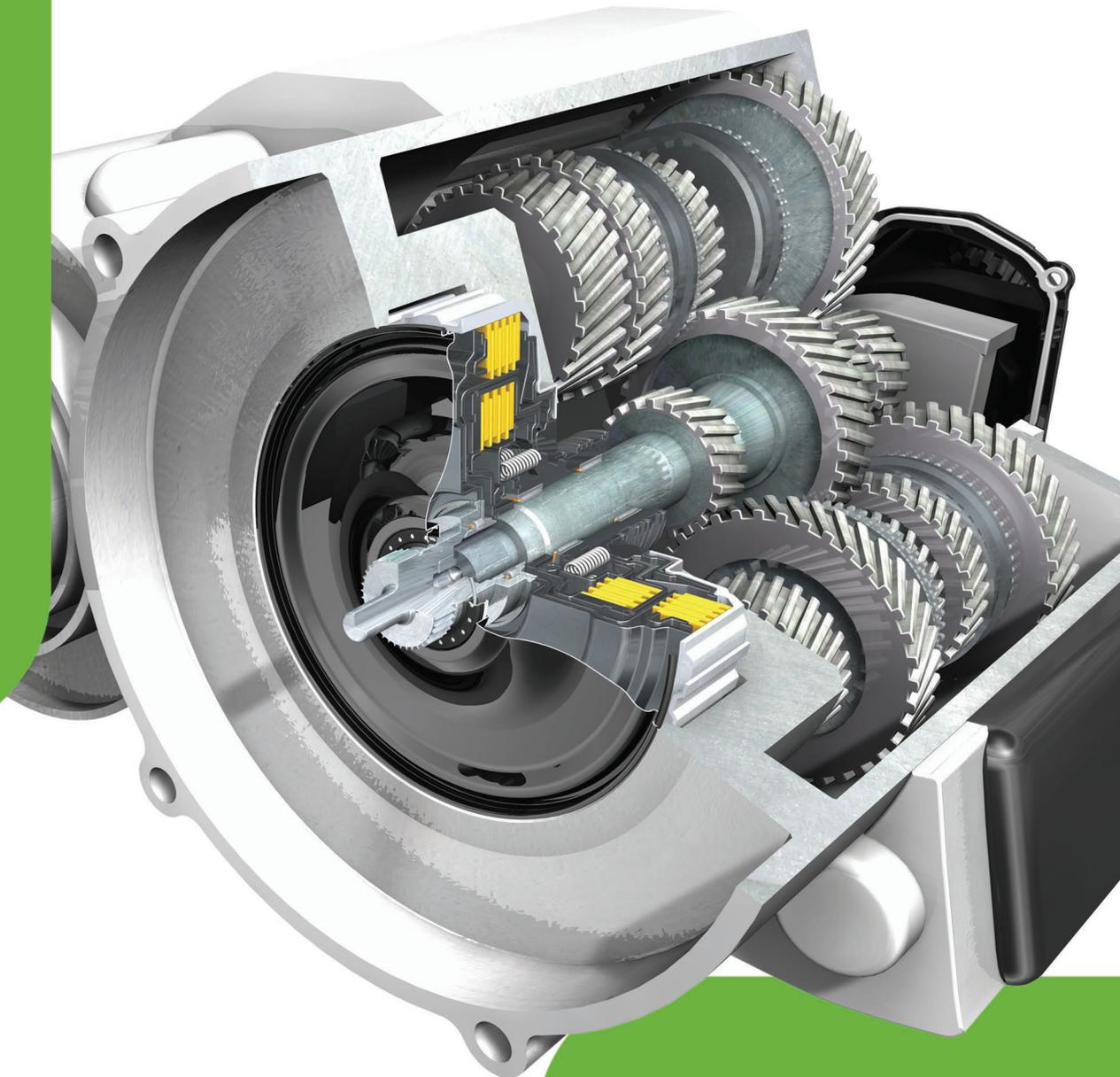




Automotive transmission seals





SKF –

Contents

SKF – the knowledge engineering company	3
Capabilities of SKF Sealing Solutions	4
Radial lip shaft seals	6
Bonded pistons	8
Transmission covers	10
Port seals	12
Magnetic tone rings	13
General information	14
Interested in other sealing solutions?	15



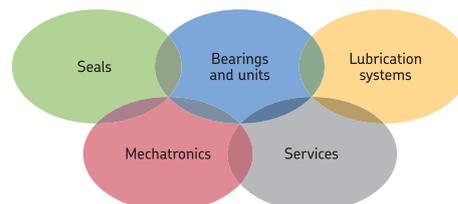
the knowledge engineering company

From the company that invented the self-aligning ball bearing more than 100 years ago, SKF has evolved into a knowledge engineering company that is able to draw on five technology platforms to create unique solutions for its customers.

These platforms include bearings, bearing units and seals, of course, but extend to other areas including: lubricants and lubrication systems, critical for long bearing life in many applications; mechatronics that combine mechanical and electronics knowledge into systems for more effective linear motion and sensorized solutions; and a full range of services, from design and logistics support to conditioning monitoring and reliability systems.

Though the scope has broadened, SKF continues to maintain the world's leadership in the design, manufacture and marketing of rolling bearings, as well as complementary products such as radial seals. SKF also holds an increasingly important position in the market for linear motion products, high-precision aerospace bearings, machine tool spindles and plant maintenance services.

The SKF Group is globally certified to ISO 14001, the international standard for environmental management, as well as OHSAS 18001, the health and safety management standard. Individual divisions have been approved for quality certification in accordance with either ISO 9001 or ISO/TS 16949. With some 100 manufacturing sites worldwide and sales companies in 70 countries, SKF is a truly international corporation. In addition, our distributors and dealers in some 15 000 locations around the world, an e-business marketplace and a global distribution system put SKF close to customers for the supply of both products and services. In essence, SKF solutions are available wherever and whenever customers need them. Overall, the SKF brand and the corporation are stronger than ever. As the knowledge engineering company, we stand ready to serve you with world-class product competencies, intellectual resources, and the vision to help you succeed.





Capabilities of SKF Sealing Solutions

SKF Sealing Solutions is one of the five technology platforms within the SKF Group and has gained over 100 years of experience as an automotive, industrial and aftermarket sealing supplier. In this time, the expertise in manufacturing, materials, engineering and testing has put SKF at the forefront of sealing technology.

Global customer account teams

Customer account teams are organized on a global basis, with account managers and application engineers located in Europe, Asia and North America. Each account team takes on responsibility for supporting the customer globally.

Engineering and R&D

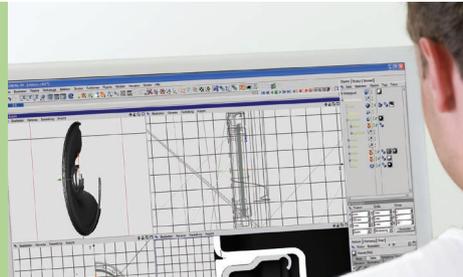
Engineering is organized in Centres of Excellence (COE) with managers located in Asia, Europe and North America. The COE organization provides engineering and development resources focused on a particular product range and family. This product focus enables the engineering community to develop deep knowledge and understanding about sealing fundamentals and robust solutions for each product category. Additionally, this structure makes sure that common design standards and lessons learned are applied on all new projects.

The engineering resources comprising the COE teams are located at the technical sites within the SKF Sealing Solutions footprint.

Additionally, SKF uses the Design for Six Sigma (DFSS) methodology, an approach that has evolved from current Six Sigma tools, in order to develop best-in-class products and manufacturing processes.

Testing

SKF testing facilities are equipped to fully validate the function and performance of transmission seals. Testing resources are available in North America, Europe and Asia. Advanced testing, such as key life testing, which uses test profiles and operating conditions taken from the real world, are available as well as testing in full customer components and assemblies.



Manufacturing

The manufacturing footprint of SKF Sealing Solutions includes facilities located around the globe, with sites in Mexico, USA, Germany, Italy, Bulgaria, India, China and Korea. This enables SKF to manufacture products close to the customer. SKF's manufacturing technologies are standardized and available at all sites.

Innovation

The sealing system is often one of the last subsystems to be fully designed. This can lead to challenges, where a unique and innovative solution is needed in order to meet the sealing needs of the application and the performance requirements of the customer. SKF can satisfy these requirements by utilizing its extensive knowledge in materials, design, and applications to offer customers robust, economical, and innovative solutions. Port seals and cover sealing modules are two examples of unique and innovative products recently launched by SKF for transmission applications.

Port seals enable pressurized fluid to flow from the aluminium valve body through the transmission case and into the inner clutch housings with no loss of fluid or pressure at the component interfaces.

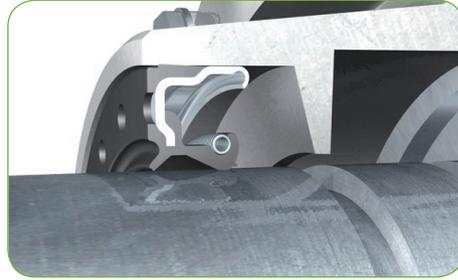
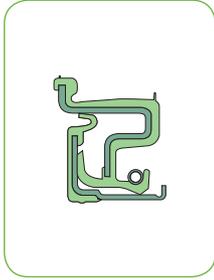
Pressure losses at these interfaces can result in a decrease of gear change performance. The port seal offers a simple, cost-effective solution to this application.

Cover sealing modules integrate a stamped O-ring groove and assembled O-ring for optimized static sealing to the transmission housing, while a separate moulded seal is assembled to the stamped cover for sealing the input shaft of the transmission. The manufacturing complexity for this design is significantly lower than for fully over-moulded solutions and as a result a more cost-effective, yet robust, solution is achieved.

Capabilities in transmission sealing

In the following pages, the SKF portfolio of dynamic and static sealing for use in automotive transmissions is described. Typical applications include radial lip shaft seals, bonded pistons, covers, port seals, as well as miscellaneous components.

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

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 lip seal design.

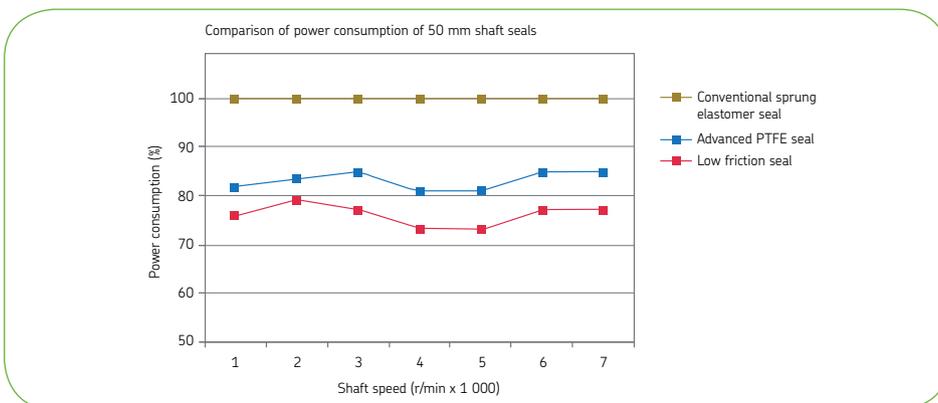
■ Spring loaded lip seal

An SKF spring loaded lip seal is a design that provides excellent sealing performance for applications where the shaft can rotate in either direction. The sealing lip incorporates hydrodynamic pumping aids that enable the seal lip to retain fluid regardless of the direction that 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 for the PTFE that 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.

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 primary seal lip designs, offering a wide range of combinations.

Integrated input shaft seal

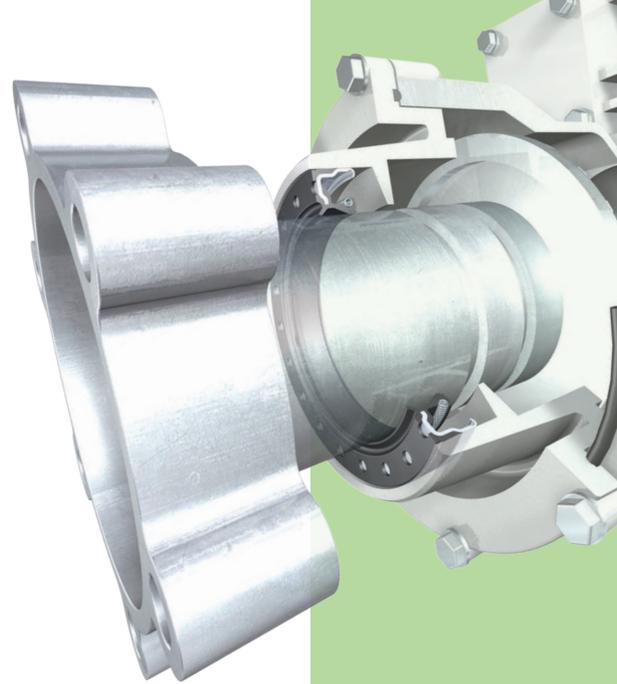
For manual transmissions, the shaft seals described previously can be integrated into a module including: a steel housing, an installation guard, a separate static seal and a clutch release bearing guide tube or a clutch actuation retaining clip. These modules simplify the installation as there is only one component, not several and provide 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 for the seal lip. A wear sleeve virtually eliminates the possibility that the seal lip will be damaged during installation. It also reduces the importance of maintaining a strict surface finish tolerance. The result: a sealing solution that reduces shaft preparation costs, is easier and faster 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 unparalleled 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 actuate clutch packs that in turn engage specific gears.

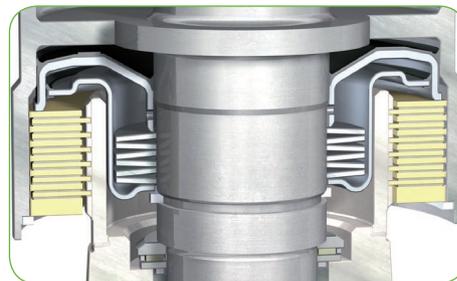
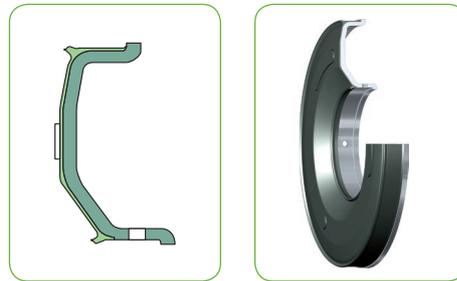
A conventional solution for a piston consists of a die-cast and machined aluminium component with assembled rings that act as the sealing elements. The bonded piston creates a more robust sealing system by replacing the assembled components with an integrated one-piece solution, wherein an elastomer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

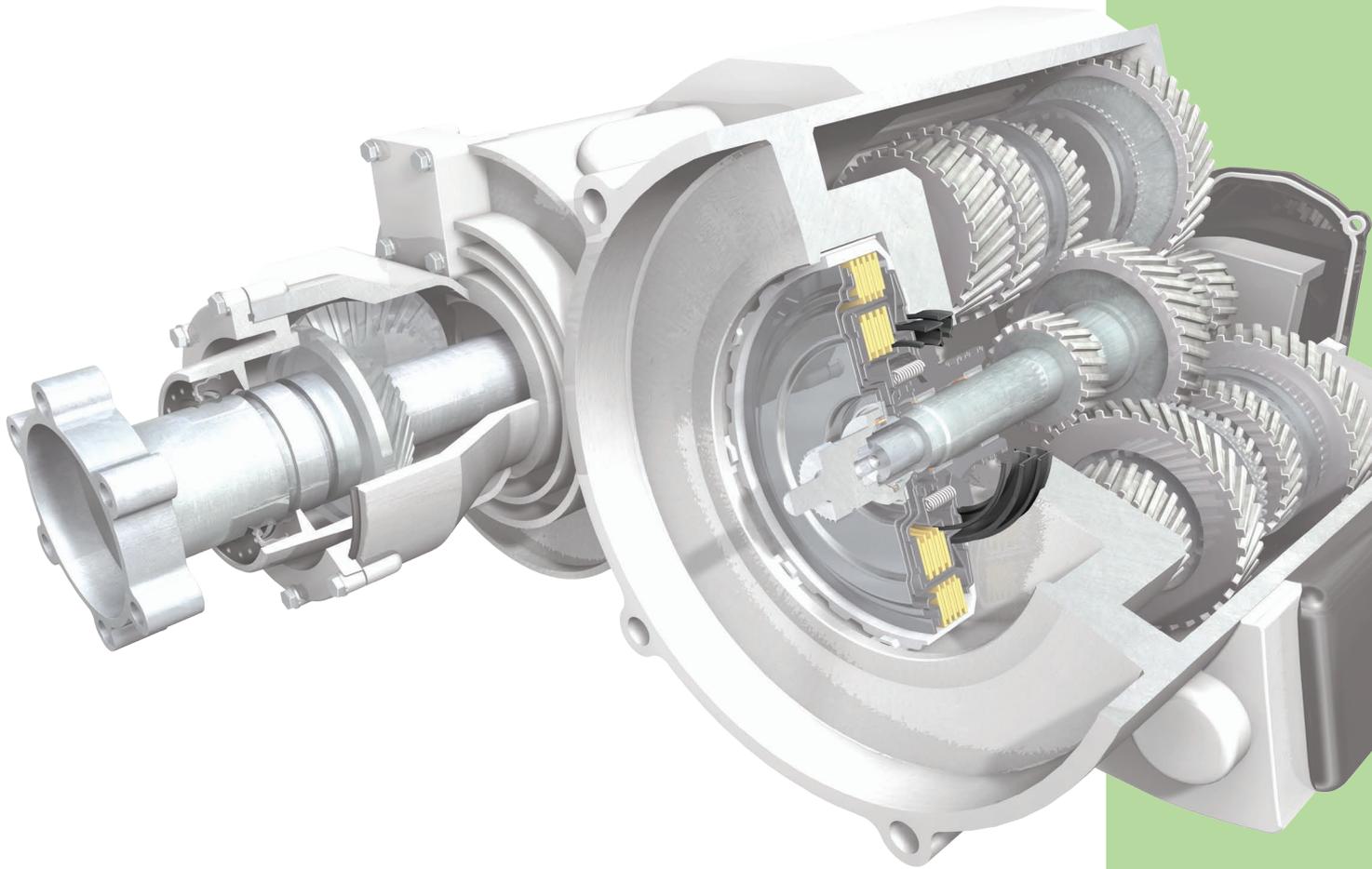
Bonded pistons can fall into several categories including actuating pistons, piston balancers (or cancellers), accumulator pistons, and servo pistons. However, the general concept of elastomer sealing lips bonded to a supporting metal component remains the same for all bonded piston types.

Available design features

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

Depending upon the level of complexity that the application demands, SKF bonded pistons may incorporate design features such as: apply surfaces, return spring locating features, bleed holes or channels, stiffening features, installation drive features, or moulded bumpers.





Advantages

Bonded pistons provide increased operating life, cost savings and potential weight reduction, compared to conventional aluminium pistons.

A primary advantage of choosing a bonded piston over a conventional piston is increased design robustness against damage during assembly or during operation. With the sealing elements bonded directly to the stamping, there is less potential for the bonded piston to be damaged during assembly. Additionally, conventional pistons can often score the mating housing over time. Once the housing is damaged, replacement pistons no longer function. SKF bonded pistons include fully rubber covered mating surfaces and as a result, this failure mode is eliminated.

A further advantage of bonded pistons is potential weight savings by replacing the aluminium material with a steel stamping.

The aluminium piston component requires a larger wall thickness, compared to steel, to compensate for its lower material strength. On the other hand, the steel stamping can be thinner, stronger, and lighter than the aluminium component.

Finally, replacement of the die-cast aluminium component with the steel stamping eliminates potential porosity leak paths.

The cost of a bonded piston is typically less than the cost of a conventional piston. This is achieved by replacing the die-cast and machined aluminium component with a stamped steel component and by eliminating the process by which the loose sealing lip elements are assembled.

Transmission covers

SKF provides two types of covers for transmissions:

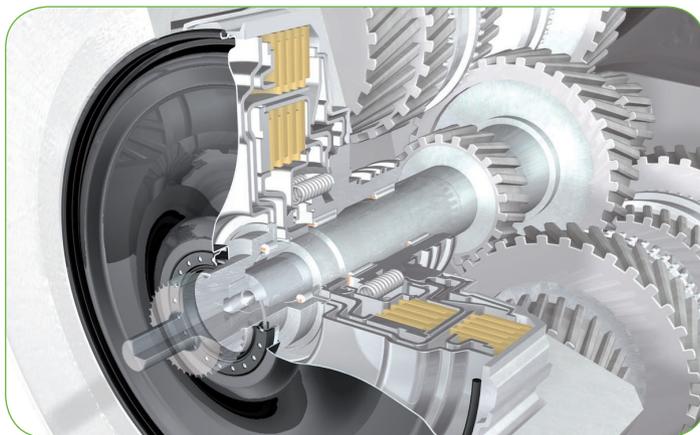
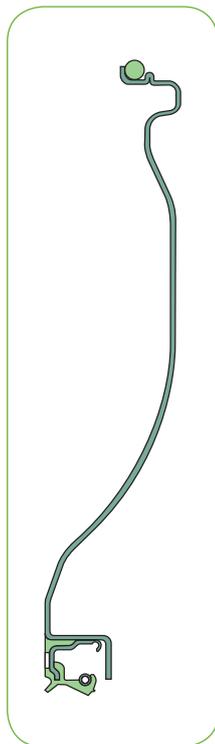
- Cover sealing modules which include a static seal to the outside diameter and a rotary shaft seal.
- End covers with a moulded-in-place static gasket.

Available designs:

■ Cover sealing module

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 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. This arrangement provides optimum cost 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.

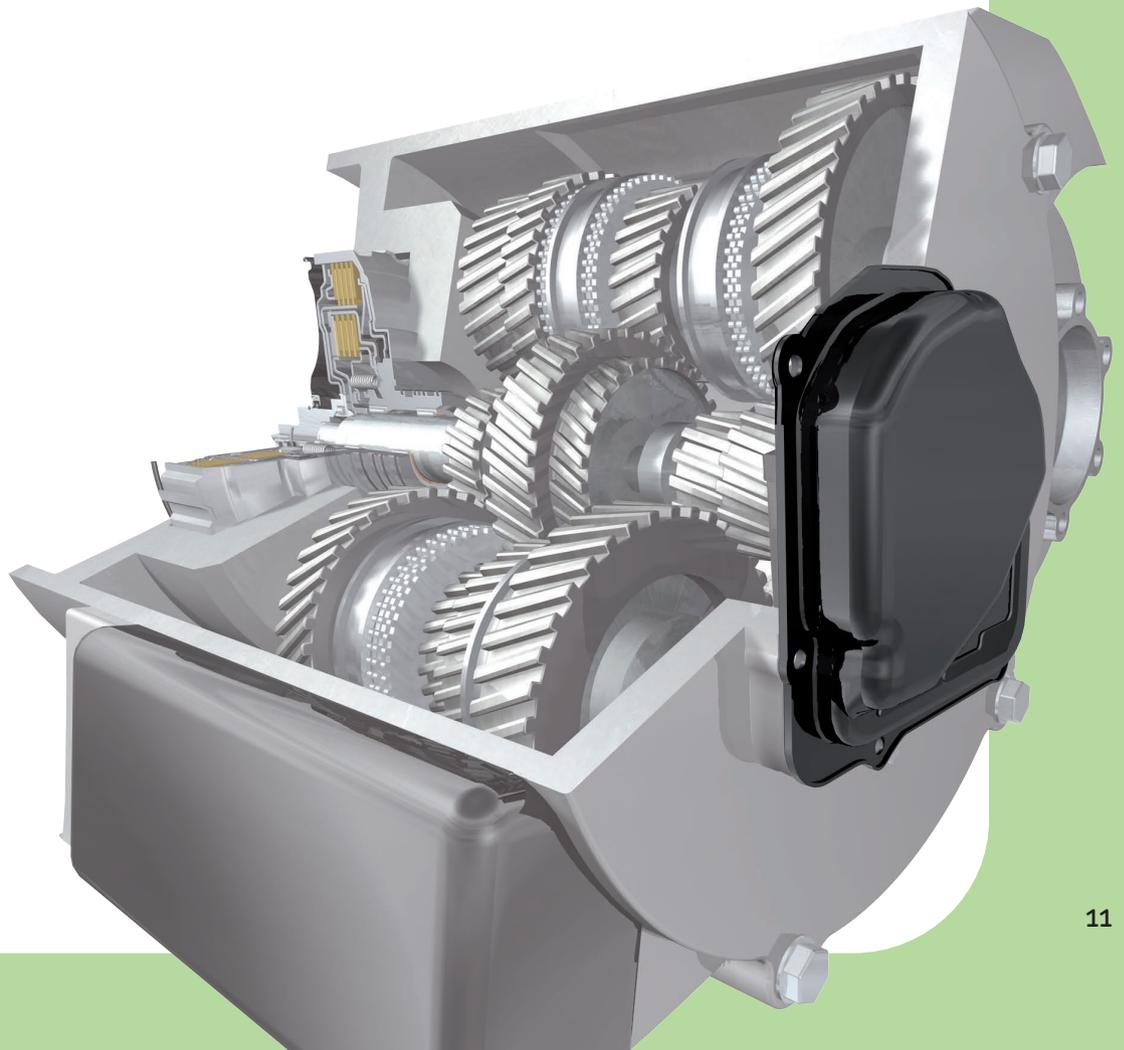




■ End cover

The end cover is based on a stamped metal or plastic cover onto which a static gasket is permanently bonded. Moulding the seal directly to the cover provides the highest level of reliability, as the seal cannot be forgotten at installation.

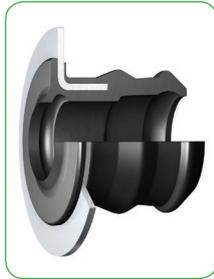
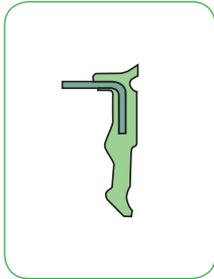
The design incorporates spacers so that the seal cannot be overcompressed when bolted to the transmission housing. The inclusion of the spacers is a cost-effective solution, eliminating the need for separate spacers attached to the bolts.



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 tone rings

Function

Magnetic tone rings are used in conjunction with sensors to measure the speed and position of rotating shafts which control the gear changes in a transmission. Magnetic tone rings 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:

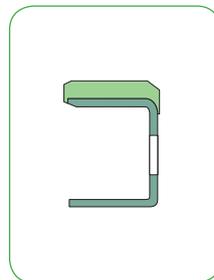
Tone rings are available with the magnetized surface either on the circumference for radial, or on the flank for axial sensing of the signal. Combined with the ability to form complex metal shapes, this component enables the magnetic tone ring to be custom designed to fit a wide variety of locations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

Advantages:

Magnetic tone rings result in increased signal accuracy compared to stamped or cast tone rings. The tooth to tooth error is lower for magnetic poles as compared to teeth that are formed in either stamped or die cast tone rings. Additionally, the sensitivity to the air gap is reduced because of the strong magnetic signal.

When non-magnetized metal tone rings 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 tone ring, 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

SKF has over 100 years of engineering and materials experience putting it at the forefront of research and design of elastomer materials for use in the sealing industry and related fields. Our materials research centres develop the compounds and evaluate their characteristics, performance and manufacturability prior to release to the production sites globally.

SKF has an extensive materials library of developed compounds offering the ability to choose a material specific to an application's performance needs. Typical materials used in sealing solutions for automotive transmissions are detailed below. The specific selection is dictated by the application conditions and operating environment.

Characteristics of SKF materials

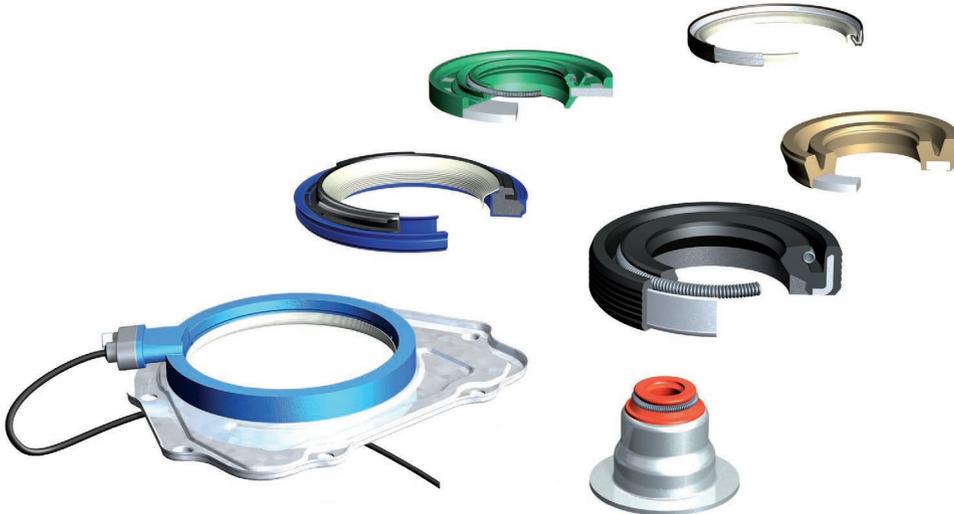
ASTM code	Name	Resistance to				
		oils	water	high temp.	low temp.	wear
ACM	Polyacrylate rubber	+	+	+	+	0
AEM	Ethylene acrylate rubber	+	+	+	++	0
HNBR	Hydrogenated nitrile rubber	+	++	0	++	++
FKM	Fluorocarbon rubber	++	+	++	0	+
PTFE	Polytetrafluoroethylene	++	++	++	++	++

Key: ++ excellent + good 0 moderate

Interested in other sealing solutions?

In addition to transmission seals, SKF products comprise complete automotive sealing solutions for engine, driveline, steering and suspension systems. This single source approach is possible through a worldwide network offering one-source accountability. SKF sealing products include seals for gas springs, valve stem seals, conventional

rubber shaft seals, PTFE seals, SKF ROTO-STAT sealing modules, driveline and wheel end systems. In addition to the sealing function, friction is a very important characteristic in our concepts. SKF is able to provide optimized solutions to reduce friction and power consumption and hence minimize fuel consumption and CO₂ emissions.





The Center of Excellence for transmission sealing products is:

SKF Sealing Solutions
900 North State Street
Elgin, IL 60123
USA

Tel. +1 847 742 7840
Fax +1 847 742 7845
E-Mail infoseals-america@skf.com

® SKF is a registered trademark of the SKF Group.

© SKF Group 2008

The contents of this publication are the copyright of the publisher and may not be reproduced (even extracts) unless written permission is granted. Every care has been taken to ensure the accuracy of the information contained in this publication but no liability can be accepted for any loss or damage whether direct, indirect or consequential arising out of the use of the information contained herein.

Publication 6863 EN

Printed in Germany.

skf.com