-ring hardness also influence.

Fig.1.5.1 shows the relation between these factors.



1. Without backup ring
2. Cylinder expansion due to pressure 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. 1.5.1 O-ring extrusion limit values

The values in the above diagram do not include cylinder expansion. If cylinder expansion should be considered due to high pressure, the gap should be 75 % of the values shown in the diagram.

If the gap is larger than the values shown in the diagram, use backup rings.

(3) Fitting groove surface roughness

Fitting groove surface should be finished as specified in Table1.5.2 below for the O-ring to have sufficient sealing performance and long service life, and to minimize frictional resistance.

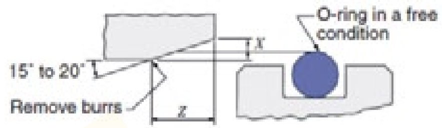
Table 1.5.2 O-ring fitting groove surface roughness

Location	Purpose	Type of pressure		Surface roughness μm Ra	Surface roughness μm Rz
Groove side and bottom	Static sealing	Constant	Flat surface	3.2	12.5
			Cylindrical surface	1.6	6.3
		Pulsating			
	Dynamic sealing	With backup rings			
		Without backup ring		0.8	3.2
O-ring sealed contact surface	Static sealing	Constant		1.6	6.3
		Pulsating		0.8	3.2
	Dynamic sealing	–		0.4	1.6
Chamfer area				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 1.5.3

Table 1.5.3 Chamfer of O-ring installed area



unit mm

O-ring cross section diameter	X (min.)	Z [1] At 15°	Z [1] At 20°
— Up to 2.4	0.9	3.4	2.5
Over 2.4 up to 3.5	1.1	4.1	3
Over 3.5 up to 5.7	1.3	4.9	3.6
Over 5.7 up to 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 O-ring does pass on pressure hole when it is installed, chamfer around the hole edge and remove burrs (Fig.1.5.2).

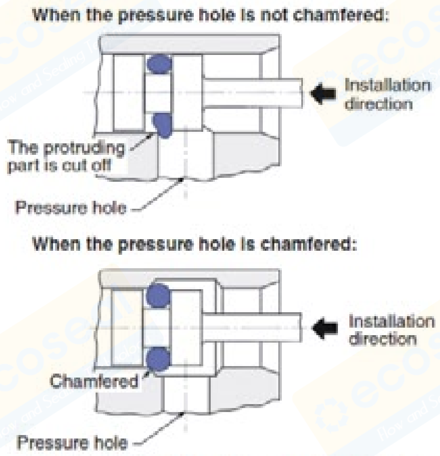


Fig.1.5.2 Chamfer of pressure-hole edges

(5) Material and surface finishing of fitting groove parts

Cylinder material for dynamic-sealing application should be steel. The most suitable 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 1.5.4 shows materials for fitting groove parts and their compatibility

Table 1.5.4 Groove materials and compatibility

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

1.6 O-ring handling

(1) Storage

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

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

(2) Handling

1) Avoid reuse of used O-rings.
2) When installing an O-ring, apply sealing fluid (lubricant) to the O-ring and contact surface.
3) Install an O-ring in the groove without twisting it.
4) Take care when O-ring equipped machine should be cleaned with cleaning oil or gasoline and protect O-ring from cleaning oil because the rubber may be swelled.
5) If an O-ring passes along a threaded surface or sharp edges during installation, take care not to damage the O-ring by using the following protection cap on the thread area as shown in Fig. 1.6.1.

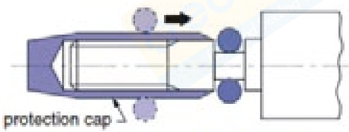


Fig. 1.6.1 O-ring installation jig

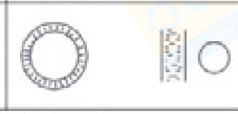
1.7 Typical O-ring failures, causes and countermeasures

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 fluid to be sealed.

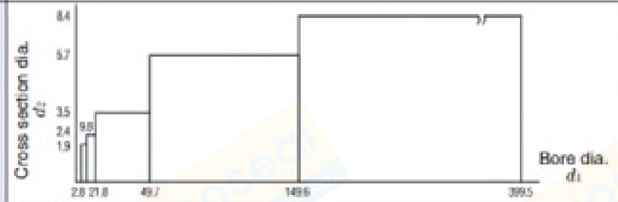
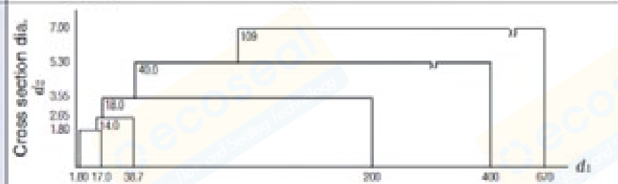
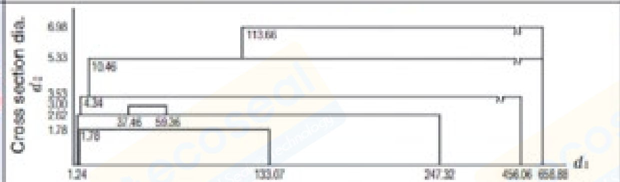
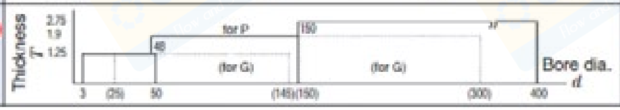
Table 1.7.1 O-ring failures, causes and countermeasures

(D): Dynamic sealing (S): Static sealing

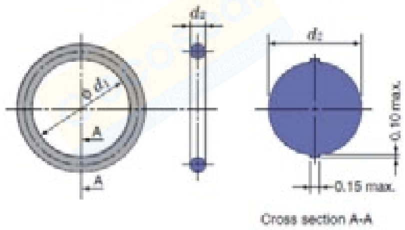
Appearance: Phenomenon	Appearance: Condition		Major causes	Countermeasures
(D) Twist	Twisted and deformed		• Excessive speed • Eccentric movements • Poor surface finish on sliding face • Twisted installation	• Replace with V-packing • Improve accuracy of equipment • Improve sliding surface finish • Install with care(Coat grease.)
(D) Chipping	Partially chipped		• Chipped by the bore edge, threads, or sharp corner at installation	• Round all sharp edges • Use an installation jig
(D) and (S) Permanent set	Deformed into the groove's shape		• Exposure to repeated drastic temperature changes • Improper adjustment of temperature, compression, and fluid	• Study alternative rubber materials • Study groove dimensions
(D) Abrasion around the circumference	Worn all round the circumference		• Poor sliding surface finish • Poor lubrication • Entry of dust or other foreign materials	• Improve sliding surface finish • Supply sufficient lubrication • Clean thoroughly and use filter etc
(D) and (S) Partial abrasion	Sliding surface is partially worn		• There are damages on sliding surface	• Remove damages on sliding surface and improve surface finish
(S) Hardening	Hardened and cracked when bent		• Operating temperature is higher than the rubber's heat resistance limit	• Study alternative rubber materials
(S) Swelling	Softened and swollen		• Improper rubber material • Cleaned with fuel oil or other incompatible cleanser	• Study alternative rubber materials • Clean with kerosene
(S) Scratch	Scratch marks are observed		• Scratched by a thread or sharp edge at installation	• Use an installation jig
(S) Protrusion	The outside or inside of the ring is cut off partially or around the entire circumference		• Inappropriate determination of pressure, gap and hardness • Due to swelling	• Restudy pressure, gap and hardness • Apply backup rings • Study alternative rubber materials
(S) Tearing	The squeezed portion is cut off or chipped		• Poor chamfer • Groove depth is not sufficient	• Improve chamfer • Restudy groove depth
(S) Crack by ozone	Cracks are observed on all over the ring		• Left in the air in a stretched condition	• 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.

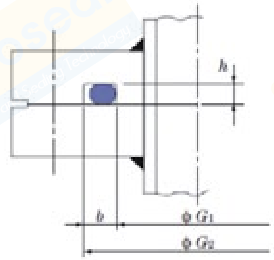
1.8 **O-ring dimensional tables (Contents)**

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

■ 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	4 ± 0.10	V 15	15	$^{+1.0}_{0}$	25	5.0	3.0
23.5	± 0.24		V 24	24		34		
33.5	± 0.33		V 34	34		44		
39.5	± 0.37		V 40	40		50		
54.5	± 0.49		V 55	55		65		
69.0	± 0.61		V 70	70		80		
84.0	± 0.72		V 85	85		95		
99.0	± 0.83		V 100	100		110		
119.0	± 0.97		V 120	120		130		
148.5	± 1.18		V 150	150		160		
173.0	± 1.36		V 175	175		185		
222.5	± 1.70	6 ± 0.15	V 225	225		241	8.0	4.5
272.0	± 2.02		V 275	275		291		
321.5	± 2.34		V 325	325		341		
376.0	± 2.68		V 380	380	$^{+1.5}_{0}$	396		
425.5	± 2.99		V 430	430		446		
475.0	± 3.30	10 ± 0.30	V 480	480		504	12.0	7.0
524.5	± 3.60		V 530	530		554		
579.0	± 3.92		V 585	585		609		
633.5	± 4.24		V 640	640		664		
683.0	± 4.54		V 690	690	$^{+2.0}_{0}$	714		
732.5	± 4.83		V 740	740		764		
782.0	± 5.12		V 790	790		814		
836.5	± 5.44		V 845	845		864		
940.5	± 6.06		V 950	950		974		
1 044.0	± 6.67		V 1 055	1 055		1 079		

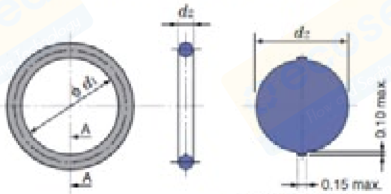
Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.

P 3~35

JIS B 2401 P (for Dynamic and Static Sealing)

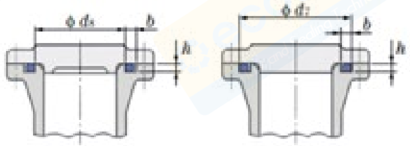
GAPI

■ O-ring shape and dimensions (unit mm)

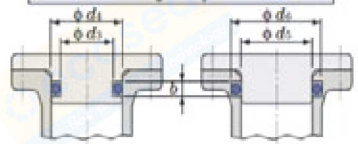


■ Fitting groove dimensions

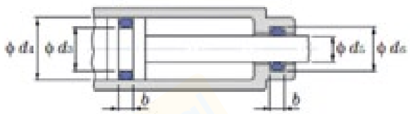
Static sealing on flat surface



For static sealing on cylindrical surface



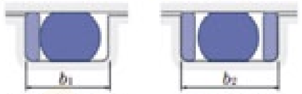
For dynamic sealing



■ Fitting groove design (unit mm)

■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



unit mm

P 3~35

O-ring dimensions: Bore dia. d_1 [1]		Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [2] (for external pressure)	d_7 [2] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
2.8	± 0.14	1.9 ± 0.08	P 3	3	6.2	2.5	1.4	0.4
3.8	± 0.14		P 4	4	7.2			
4.8	± 0.15		P 5	5	8.2			
5.8	± 0.15		P 6	6	9.2			
6.8	± 0.16		P 7	7	10.2			
7.8	± 0.16		P 8	8	11.2			
8.8	± 0.17		P 9	9	12.2			
9.8	± 0.17		P 10	10	13.2			
9.8	± 0.17	2.4 ± 0.09	P 10A	10	14	3.2	1.8	0.4
10.8	± 0.18		P 11	11	15			
11.0	± 0.18		P 11.2	11.2	15.2			
11.8	± 0.19		P 12	12	16			
12.3	± 0.19		P 12.5	12.5	16.5			
13.8	± 0.19		P 14	14	18			
14.8	± 0.20		P 15	15	19			
15.8	± 0.20		P 16	16	20			
17.8	± 0.21		P 18	18	22			
19.8	± 0.22		P 20	20	24			
20.8	± 0.23		P 21	21	25			
21.8	± 0.24		P 22	22	26			
21.7	± 0.24	3.5 ± 0.10	P 22A	22	28	4.7	2.7	0.8
22.1	± 0.24		P 22.4	22.4	28.4			
23.7	± 0.24		P 24	24	30			
24.7	± 0.25		P 25	25	31			
25.2	± 0.25		P 25.5	25.5	31.5			
25.7	± 0.26		P 26	26	32			
27.7	± 0.28		P 28	28	34			
28.7	± 0.29		P 29	29	35			
29.2	± 0.29		P 29.5	29.5	35.5			
29.7	± 0.29		P 30	30	36			
30.7	± 0.30		P 31	31	37			
31.2	± 0.31		P 31.5	31.5	37.5			
31.7	± 0.31		P 32	32	38			
33.7	± 0.33		P 34	34	40			
34.7	± 0.34		P 35	35	41			

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.
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.

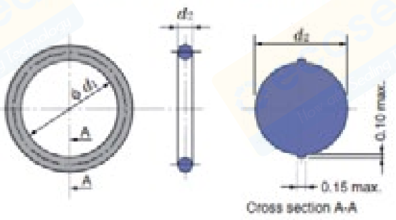
O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3, d_5		Reference fitting codes corresponding to d_3 and d_5 tolerances			d_4, d_6		Fitting code [3]	b $^{+0.25}_{0}$ Without backup ring	b_1 $^{+0.25}_{0}$ With one backup ring	b_2 $^{+0.25}_{0}$ With two backup rings	E [4] max.	r_1 max.
P 3	3	0 / − 0.05	h9	f8	e9	6	+ 0.05 / 0	H10	2.5	3.9	5.4	0.05	0.4
P 4	4					7		H9					
P 5	5					8							
P 6	6					9							
P 7	7				e8	10							
P 8	8					11							
P 9	9					12							
P 10	10					13							
P 10A	10	0 / − 0.06				14	+ 0.06 / 0		3.2	4.4	6.0	0.05	0.4
P 11	11					15							
P 11.2	11.2					15.2							
P 12	12					16							
P 12.5	12.5					16.5							
P 14	14					18							
P 15	15					19							
P 16	16					20							
P 18	18					22							
P 20	20				e7	24							
P 21	21					25							
P 22	22					26							
P 22A	22	0 / − 0.08			e8	28	+ 0.08 / 0		4.7	6.0	7.8	0.08	0.8
P 22.4	22.4					28.4							
P 24	24					30							
P 25	25					31							
P 25.5	25.5					31.5							
P 26	26					32							
P 28	28					34							
P 29	29					35							
P 29.5	29.5					35.5							
P 30	30					36							
P 31	31				e7	37							
P 31.5	31.5					37.5							
P 32	32					38							
P 34	34					40							
P 35	35					41							

3) The fitting code is corresponding to the d_3 and d_5 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.

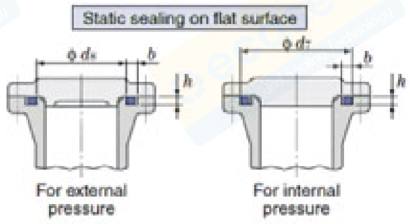
JIS B 2401 P (for Dynamic and Static Sealing)

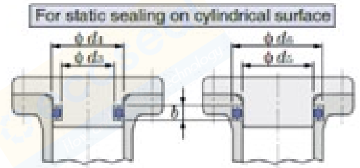
GAPI

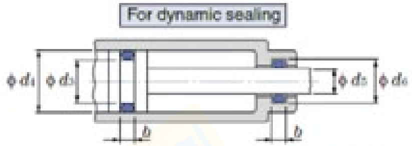
■ O-ring shape and dimensions (unit mm)



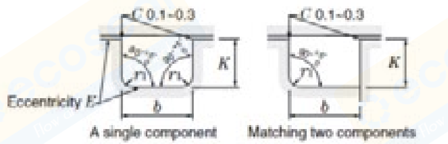
■ Fitting groove dimensions





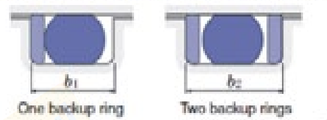


■ Fitting groove design (unit mm)



■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



P 35.5~105

O-ring dimensions: Bore dia. d_1 [1]		Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [2] (for external pressure)	d_7 [2] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
35.2	± 0.34		P 35.5	35.5	41.5			
35.7	± 0.34		P 36	36	42			
37.7	± 0.37		P 38	38	44			
38.7	± 0.37		P 39	39	45			
39.7	± 0.37		P 40	40	46			
40.7	± 0.38		P 41	41	47			
41.7	± 0.39	3.5 ± 0.1	P 42	42	48	4.7	2.7	0.8
43.7	± 0.41		P 44	44	50			
44.7	± 0.41		P 45	45	51			
45.7	± 0.42		P 46	46	52			
47.7	± 0.44		P 48	48	54			
48.7	± 0.45		P 49	49	55			
49.7	± 0.45		P 50	50	56			
47.6	± 0.44		P 48A	48	58			
49.6	± 0.45		P 50A	50	60			
51.6	± 0.47		P 52	52	62			
52.6	± 0.48		P 53	53	63			
54.6	± 0.49		P 55	55	65			
55.6	± 0.50		P 56	56	66			
57.6	± 0.52		P 58	58	68			
59.6	± 0.53		P 60	60	70			
61.6	± 0.55		P 62	62	72			
62.6	± 0.56		P 63	63	73			
64.6	± 0.57		P 65	65	75			
66.6	± 0.59	5.7 ± 0.13	P 67	67	77	7.5	4.6	0.8
69.6	± 0.61		P 70	70	80			
70.6	± 0.62		P 71	71	81			
74.6	± 0.65		P 75	75	85			
79.6	± 0.69		P 80	80	90			
84.6	± 0.73		P 85	85	95			
89.6	± 0.77		P 90	90	100			
94.6	± 0.81		P 95	95	105			
99.6	± 0.84		P 100	100	110			
101.6	± 0.85		P 102	102	112			
104.6	± 0.87		P 105	105	115			

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.
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.

unit mm

O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3, d_5		Reference fitting codes corresponding to d_3 and d_5 tolerances			d_4, d_6		Fitting code [3]	b $^{+0.25}_{0}$ 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.
P 35.5	35.5					41.5							
P 36	36					42							
P 38	38					44							
P 39	39					45							
P 40	40					46							
P 41	41					47							
P 42	42	0 / −0.08			e7	48	+0.08 / 0		4.7	6.0	7.8	0.08	0.8
P 44	44					50							
P 45	45					51							
P 46	46					52							
P 48	48					54							
P 49	49					55							
P 50	50					56							
P 48A	48				e8	58							
P 50A	50					60							
P 52	52					62							
P 53	53					63							
P 55	55		h9	f8		65		H9					
P 56	56					66							
P 58	58					68							
P 60	60					70							
P 62	62					72							
P 63	63				e7	73							
P 65	65					75							
P 67	67	0 / −0.10				77	+0.10 / 0		7.5	9.0	11.5	0.10	0.8
P 70	70					80							
P 71	71					81							
P 75	75					85							
P 80	80					90							
P 85	85					95							
P 90	90					100							
P 95	95				e6	105							
P 100	100					110							
P 102	102					112							
P 105	105					115							

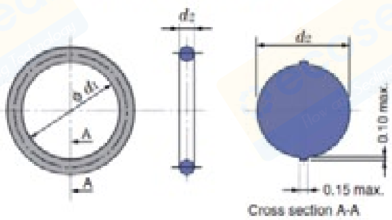
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K. The eccentricity can also be defined as double the coaxiality measurement.

P 110~260

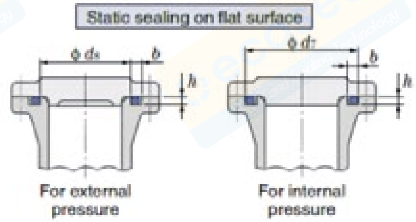
JIS B 2401 P (for Dynamic and Static Sealing)

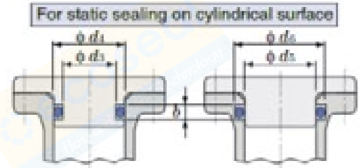
GAPI

■ O-ring shape and dimensions (unit mm)

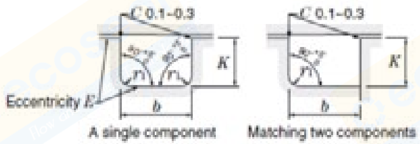


■ Fitting groove dimensions

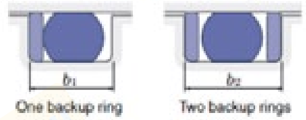




■ Fitting groove design (unit mm)



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



P 110~260

O-ring dimensions: Bore dia. d_1 [1]		O-ring dimensions: Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [2] (for external pressure)	d_7 [2] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
109.6	± 0.91	5.7 ± 0.13	P 110	110	120	7.5	4.6	0.8
111.6	± 0.92		P 112	112	122			
114.6	± 0.94		P 115	115	125			
119.6	± 0.98		P 120	120	130			
124.6	± 1.01		P 125	125	135			
129.6	± 1.05		P 130	130	140			
131.6	± 1.06		P 132	132	142			
134.6	± 1.09		P 135	135	145			
139.6	± 1.12		P 140	140	150			
144.6	± 1.16		P 145	145	155			
149.6	± 1.19		P 150	150	160			
149.5	± 1.19	8.4 ± 0.15	P 150A	150	165	11.0	6.9	1.2
154.5	± 1.23		P 155	155	170			
159.5	± 1.26		P 160	160	175			
164.5	± 1.30		P 165	165	180			
169.5	± 1.33		P 170	170	185			
174.5	± 1.37		P 175	175	190			
179.5	± 1.40		P 180	180	195			
184.5	± 1.44		P 185	185	200			
189.5	± 1.48		P 190	190	205			
194.5	± 1.51		P 195	195	210			
199.5	± 1.55		P 200	200	215			
204.5	± 1.58		P 205	205	220			
208.5	± 1.61		P 209	209	224			
209.5	± 1.62		P 210	210	225			
214.5	± 1.65		P 215	215	230			
219.5	± 1.68		P 220	220	235			
224.5	± 1.71		P 225	225	240			
229.5	± 1.75		P 230	230	245			
234.5	± 1.78		P 235	235	250			
239.5	± 1.81		P 240	240	255			
244.5	± 1.84		P 245	245	260			
249.5	± 1.88		P 250	250	265			
254.5	± 1.91		P 255	255	270			
259.5	± 1.94		P 260	260	275			

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.
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.

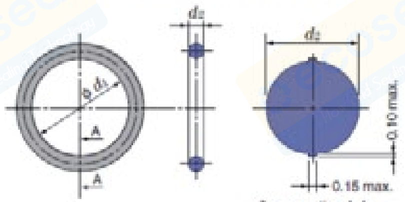
unit mm

O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3, d_5		Reference fitting codes corresponding to d_3 and d_5 tolerances			d_4, d_6		Fitting code [3]	b $^{+0.25}_{0}$ 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.
P 110	110	0 / −0.10	h9	f8	e6	120	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
P 112	112					122							
P 115	115					125							
P 120	120					130							
P 125	125			f7		135							
P 130	130					140							
P 132	132					142							
P 135	135					145							
P 140	140					150							
P 145	145					155							
P 150	150					160							
P 150A	150					165			11.0	13.0	17.0	0.12	1.2
P 155	155					170							
P 160	160					175							
P 165	165					180							
P 170	170					185		H8					
P 175	175					190							
P 180	180					195							
P 185	185		h8			200							
P 190	190					205							
P 195	195					210							
P 200	200					215							
P 205	205					220							
P 209	209					224							
P 210	210					225							
P 215	215					230							
P 220	220					235							
P 225	225					240							
P 230	230					245							
P 235	235					250							
P 240	240					255							
P 245	245					260							
P 250	250					265							
P 255	255			f6		270							
P 260	260					275							

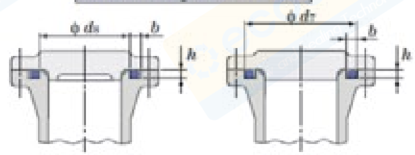
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K. The eccentricity can also be defined as double the coaxiality measurement.

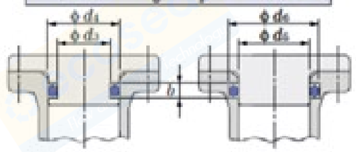
JIS B 2401 P (for Dynamic and Static Sealing)

■ O-ring shape and dimensions (unit mm)



■ Fitting groove dimensions

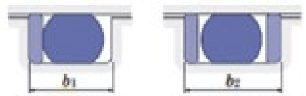




■ Fitting groove design (unit mm)

■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



P 265~400

O-ring dimensions: Bore dia. d_1 [1]		Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [2] (for external pressure)	d_7 [2] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
264.5	± 1.97		P 265	265	280			
269.5	± 2.01		P 270	270	285			
274.5	± 2.04		P 275	275	290			
279.5	± 2.07		P 280	280	295			
284.5	± 2.10		P 285	285	300			
289.5	± 2.14		P 290	290	305			
294.5	± 2.17		P 295	295	310			
299.5	± 2.20		P 300	300	315			
314.5	± 2.30	8.4 ± 0.15	P 315	315	330	11.0	6.9	1.2
319.5	± 2.33		P 320	320	335			
334.5	± 2.42		P 335	335	350			
339.5	± 2.45		P 340	340	355			
354.5	± 2.54		P 355	355	370			
359.5	± 2.57		P 360	360	375			
374.5	± 2.67		P 375	375	390			
384.5	± 2.73		P 385	385	400			
399.5	± 2.82		P 400	400	415			

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.
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.

unit mm

O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3, d_5		Reference fitting codes corresponding to d_3 and d_5 tolerances	d_4, d_6		Fitting code [3]	b $^{+0.25}_{0}$ 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.
P 265	265			280							
P 270	270			285							
P 275	275			290							
P 280	280			295							
P 285	285			300							
P 290	290			305							
P 295	295			310							
P 300	300			315							
P 315	315	0 / −0.10	h8 f6	330	+0.10 / 0	H8	11.0	13.0	17.0	0.12	1.2
P 320	320			335							
P 335	335			350							
P 340	340			355							
P 355	355			370							
P 360	360			375							
P 375	375			390							
P 385	385			400							
P 400	400			415							

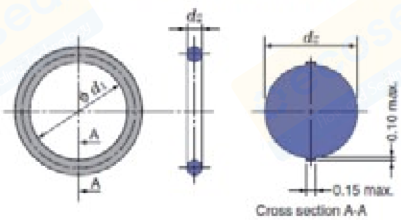
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K. The eccentricity can also be defined as double the coaxiality measurement.

G 25~300

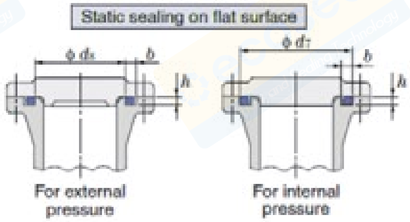
JIS B 2401 G (for Static Sealing)

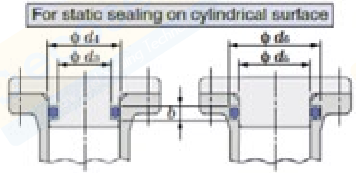
GAPI

■ O-ring shape and dimensions (unit mm)



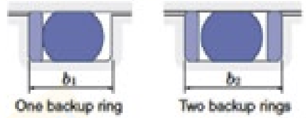
■ Fitting groove dimensions





■ Fitting groove design (unit mm)

■ Backup rings
(For static sealing on cylindrical surface)



unit mm

G 25~300

O-ring dimensions: Bore dia. d_1 [1]		Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_6 [2] (for external pressure)	d_7 [2] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
24.4	± 0.25	3.1 ± 0.10	G 25	25	30	4.1	2.4	0.7
29.4	± 0.29	3.1 ± 0.10	G 30	30	35	4.1	2.4	0.7
34.4	± 0.33	3.1 ± 0.10	G 35	35	40	4.1	2.4	0.7
39.4	± 0.37	3.1 ± 0.10	G 40	40	45	4.1	2.4	0.7
44.4	± 0.41	3.1 ± 0.10	G 45	45	50	4.1	2.4	0.7
49.4	± 0.45	3.1 ± 0.10	G 50	50	55	4.1	2.4	0.7
54.4	± 0.49	3.1 ± 0.10	G 55	55	60	4.1	2.4	0.7
59.4	± 0.53	3.1 ± 0.10	G 60	60	65	4.1	2.4	0.7
64.4	± 0.57	3.1 ± 0.10	G 65	65	70	4.1	2.4	0.7
69.4	± 0.61	3.1 ± 0.10	G 70	70	75	4.1	2.4	0.7
74.4	± 0.65	3.1 ± 0.10	G 75	75	80	4.1	2.4	0.7
79.4	± 0.69	3.1 ± 0.10	G 80	80	85	4.1	2.4	0.7
84.4	± 0.73	3.1 ± 0.10	G 85	85	90	4.1	2.4	0.7
89.4	± 0.77	3.1 ± 0.10	G 90	90	95	4.1	2.4	0.7
94.4	± 0.81	3.1 ± 0.10	G 95	95	100	4.1	2.4	0.7
99.4	± 0.85	3.1 ± 0.10	G 100	100	105	4.1	2.4	0.7
104.4	± 0.87	3.1 ± 0.10	G 105	105	110	4.1	2.4	0.7
109.4	± 0.91	3.1 ± 0.10	G 110	110	115	4.1	2.4	0.7
114.4	± 0.94	3.1 ± 0.10	G 115	115	120	4.1	2.4	0.7
119.4	± 0.98	3.1 ± 0.10	G 120	120	125	4.1	2.4	0.7
124.4	± 1.01	3.1 ± 0.10	G 125	125	130	4.1	2.4	0.7
129.4	± 1.05	3.1 ± 0.10	G 130	130	135	4.1	2.4	0.7
134.4	± 1.08	3.1 ± 0.10	G 135	135	140	4.1	2.4	0.7
139.4	± 1.12	3.1 ± 0.10	G 140	140	145	4.1	2.4	0.7
144.4	± 1.16	3.1 ± 0.10	G 145	145	150	4.1	2.4	0.7
149.3	± 1.19	5.7 ± 0.13	G 150	150	160	7.5	4.6	0.8
154.3	± 1.23	5.7 ± 0.13	G 155	155	165	7.5	4.6	0.8
159.3	± 1.26	5.7 ± 0.13	G 160	160	170	7.5	4.6	0.8
164.3	± 1.30	5.7 ± 0.13	G 165	165	175	7.5	4.6	0.8
169.3	± 1.33	5.7 ± 0.13	G 170	170	180	7.5	4.6	0.8
174.3	± 1.37	5.7 ± 0.13	G 175	175	185	7.5	4.6	0.8
179.3	± 1.40	5.7 ± 0.13	G 180	180	190	7.5	4.6	0.8
184.3	± 1.44	5.7 ± 0.13	G 185	185	195	7.5	4.6	0.8
189.3	± 1.47	5.7 ± 0.13	G 190	190	200	7.5	4.6	0.8
194.3	± 1.51	5.7 ± 0.13	G 195	195	205	7.5	4.6	0.8
199.3	± 1.55	5.7 ± 0.13	G 200	200	210	7.5	4.6	0.8
209.3	± 1.61	5.7 ± 0.13	G 210	210	220	7.5	4.6	0.8
219.3	± 1.68	5.7 ± 0.13	G 220	220	230	7.5	4.6	0.8
229.3	± 1.73	5.7 ± 0.13	G 230	230	240	7.5	4.6	0.8
239.3	± 1.81	5.7 ± 0.13	G 240	240	250	7.5	4.6	0.8
249.3	± 1.88	5.7 ± 0.13	G 250	250	260	7.5	4.6	0.8
259.3	± 1.94	5.7 ± 0.13	G 260	260	270	7.5	4.6	0.8
269.3	± 2.01	5.7 ± 0.13	G 270	270	280	7.5	4.6	0.8
279.3	± 2.07	5.7 ± 0.13	G 280	280	290	7.5	4.6	0.8
289.3	± 2.14	5.7 ± 0.13	G 290	290	300	7.5	4.6	0.8
299.3	± 2.20	5.7 ± 0.13	G 300	300	310	7.5	4.6	0.8

Notes 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.
2) For a static sealing application on a flat surface, design the groove according to dimension d_6 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.

O-ring No.	Groove dimensions for static sealing on cylindrical surface: d_3, d_5		Reference fitting codes corresponding to d_3 and d_5 tolerances			d_4, d_6		Fitting code [3]	b $^{+0.25}_{0}$ 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.
G 25	25	0 / −0.10	h9	f8	e9	30	+0.10 / 0	H10	4.1	5.6	7.3	0.08	0.7
G 30	30	0 / −0.10	h9	f8	e9	35	+0.10 / 0	H10	4.1	5.6	7.3	0.08	0.7
G 35	35	0 / −0.10	h9	f8	e8	40	+0.10 / 0	H10	4.1	5.6	7.3	0.08	0.7
G 40	40	0 / −0.10	h9	f8	e8	45	+0.10 / 0	H10	4.1	5.6	7.3	0.08	0.7
G 45	45	0 / −0.10	h9	f8	e8	50	+0.10 / 0	H10	4.1	5.6	7.3	0.08	0.7
G 50	50	0 / −0.10	h9	f8	e8	55	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 55	55	0 / −0.10	h9	f8	e7	60	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 60	60	0 / −0.10	h9	f8	e7	65	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 65	65	0 / −0.10	h9	f8	e7	70	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 70	70	0 / −0.10	h9	f8	e7	75	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 75	75	0 / −0.10	h9	f8	e7	80	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 80	80	0 / −0.10	h9	f8	e7	85	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 85	85	0 / −0.10	h9	f8	e6	90	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 90	90	0 / −0.10	h9	f8	e6	95	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 95	95	0 / −0.10	h9	f8	e6	100	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 100	100	0 / −0.10	h9	f8	e6	105	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 105	105	0 / −0.10	h9	f8	e6	110	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 110	110	0 / −0.10	h9	f8	e6	115	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 115	115	0 / −0.10	h9	f8	e6	120	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 120	120	0 / −0.10	h9	f8	e6	125	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 125	125	0 / −0.10	h9	f8	e6	130	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 130	130	0 / −0.10	h9	f7		135	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 135	135	0 / −0.10	h9	f7		140	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 140	140	0 / −0.10	h9	f7		145	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 145	145	0 / −0.10	h9	f7		150	+0.10 / 0	H9	4.1	5.6	7.3	0.08	0.7
G 150	150	0 / −0.10	h9	f7		160	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
G 155	155	0 / −0.10	h9	f7		165	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
G 160	160	0 / −0.10	h9	f7		170	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
G 165	165	0 / −0.10	h9	f7		175	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
G 170	170	0 / −0.10	h9	f7		180	+0.10 / 0	H9	7.5	9.0	11.5	0.10	0.8
G 175	175	0 / −0.10	h9	f7		185	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 180	180	0 / −0.10	h8	f7		190	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 185	185	0 / −0.10	h8	f7		195	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 190	190	0 / −0.10	h8	f7		200	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 195	195	0 / −0.10	h8	f7		205	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 200	200	0 / −0.10	h8	f7		210	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 210	210	0 / −0.10	h8	f7		220	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 220	220	0 / −0.10	h8	f7		230	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 230	230	0 / −0.10	h8	f7		240	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 240	240	0 / −0.10	h8	f7		250	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 250	250	0 / −0.10	h8	f7		260	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 260	260	0 / −0.10	h8	f7		270	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 270	270	0 / −0.10	h8	f7		280	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 280	280	0 / −0.10	h8	f6		290	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 290	290	0 / −0.10	h8	f6		300	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8
G 300	300	0 / −0.10	h8	f6		310	+0.10 / 0	H8	7.5	9.0	11.5	0.10	0.8

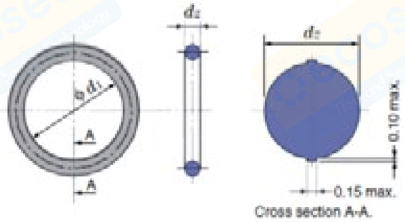
3) The fitting code is corresponding to the d_4 and d_6 tolerances.
4) Eccentricity E means the difference between the maximum value and minimum value of dimension K. The eccentricity can also be defined as double the coaxiality measurement.

S 3~150

Sim Series (for Static Sealing)

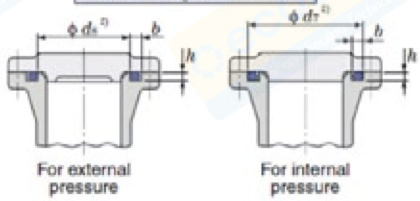
GAPI

■ O-ring shape and dimensions (unit mm)

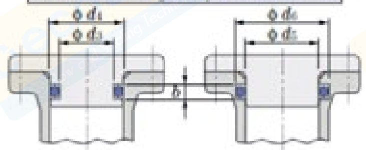


■ Fitting groove dimensions

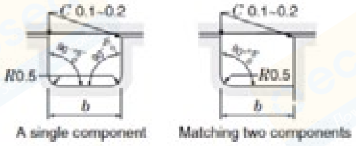
Static sealing on flat surface



For static sealing on cylindrical surface



■ Fitting groove design (unit mm)



S 3~40

unit mm

O-ring dimensions: Bore dia. d_1 [1]		O-ring dimensions: Cross section dia. d_2	O-ring No.	Groove dimensions: d_3, d_5, d_8 $^{0}_{-0.05}$	d_4, d_6 $^{+0.05}_{0}$	d_7 [2]	b $^{+0.25}_{0}$	h $^{0}_{-0.1}$
2.5			S 3	3	5	5.3		
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		1.5 ± 0.1	S 11.2	11.2	13.2	13.5	2.5	1.0
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			S 20	20	22	22.3		
21.5	± 0.15		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		2.0 ± 0.1	S 31.5	31.5	34.5	35	2.7	1.5
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 class 1-A, 1-B, 2 and 3 products. For class 4-C products, the tolerance is 1.5 times these values, and for class 4-D products, 1.2 times.

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

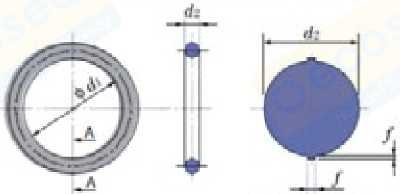
unit mm

O-ring dimensions: Bore dia. d_1 [1]		O-ring dimensions: Cross section dia. d_2	O-ring No.	Groove dimensions: d_3, d_5, d_8 $^{0}_{-0.05}$	d_4, d_6 $^{+0.05}_{0}$	d_7 [2]	b $^{+0.25}_{0}$	h $^{0}_{-0.1}$
41.5			S 42	42	45	45.5		
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	± 0.25		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		2.0 ± 0.1	S 80	80	83	83	2.7	1.5
84.5			S 85	85	88	88		
89.5			S 90	90	93	93		
94.5			S 95	95	98	98		
99.5	± 0.4		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	± 0.6		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		

ISO A,B,C,D 1.8~75 ISO 3601 (for General Industrial Applications)

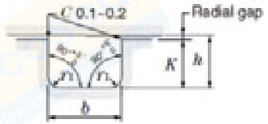
GAPI

■ O-ring shape and dimensions (unit mm)



Cross section A-A

■ Fitting groove dimensions (unit mm)



Cross section dia. d_2	Corner radius r_1
1.80	0.3 ± 0.1
2.65	0.3 ± 0.1
3.55	0.6 ± 0.2
5.30	0.6 ± 0.2
7.00	1.0 ± 0.2

1) Groove depth

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

Compression amount = $\frac{d_2 - h}{d_2} \times 100$ (%) = 8 % ~ 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. 2.5.1.

Therefore: $K = h$ – 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.

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

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		

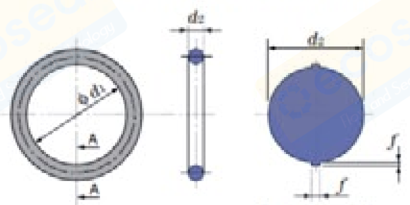
21.2~75

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	

ISO 3601 (for General Industrial Applications)

■ O-ring shape and dimensions (unit mm)



Cross section A-A

■ Fitting groove dimensions (unit mm)

Cross section dia. d_2	Corner radius r_1
1.80	0.3 ± 0.1
2.65	0.3 ± 0.1
3.55	0.6 ± 0.2
5.30	0.6 ± 0.2
7.00	1.0 ± 0.2

1) Groove depth

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

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

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.1.

Therefore: $K = h$ − 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.

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

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

236~670

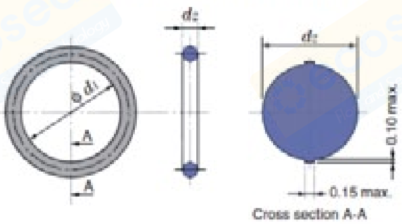
unit mm

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

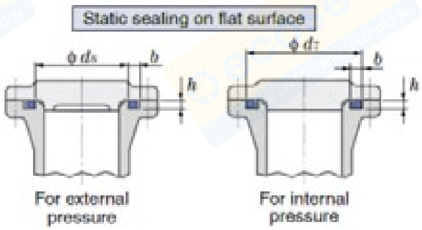
JASO d2 1.9 — JASO F404 (for Dynamic and Static Sealing)

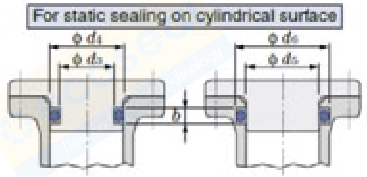
GAPI

■ O-ring shape and dimensions (unit mm)

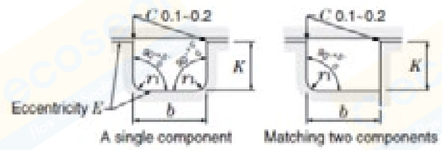


■ Fitting groove dimensions



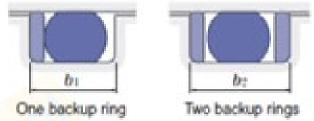


■ Fitting groove design (unit mm)



■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



d2 1.9

O-ring dimensions: Bore dia. d_1	Tolerance	Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [1] (for external pressure)	d_7 [1] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
2.8	Classes 1-A and 2 ±0.12; Classes 3 and 4-D ±0.24; Classes 4-C, 4-E and 5 ±0.36	1.9 ± 0.07	JASO 1003	3	6.3	2.5	1.4	0.4
3.8			JASO 1004	4	7.3			
4.8			JASO 1005	5	8.3			
5.8			JASO 1006	6	9.3			
6.8			JASO 1007	7	10.3			
7.8			JASO 1008	8	11.3			
8.8			JASO 1009	9	12.3			
9.8			JASO 1010	10	13.3			
11.0			JASO 1011	11.2	14.4			
12.3			JASO 1012	12.5	15.7			
13.0			JASO 1013	13.2	16.4			
13.8			JASO 1014	14	17.2			
14.8			JASO 1015	15	18.2			
15.8			JASO 1016	16	19.2			
16.8			JASO 1017	17	20.2			
17.8			JASO 1018	18	21.2			
18.8	Classes 1-A and 2 ±0.15; Classes 3 and 4-D ±0.30; Classes 4-C, 4-E and 5 ±0.45		JASO 1019	19	22.2			
19.8			JASO 1020	20	23.2			
21.0			JASO 1021	21.2	24.4			
22.1			JASO 1022	22.4	25.5			
23.3			JASO 1023	23.6	26.7			
24.7			JASO 1025	25	28.1			
26.2			JASO 1026	26.5	29.6			
27.7			JASO 1028	28	31.1			
29.7			JASO 1030	30	33.1			
31.2			JASO 1031	31.5	34.6			
33.2			JASO 1033	33.5	36.6			
35.2			JASO 1035	35.5	38.6			

unit mm

O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: 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.
JASO 1003	3.1	3	0 / −0.05	6	5.9	+0.05 / 0	2.5	3.9	5.4	0.05	0.4
JASO 1004	4.1	4		7	6.9						
JASO 1005	5.1	5		8	7.9						
JASO 1006	6.1	6		9	8.9						
JASO 1007	7.1	7		10	9.9						
JASO 1008	8.1	8		11	10.9						
JASO 1009	9.1	9		12	11.9						
JASO 1010	10.1	10		13	12.9						
JASO 1011	11.3	11.2		14.2	14.1						
JASO 1012	12.6	12.5	0 / −0.06	15.5	15.4	+0.06 / 0					
JASO 1013	13.3	13.2		16.2	16.1						
JASO 1014	14.1	14		17	16.9						
JASO 1015	15.1	15		18	17.9						
JASO 1016	16.1	16		19	18.9						
JASO 1017	17.1	17		20	19.2						
JASO 1018	18.1	18		21	20.9						
JASO 1019	19.1	19		22	21.9						
JASO 1020	20.1	20		23	22.9						
JASO 1021	21.3	21.2		24.2	24.1						
JASO 1022	22.5	22.4	0 / −0.08	25.4	25.3	+0.08 / 0					
JASO 1023	23.7	23.6		26.6	26.5						
JASO 1025	25.1	25		28	27.9						
JASO 1026	26.6	26.5		29.5	29.4						
JASO 1028	28.1	28		31	30.9						
JASO 1030	30.1	30		33	32.9						
JASO 1031	31.6	31.5		34.5	34.4						
JASO 1033	33.6	33.5		36.5	36.4						
JASO 1035	35.6	35.5		38.5	38.4						

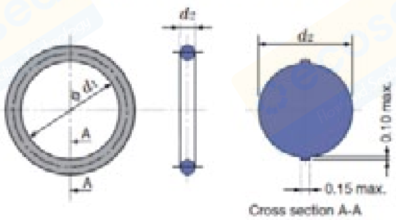
Notes 1) For a static sealing application on a flat surface, design the groove according to dimension d_8 for use under external pressure, or according to dimension d_7 for use under internal pressure. An O-ring for use under external pressure can thus have its bore surface in close contact with the 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.

JASO d_2 2.4

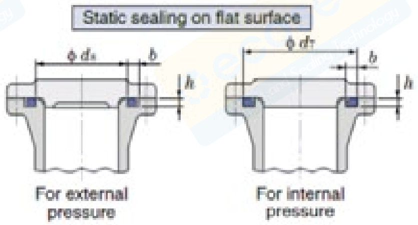
JASO F404 (for Dynamic and Static Sealing)

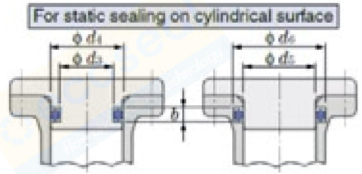
GAPI

■ O-ring shape and dimensions (unit mm)

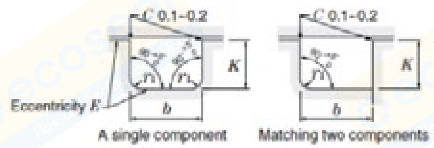


■ Fitting groove dimensions



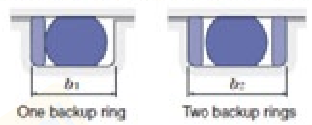


■ Fitting groove design (unit mm)



■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



d_2 2.4

O-ring dimensions: Bore dia. d_1		O-ring dimensions: Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_6 [1] (for external pressure)	d_7 [1] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
9.8	Classes 1-A and 2 ±0.12		JASO 2010	10	14.1			
11.0			JASO 2011	11.2	15.3			
12.3			JASO 2012	12.5	16.6			
13.0	Classes 3 and 4-D ±0.24		JASO 2013	13.2	17.3			
13.8			JASO 2014	14	18.1			
14.8			JASO 2015	15	19.1			
15.8	Classes 4-C, 4-E and 5 ±0.36		JASO 2016	16	20.1			
16.8			JASO 2017	17	21.1			
17.8			JASO 2018	18	22.1			
18.8			JASO 2019	19	23.1			
19.8			JASO 2020	20	24.1			
20.8			JASO 2021	21	25.1			
22.1	Classes 1-A and 2 ±0.15		JASO 2022	22.4	26.4			
23.3			JASO 2023	23.6	27.6			
24.7			JASO 2025	25	29			
26.2	Classes 3 and 4-D ±0.30		JASO 2026	26.5	30.5			
27.7			JASO 2028	28	32			
29.7	Classes 4-C, 4-E and 5 ±0.45		JASO 2030	30	34			
31.2		2.4 ± 0.07	JASO 2031	31.5	35.5	3.2	1.8	0.4
33.2			JASO 2033	33.5	37.5			
35.2			JASO 2035	35.5	39.5			
37.2			JASO 2037	37.5	41.5			
39.7			JASO 2040	40	44			
42.2	Classes 1-A and 2 ±0.25		JASO 2042	42.5	46.5			
44.7			JASO 2045	45	49			
47.2			JASO 2047	47.5	51.5			
49.7	Classes 3 and 4-D ±0.50		JASO 2050	50	54			
52.6			JASO 2053	53	57			
55.6			JASO 2056	56	60			
59.6	Classes 4-C, 4-E and 5 ±0.75		JASO 2060	60	64			
62.6			JASO 2063	63	67			
66.6			JASO 2067	67	71			
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 2071	71	75			

Notes 1) For a static sealing application on a flat surface, design the groove according to dimension d_6 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.

unit mm

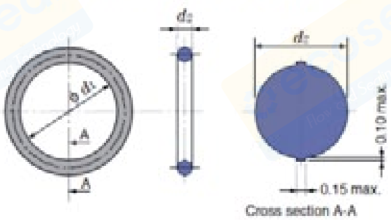
O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3	d_5	Tolerances of d_3 and d_5	d_4	d_6	Tolerances of d_4 and d_6	b $^{+0.25}_{0}$ Without backup ring	b_1 $^{+0.25}_{0}$ With one backup ring	b_2 $^{+0.25}_{0}$ With two backup rings	E [2] max.	r_1 max.
JASO 2010	10.2	10		14	13.8						
JASO 2011	11.4	11.2		15.2	15						
JASO 2012	12.7	12.5		16.5	16.3						
JASO 2013	13.4	13.2		17.2	17						
JASO 2014	14.2	14		18	17.8						
JASO 2015	15.2	15	0 −0.06	19	18.8	+0.06 0					
JASO 2016	16.2	16		20	19.8						
JASO 2017	17.2	17		21	20.8						
JASO 2018	18.2	18		22	21.8						
JASO 2019	19.2	19		23	22.8						
JASO 2020	20.2	20		24	23.8						
JASO 2021	21.2	21		25	24.8						
JASO 2022	22.6	22.4		26.4	26.2						
JASO 2023	23.8	23.6		27.6	27.4						
JASO 2025	25.2	25		29	28.8						
JASO 2026	26.7	26.5		30.5	30.3						
JASO 2028	28.2	28		32	31.8						
JASO 2030	30.2	30		34	33.8						
JASO 2031	31.7	31.5		35.5	35.3		3.2	4.4	6.0	0.05	0.4
JASO 2033	33.7	33.5	0 −0.08	37.5	37.3	+0.08 0					
JASO 2035	35.7	35.5		39.5	39.3						
JASO 2037	37.7	37.5		41.5	41.3						
JASO 2040	40.2	40		44	43.8						
JASO 2042	42.7	42.5		46.5	46.3						
JASO 2045	45.2	45		49	48.8						
JASO 2047	47.7	47.5		51.5	51.3						
JASO 2050	50.2	50		54	53.8						
JASO 2053	53.2	53		57	56.8						
JASO 2056	56.2	56		60	59.8						
JASO 2060	60.2	60		64	63.8						
JASO 2063	63.2	63		67	66.8						
JASO 2067	67.2	67	0 −0.10	71	70.8	+0.10 0					
JASO 2071	71.2	71		75	74.8						

JASO $d2$ 3.5

JASO F404 (for Dynamic and Static Sealing)

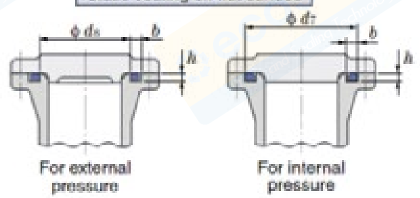
GAPI

■ O-ring shape and dimensions (unit mm)

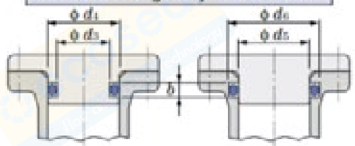


■ Fitting groove dimensions

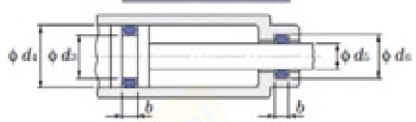
Static sealing on flat surface



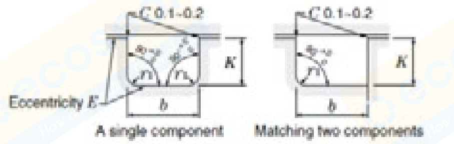
For static sealing on cylindrical surface



For dynamic sealing

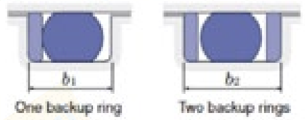


■ Fitting groove design (unit mm)



■ Backup rings

(For dynamic sealing and static sealing on cylindrical surface)



$d2$ 3.5

unit mm

O-ring dimensions: Bore dia. d_1	Tolerance	Cross section dia. d_2	O-ring No.	Groove dimensions for static sealing on flat surface: d_8 [1] (for external pressure)	d_7 [1] (for internal pressure)	b $^{+0.25}_{0}$	h ± 0.05	r_1 max.
22.1	Classes 1A and 2 ±0.15; Classes 3 and 4D ±0.30; Classes 4C, 4E and 5 ±0.45	3.5 ± 0.10	JASO 3022	22.4	28.4	4.7	2.7	0.7
23.7			JASO 3024	24	30			
24.7			JASO 3025	25	31			
25.7			JASO 3026	26	32			
27.7			JASO 3028	28	34			
29.7			JASO 3030	30	36			
31.2			JASO 3031	31.5	37.5			
33.7			JASO 3034	34	40			
35.2			JASO 3035	35.5	41.5			
37.7			JASO 3038	38	44			
38.7			JASO 3039	39	45			
39.7			JASO 3040	40	46			
41.7	Classes 1A and 2 ±0.25; Classes 3 and 4D ±0.50; Classes 4C, 4E and 5 ±0.75		JASO 3042	42	48			
43.7			JASO 3044	44	50			
44.7			JASO 3045	45	51			
47.7			JASO 3048	48	54			
49.7			JASO 3050	50	56			
52.6			JASO 3053	53	59			
55.6			JASO 3056	56	62			
59.6			JASO 3060	60	66			
62.6			JASO 3063	63	69			
66.6			JASO 3067	67	73			
70.6	Classes 1A and 2 ±0.40; Classes 3 and 4D ±0.80; Classes 4C, 4E and 5 ±1.20		JASO 3071	71	77			
74.6			JASO 3075	75	81			
79.6			JASO 3080	80	86			
84.6			JASO 3085	85	91			
89.6			JASO 3090	90	96			
94.6			JASO 3095	95	101			
99.6			JASO 3100	100	106			
105.6			JASO 3106	106	112			
111.6			JASO 3112	112	118			
117.6			JASO 3118	118	124			
124.6			JASO 3125	125	131			
131.6	Classes 1A and 2 ±0.60; Classes 3 and 4D ±1.20; Classes 4C, 4E and 5 ±1.80		JASO 3132	132	138			
139.6			JASO 3140	140	146			
149.6			JASO 3150	150	156			

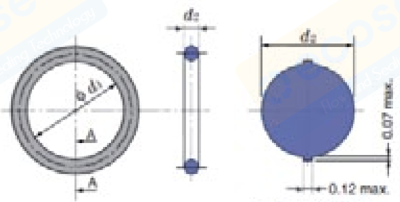
O-ring No.	Groove dimensions for dynamic sealing and static sealing on cylindrical surface: d_3	d_5	Tolerances of d_3 and d_5	d_4	d_6	Tolerances of d_4 and d_6	b $^{+0.25}_{0}$ Without backup ring	b_1 $^{+0.25}_{0}$ With one backup ring	b_2 $^{+0.25}_{0}$ With two backup rings	E [2] max.	r_1 max.
JASO 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
JASO 3024	24.3	24		30	29.7						
JASO 3025	25.3	25		31	30.7						
JASO 3026	26.3	26		32	31.7						
JASO 3028	28.3	28		34	33.7						
JASO 3030	30.3	30		36	35.7						
JASO 3031	31.8	31.5		37.5	37.2						
JASO 3034	34.3	34		40	39.7						
JASO 3035	35.8	35.5		41.5	41.2						
JASO 3038	38.3	38		44	43.7						
JASO 3039	39.3	39		45	44.7						
JASO 3040	40.3	40		46	45.7						
JASO 3042	42.3	42		48	47.7						
JASO 3044	44.3	44		50	49.7						
JASO 3045	45.3	45		51	50.7						
JASO 3048	48.3	48		54	53.7						
JASO 3050	50.3	50		56	55.7						
JASO 3053	53.3	53		59	58.7						
JASO 3056	56.3	56	0 / −0.10	62	61.7	+0.10 / 0					
JASO 3060	60.3	60		66	65.7						
JASO 3063	63.3	63		69	68.7						
JASO 3067	67.3	67		73	72.7						
JASO 3071	71.3	71		77	76.7						
JASO 3075	75.3	75		81	80.7						
JASO 3080	80.3	80		86	85.7						
JASO 3085	85.3	85		91	90.7						
JASO 3090	90.3	90		96	95.7						
JASO 3095	95.3	95		101	100.7						
JASO 3100	100.3	100		106	105.7						
JASO 3106	106.3	106		112	111.7						
JASO 3112	112.3	112		118	117.7						
JASO 3118	118.3	118		124	123.7						
JASO 3125	125.3	125		131	130.7						
JASO 3132	132.3	132		138	137.7						
JASO 3140	140.3	140		146	145.7						
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_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.

GAPI

■ O-ring shape and dimensions (unit mm)



Cross section A-A

■ Fitting groove dimensions (unit mm)

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

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

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.1.
Therefore: $K = h$ − 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.

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

$d2$ 1.02~(1.78)

unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1]			AN 6227	AN 6230
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	± 0.10	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	1	
	3.68		AS 007	2	
	4.47		AS 008	3	
	5.28		AS 009	4	
	6.07		AS 010	5	
	7.65		AS 011	6	
	9.25		AS 012	7	
	10.82		AS 013		
	12.42		AS 014		
	14.00		AS 015		
	15.60		AS 016		
	17.17		AS 017		
	18.77		AS 018		
	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		
	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 class 1-A and 1-B products.
For class 4-D products, the tolerance is 1.2 times there values.

$d2$ (1.78)~(2.62)

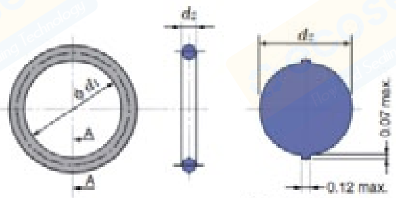
unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1]			AN 6227	AN 6230
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		AS 045		
	107.67		AS 046		
	114.02		AS 047		
	120.37		AS 048		
	126.72	± 0.58	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	8	
	10.77		AS 111	9	
	12.37		AS 112	10	
	13.94		AS 113	11	
	15.54		AS 114	12	
	17.12		AS 115	13	
	18.72		AS 116	14	
	20.29	± 0.15	AS 117		
	21.89		AS 118		
	23.47		AS 119		
	25.07		AS 120		
	26.64		AS 121		
	28.24		AS 122		
	29.82		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		

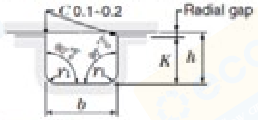
AS $d2$ (2.62)~(3.53) AS 568 for Aircraft Hydraulic Applications (Dynamic Sealing and Static Sealing)

GAPI

■ O-ring shape and dimensions (unit mm)



■ Fitting groove dimensions (unit mm)



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

Compression amount = $\frac{d_2 - h}{d_2} \times 100$ (%) = 8 % - 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. 2.5.1.
Therefore: $K = h$ − 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.

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

$d2$ (2.62)

unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1[1)]			AN 6227	AN 6230
2.62 ± 0.07	55.24	± 0.25	AS 139		
	56.82		AS 140		
	58.42		AS 141		
	59.99		AS 142		
	61.60		AS 143		
	63.17		AS 144		
	64.77		AS 145		
	66.34		AS 146		
	67.94	± 0.38	AS 147		
	69.52		AS 148		
	71.12		AS 149		
	72.69		AS 150		
	75.87		AS 151		
	82.22		AS 152		
	88.57		AS 153		
	94.92		AS 154		
	101.27		AS 155		
	107.62		AS 156		
	113.97		AS 157		
	120.32		AS 158		
	126.67		AS 159		
	133.02	± 0.58	AS 160		
	139.37		AS 161		
	145.72		AS 162		
	152.07		AS 163		
	158.42		AS 164		
	164.77		AS 165		
	171.12		AS 166		
	177.47		AS 167		
	183.82	± 0.76	AS 168		
	190.17		AS 169		
	196.52		AS 170		
	202.87		AS 171		
	209.22		AS 172		
	215.57		AS 173		
	221.92		AS 174		
	228.27		AS 175		
	234.62		AS 176		
	240.97		AS 177		
	247.32		AS 178		

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A and 1-B products.
For class 4-D products, the tolerance is 1.2 times there values.

$d2$ 2.95~(3.53)

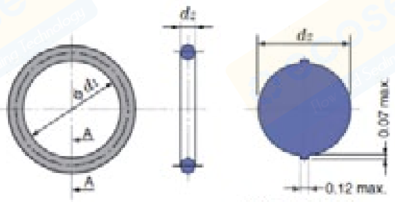
unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1[1)]			AN 6227	AN 6230
2.95 ± 0.10	21.92	± 0.12	AS 911		
	23.47	± 0.15	AS 912		
	25.04		AS 913		
	26.59		AS 914		
	29.74		AS 916		
	34.42		AS 918		
3.00 ± 0.10	37.46	± 0.25	AS 920		
	43.69		AS 924		
	53.09		AS 928		
	59.36		AS 932		
3.53 ± 0.10	4.34	± 0.12	AS 201		
	5.94		AS 202		
	7.52		AS 203		
	9.12		AS 204		
	10.69		AS 205		
	12.29		AS 206		
	13.87		AS 207		
	15.47		AS 208		
	17.04		AS 209		
	18.64	± 0.15	AS 210	15	
	20.22		AS 211	16	
	21.82		AS 212	17	
	23.39		AS 213	18	
	24.99		AS 214	19	
	26.57		AS 215	20	
	28.17		AS 216	21	
	29.74		AS 217	22	
	31.34		AS 218	23	
	32.92		AS 219	24	
	34.52		AS 220	25	
	36.09		AS 221	26	
	37.69		AS 222	27	
	40.87	± 0.25	AS 223		1
	44.04		AS 224		2
	47.22		AS 225		3
	50.39		AS 226		4
	53.57		AS 227		5
	56.74		AS 228		6
	59.92		AS 229		7
	63.09		AS 230		8
	66.27		AS 231		9
	69.44	± 0.38	AS 232		10
	72.62		AS 233		11
	75.79		AS 234		12
	78.97		AS 235		13
	82.14		AS 236		14
	85.32		AS 237		15
	88.49		AS 238		16
	91.67		AS 239		17
	94.84		AS 240		18
	98.02		AS 241		19
	101.19		AS 242		20
	104.37		AS 243		21
	107.54		AS 244		22
	110.72		AS 245		23
	113.89		AS 246		24
	117.07		AS 247		25

AS $d2$ (3.53)~(5.33) AS 568 for Aircraft Hydraulic Applications (Dynamic Sealing and Static Sealing)

GAPI

■ O-ring shape and dimensions (unit mm)



■ Fitting groove dimensions (unit mm)

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

Compression amount = $\frac{d_2 - h}{d_2}$ × 100 (%) = 8 % ~ 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. 2.5.1.
Therefore: $K = h$ − 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.

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

$d2$ (1.78)~(5.33)

unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1)]			AN 6227	AN 6230
3.53 ± 0.10	120.24	± 0.38	AS 248		26
	123.42		AS 249		27
	126.59		AS 250		28
	129.77	± 0.58	AS 251		29
	132.94		AS 252		30
	136.12		AS 253		31
	139.29		AS 254		32
	142.47		AS 255		33
	145.64		AS 256		34
	148.82		AS 257		35
	151.99		AS 258		36
	158.34		AS 259		37
	164.69		AS 260		38
	171.04		AS 261		39
	177.39		AS 262		40
	183.74	± 0.76	AS 263		41
	190.09		AS 264		42
	196.44		AS 265		43
	202.79		AS 266		44
	209.14		AS 267		45
	215.49		AS 268		46
	221.84		AS 269		47
	228.19		AS 270		48
	234.54		AS 271		49
	240.89		AS 272		50
	247.24		AS 273		51
	253.59		AS 274		52
	266.29		AS 275		
	278.99		AS 276		
	291.69		AS 277		
	304.39		AS 278		
	329.79		AS 279		
	355.19		AS 280		
	380.59		AS 281		
	405.26	± 1.14	AS 282		
	430.66		AS 283		
	456.06		AS 284		
5.33 ± 0.12	10.46	± 0.12	AS 309		
	12.06		AS 310		
	13.64		AS 311		

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A and 1-B products. For class 4-D products, the tolerance is 1.2 times there values.

$d2$ (5.33)

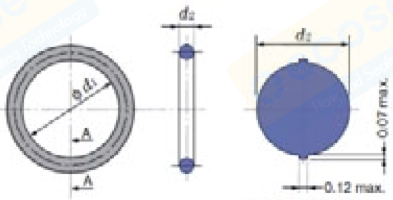
unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1)]			AN 6227	AN 6230
5.33 ± 0.12	15.24	± 0.12	AS 312		
	16.81		AS 313		
	18.42	± 0.15	AS 314		
	19.99		AS 315		
	21.59		AS 316		
	23.16		AS 317		
	24.76		AS 318		
	26.34		AS 319		
	27.94		AS 320		
	29.51		AS 321		
	31.12		AS 322		
	32.69		AS 323		
	34.29		AS 324		
	37.46	± 0.25	AS 325	28	
	40.64		AS 326	29	
	43.82		AS 327	30	
	46.99		AS 328	31	
	50.16		AS 329	32	
	53.34		AS 330	33	
	56.52		AS 331	34	
	59.69		AS 332	35	
	62.86		AS 333	36	
	66.04		AS 334	37	
	69.22	± 0.38	AS 335	38	
	72.39		AS 336	39	
	75.56		AS 337	40	
	78.74		AS 338	41	
	81.92		AS 339	42	
	85.09		AS 340	43	
	88.26		AS 341	44	
	91.44		AS 342	45	
	94.62		AS 343	46	
	97.79		AS 344	47	
	100.96		AS 345	48	
	104.14		AS 346	49	
	107.32		AS 347	50	
	110.49		AS 348	51	
	113.66		AS 349	52	
	116.84		AS 350		
	120.02		AS 351		
	123.19		AS 352		
	126.36		AS 353		
	129.54	± 0.58	AS 354		
	132.72		AS 355		
	135.89		AS 356		
	139.07		AS 357		
	142.24		AS 358		
	145.42		AS 359		
	148.59		AS 360		
	151.77		AS 361		
	158.12		AS 362		
	164.47		AS 363		
	170.82		AS 364		
	177.17		AS 365		
	183.52	± 0.76	AS 366		
	189.87		AS 367		
	196.22		AS 368		

AS d2 (5.33)~6.98 AS 568 for Aircraft Hydraulic Applications (Dynamic Sealing and Static Sealing)

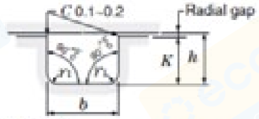
GAPI

■ O-ring shape and dimensions (unit mm)



Cross section A-A

■ Fitting groove dimensions (unit mm)



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

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

Determine the radial gap by the consideration that the double radial gap (gap in diameter) should be less than the value shown in Fig. 2.5.1.
Therefore: $K = h$ – 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.

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

d2 (5.33)~(6.98)

unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1]			AN 6227	AN 6230
5.33 ± 0.12	202.57	± 0.76	AS 369		
	208.92		AS 370		
	215.26		AS 371		
	221.62		AS 372		
	227.96		AS 373		
	234.32		AS 374		
	240.67		AS 375		
	247.02		AS 376		
	253.37		AS 377		
	266.07		AS 378		
	278.77		AS 379		
	291.47		AS 380		
	304.17		AS 381		
	329.57		AS 382		
	354.97		AS 383		
	380.37		AS 384		
	405.26	± 1.14	AS 385		
	430.66		AS 386		
	456.06		AS 387		
	481.46		AS 388		
	506.86		AS 389		
	532.26		AS 390		
	557.66		AS 391		
	582.68	± 1.52	AS 392		
	608.08		AS 393		
	633.48		AS 394		
	658.88		AS 395		
6.98 ± 0.15	113.66	± 0.38	AS 425	88	
	116.84		AS 426	53	
	120.02		AS 427	54	
	123.19		AS 428	55	
	126.36		AS 429	56	
	129.54	± 0.58	AS 430	57	
	132.72		AS 431	58	
	135.89		AS 432	59	
	139.06		AS 433	60	
	142.24		AS 434	61	
	145.42		AS 435	62	
	148.59		AS 436	63	
	151.76		AS 437	64	

Note 1) The tolerance of bore diameter d_1 shows the specified values in JIS B 2401 for class 1-A and 1-B products. For class 4-D products, the tolerance is 1.2 times there values.

d2 (6.98)

unit mm

O-ring dimensions			O-ring No.	Reference No.	
Cross section dia. d_2	Bore dia. d_1 [1]			AN 6227	AN 6230
6.98 ± 0.15	158.12	± 0.58	AS 438	65	
	164.46		AS 439	66	
	170.82		AS 440	67	
	177.16		AS 441	68	
	183.52	± 0.76	AS 442	69	
	189.86		AS 443	70	
	196.22		AS 444	71	
	202.56		AS 445	72	
	215.26		AS 446	73	
	227.96		AS 447	74	
	240.66		AS 448	75	
	253.36		AS 449	76	
	266.06		AS 450	77	
	278.76		AS 451	78	
	291.46		AS 452	79	
	304.16		AS 453	80	
	316.86		AS 454	81	
	329.56		AS 455	82	
	342.26		AS 456	83	
	354.96		AS 457	84	
	367.66		AS 458	85	
	380.36		AS 459	86	
	393.06		AS 460	87	
	405.26	± 1.14	AS 461		
	417.96		AS 462		
	430.66		AS 463		
	443.36		AS 464		
	456.06		AS 465		
	468.76		AS 466		
	481.46		AS 467		
	494.16		AS 468		
	506.86		AS 469		
	532.46		AS 470		
	557.66		AS 471		
	582.68	± 1.52	AS 472		
	608.08		AS 473		
	633.48		AS 474		
	658.88		AS 475		

Gland & Groove Standards

Specification Index	
ISO 3601-2	International standard for metric and inch series O-rings gland and groove specification. This standard is not yet avialable from ISO.
SAE AS568B	American standard for O-ring Gland & Groove specifications. AS-568 is the Aerospace Standard (AS) as well as the SAE standard and is used for military and industrial manufacturing in North America.
DIN 3771	German metric standard for fluid-sealing O-ring Gland & Groove specifications.
JIS B2406	Japanese industrial standard for metric series O-ring housings.
Military Standards	MIL-G-5514 Gland Dimensions MS33649 Boss End Dimensions MS33656 Boss Fitting End Dimensions

Dimensional Standards

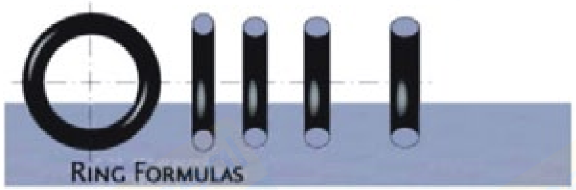
Over the last several years, there has been a concerted effort worldwide to consolidate Basic Ring specifications into a single, worldwide standard. The result is the International Standards Organization (ISO), which has been the driving force in this consolidation effort. While AFM still recognizes and manufactures to existing standards, our dimensional, material, and quality mindset follow the guidelines set forth by ISO.

Specification Index	
ISO 3601-1	International standard for metric and inch series O-rings. The second edition includes the requirements for Aerospace (AS) applications.
SAE AS568B	American standard for O-rings. AS-568 is the Aerospace Standard (AS) as well as the SAE standard and is used for military and industrial manufacturing in North America.
BS 1806	British standard for inch series O-rings. This standard is derived from SAE AS-568B.
BS 4518	British standard for metric series O-rings. BS 4518 incorporates European practices used for sealing components against fluids under dynamic and static conditions.
JIS B2401	Japanese industrial standard for metric series O-rings. This standard now includes the second edition of ISO 3601-1.
DIN 3771	German metric standard for fluid-sealing O-rings.
NF T47-501	French standard for O-rings. This standard is similar to the ISO 3601 and the DIN 3771 standards with some unique class designations.

Ring Calculations

Calculating Design Specifications

- **Ring Calculations**
- Gland Calculations
- Examples



Click an any of the formulas below to pop up the interactive calculator for that formula.

Maximum % Compression

$$\left[\frac{\left(\frac{\text{Min. Bore Dia.} - \text{Max. Groove Dia.}}{2}\right)}{\text{Max. O-Ring C.S.}} - 1\right] \times 100$$

Minimum % Compression

$$\left[\frac{\left(\frac{\text{Max. Bore Dia.} - \text{Min. Groove Dia.}}{2}\right)}{\text{Min. O-Ring C.S.}} - 1\right] \times 100$$

Maximum O-Ring C.S.

$$\left[\frac{\left(\frac{\text{Min. Bore Dia.} - \text{Max. Groove Dia.}}{2}\right)}{\left(\frac{\text{Max. \% Compression}}{100}\right) + 1}\right] - \text{O-Ring Tolerance}$$

Minimum O-Ring C.S.

$$\left[\frac{\left(\frac{\text{Max. Bore Dia.} - \text{Min. Groove Dia.}}{2}\right)}{\left(\frac{\text{Max. \% Compression}}{100}\right) + 1}\right] + \text{O-Ring Tolerance}$$

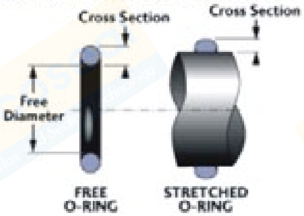
% Stretch

$$\left(\frac{\text{Groove Dia.}}{\text{O-Ring I.D.}} - 1\right) \times 100$$

Reduced Cross Section

$$\text{C.S.} - \left(\frac{\text{C.S.} \times \text{\% Reduction}}{100}\right)$$

Illustration of Reduced Cross Section



% Stretch

$$\left(\frac{\text{Max. Rod Dia.}}{\text{O-Ring I.D.}} - 1\right) \times 100$$

Reduced Cross Section

$$\text{C.S.} - \left(\frac{\text{C.S.} \times \%\ \text{Reduction}}{100}\right)$$

Actual O-Ring Cross Section

$$\text{C.S.} - \left[\text{C.S.} \times \left(1 - \frac{10}{\sqrt{100 + \%\ \text{Stretch}}}\right)\right]$$

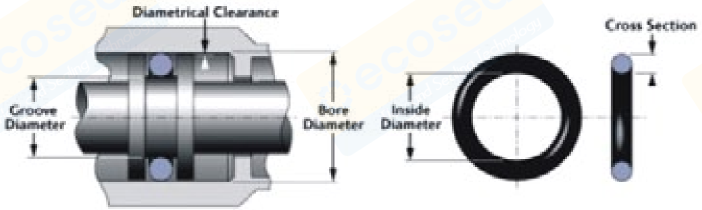
Maximum O-Ring Volume

$$\frac{\pi^2}{8} \times \left[\left(\text{Max. O-Ring I.D.} + 2 \times \text{Max. O-Ring C.S.}\right) - \text{Min. O-Ring I.D.}\right]^2 \times \ldots$$

$$\left(\text{Max. O-Ring I.D.} + 2 \times \text{Max. O-Ring C.S.}\right)$$

O-Ring I.D.

$$\frac{\text{Groove Dia.}}{\%\ \text{of Stretch Desired (1\% to 5\%)}}$$



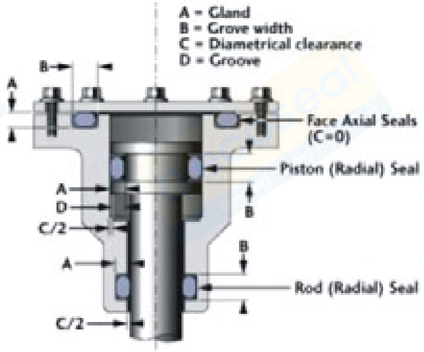
Gland Calculations

Calculating Design Specifications

- Ring Calculations
- **Gland Calculations**
- Examples

Grooves and Glands

A groove is machined into one surface. A gland consists of the groove plus diametrical clearance and is used to calculate seal compression.



Guidelines for Gland Calculations

O-Ring Gland Design for Dynamic Seals

O-Ring Cross Section	Gland Depth	Squeeze		Diametrical Clearance Max	Groove Width (±.005)			Groove Radius	Eccentricity Max
		Inches	Percent		0 Backup Rings	1 backup ring	2 backup rings		
.020	.015/.017	.003/.005	15 - 25	.003	.035	-	-	-	.0015
.030	.023/.025	.005/.007	16 - 23	.003	.046	-	-	-	.0015
.040	.031/.033	.007/.009	17 - 25	.004	.063	-	-	.005/.008	.002
.050	.039/.041	.009/.011	18 - 25	.004	.073	-	-	.005/.008	.002
.060	.047/.049	.011/.013	18 - 22	.004	.084	-	-	.005/.008	.002
.070	.055/.057	.010/.018	15 - 25	.004	.095	.150	.208	.005/.015	.002
.103	.087/.090	.010/.019	10 - 18	.005	.145	.187	.249	.005/.020	.003
.139	.119/.123	.012/.024	9 - 17	.006	.185	.222	.301	.005/.030	.004
.210	.183/.188	.017/.032	8.5 - 15	.006	.285	.338	.428	.005/.050	.006
.275	.234/.240	.029/.047	10.5 - 17	.007	.375	.440	.579	.005/.060	.008

O-Ring Gland Design for Static Seals

O-Ring Cross Section	Gland Depth		Squeeze Radial		Squeeze Axial		Diametrical Clearance Max	Groove Width (±.005)			Groove Radius	Eccentricity Max
	Radial	Axial	Inches	Percent	Inches	Percent		1 backup rings	1 backup ring	2 backup rings		
.020	.013/.015	.013/.015	.005/.007	25/35	.005/.007	25/35	.002	.040	-	-	-	.0015
.030	.020/.023	.020/.022	.007/.010	23/33	.008/.010	27/33	.003	.052	-	-	-	.0015
.040	.026/.031	.026/.029	.009/.014	23/35	.011/.013	28/33	.003	.101	-	-	.005/.008	.002
.050	.033/.039	.032/.036	.011/.017	22/34	.014/.018	28/35	.004	.101	-	-	.005/.008	.002
.060	.042/.047	.039/.043	.013/.018	22/30	.017/.021	28/35	.004	.105	-	-	.005/.008	.002
.070	.049/.055	.045/.050	.012/.014	18/19	.017/.028	25.5/38.5	.004	.105	.150	.208	.005/.015	.002
.103	.080/.086	.072/.080	.014/.026	13.5/25	.020/.034	20/32	.005	.146	.182	.244	.005/.020	.003
.139	.112/.118	.100/.110	.017/.031	12.5/29	.025/.043	18.5/30	.006	.195	.217	.296	.005/.030	.004
.210	.176/.184	.165/.175	.021/.039	10/18	.030/.050	14.5/23	.006	.280	.333	.423	.005/.050	.006
.275	.225/.235	.220/.230	.034/.056	12.5/20	.039/.061	14.5/21.5	.007	.350	.435	.574	.005/.060	.008

Guidelines for Gland Calculations

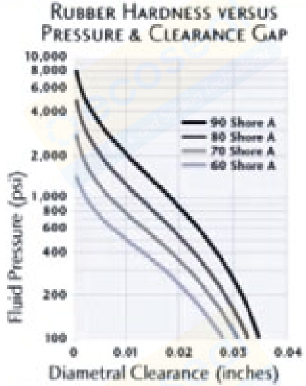
O-Ring Gland Design for Dynamic Seals

O-Ring Cross Section	Gland Depth	Squeeze		Diametrical Clearance Max.	Groove Width (±.005)			Groove Radius	Eccentricity Max.
		Inches	Percent		0 Backup Rings	1 backup ring	2 backup rings		
.020	.015/.017	.003/.005	15 - 25	.003	.035	-	-	-	.0015
.030	.023/.025	.005/.007	16 - 23	.003	.046	-	-	-	.0015
.040	.031/.033	.007/.009	17 - 25	.004	.063	-	-	.005/.008	.002
.050	.039/.041	.009/.011	18 - 25	.004	.073	-	-	.005/.008	.002
.060	.047/.049	.011/.013	18 - 22	.004	.084	-	-	.005/.008	.002
.070	.055/.057	.010/.018	15 - 25	.004	.095	.150	.208	.005/.015	.002
.103	.087/.090	.010/.019	10 - 18	.005	.145	.187	.249	.005/.020	.003
.139	.119/.123	.012/.024	9 - 17	.006	.185	.222	.301	.005/.030	.004
.210	.183/.188	.017/.032	8.5 - 15	.006	.285	.338	.428	.005/.050	.006
.275	.234/.240	.029/.047	10.5 - 17	.007	.375	.440	.579	.005/.060	.008

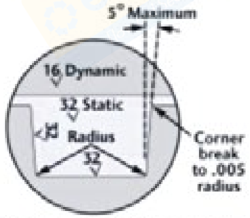
O-Ring Gland Design for Static Seals

O-Ring Cross Section	Gland Depth		Squeeze Radial		Squeeze Axial		Diametrical Clearance Max	Groove Width (±.005)			Groove Radius	Eccentricity Max
	Radial	Axial	Inches	Percent	Inches	Percent		1 backup rings	1 backup ring	2 backup rings		
.020	.013/.015	.013/.015	.005/.007	25/35	.005/.007	25/35	.002	.040	-	-	-	.0015
.030	.020/.023	.020/.022	.007/.010	23/33	.008/.010	27/33	.003	.052	-	-	-	.0015
.040	.026/.031	.026/.029	.009/.014	23/35	.011/.013	28/33	.003	.101	-	-	.005/.008	.002
.050	.033/.039	.032/.036	.011/.017	22/34	.014/.018	28/35	.004	.101	-	-	.005/.008	.002
.060	.042/.047	.039/.043	.013/.018	22/30	.017/.021	28/35	.004	.105	-	-	.005/.008	.002
.070	.049/.055	.045/.050	.012/.014	18/19	.017/.028	25.5/38.5	.004	.105	.150	.208	.005/.015	.002
.103	.080/.086	.072/.080	.014/.026	13.5/25	.020/.034	20/32	.005	.146	.182	.244	.005/.020	.003
.139	.112/.118	.100/.110	.017/.031	12.5/29	.025/.043	18.5/30	.006	.195	.217	.296	.005/.030	.004
.210	.176/.184	.165/.175	.021/.039	10/18	.030/.050	14.5/23	.006	.280	.333	.423	.005/.050	.006
.275	.225/.235	.220/.230	.034/.056	12.5/20	.039/.061	14.5/21.5	.007	.350	.435	.574	.005/.060	.008

Determine Maximum Gap



Calculate Tolerances Applicable To Gland Dimensions



Click an any of the formulas below to pop up the interactive calculator for that formula.

Gland Tolerance

$$\frac{|\text{Max. Gap.}| - |\text{Min. Clearance}|}{2} + .01 \times \left(\text{Reduced O-Ring Cross Section}\right)$$

Minimum Gland Volume

$$\frac{\pi}{2} \times \left(\text{Min. Bore Dia.}^2 \times \text{Max. Groove Dia.}^2\right) \times \text{Min. Groove Width}$$

Minimum Groove Width: Option 1

$$\frac{\left(\frac{\pi \times \text{Max. O-Ring C.S.}^2}{4}\right) \times \left[\left(\frac{\%\ \text{Void}}{100}\right) - 1\right]}{\frac{\text{Min. Bore Dia.} - \text{Max. Groove Dia.}}{2}}$$

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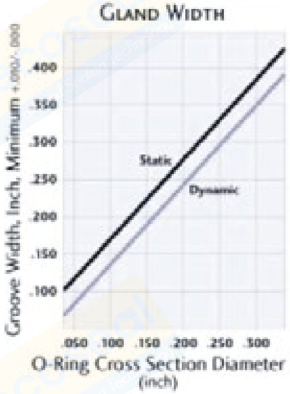
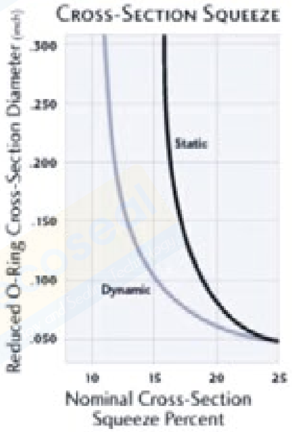
Minimum Groove Width: Option 2

From Groove Width Graph $^{+.010}_{-.000}$



Calculate Nominal Gland Depth



Modifying Existing Dimensional Information

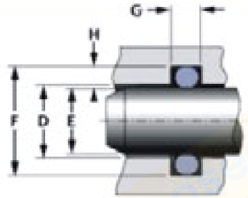
If a standard size O-ring is used and gland dimensions in a table are within 2% of intended use, then table figures can be modified as long as squeeze doesn't change.

Examples

Calculating Design Specifications

- Ring Calculations
- Gland Calculations
- **Examples**

Example: Calculating O-ring Size and Custom Gland Dimensions for an O-ring in a Bore (rod seal)



Type of application: Dynamic, groove in bore
Bore diameter (D): .912 inch, minimum
System pressure: 1000 psi, maximum

Select O-ring size

Determine maximum rod diameter (E_{Max}) using a typical diametrical clearance for parts this size is (.002 inch).

$$E_{Max} = D_{Min} - .002$$

$$E_{Max} = .912 - .002$$

$$E_{Max} = .910$$

E_{Max} allows selection of an O-ring size from the standard or special sizing tables. For this example, special size (.899 ± .009 inch ID by .172 ± .005 CS was chosen)

Calculate stretch reduced O-ring cross-section

$$\% \text{ Stretch} = \left(\frac{\text{Max. Rod Dia.}}{\text{O-Ring I.D.}} - 1 \right) \times 100$$

$$\% \text{ Stretch} = (.910/.899 - 1) \times 100$$

$$\% \text{ Stretch} = 1.2\%$$

Use Reduced Cross Section Due to Stretch Chart to locate 1.2% on the horizontal axis and read percent cross section reduction on the vertical axis. Use 2.6% to calculate reduced O-ring cross-section.

$$\text{Reduced Cross-Section} = \text{C.S.} - \left(\frac{\text{C.S. X \% Reduction}}{100}\right)$$

Reduced C.S. = .172 - (.172 x 2.5 / 100)

Reduced C.S. = .168 Inch

Determine Maximum Gap

Using the Rubber Hardness vs. Pressure and Clearance Gap Graph and a typical O-ring hardness will be 70A, locate pressure (1000 psi) on the vertical axis and read maximum gap on the horizontal axis: 0.008 inch.

Calculate tolerances applicable to gland dimensions

$$\text{Tolerance} = \frac{\text{Max. Gap - Min. Clearance}}{2} + .01 \text{ X (Reduced O-Ring C.S.)}$$

Tolerance = (.008 - .002)/2 + .01(.168)

Tolerance = .005 Inch

Calculate nominal gland depth (H)

Use Reduced Cross Section Due to Squeeze Chart to locate reduced O-ring CS (.168) on the vertical axis and read percent squeeze on the horizontal axis: 12.5%.

$$\text{H} = \text{Reduced O-Ring C.S.} - \left(\frac{\text{\% Squeeze X Reduced O-Ring C.S.}}{100}\right)$$

H = .168 - (12.5 x .168/100)

H = .147 Inch

Calculate gland dimensions and tolerances

Bore Diameter (D) = .912 +.005/-.000 Inch

Rod Diameter (E) = .910 +.000/-.005 Inch

$$\text{Nominal Gland Dia.} = \text{(2 X Nominal Gland Depth) + Nominal Rod Dia.}$$

F = 2H + E

F = 2(.147) + .908

F = 1.202

Tolerance is .005 because 1.202 is nominal.

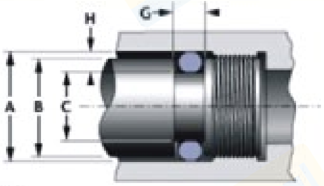
F = 1.200 +.005/-.000 Inch

Determine gland width (G)

Using the Gland Width chart locate nominal O-ring cross-section diameter (.172 inch) on the horizontal axis and read gland width (G) on the vertical axis.

G = .210 +.010/-.000 Inch

Example: Calculating O-ring Size and Custom Gland Dimensions for an O-ring on a Piston (Piston Seal)



Type of application: Static, groove in piston
Bore diameter (A): 4.650 inch, minimum
System pressure: 1200 psi, maximum

Select O-ring size

Select O-ring cross section diameter from the appropriate table. For this example, the cross section chosen was .139 ± .004 inch.

Using the Reduced Cross Section Due to Squeeze Chart, locate cross section (.139) on the vertical axis and read percent squeeze off the static curve on the horizontal axis: 17.5%.

$$\text{Approximate Gland Depth} = \text{O-Ring C.S.} - \left(\frac{\text{\% Squeeze X O-Ring C.S.}}{100}\right)$$

Approximate Gland Depth (H) = .139 - (17.5 x .139 / 100)

Approximate Gland Depth (H) = .115 Inch

$$\text{Approximate Gland Diameter} = \text{Min. Bore Dia. - 2 X Approximate Gland Depth}$$

Approximate Gland Diameter (C) = 4.650 - 2(.115)

Approximate Gland Diameter (C) = 4.420 Inch

Select O-ring inside diameter and part number from the tables. For this example size (4.402 ± .030 inch ID by .139 ± .004 CS) was chosen.

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Calculate reduced O-ring cross-section caused by stretch

$$\% \text{ Stretch} = \left(\frac{\text{Approximate Gland Dia.}}{\text{O-Ring I.D.}} - 1\right) \times 100$$

$$\% \text{ Stretch} = (4.420/4.402 - 1) \times 100$$

$$\% \text{ Stretch} = .4\%$$

Using the Reduced Cross Section Due to Stretch Chart, locate .4% on the horizontal axis and read percent cross section reduction on the vertical axis. In this case 1.5%.

$$\text{Reduced Cross-Section} = \text{C.S.} - \left(\frac{\text{C.S. X \% Reduction}}{100}\right)$$

$$\text{Reduced Cross Section} = .139 - (.139 \times 1.5/100)$$

$$\text{Reduced Cross Section} = .137 \text{ Inch}$$

Determine Maximum Gap

Using the Rubber Hardness vs. Pressure and Clearance Gap Graph and a typical O-ring hardness will be 70A, locate pressure (1200 psi) on the vertical axis and read maximum gap on the horizontal axis: 0.006 inch.

Calculate tolerances applicable to gland dimensions

Determine maximum piston diameter (B_{Max}) using a typical diametrical clearance for parts this size is (.003 inch).

$$B_{Max} = A_{Min} - .003$$

$$B_{Max} = 4.650 - .003$$

$$B_{Max} = 4.647 \text{ Inch}$$

$$\text{Tolerance} = \frac{\text{Max. Gap} - \text{Min. Clearance}}{2} + .01 \text{ X (Reduced O-Ring C.S.)}$$

$$\text{Tolerance} = (.006 - .003)/2 + .01(.137)$$

$$\text{Tolerance} = .003 \text{ Inch}$$

Calculate nominal gland depth (H)

$$H = \text{Reduced O-Ring C.S.} - \left(\frac{\text{\% Squeeze X Reduced O-Ring C.S.}}{100}\right)$$

$$H = .137 - (17.5 \times .137 / 100)$$

$$H = .113 \text{ Inch}$$

Calculate gland dimensions and tolerances

$$A = 4.650 +.003/-.000 \text{ Inch}$$

$$B = 4.647 +.000/-.003 \text{ Inch}$$

$$\text{Nominal Gland Dia.} = \text{Nominal Bore Dia.} - 2 \text{ X Nominal Gland Depth}$$

$$C = A - 2H$$

$$C = 4.652 - 2(.113)$$

$$C = 4.426$$

Tolerance is .003 because 4.426 is nominal.

$$C = 4.427 +.003/-.000 \text{ Inch}$$

Calculate gland dimensions and tolerances

$$A = 4.650 +.003/-.000 \text{ Inch}$$

$$B = 4.647 +.000/-.003 \text{ Inch}$$

$$\text{Nominal Gland Dia.} = \text{Nominal Bore Dia.} - 2 \text{ X Nominal Gland Depth}$$

$$C = A - 2H$$

$$C = 4.652 - 2(.113)$$

$$C = 4.426$$

Tolerance is .003 because 4.426 is nominal.

$$C = 4.427 +.003/-.000 \text{ Inch}$$

Determine gland width (G)

In the Gland Width Chart, locate nominal O-ring cross-section diameter (.139 inch) on the horizontal axis and read gland width (G) on the static curve vertical axis.

$$G = .210 +.010/-.000 \text{ Inch}$$