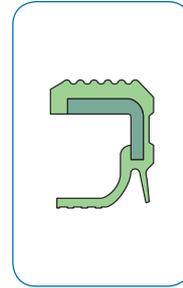
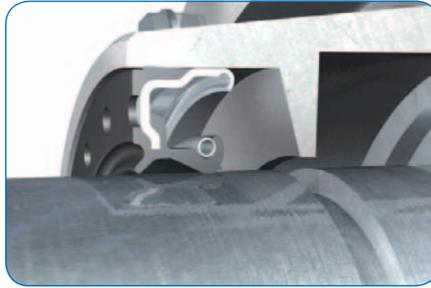
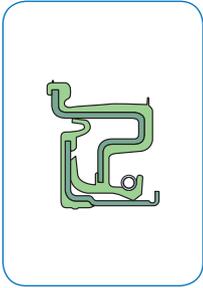


# Automotive transmission and driveline seals



# Radial lip shaft seals



## Function

SKF radial lip shaft seals, which can be used in a number of locations on a transmission or differential, provide an effective way to retain fluid while excluding external contamination. Radial lip shaft seals are available for virtually any front or rear wheel drive transmission, including dual clutch transmissions and continuously variable transmissions. These seals are also used extensively in differentials, transfer cases and power take-off units. Typical examples of sealing locations covered by radial lip shaft seals are input, output, pump and shifter shafts.

SKF radial lip seals offer optimum performance in extreme operating conditions.

Seal designs are available for applications where any of the following conditions exist:

- significant misalignment
- aggressive lubricants, which can attack and break down standard elastomers
- high levels of external contamination
- a wide temperature spectrum

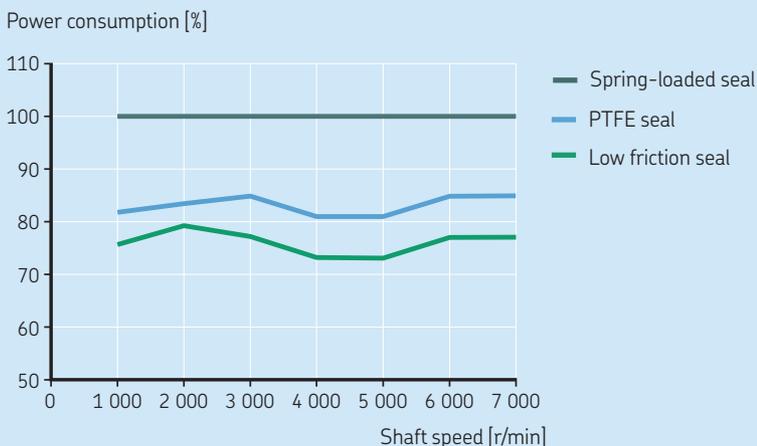
## Contamination exclusion features

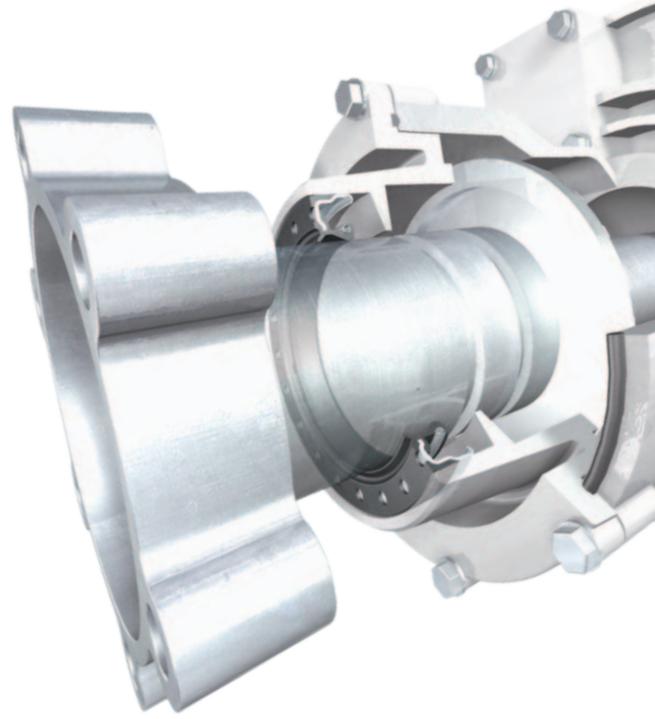
While the primary function of a radial lip shaft seal is to retain fluids within the transmission, the secondary function is to exclude external contaminants. Various exclusion features are available, including radial and axial dirt lips, and felt exclusion rings. Each feature offers

unique exclusion possibilities and should be selected based on the application and the operating conditions.

Each contamination exclusion feature can be incorporated with any of the following primary seal lip designs, offering a wide range of combinations.

Comparison of power consumption of 50 mm shaft seals





## Primary sealing lip designs

There are three main seal lip designs used for sealing rotating shafts in transmission applications. The choice depends on the application and operating conditions. The chart below shows the relative power consumption for each seal lip design.

### ■ Spring-loaded sealing lip

An SKF spring-loaded lip seal is designed to provide excellent sealing performance for applications where the shaft can rotate in either direction. The sealing lip incorporates a hydrodynamic pumping aid that enables the seal lip to retain fluid regardless of the direction in which the shaft rotates.

For applications where up to 1,5 mm of misalignment can occur, a high flex version is also available.

### ■ PTFE sealing lip

PTFE sealing lips are excellent for applications with aggressive fluids, or for applications where there is a possibility of the sealing lips running dry. An additional advantage of PTFE is the low friction characteristic of the material, which reduces torque losses and power consumption. The PTFE sealing lip incorporates a spiral hydrodynamic pumping aid that enables the seal lip to retain fluid under uni-directional shaft rotation.

### ■ Low friction elastomer sealing lip

The low friction sealing lip is similar in design to the PTFE seal, except that the PTFE is replaced with specially formulated elastomer materials. The sealing lip incorporates a spiral pumping aid for uni-directional applications similar to the PTFE design. The low friction sealing lip results in a very light radial load that reduces frictional losses and power consumption without sacrificing sealing performance.

## Integrated input shaft seal

For manual transmissions, the shaft seals described above can be integrated into a module, including a steel housing, an installation guard, a separate static seal, and a clutch release bearing guide tube or a clutch actuation retaining clip. These modules simplify the installation as there is only one component, not several, and they have the potential to reduce the overall cost. Possible leakage through the porosity of the aluminium transmission housing in the seal area is prevented.

## Unitization of seal with running surface

The most robust sealing solution incorporates a wear sleeve to provide a counter-face running surface for the seal lip. A wear sleeve virtually eliminates the possibility of damage to the seal lip during installation. It reduces the importance of maintaining a strict surface finish tolerance on the application's shaft, and can provide more robust external contamination exclusion capability. The result: a sealing solution that reduces shaft preparation costs, is easier to install and provides longer, more dependable service life.

## Advantages

SKF transmission seals, which have a proven record of success in a variety of applications, can deliver excellent performance over a wide range of operating conditions. SKF can apply its standards and knowledge in materials, design and manufacturing in a multitude of combinations, to offer a solution tailored to specific application requirements.

# Bonded pistons

## Function and typical applications

Bonded pistons convert hydraulic pressure into linear motion. In a typical automatic transmission, pistons stroked under fluid pressure are used to engage clutch packs that in turn actuate specific gear sets.

A conventional solution for a piston consists of a die-cast and machined aluminium component with assembled rings that act as the sealing elements. The bonded piston however, creates a robust sealing system by replacing the assembled components with an integrated one-piece solution, wherein an elastomer is over-moulded and physically bonded to a stamped metal component.

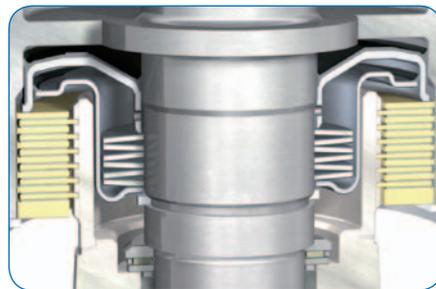
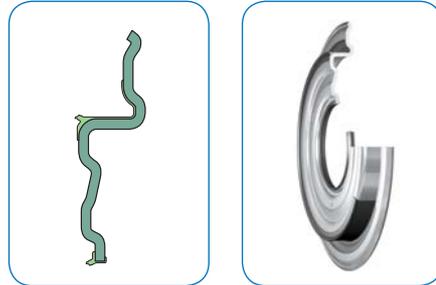
Bonded pistons can fall into several categories, including actuating pistons, piston balancers (or cancellers), accumulator pistons, and servo pistons. However, the general concept of elastomer sealing lips bonded to a supporting metal component remains the same for all bonded piston types.

In some applications, the complexity of design means that an aluminium cast piston is preferable to a steel bonded piston. SKF can provide solutions also for these applications.

## Available designs

Bonded pistons by SKF feature pressure-activated sealing lips that flex under pressure to retain the fluid and maintain pressure.

Depending on the level of complexity that the application demands, bonded pistons by SKF may incorporate various design features such as apply surfaces, return spring locating features, bleed holes or channels, stiffening features, installation drive features, and/or rest protrusions. In addition, patented beaded sealing lip designs are available to significantly lower friction. This design concept features an oil-retention cavity between the sealing elements to reduce sliding friction by minimizing sealing lip contact surfaces and loads.





## Advantages

Bonded pistons by SKF have a well-earned place as a preferred solution in today's advanced transmission designs. The comparison of SKF bonded pistons versus conventional die-cast aluminium assembled pistons reveals the following benefits:

- Fully rubber-covered mating surfaces minimize the possibility of damage by metal-to-metal contact between the piston and the lip running surfaces
- Potential for space savings by replacing aluminium with stronger steel material which will result in minimized part thickness. In some cases, the reduced steel thickness can result in an overall part weight that is comparable to aluminium pistons.
- Simplified one-piece solution versus an assembly of components
- Reduced sliding resistance associated with SKF patented sealing lip geometry and proprietary elastomer materials
- Reduced potential for lip damage during piston installation
- Elimination of potential leak paths due to porosity associated with cast-aluminium
- Economical solution

# Transmission covers

SKF provides transmission cover sealing modules, which include a static seal to the outside diameter and a rotary shaft seal.

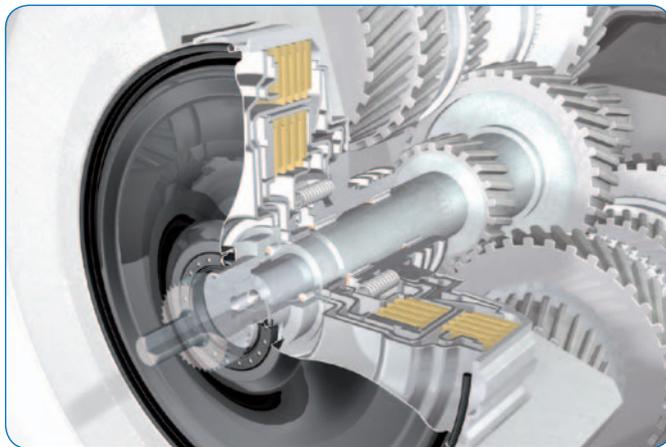
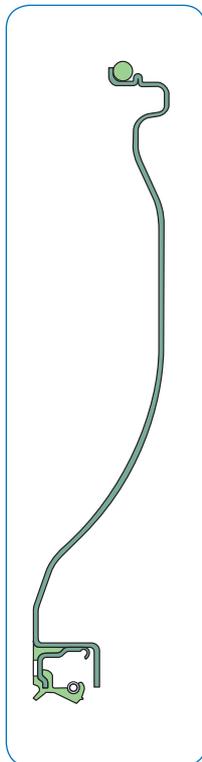
## Available designs

The cover sealing module consists of a cover plate with an outer static seal and an inner rotary shaft seal integrated into the unit. The cover sealing module can be based on a design with static seals and shaft seals bonded directly to the cover. For large sizes however, there are advantages in using an assembled design. An O-ring is assembled in a groove on the outside diameter of the cover and a rotary shaft seal is pressed into a stamped bore at the inside diameter of the cover.

Use of the separate O-ring and shaft seal enables individual sealing materials to be easily incorporated into the design.

## Advantages

This arrangement provides optimum cost efficiency compared to fully bonded solutions, through reduced manufacturing complexity. All the radial lip shaft seal designs previously mentioned in this brochure, can be incorporated into the module.



# Driveline seals

## Function and typical applications

Driveline seals are used for all shafts not included in the transmission, for example in a differential/rear drive unit, transfer case, power transfer unit, axle etc. SKF seals for all such applications are designed and manufactured with the emphasis on extended service life and low power loss. Key is the retention of oil within the system and elimination of contamination ingress – a major reason for seal failure.

ensures that the sealing lip rides on a controlled surface supplied by SKF, and reduces dirt ingress. A spacer can be used to aid installation positioning and it also acts as a labyrinth to support dirt exclusion.

For lighter duty applications, individual seals which run directly on the shaft/yoke are more popular. Because higher speeds are common with these applications, the vacuum created by the pumping of the helix of the sealing lip needs to be ventilated. Here, innovative techniques are used to create small openings in the system.

## Available designs

The specific design and materials of the seal are dependent on the operating conditions, and can vary greatly.

The designs range from those described in the previous sections on transmission seals, to complex unitized designs which incorporate a wear sleeve.

For heavy duty applications, unitized solutions are often chosen. Unitized pinion seals by SKF combine a unitized, one-piece cassette solution with a specially formulated Waveseal fluoroelastomer sealing lip. The advanced fluoroelastomer material allows the sealing lips to combat oil additives, while the patented Waveseal design sweeps oil back towards the bearing, and allows the seal to run cooler. The cassette solution

## Advantages

- Easy one-piece installation
- Reliability, extended service life and vehicle up-time through:
  - Sealing lip materials for high temperatures and aggressive oils in the applications
  - Excellent contamination exclusion

*Pinion seal for heavy duty truck*



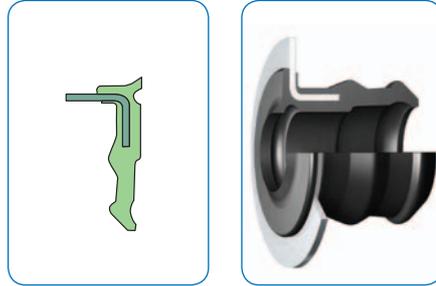
*Pinion seal for light duty truck*



# Port seals

## Function and typical applications

Port seals provide a sealed port for transferring pressurized fluid between mating housings. Pressure losses at these locations decrease hydraulic pump efficiency and transmission performance. The design of the port seal creates a flexible sealing joint that seals via axial and/or radial compression of the rubber. The elastomer material and design geometry enable the port seal to function under a wide range of assembly tolerances and application temperatures and pressures. Typical applications involve sealing hydraulic circuits within an automatic transmission.



## Available designs

Port seals are custom designed for specific use in their application but typical designs can be:

- Unsupported – for applications with full housing support for radial sealing and wide assembly axial tolerances
- Stamping or spring supported – for applications with limited housing support and tight assembly axial tolerances
- Multiple port – for integrating multiple port seals into one part

## Advantages

Multiple port seals can be combined into one integrated unit to reduce inventory and assembly complexity.

The designs can include metal stampings and coil springs to provide additional support for the elastomer material. This reduces the potential for rubber fatigue under high pressure and thereby provides consistent flow and optimum gear change performance.

# Magnetic encoders

## Function

Magnetic encoders are used in conjunction with sensors, to measure the speed and position of rotating shafts that control the gear changes in a transmission. Magnetic encoders consist of an elastomer material over-moulded onto a metal stamping. The elastomer material used is specially formulated with ferromagnetic particles, which enables the material to be magnetized with alternating north and south magnetic poles.



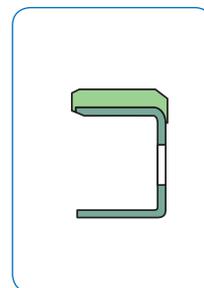
## Available designs

Encoders are available with the magnetized surface either on the circumference for radial, or on the flank for axial sensing of the signal. Combined with the ability to form complex metal shapes, this component enables the magnetic encoder to be custom designed to fit a wide variety of locations within the transmission. Nitrile rubber (NBR) and hydrogenated nitrile rubber (HNBR) compounds are available, with the HNBR material being used in applications with operating temperatures of up to 150 °C.

## Advantages

Magnetic encoders result in increased signal accuracy compared to stamped or cast encoders. The pole to pole error is lower for magnetic poles as compared to teeth that are formed in either stamped or die-cast encoders. In addition, sensitivity to the air gap is reduced because of the strong magnetic signal.

When non-magnetized metal encoders are used, a magnet must be incorporated in the sensor to generate the alternating north and south poles as the ring passes beneath it. The magnet is no longer needed with the SKF magnetic encoder, as the ring itself provides the north and south poles from the magnetized surface. As a result, the magnet is eliminated from the sensor, which lowers its cost and reduces the size of the sensor.



# General information

## Other transmission sealing products

There are additional SKF sealing products available for transmissions, e.g. O-rings, gaskets, shaft guides or PTFE sealing rings. Contact your SKF representative for information.

## Materials expertise

The selection and development of suitable materials is a critical element in sealing technology. Seals must resist increasingly high temperatures, forces and pressures. Specific media or lubricant properties must also be considered, to provide the right solution for specific customer application requirements. Newly developed materials include elastomers that provide lower friction or withstand a wide range of operating temperatures.

Typical materials used in sealing solutions for automotive transmissions are detailed below. The specific selection is dictated by the application conditions and operating environment.

| ASTM code | Name                        | Resistance to |       |            |           |      |
|-----------|-----------------------------|---------------|-------|------------|-----------|------|
|           |                             | oils          | water | high temp. | low temp. | wear |
| ACM       | Polyacrylate rubber         | +             | +     | +          | ++        | +    |
| AEM       | Ethylene acrylate rubber    | +             | +     | +          | ++        | 0    |
| HNBR      | Hydrogenated nitrile rubber | +             | ++    | 0          | ++        | ++   |
| FKM       | Fluorocarbon rubber         | ++            | +     | ++         | 0         | ++   |
| PTFE      | Polytetrafluoroethylene     | ++            | ++    | ++         | ++        | ++   |

Key:    ++ excellent    + good    0 moderate

# Sealing Solutions from SKF

In addition to transmission and driveline seals, SKF products provide complete automotive sealing solutions for engine, steering and suspension systems. This single source approach is possible through a worldwide network offering one-source accountability. In all SKF sealing concepts, there is a strong focus on minimizing friction, either to reduce CO<sub>2</sub> emissions and fuel consumption or to improve the functional characteristics.

## Global availability

SKF has the commitment and global resources to support the unique requirements of its customers' operations. With a global operations footprint, SKF offers sealing solutions for rotating and reciprocating applications, from prototype to serial production, close to its customers.

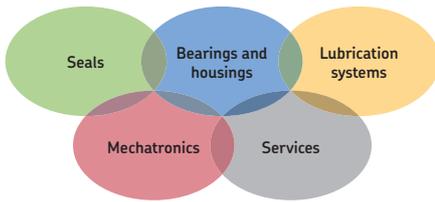
## Engineering and R&D

SKF uses the Design for Six Sigma (DFSS) methodology to develop best-in-class products and manufacturing processes. With increasing pressure to save development time and cost, SKF engineers also benefit from a proprietary and newly designed software. This software helps SKF designers to simulate sealing performance under a variety of conditions, to receive confirmation of seal design suitability.

## Testing and analysis

SKF has a global network of testing facilities that are equipped to fully validate the function and performance of seals. Advanced testing, such as key life testing, which uses test-profiles and operating conditions taken from real applications is available, as well as testing of customer components and assemblies. All tests are conducted using final application requirements to represent end user working conditions.





### The Power of Knowledge Engineering

Combining products, people, and application-specific knowledge, SKF delivers innovative solutions to equipment manufacturers and production facilities in every major industry worldwide. Having expertise in multiple competence areas supports SKF Life Cycle Management, a proven approach to improving equipment reliability, optimizing operational and energy efficiency and reducing total cost of ownership.

These competence areas include bearings and units, seals, lubrication systems, mechatronics, and a wide range of services, from 3-D computer modelling to cloud-based condition monitoring and asset management services.

SKF's global footprint provides SKF customers with uniform quality standards and worldwide product availability. Our local presence provides direct access to the experience, knowledge and ingenuity of SKF people.

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