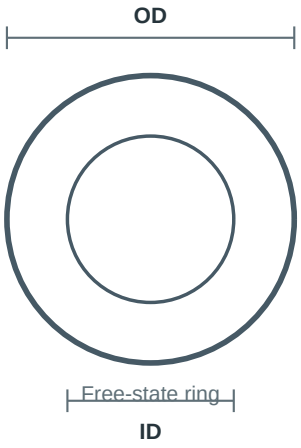
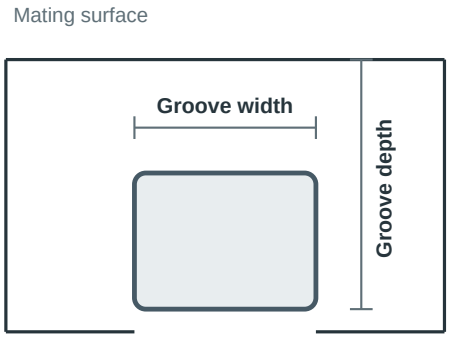
Square-Cut Silicone Ring Flat-Groove Design Guide

Geometry, squeeze, material selection, manufacturing, inspection, and RFQ requirements for static sealing applications





Flat groove and compressed section

Key definition. A square-cut silicone ring has a square or rectangular elastomer cross-section and is generally evaluated for static axial or face-seal use in a flat groove. The profile, groove, mating surfaces, pressure direction, material, and tolerance stack must be reviewed as one sealing system.

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Scope. This guide supports preliminary design and quotation review. Final dimensions, squeeze, groove fill, material compatibility, pressure capability, and functional testing must be validated for the actual assembly.

1. Application Scope

Square-cut silicone rings are commonly considered where two mating components remain stationary during service and the seal is compressed in a flat groove. Typical projects include equipment covers, housings, flanges, access panels, inspection ports, protective enclosures, and legacy assemblies with broad rectangular grooves.

A square profile is not automatically better than a round O-ring. It may be useful when the existing groove geometry, broad contact band, shape stability, assembly method, or replacement requirement favors a square or rectangular section. Dynamic sliding or rotary service requires a separate review because friction, heat generation, wear, and lubrication become more important.

2. Dimension Definition

1. ID - Inner diameter

The free-state inside diameter of the ring.

2. OD - Outer diameter

The free-state outside diameter of the ring.

3. W - Radial width

For a concentric ring, W = (OD - ID) / 2.

4. T - Axial thickness

The free-state thickness compressed between the groove bottom and mating surface.

5. Square or rectangular section

For a true square section, W and T are approximately equal. For a rectangular section, specify both independently.

3. Flat-Groove Design Inputs

1. Groove width and depth

These dimensions control available space, initial squeeze, and how the elastomer can displace during assembly.

2. Corner radii and edge condition

Sharp groove edges can damage the ring during installation or concentrate stress. Radii must also be compatible with the ring profile.

3. Mating-surface finish and flatness

Surface condition influences contact continuity, leakage paths, closure force, and repeatability.

4. Pressure direction and clearance gap

The seal must be positioned and supported so pressure does not drive material into an uncontrolled gap.

5. Tolerance stack

Evaluate the minimum and maximum ring dimensions together with the minimum and maximum groove dimensions.

Nominal axial squeeze: (free-state seal thickness - compressed groove depth) / free-state seal thickness x 100. Use the formula only as a starting point. The suitable range depends on material, hardness, pressure, surface condition, temperature, assembly force, and tolerance extremes.

4. Material and Hardness Review

1. Operating temperature

State both the normal and short-duration temperature range. Heat history can affect hardness, recovery, and compression behavior.

2. Contact media

Identify oils, fuels, solvents, detergents, water, air, gases, or cleaning chemicals. Silicone is not compatible with every medium.

3. Outdoor exposure

Confirm UV, ozone, rain, humidity, and repeated temperature cycling when the assembly is used outdoors.

4. Hardness and clamp load

Softer material may conform more easily but can require more support against gaps. Harder material can resist deformation but may increase closure force.

5. Color and documentation

Color, material declarations, food-contact direction, or other test requirements must be defined for the actual project and sample scope.

5. Manufacturing Route Selection

1. Compression molding

Suitable for continuous custom rings and repeat production. Tooling, cavity count, parting line, venting, flash control, shrinkage, and demolding must be reviewed.

2. Precision cutting from prepared stock

Useful for prototypes, selected low-volume parts, or special sizes when the required profile and dimensional capability are available.

3. Die cutting from sheet

More appropriate for flat washer or gasket-style rings. It does not create the same three-dimensional square cross-section as a molded ring.

4. Joined cord or strip

May be considered for very large diameters or maintenance replacements. Joint geometry, strength, dimensional consistency, and leakage risk must be validated.

For molded production, the lowest part price does not come from material weight alone. Tooling layout, cavity quantity, preform loading, cure time, flash removal, inspection, and demolding labor all influence cost.

6. Prototype and Inspection Requirements

- Measure ID, OD, W, T, and any critical concentricity or flatness requirement.
- Confirm material identification, hardness, color, and agreed document scope.
- Inspect flash, parting-line condition, trim marks, tears, contamination, distortion, and surface defects.
- Install the ring in the actual groove and review closure force at tolerance extremes.
- Run the application-specific leak, pressure, vacuum, water, dust, or environmental test.
- Evaluate recovery or compression behavior when long-term clamping is important.
- Confirm packaging prevents twisting, sharp folds, contamination, or permanent deformation.

Approval principle: Dimensional inspection alone does not prove sealing performance. The ring should be evaluated in the intended groove, with the actual mating surfaces, closure method, pressure direction, and operating environment.

7. Common Failure Modes to Investigate

1. Leakage at low pressure

Review insufficient squeeze, local surface gaps, flatness, ring twist, dimensional variation, and surface damage.

2. Excessive closure force

Review over-compression, excessive ring volume, high hardness, narrow groove width, and housing tolerance stack.

3. Extrusion or nibbling

Review pressure, clearance gap, support condition, hardness, temperature, and material compatibility.

4. Permanent flattening

Review compression level, material formulation, temperature exposure, service duration, and groove volume.

5. Chemical swelling or softening

Review the actual contact media, concentration, temperature, and exposure time.

6. Installation cuts or twisting

Review sharp edges, assembly stretch, lubrication policy, groove access, and operator method.

8. Information Required for a Reemane Project Review

- Part or equipment name and sealing function.
- Ring ID, OD, W, T, and dimensional tolerances.
- Groove drawing with width, depth, corner radii, and housing tolerances.
- Mating-surface material, finish, flatness, and closure method.
- Static or dynamic service and pressure direction.
- Pressure, vacuum, dust, water, or leakage target.
- Operating temperature and contact media.
- Preferred material, hardness, color, and surface requirement.
- Testing, documentation, labeling, or packaging requirements.
- Prototype quantity, first production quantity, and estimated annual usage.
- Current failure mode or reason for changing suppliers.
- STEP file, 2D drawing, photographs, or a physical sample when available.

Project Review

Reemane supports custom silicone ring development from drawings, samples, groove data, and application requirements. We can review manufacturing feasibility, material and hardness direction, mold development, prototype sampling, inspection points, and production quantity before quotation.

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Disclaimer. This guide is for preliminary engineering and sourcing discussion. It is not a guaranteed pressure rating, universal groove specification, certification statement, or substitute for application-specific testing and validation.