

SKF engine guide

Understanding and troubleshooting
engine malfunction and failure

Timing system – Auxiliary system – Water pump



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Timing

Auxiliary

Water pump

Case studies

Always follow the vehicle manufacturer's recommended procedures for removal and replacement. Support the vehicle as per garage Health and Safety guidelines. Failure to follow these guidelines could result in injury or property damage. SKF disclaims all liability due to failure to follow these instructions.

1. The SKF vehicle aftermarket

Through a strong network of more than 10 000 distributors and dealers within the vehicle (or 'independent') aftermarket, spare parts for cars, trucks and two-wheelers reach their destination at workshops all over the world.

With over 20 000 variations SKF offers parts and kits to carry out complete repairs for virtually every automotive make and model in the world.



Who we are

A broad range of products and services and a focus on continuous innovation and improvement make us a trusted partner for the top vehicle aftermarket distributors.

For decades SKF has been a trusted OE supplier to the world's top car manufacturers around the globe. We utilize this experience to deliver high quality products and premium services to our customers in the aftermarket for cars and commercial vehicles all over the world.

What we stand for

- **Broad range**
With over 20 000 variations we offer parts and kits for virtually every car make and model in the world.
- **Latest technology and OE expertise**
For decades the world's top manufacturers have put their trust in us.
- **"Complete Kit Concept"**
Our specific packaging approach enables a complete repair with just one kit.
- **On-demand delivery**
24/7 online parts ordering and next day delivery make us "best in class" in logistics.
- **Comprehensive support offer**
With TecDoc, training programs, digital catalogues, technical guides and educational videos, we help you install confidence every day.





- Wheel end

- Driveline

- Engine

- Suspension

- And more

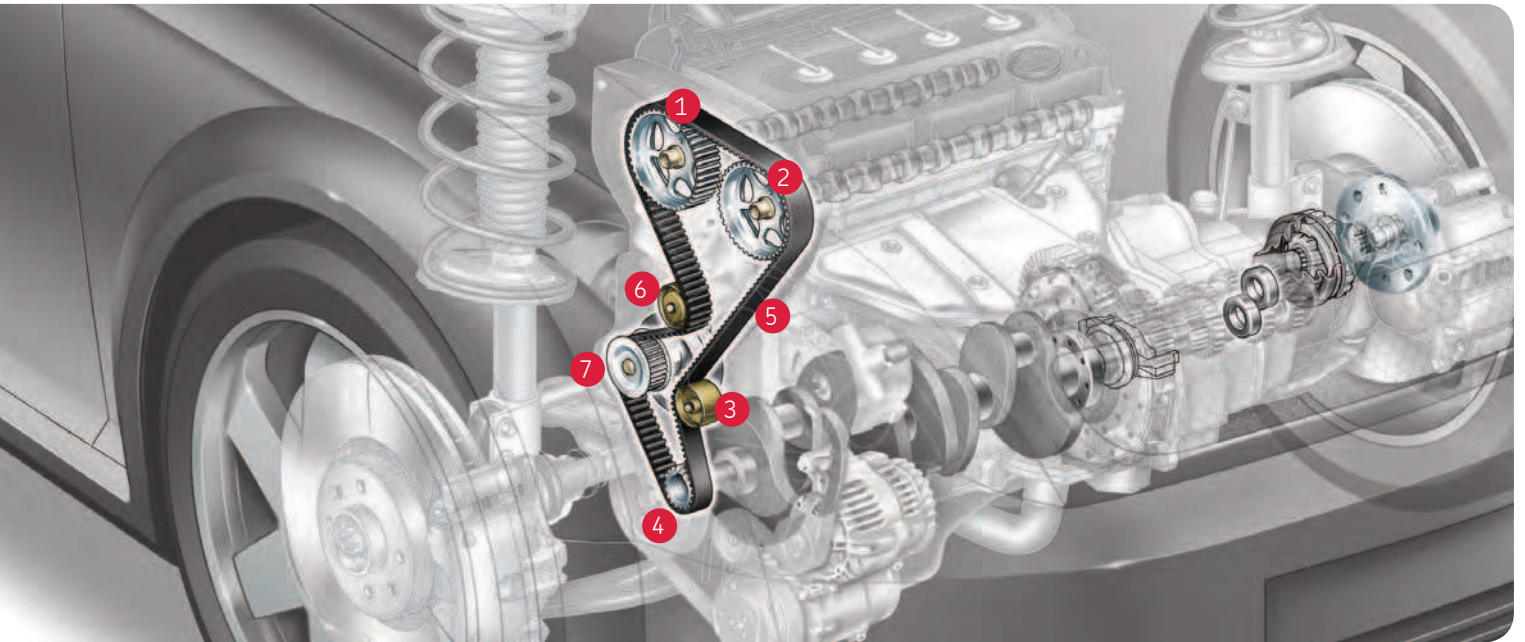
A collection of SKF automotive maintenance products. From left to right: a tube of grease, a CV-Joint kit box with a CV axle and seal, a Scotseal box with a seal, a Wheel bearing kit box with a bearing and hub assembly, and a Suspension kit box with a shock absorber and coil spring. Various individual components like bearings, seals, and bolts are also displayed.





2 Timing system

2.1. Timing system technology



The timing system is a crucial part of the four stroke internal combustion engine and its components are fundamental to the synchronized rotation of the camshaft(s) so that the engine's inlet and outlet valves open and close at the proper times. In most cases either a timing belt or timing chain transmit the force needed to rotate the camshaft(s).

If any of the timing components fail, the car will no longer operate properly, and high cost damage to the engine may occur.



1 2 3 4 Guiding elements and/or pulleys

These elements guide the chain or belt (pulleys are used to guide a belt, plastic guiding elements are used to support the chain).



5 The belt/chain

The belt or chain is driven by the crankshaft gearwheel and operates the camshaft(s). Instead of a chain or belt, in more seldom cases a combination of lower gearwheels and upper drive with a short timing belt is applied. On some popular applications a small extra belt that drives one of the camshafts can be found.



6 The timing tensioners

The tensioners maintain the correct tension on the belt at all times. Typically two different types of tensioners can be found in modern engines: manual adjustable tensioners or automatic tensioners. Sometimes the automatic tensioner also includes a hydraulic piston.

With manual tensioners the tension has to be set manually and kept in place with a locked screw. The advantage of automatic tensioners is the included spring, which adjusts and maintains the tension for the design life of both components. However, the word “automatic” can be somewhat misleading as during the first initial fitting the automatic tensioners must also be installed and adjusted according to the fitting instructions.



7 The water pump

The water pump moves large volumes of coolant through the engine and the radiator. This key component ensures the optimum engine temperature allowing a good engine combustion.

Additional information

Main advantages of the timing belt:

- Lower manufacturing cost
- Easy to integrate the water pump in the system
- Easier to drive a high pressure diesel injection pump
- Lower noise level and slightly lower friction (slight CO₂ reduction)
- Stable valve timing, meaning nearly no stretch during its life cycle
- Easier to drive additional components like oil pump or balance shafts

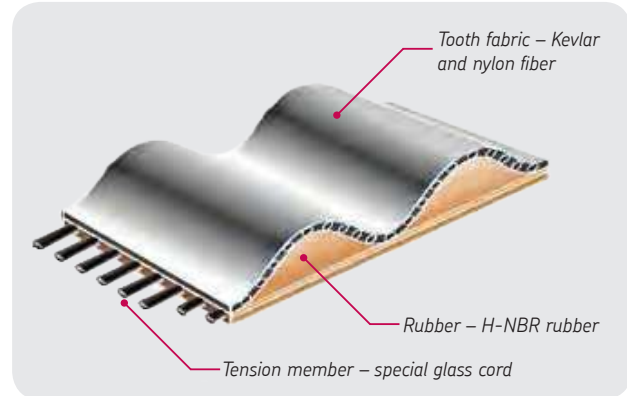
Main advantages of the timing chain:

- Significantly longer life span (expected to last maintenance-free for the entire life of the vehicle)
- Failure is usually evident due to a rattling noise, no sudden breakdown occurs
- 15-20 mm less engine length, no extra space needed for servicing
- Suitable for complicated timing systems (especially for V6 and V8 engines)

2.1.1. Understanding timing belt designs

Reinforced design

This extra strong belt is designed to withstand high peak loads and the increased temperatures in the engine compartment of a modern car. The rubber belt material is reinforced with high tensile fibers like Kevlar and can reach a life span from 150 000 to up to over 200 000 km.

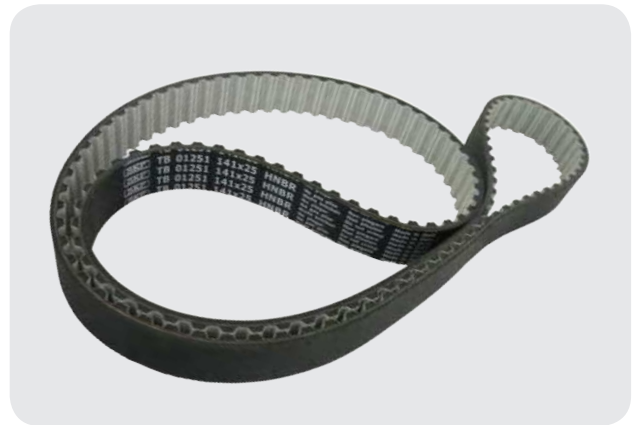


PTFE coated belts

Going forward more and more timing belts will be coated with PTFE (usually white or black). Typical applications are high performance diesel engines where the high pressure (common rail) injection pump is driven by the timing belt.

Main advantages:

- Extremely strong
- Less noise
- Lower tolerances
- Longer lifespan
- Less friction leading to a slight CO₂ reduction
- Further limited stretch under severe conditions



The oily belt

Since 2012 modern technology has lead to the development of oiled timing belts similar to the timing chains.

This component combines the best attributes of a belt and a chain in one single solution:

- Very long lifespan
- Less noise
- Minimum vibrations
- Less friction and CO₂ reduction

Important: engines with an oily belt application do require special engine oil specifications and recommended maintenance routines to allow maximum life span of this timing belt type!

Strictly follow the car manufacturer recommendations.



2.1.2. Understanding pulley misalignment

To be sure the timing is 100% correct all pulleys have to be perfectly aligned to allow the belt or chain to run evenly on one level. With regards to misalignment, two types can be identified: **parallel** misalignment (e.g. due to pulleys that are improperly positioned on their shafts) or **angular** misalignment (due to non-parallel, skewed shafts).

Keep in mind that all components in the timing system are interrelated: therefore misalignment of the pulleys due to, for example, incorrect set up can damage other components (typically a worn belt).

However misalignment can also be the result of the incorrect set-up of another part (belt tension that is set too high, for example, can cause a pulley to tilt).

Damage due to parallel pulley misalignment



Belt is damaged on one of its flanges.



Belt teeth have been torn off.

Damage due to angular pulley misalignment



Belt ran on one side of the pulley.



Pulley misalignment caused by bent back plate.

2.1.3. Understanding belt tension

Incorrect tension can relate to two different circumstances: tension that is too low or too high.

If the belt tension is too low, the belt may jump and cause noise and uneven wear. Tension that is too low may also drastically decrease the belt's life span.

If the belt tension is too high, the pressure put on the water pump bearings and the tensioners is too excessive, which can cause the water pump to fail and the tensioners to break. In extreme cases the alignment of the pulleys can be distorted and cause further damage to the entire system.



Tips for setting the correct belt tension

- Never start the job when the engine is either too hot or too cold. Wait until the engine block has reached ambient/room temperature. Remember: a belt replaced at the wrong temperature will slacken. Insufficient tension increases the risk of premature failure and may damage the reputation of your garage.
- Always follow the manufacturer's instruction.
- Set the tension as prescribed, check the precise position of the tensioner indicators. Rotate the engine manually, at least the number of times mentioned in the manufacturer's instructions.
- Check the position of the tensioner indicator again; if it is not correct restart initial procedure to set the tension.
- Always ensure the correct fitting and tension setting with SKF's range of tools (**see p. 14 and 25**). SKF also offers specific fitting instructions for the more complicated engine types, which include precise technical data and step-by-step guides for setting the correct tension.



Damage caused by excessive tension



Hammering marks on the end stop or a cracked tensioner casting are clear signs of over tensioning.



A snapped belt and belt residue on the tensioner pulley (signs of high temperatures) are other clear indicators of extreme over tensioning.

Damage caused by lack of tension



Belt is worn on one side, marks can be seen on the pulley.



Back plate of tensioner broken, indicator has come into contact with end stop.

2.1.4. Understanding the importance of using the right tools

Timing/distribution systems on today's engines require the use of special service tools, so that after repair, the engine's power, fuel economy and longevity are all assured.

VKN 1000 tool kit



VKN 1000-1



VKN 1000-5



VKN 1000-3



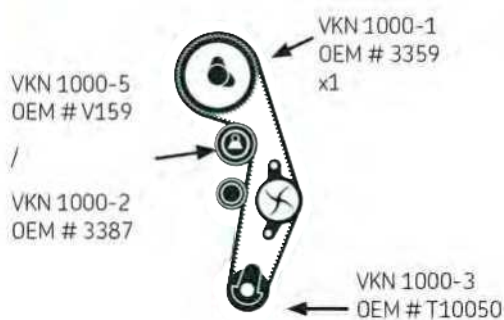
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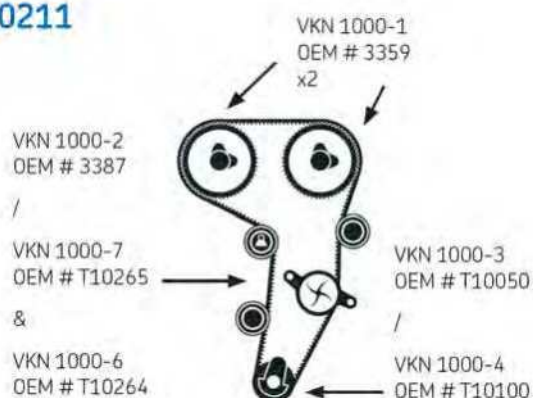
VKN 1000-7

Application examples

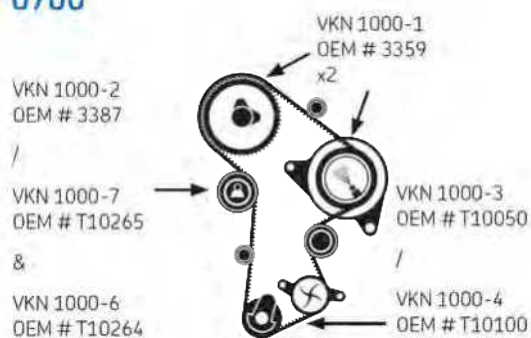
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T 0700



More tips

In addition to using the right tools, a number of other factors are critical for a correct and professional timing system set-up:

- Use the **correct and complete kit** for the specific engine (including components like a water pump if driven off the timing system and a hydraulic unit if required plus all nuts, studs and bolts that require replacement.)
- Consider replacing the auxiliary belt or complete auxiliary system with a kit (replacing the auxiliary system at the same time as the timing system is also recommended by some vehicle manufacturers.)
- Examine the **condition of the TVD** - Torsional Vibration Damper and replace it if necessary
- Check for **over-/under-tension** according to the vehicle manufacturer's recommendations
- **Rotate the adjuster plate** (if applicable) in the right direction (check for clockwise or counter clockwise directional arrow on the adjuster plate). Rotating in the wrong direction can cause an incorrect wrap angle and lead to belt overheating and failure resulting in engine damage.

2.2. Inspecting, diagnosing and fixing damage

The timing system is a complex and interlinked structure. Damaged components can influence and further impair one another. A worn belt, a misaligned tensioner or an impaired pulley can cause the entire system to fail and have serious effects on the engine as a whole. A broken or “tooth-jumped” timing belt in today’s most common “interference” type engines, with the valves and pistons in close proximity, can for example cause the piston to crash into an open valve, resulting in bent valves, broken pistons, and serious engine damage.

We recommend never isolating just one component as the cause of failure. Instead look at all system components when carrying out a repair and if possible always replace with an entire system kit (including the bolts, nuts, tensioners and water pump if applicable), where all parts are guaranteed to work well together and will have an identical life expectancy.

Replacing only the timing belt and not the timing belt driven water pump creates the risk for a slightly changed setting of the dynamic seal when tensioning the new belt. As a result water pump leakage could occur short after the timing belt replacement.

Important Tips

Safety precautions

- Follow the **correct sequence** of the repair as provided by the car manufacturer.
- Disconnect the car’s battery.
- Take special care when working on cars with start-stop systems.
- Adhere to the **safety guidelines** of your garage and properly support the vehicle.
- Download and print all available support material. Check the SKF website or use the QR code printed on the SKF packaging to **access SKF specific fitting instructions**, technical bulletins, engine diagrams or additional service information via your smart phone (you can easily download a QR code reader from your app store).

Inspection

- **Listen for** any unusual noise. If something sounds wrong, it usually is.
- **Feel for** roughness when rotating the pulleys and water pump by hand (water pump if timing belt driven) and feel for excessive end play movement on tensioners, guide rollers and drive components
- **Look for** cracks/damage/in the belt, misalignment of the belt, pulley wear/tear, belt residue on the plastics or steel rollers, signs of leakage, corrosion around the tensioner and water pump and friction marks on engine covers.

Customer care

- Show them the damaged components or pictures you took during the repair. Customers understand better when shown what was wrong rather than just hearing about it.
- **Explain the advantages** of having used a complete kit and taken out other parts at the same time. Highlight the **costs for labor you have saved them** by doing so.
- Educate them about always respecting and following the vehicle manufacturer’s service intervals, both regarding mileage and time. Even on cars with very low mileage an aged belt can lead to failure and/or expensive damage.

Repair

- Let the engine block cool down or adjust to ambient/room temperature. **Never work on engines that are hot or too cold.** A belt replaced at the wrong temperature will slacken. Insufficient tension increases the risk of premature failure and may damage the reputation of your garage.
- Find the **cause of the damage** before you start fixing it. If you receive a car with a broken timing system outside its regular replacement interval, check the reason for the brake down in detail.
- The **top causes** of future failure: Alignment of the pulleys and tension of the belt.
- Use the prescribed **special tools**, never crimp a belt or try to fit the belt with improper tools like screwdrivers etc. This will cause initial damage and could strongly influence the lifetime of the timing belt. **Use a small torque wrench** to set the tensioner bolts/nuts. Torque values in a range of 20-30 Nm are quickly exceeded without the right tools.
- Use the correct parts and kits. Remember it's critically important to select the **correct timing belt for a specific engine application**. Mixing up kits or belt designs could lead to a shortened belt life time or expensive engine damage!
- Make sure you have considered all interrelated components. Keep in mind that in many cases the timing belt is also driving the water pump, which is integrated in the cylinder block. It's strongly advised to **replace the water pump together** with all tensioners and pulleys when the timing belt is replaced.
- **Check the complete job** and rotate the engine a number of times by hand. Doing so will help identify incorrect timing. This is especially important when working on V6 engines where one belt is driving four camshafts or engines and often the initial belt tension is only set on a small part of the belt.
- **Don't start the engine before having rechecked the set tension and timing.**

! Before you start

Always follow the vehicle manufacturer's procedures for removal and replacement.
Support the vehicle as per garage Health and Safety guidelines.

Failure to follow these guidelines could result in injury or property damage.
 SKF disclaims all liability due to failure to follow these instructions.

Pay extra attention when working on cars with a start-stop system!

Take the right safety measurements before starting work on a car with a start-stop system. Some cars are well safeguarded and the ECM will detect an open engine hood or door, but on others an unexpected restart may occur while working in the engine compartment. Even differences in system approach within one single vehicle brand can be found. Isolate the battery as described by the car manufacturer or take out the ignition key to be on the safe side.



Damage

Visual fibers between the teeth



Likely cause

Fibers between the teeth are **very normal** and are caused by the manufacturing process of the timing belt.

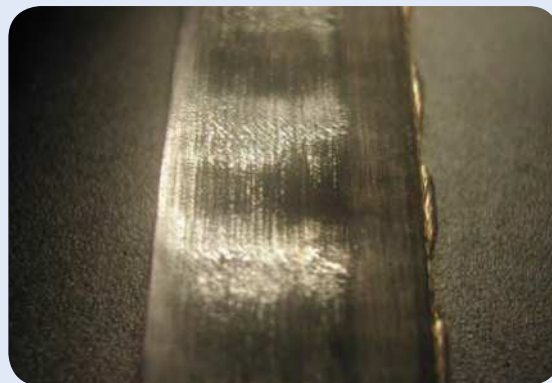
Solution

No corrective action necessary.

1

Damage

One of the flanges is worn



Likely cause

- Misalignment of the tensioner pulleys
- Damaged teeth pulley camshaft and/or crankshaft

Solution

- Change the belt, ensure it is properly aligned
- Check and replace pulley camshaft and/or crankshaft

2

Damage

Belt is worn on one side, marks can be seen on the pulley



Likely cause

- Incorrect belt tension (too low)
- Misalignment of the pulleys
- Jamming of a driven component

Solution

- Change belt, adjust tension properly
- Change belt, align/seat properly
- Check for jamming components, adjust if necessary

3

Damage

Belt has ripped/cut apart



Likely cause

- Incorrect belt tension (excessively high)
 - Foreign matter interfering with the timing system
- Note: Excessively high belt tension can damage the tensioner or water pump bearings

Solution

- Change belt, adjust tension properly
- Remove foreign matter, change belt

4

Damage

Belt has snapped/broken

**Likely cause**

- Driven component seriously blocked by foreign body or other cause
- Incorrect handling or storage: belt might have been folded/pinched before or during fitting. Folding or pinching will crack the internal fiberglass cords and as a consequence lead to reduced belt lifetime!

Solution

- Remove foreign matter, change belt
- Change belt, adjust tension properly

5

Damage

Belt is damaged on one of its flanges

**Likely cause**

- Misalignment (bad parallelism) of the pulleys
- Damaged teeth on camshaft and/or crankshaft pulley
- Cracked vulcanization of the camshaft gearwheel

Solution

- Change belt, align/seal properly
- Change camshaft and/or crankshaft pulley, change belt
- Change camshaft gearwheel, change belt

6

Damage

Belt teeth have been torn off

**Likely cause**

- Incorrect timing belt tension (too low)
- Seizing of a driven component
- Incorrect parallelism/worn out pulleys

Solution

- Change belt, adjust tension properly
- Check free rotating of all driven components
- Change belt, align/seal properly

7

Damage

Belt teeth sheared, "hollow tooth effect"

**Likely cause**

- Initial set-up during fitting not correct and/or engine was hot during fitting
- Incorrect timing belt tension (much too low)

Solution

- Replace and adjust timing belt according to car manufacturer instructions
- Change belt, adjust tension properly

8

Damage

Abnormal hit marks on the pulley

**Likely cause**

Foreign matter (which can also cause belt misalignment).

Solution

Remove foreign matter, change belt.

9

Damage

Back plate of tensioner broken, indicator has come into contact with end stop

**Likely cause**

- Incorrect installation set-up
- Sudden blocked component (indicated most likely by only one strong mark on end stop)
- Incorrect timing belt tension (far too high or low)

Solution

- Change and replace components under the right conditions (engine must be ambient temperature)
- Change belt, adjust tension properly

10

Damage

Tensioner is blocked and there are visible marks of leaked cooling fluid

**Likely cause**

- Water pump is leaking and polluted cooling fluid has attacked the tensioner bearing
- Higher up leakage of a cooling hose or a leaking cylinder head gasket

Solution

Check the cooling system for leakage, repair the root cause and replace the timing system.

11

Damage

Metal sheet or tension indicator is broken

**Likely cause**

- Improper set up (indicated by abnormal mark on the end stop of the tensioner)
- Installing the tensioner on a very hot or very cold engine
- Incorrect adjustment of the screw torque value
- Improper handling of the gearbox by the car owner

Solution

- Set up under the right conditions and according to manufacturer recommendations
- Use the appropriate torque wrench

12

Damage

End stop is broken

**Likely cause**

- Improper set up, improper conditions (engine was hot)
- Incorrect tension (too high)
- Foreign matter interfering with the timing system

Solution

- Change and replace components when engine is cold and according to manufacturer recommendations
- Change belt, adjust tension properly
- Remove foreign matter, change belt

13

Damage

Mark on the eccentric and a belt with low tension

**Likely cause**

Incorrect tightened screw.

Solution

Replace tensioner and tighten with specified torque.

14

Damage

Base plate extremely bent

**Likely cause**

- Incorrect fitting operation
- Incorrect tension of the belt
- Fitting of the part when the engine was too hot
- Back plate lip not inserted correctly in engine block

Solution

- Check if lip is inserted properly in the engine block
- Set up belt tension according to fitting instructions
- Work under the right temperature conditions

15

Damage

Dented pulley edge

**Likely cause**

- Installation damage caused by a screw-driver
- Pulley fell on the floor
- A hammer or screwdriver have been used in attempt to repair a damaged part (picture 9 shows the result of using incorrect tools or applying pressure at an incorrect angle)

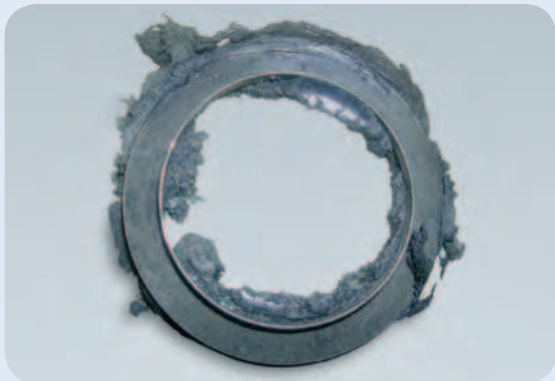
Solution

- Work with the right tools
 - Avoid too much pressure by using an Allen key
- Note:** Don't try to push back the hydraulic tensioner piston once the tensioner has been fitted.

16

Damage

Residue has polluted the tensioner seal and damaged the belt

**Likely cause**

Oil or fuel has leaked into the system and attacked the rubber components (like seals and belt).

Solution

Check and replace leaking crankshaft, camshaft, oil pump seals or cylinder head gasket before replacing the timing system.

17

Damage

Blocked bearing; rusty tensioner

**Likely cause**

Rust from the tensioner has made its way into the bearing, belt has slipped on the pulley due to the blocked bearing. Most likely in areas with flooding.

Solution

Replace the tensioner and timing belt.

18

Damage

Tensioner fixing bolt or stud broken, **in most cases severe engine damage!**

**Likely cause**

- Abnormal radial load (very high belt tension) or a blocked camshaft
- Bolt tread in engine block damaged earlier during an unprofessional repair
- Tensioner not firmly pressed towards the engine block. The "lip" was not inserted deep enough into the engine block. The back plate will rotate and break the stud

Solution

Take the broken bolt or stud out. Accurate inspection of tread in the light alloy cylinder block. If tread is damaged only a professional repair will be a durable solution.

19

Damage

Timing system completely destroyed and most likely water pump defect

**Likely cause**

- Timing system with a "one way" piston (piston can't get pushed back). On engines with worn out camshafts and irregular idling this piston will try to compensate the fluttering of the timing belt
- The constant increasing belt pressure has lead to a water pump failure and finally caused a broken belt

Solution

- In most cases a durable repair is only possible after replacing the camshafts!
- Always check position of the hydraulic tensioner piston

20

Damage

Tensioner backplate "fingers" (to fit around the bolt head) completely bent.

**Likely cause**

Faulty set up during fitting, backplate moved from its original setting.

Solution

First check the engine for resulting damages. Replace timing belt kit and set up according to manufacturer instructions.

21

Damage

Part of idler pulley broken

**Likely cause**

Incorrect tension of the belt (too high tension).

Solution

Replace timing kit and set up according to manufacturer instructions.

22

Damage

Tensioner cracked and part broke out of the housing

**Likely cause**

Hydraulic piston got pushed back by rotating the tensioner or by using a wrong sized Allen key, applying too much force and/or placing it under an incorrect angle.

Solution

Don't try to push back the piston by rotating the tensioner. Use the correct tools and work under a correct angle.

23

Damage

No visible damage at the front side of the timing gear wheel(s) but rattling noise at engine idling speed

**Likely cause**

Rubber damping material on the inside of the timing gear cracked.

Solution

Replace the timing gear wheels by new OE parts.

2.3 Parts, kits and tools by SKF

At SKF we have more than 1 326 timing system kits with OE quality parts available. Our offer covers more than 96% of the car parc in Europe and includes popular European and Asian applications for recent and older vehicles.

All our belts are SKF branded to guarantee quality and deter counterfeits. They are PTFE coated or treated with highly saturated nitrile, fiberglass tensile cords (HSN) according to OE specifications.



Timing belt kits (VKMA/C)

Our kits contain the same parts or even **more content than the OE**. All parts are guaranteed to work well together and will have the same expected life span.



Timing belt kit

Timing belt kit with components (VKMA)

- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary
- High-class camshaft seals/timing cover seals in OE specification design



Timing belt kit with water pump

Timing belt kit with water pump (VKMC)

- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary
- High-class camshaft seals/timing cover seals in OE specification design
- Premium water pump for maximum performance



Timing system loose parts (VKMT/VKM/VKPC/VKS)

SKF kits for the timing system include all parts necessary to complete the installation. However there might be situations where a complete kit isn't necessary. In these circumstances SKF also offers the same quality parts individually.



Loose belt kit



Belt tensioner pulleys



Idler pulleys



Water pump



Seals

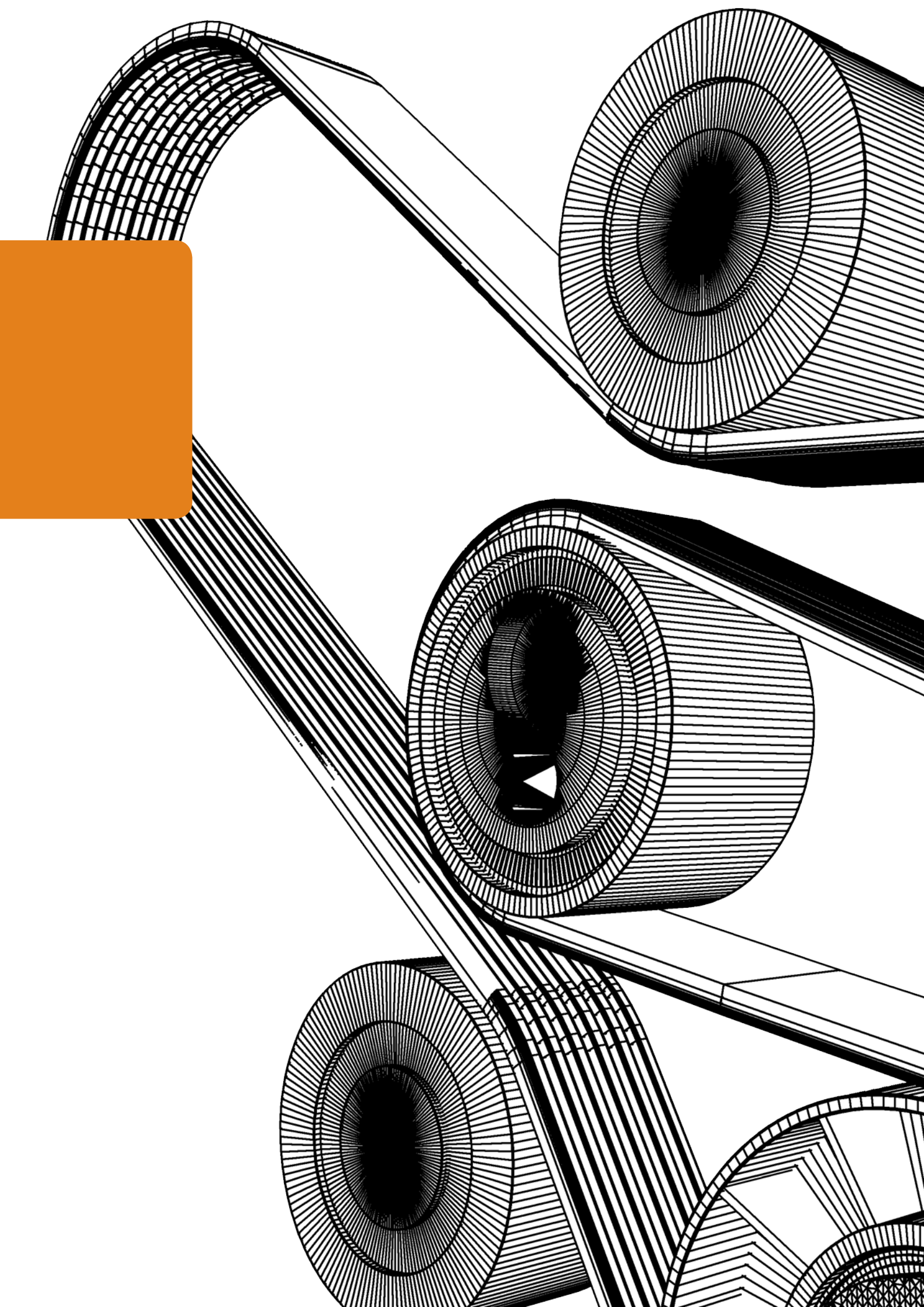
Timing tools by SKF (VKN 1000 – VKN 1009)

In addition to the replacement kits, SKF also offers a range of specific tools available for every engine type to maintain the camshaft/crankshaft synchronization and replace the timing system safely and correctly.

- They cover a combined total of 90 timing belt kits and timing belt kits with water pump and link to over 5 000 applications in the European car parc.
- Each tool kit includes a QR code to download the engine applications covered by the kit. Also available for download are step-by-step guidelines on how to carry out the locking of the timing system correctly.
- The packaging of the SKF tool kits is robust, light and easy to transport if necessary.
- The box comes complete with a durable sticker showing the exact content of each kit designed to help keep track of the small pieces that can easily get misplaced.



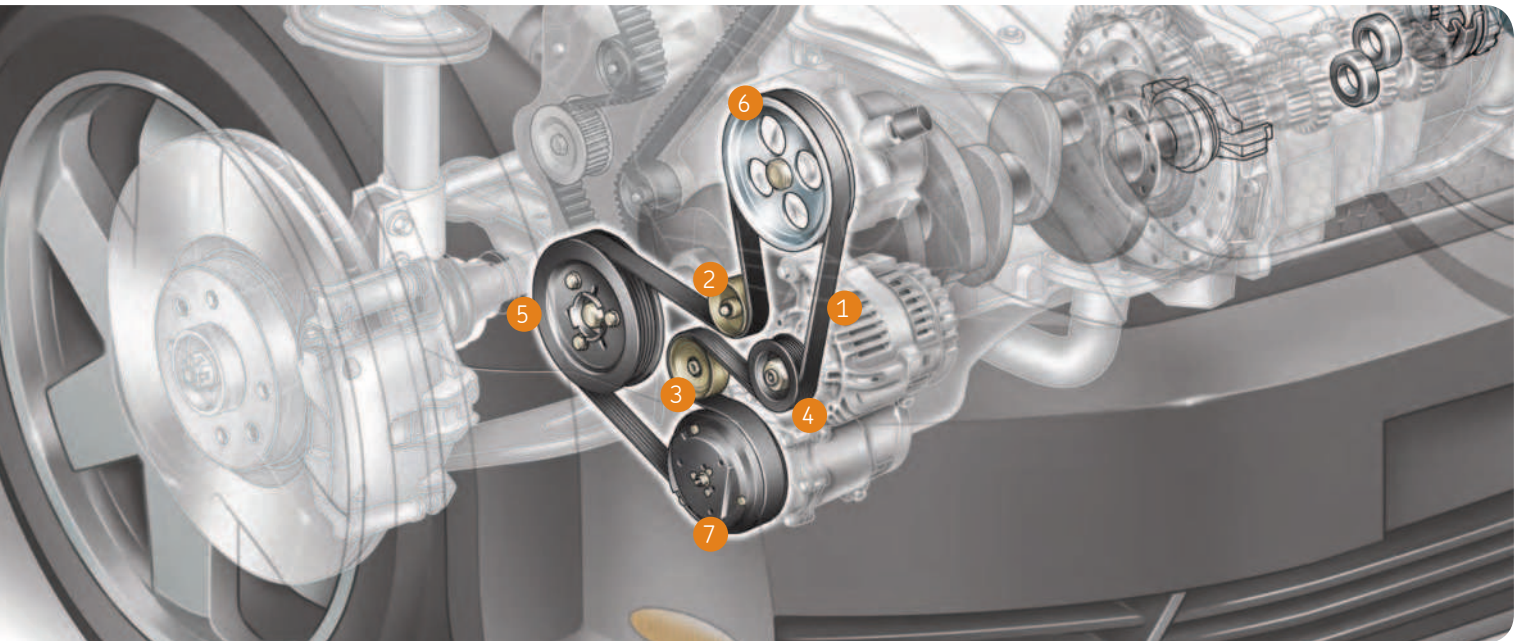
VKN 1007





3 Auxiliary system

3.1. Auxiliary system technology



The auxiliary system drives a range of components such as the alternator, the air-conditioning compressor, the hydraulic power steering pump and in some cases also the water pump.

In more seldom cases you can also find a brake booster vacuum pump or a mechanic charger driven by the auxiliary system. In a limited number of cars components are driven by two belts with a “double pulley” on the crankshaft.



1 The belt

The multi-V belt is driven by the crankshaft and includes six or more grooves depending on the amount of power the belt is able to transfer.



2 3 Auxiliary tensioners/pulleys

The belt tensioner unit sets the right tension and provides guidance for the multi-V belt. The adjustment of tension during installation is achieved by the automatic belt tensioner unit (ABTU). Its built-in spring maintains the tension of the belt constantly while the engine is running. The ABTU will compensate temperature differences and the belt's stretch during its life span.

The idler pulley is fixed and allows the belt to be wound around the driven component correctly. An ABTU can also be designed as a hydraulic piston version.



4 Freewheel alternator pulley

Despite its size, the freewheel alternator pulley plays a vital role in the engine. It absorbs the potentially damaging torque as well as reducing noise and belt vibrations. The alternator generates the 12 volt electric power to charge the battery and to supply power to the car's electric components.



5 Crankshaft damper

The crankshaft damper dampens the torsional vibrations of the crankshaft filtering the generated low frequency vibrations (in particular on diesel engines), which enables a longer life span of the auxiliary system.



Water pump (not visible here)

The water pump moves large volumes of coolant through the engine and the radiator. This key component ensures the optimum engine temperature allowing a good engine combustion. It can be driven by the timing or auxiliary belt.



6 Hydraulic Power steering pump

The hydraulic power steering pump provides the power steering rack with hydraulic pressure. Going forward more and more cars will be equipped with an electro mechanical system instead of a hydraulic power steering system as this helps to reduce CO₂ emissions.



7 Air-conditioning compressor

The air-conditioning compressor compresses the refrigerant. It is usually driven by the auxiliary system. On some hybrid cars and on all electric vehicles however the air-conditioning compressor is driven electrically and the power is supplied by the high voltage battery package.

3.1.1. Understanding auxiliary belt designs

Multi-V belt

The multi-V drive belt has been a standard feature on new applications since the late 1990's. Previously used single-V belts are nowadays only found in older or classic cars.

The multi-V design reflects the need to drive multiple accessories from one belt around a compact area. The belt therefore needs to be flexible to offer tight wraps and return the belt on small radius pulleys, but also to be able to handle the higher tension needed to "grip" the functioning components without slippage. Reliability and endurance will similarly match the timing system on the engine.



The multi-V belt operates in tough environments, sometimes low down in the car's engine compartment and often exposed to dirt, water and oil. With more utilities added to the car, the strain on the belt increases. Other arrangements may see the system operate high up in a compact area where higher temperatures will affect the belt.

The stretchy belt

In comparison to the multi-V, which always needs to have a tensioner to avoid slipping, the stretchy belt allows car manufacturers to save a tensioner.

Instead of polyester the stretchy belt has a polyamide cord and a special rubber applied to avoid slipping. This elastic material of the belt keeps the tension at the correct level which means that no additional tensioner is needed.

With the increase of electric components for water pumps and power steering, fewer of them need to be driven by the belt, which allows for the fitting of stretchy belts instead of traditional multi-V belts.



Note: Never re-use a stretchy belt. Even in cases where a healthy belt has to be removed in order to perform a repair on a surrounding component. Do not refit the stretchy belt even if it only had a short running period up to this point. **If the belt gets re-fitted it will start to slip and break after a very short period of time.**

Newer materials, such as EPDM, are common on the belts offering superior performance features.

Even though the multi-V belt profile (pk) has become a recognized standard, there is no standard belt for the application. For every engine model there can be more than a handful of different auxiliary drive belt arrangements (different span lengths), depending on the type of equipment fitted. This span length is very important, down to the last millimeter for optimum operation.

The belt's 2-3% shorter length, however, means that the system is not adjustable and a special tool is needed when fitting the belt. For this purpose SKF offers VKN 300, a specific fitting tool for stretchy belts.



3.1.2. Understanding the importance of belt length

The belt length is crucial. Incorrect length can lead to slipping and drastically reduce the belt's life span.

Remember that the tensioner can only compensate the stretch due to normal wear and varying temperature conditions (→ **Fig. 1** the nominal position when newly installed). It cannot compensate for a different length of belt compared to its OE set-up!

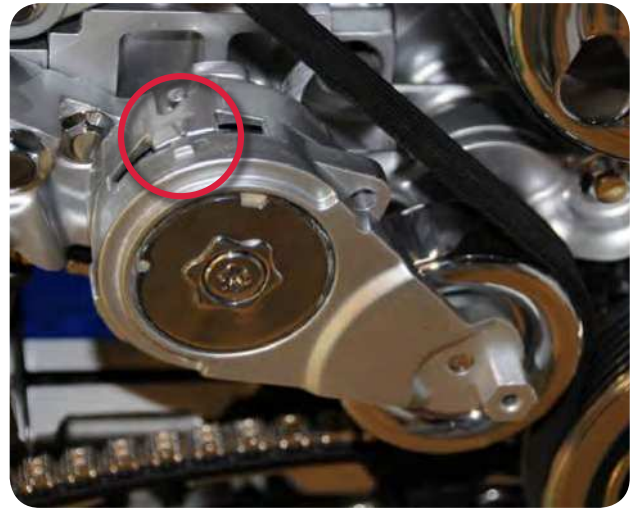
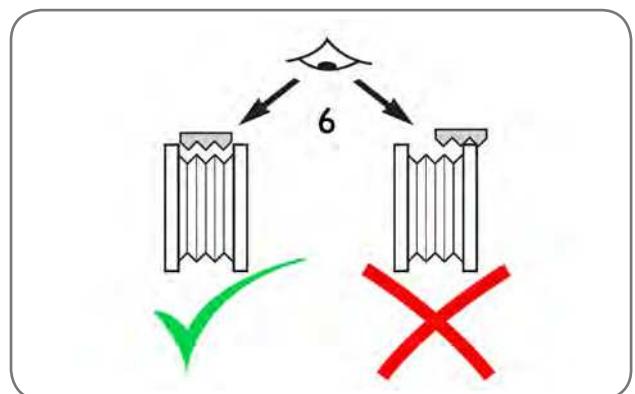
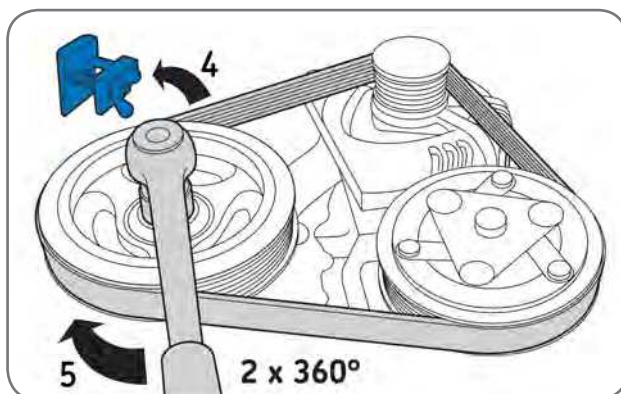
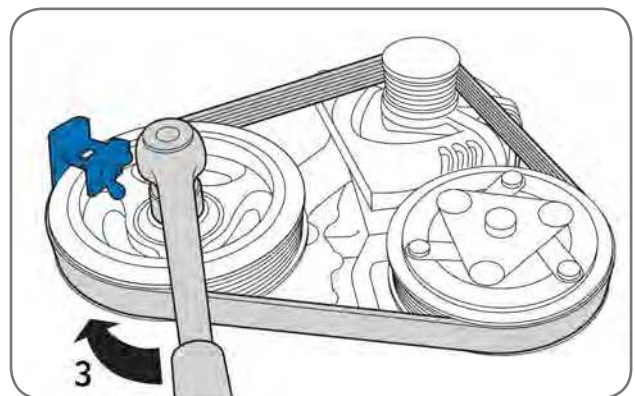
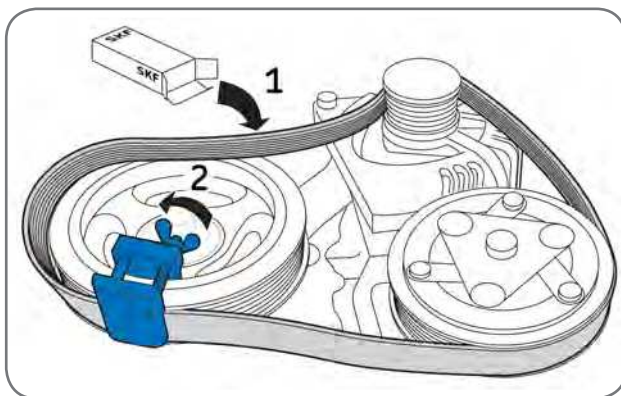


Fig. 1 New installed tensioner

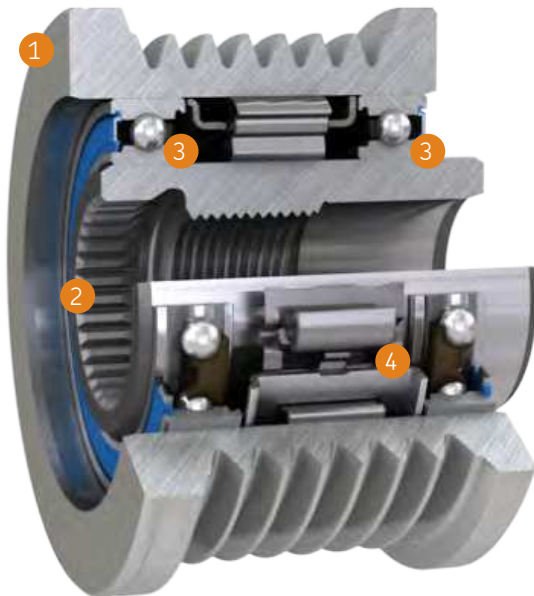
Fitting a stretchy belt using the specific fitting tool by SKF



3.1.3. Understanding the freewheel alternator pulley



The role of the freewheel alternator pulley is to reduce vibrations in the auxiliary system which helps maintain the performance of the system components and the multi-V belt for as long as possible. It also plays a role in saving energy by using the kinetic energy of the high speed rotating alternator when the engine r/min suddenly drops.



The Overrunning Alternator Pulley Unit (OAPU) is made of standard components that include two deep groove ball bearings (DGBB), a one-way clutch, a pulley and a shaft that are all assembled on the alternator.

- 1 **Pulley**, integrated inside belt drive
- 2 **Shaft**, installed on alternator shaft
- 3 **Two sealed ball bearings** supporting the radial belt load
- 4 **One-way clutch** based on SKF technology for gearbox applications with sprags

Signs and consequences of an incorrectly functioning freewheel alternator:

- Abnormal noise at idle speed, which disappears when the engine speed increases
- Poor alternator capacity (battery doesn't charge correctly – battery doesn't charge properly even after longer trips)
- Strong vibrations in the auxiliary drive, engine vibrations are not absorbed which can result in a broken tensioner
- The biggest risk however is an engine breakdown where the auxiliary belt blocks the timing belt, which will destroy the timing system and may cause further engine damage. Keep in mind that in over 50% of cars with a broken timing belt **the root cause is actually a snapped multi-V belt.**

Fitting recommendations for the Freewheel alternator pulley using the specific tools by SKF

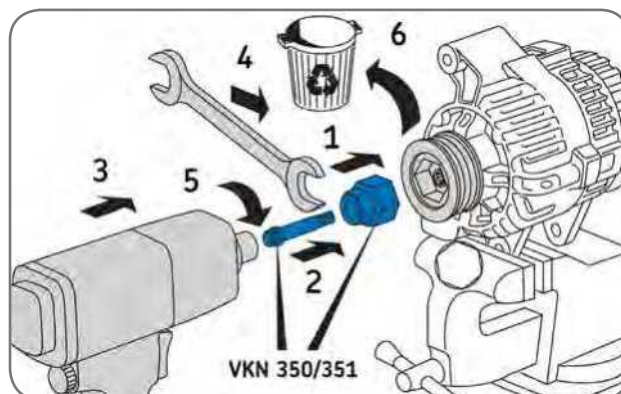


To make sure the freewheel alternator pulley is working correctly you can test the pulley when the belt is dismantled.

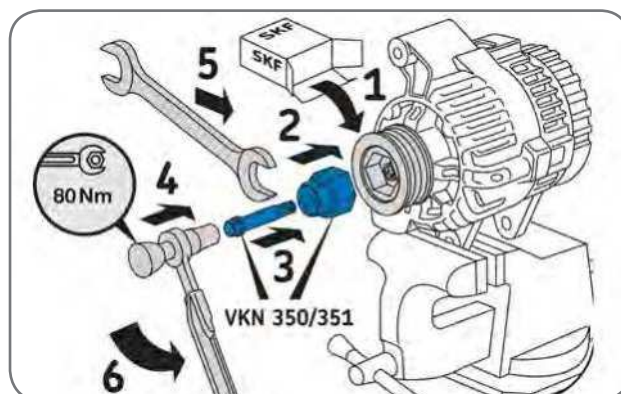
Block the pulley with SKF's special tool VKN 350/351 to check if the pulley can be rotated by hand in just one direction. If it moves in both directions or not at all, the pulley is not working correctly.

Beware: On some older cars "budget alternators" with a solid pulley instead of the original version with a freewheel alternator pulley can be found! This is not a professional solution and will, over time, lead to damage.

- Prepare the car correctly.
- Remove the accessory belt, tensioner and idler, the electrical connectors and the alternator.
- Place the alternator on a suitable surface (such as a workbench).
- Remove the plastic cap from the FAP (if fitted). Fit the correct insert into the FAP thread from either the VKN 350 or 351 kit.
- With an impact wrench, remove the old FAP unit by using the correct insert and nut from the VKN 350 or 351 kit.



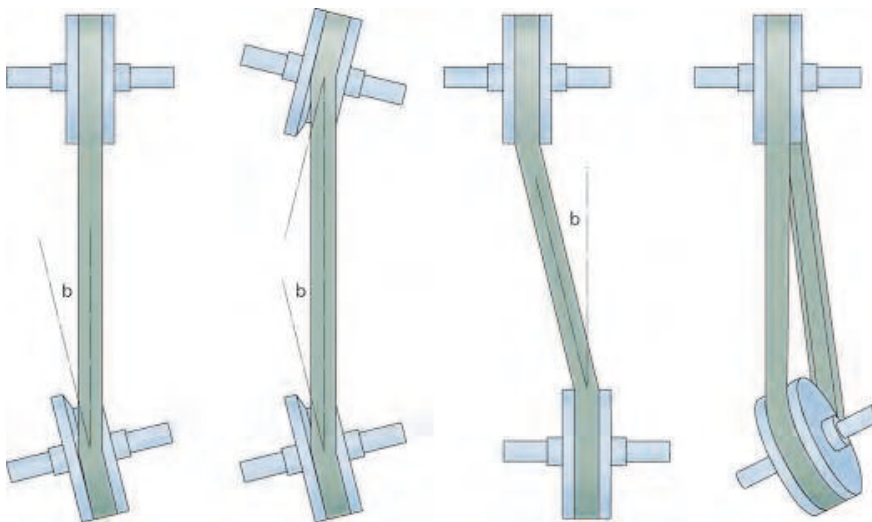
- Install the new FAP unit using the corresponding tools from the VKN 350 or 351 kit.
- Immobilise the alternator shaft with the appropriate inserts, nuts or locking tools.
- Tighten the FAP unit using a torque wrench, to a torque of 80 Nm.
- Refit the plastic cap (if fitted), otherwise this could cause premature failure due to contaminants or foreign bodies entering and damaging the FAP unit.
- Refit all of the other dismantled components.



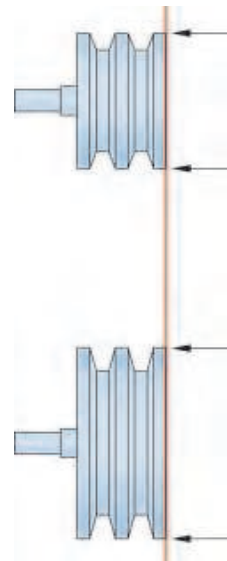
3.1.4. Understanding pulley misalignment

Alignment of the pulleys can affect the belt life and pulley life severely. The result of misalignment is accelerated wear and increased temperature. Best practise is to align the pulley as accurately as possible.

Incorrect alignment:



Correct alignment:

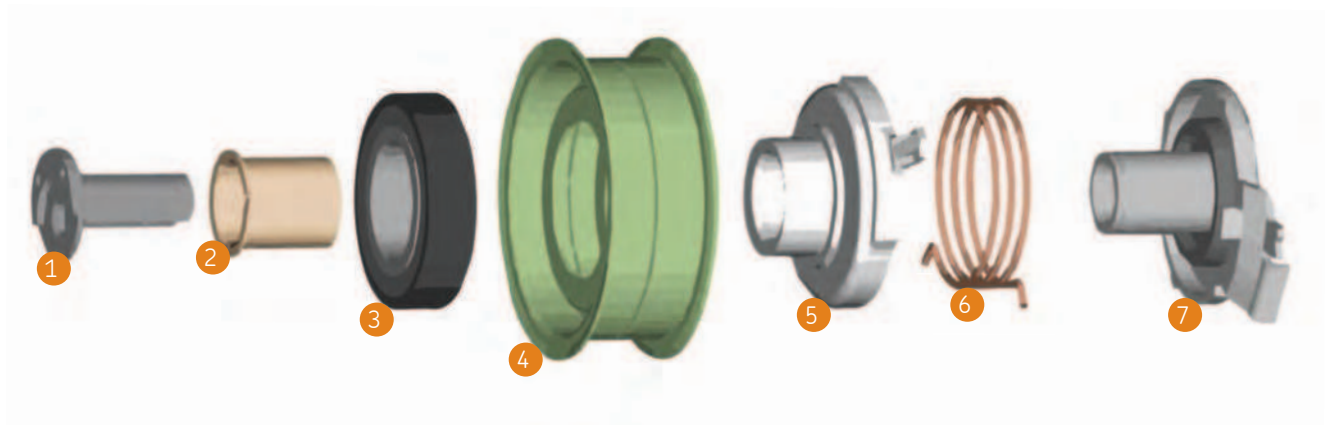


3.1.5. Understanding belt tensioners

The automatic belt tensioner unit (ABTU) is an automatic adjustment device, which includes BTU features as well as a dynamic function. The static eccentric enables the initial tension to be set during installation while the dynamic eccentric compensates for temperature differences and the belt's stretch during its life span. The ABTU's built-in spring maintains the tension of the belt while the engine is running. An ABTU can also be equipped with a hydraulic piston to help maintain the tension of the belt.



SKF ABTU in detail



- 1 **Mounting eccentric:** enables the tensioner to be set correctly during installation.
- 2 **Bushing:** reduces radial friction and component wear as well as dampening vibrations. Made with highly wear resistant polymer.
- 3 **Ball bearing:** maintenance free and sealed for life component.
- 4 **Pulley:** made of steel or plastic according to OE specifications.
- 5 **Hub:** contains the dynamic eccentric and anchors the first spring tang.
- 6 **Spring:** maintains the correct belt tension while the engine is running.
- 7 **Pivot plate:** anchors the second spring tang to the backplate and enables correct tensioner angle.

3.1.6. Understanding the active crankshaft damper/torsional vibration damper (TVD)

The downsizing of engines and increased torque at low revs will bring unwanted torsional vibrations which have to be dampened by an active crankshaft damper, also known as a torsional vibration damper (TVD).

Additionally to the TVD other applications may be used to reduce the engine vibration level:

- Balance shafts integrated in the engine block
- Optimized, low weight crankshaft piston and connecting rod design
- Dual mass flywheel
- Freewheel alternator pulley (also to save energy)



Testing the TVD

A “worn out” active crankshaft damper will have visible cracks in the vulcanized rubber element and need to be replaced immediately.

Procedure

If the damage isn't as visible as on → **fig. 3**, a simple test can help to detect if the TVD has to be replaced:

- Put a straight white line over the whole damper (→ **fig. 1**) and accelerate the engine from idle to 2 500 – 3 000 r/min as quick as possible
- The line will split between the inner and outer parts of the damper and move away from each other (→ **fig. 2**)
- After dropping back to an idle speed the line on the inner and outer parts will go back to its original position (→ **fig. 1**)



Fig. 1 - Damper before speeding up to 3 000 r/min



Fig. 2 - Damper during engine run

Conclusion

If the line doesn't move back to its original position but remains divided (→ **fig. 2**) the TVD is defective.

The vulcanized rubber between the inner and outer parts has separated and the TVD is no longer able to dampen engine vibrations. Replace the TVD immediately.

If the line on the inner part did not move at all compared to the line on the outer part there are two possible explanations:

- The engine has never been equipped with a TVD pulley (check engine specifications).
- The pulley was replaced by a counterfeit part, a "look-alike" that lacks actual functionality. → **Fig. 4** shows the cut-out of such a "lookalike" counterfeit part. From the outside this looks like a TVD but in reality it is a solid pulley without any damping capabilities.



Fig. 3 - Rusty damper



Fig. 4 - Counterfeit damper

3.2. Inspecting, diagnosing and fixing damage

Just like the timing system, the auxiliary system is a complex structure that consists of many components that need to work together in order to allow proper engine function and driver safety. We therefore recommend never isolating just one component as the cause of failure. Instead look at all system components when carrying out a repair and if possible always replace with an entire system kit (including the multi-V belt, tensioner and guiding pulleys), where all parts are guaranteed to work well together and will have an identical life expectancy.

As with all belt repairs, it's always good practice to inspect other components that run off the auxiliary belt system for signs of wear or distress, such as the idler and crankshaft damper. Slipping multi-V belts usually have shiny sidewalls (glazing) caused by heat from sliding in the pulleys. The glazing often causes a chattering, slapping or squealing noise. It also hardens the belt, increasing the risk of cracking and early failure.

Belt slippage also often occurs because of low tension due to poor mechanical tension, either due to the wrong belt length being fitted, or because of grease/oil contaminating the belt. Inspect the belt closely for any cracks in the ribbed area. Also check the back of the belt for grooves, fraying, or splitting. Although a few random cracks across the ribs can be a sign of normal belt wear and doesn't necessarily mean the belt will fail immediately, it is still a good idea to replace the belt during this service. Any traces of oil or material debris need to be investigated and corrected before installing a new belt.

Important Tips

Safety precautions

- Follow the **correct sequence** of the repair as provided by the car manufacturer.
- Disconnect the car's battery.
- Take special care when working on cars with start-stop systems.
- Adhere to the **safety guidelines** of your garage and properly support the vehicle.
- Download and print all available support material. Check the SKF website or use the QR code printed on the SKF packaging to **access SKF specific fitting instructions**, technical bulletins, engine diagrams or additional service information **via your smart phone** (you can easily download a QR code reader from your app store).

Inspection

- **Listen for** any unusual noise (for example a chattering, slapping or squealing noise). If something sounds wrong, it usually is.
- **Feel for** roughness when rotating the pulleys and water pump (if driven by the auxiliary system) by hand, excessive end play movement on tensioners, guide rollers and drive components and functionality of the free alternator pulley (if the engine is equipped with one).
- **Look for** belt cracks, separating layers or shiny sidewalls (glazing), damaged grooves, fraying, or splitting on the back of the belt, misalignment of the belt, worn out pulley grooves, belt residue on the plastic or steel pulleys, signs of wear on the alternator brackets, air conditioning pump and other components and friction marks on surrounding components.

Repair

- Find the **cause of the damage** before you start fixing it. If you receive a car with a broken auxiliary system outside its regular replacement interval, check the reason of the brake down in detail.
- **Top causes** of future failure: alignment of the pulleys, worn out pulleys or residue in the grooves of the belt.
- **Beware:** pulleys need to be cleaned or replaced when a previously installed old and damaged belt has left residue on the pulley grooves. Remaining residue may otherwise affect the newly fitted belt and decrease its life span and performance drastically.
- Use the prescribed **special tools**. In case of a stretchy belt or a system with a freewheel alternator pulley use the right tools. Never try to fit stretchy belts with improper tools like screwdrivers etc. This will cause initial damage and could drastically reduce the lifetime of the stretchy belt.
- Use the correct parts and kits. Remember it's critically important to select the **correct auxiliary belt length for each specific engine application**. Mixing up kits or belt lengths could lead to a shortened belt life span.
- Make sure you have considered all interrelated components. Keep in mind that in many cases modern engines are equipped with a freewheel alternator pulley. Check the correct functioning of this pulley. Check driven components regarding alignment and supports. If the water pump is driven by the multi-V belt, **also inspect the water pump for leakage**.

Customer care

- Show them the **damaged components** or pictures you took during the repair. Customers understand better when shown what was wrong rather than just hearing about it.
- Explain the **advantages** of having used a complete kit and taken out the tensioner and the rollers at the same time.
- Educate them about always respecting and following the vehicle manufacturer's service intervals, both regarding mileage and time. Even on cars with very low mileage an aged multi-V belt can lead to failure and/or expensive damage.

! Before you start

**Always follow the vehicle manufacturer's procedures for removal and replacement.
Support the vehicle as per garage Health and Safety guidelines.**

Failure to follow these guidelines could result in injury or property damage.
SKF disclaims all liability due to failure to follow these instructions.

Pay extra attention when working on cars with a start-stop system!

Take the right safety measurements before starting work on a car with a start-stop system. Some cars are well safeguarded and the ECM will detect an open engine hood or door, but on others an unexpected restart may occur while working in the engine compartment. Even differences in system approach within one single Vehicle brand can be found. Isolate the battery as described by the car manufacturer or take out the ignition key to be on the safe side.

1

Damage

Completely worn belt showing micro cracks as well as big, deep cracks

**Likely cause**

Normal aging.

Solution

Replace belt.

2

Damage

Strange wear of multi-V belt or one of the ribs torn off

**Likely cause**

Misalignment of the belt or one of the pulleys.

Solution

Carefully check the alignment of the components and the correct fitting of the multi-V belt.

3

Damage

Auxiliary system suddenly loses tension, belt has come off and tensioner is destroyed

**Likely cause**

Tensioner fitting bolts not correctly torqued. Bad set up, tensioner could slide. See tread marks of the bolt inside the tensioner.

Solution

Replace the auxiliary system and torque tensioner according to manufacturer recommendations.

4

Damage

Tips of the belt ribs are glazed and worn

**Likely cause**

One or more pulleys in the system are worn out. Insufficient (low) pulley groove profile causes the pulley to touch only the tips of the belt ribs instead of the rib sidewalls.

Solution

Check all pulleys in the auxiliary system for wear, replace the worn out pulley(s) and use the correct belt application for the vehicle. Don't forget to check the crankshaft pulley or TVD.

5

Damage

Tensioner pulley construction heavily damaged. Strong marks visible caused by the pulley

**Likely cause**

- Misalignment caused by incorrect set up during installation. Retaining bushing on hydraulic piston fitted on the wrong side.
- Bolt not torqued at a 90 degree angle.

Solution

Replace the tensioner pulley, fit and torque according to manufacturer guidelines. **Note:** Don't overlook the correct fitting of the O-ring before fitting the stud to the engine block.

6

Damage

Belt residue found on pulley

**Likely cause**

Incorrect belt fitted, (length and/or quality does not match OE specifications). Temperature increase has caused residue on the pulley.

Solution

Replace pulley and fit correct multi-V belt according to OE length and specification.

7

Damage

Tensioner unit slightly bent

**Likely cause**

Tensioner unit not torqued at the right angle, unit bent and as a result incorrect alignment of the multi-V belt.

Solution

Replace the tensioner using the right tools. Also check if the freewheel alternator pulley is working correctly.

8

Damage

Tensioner broken/cracked

**Likely cause**

Strong auxiliary drive vibrations, caused by a defective freewheel alternator pulley.

Solution

Replace tensioner and pulley. Please also check the condition of the dual mass flywheel and crankshaft damper if applicable.

3.3. Parts, kits and tools by SKF

At SKF we have more than 1 985 auxiliary belt kits with OE quality parts available. Our offer covers more than 96% of the car park in Europe and includes popular European and Asian applications on recent and older vehicles.

All our belts are SKF branded to guarantee quality and deter counterfeits. They are PTFE coated or treated with highly saturated nitrile, fiberglass tensile cords (HSN) according to OE specifications.



Auxiliary belt kits (VKMA/C)

The SKF auxiliary range offers complete kits, including belt, freewheel alternator or water pump as well as the “Virtual Kit Concept” which allows customers to choose **whatever combination of belts and metal accessories they need** for a complete and safe repair on one specific car or engine.

Auxiliary



Auxiliary belt kit

Auxiliary belt kit with components (VKMA)

- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary



Auxiliary belt kit with freewheel alternator pulley

Auxiliary belt kit with freewheel alternator pulley (VKMAF)

- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary
- OE quality freewheel alternator pulley



Auxiliary belt kit with water pump

Auxiliary belt kit with water pump (VKMC)

- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary
- Premium water pump for maximum performance



Auxiliary system loose parts (VKMA/VKM/VKPC/VKS)

SKF kits for the auxiliary system include all parts necessary to complete the installation. However there might be situations where a complete kit isn't necessary. In these circumstances SKF also offers the same quality parts individually.



Stretchy belt



Auxiliary tensioner



Idler pulley



Freewheel alternator pulley



Crankshaft damper



Water pump

Auxiliary tools by SKF (VKN 300/350/351)

Reusable fitting tool VKN 300

This tool helps you determine and achieve the perfect fit for most popular car applications. By locking the pulley, it makes "stretching the belt to fit" much easier and renders the repair simpler and quicker. There is no need to purchase a fitting tool every time thanks to our unique reusable tool.

The VKN 300 covers most popular car applications, comes in a plastic carry case and includes fitting instructions.

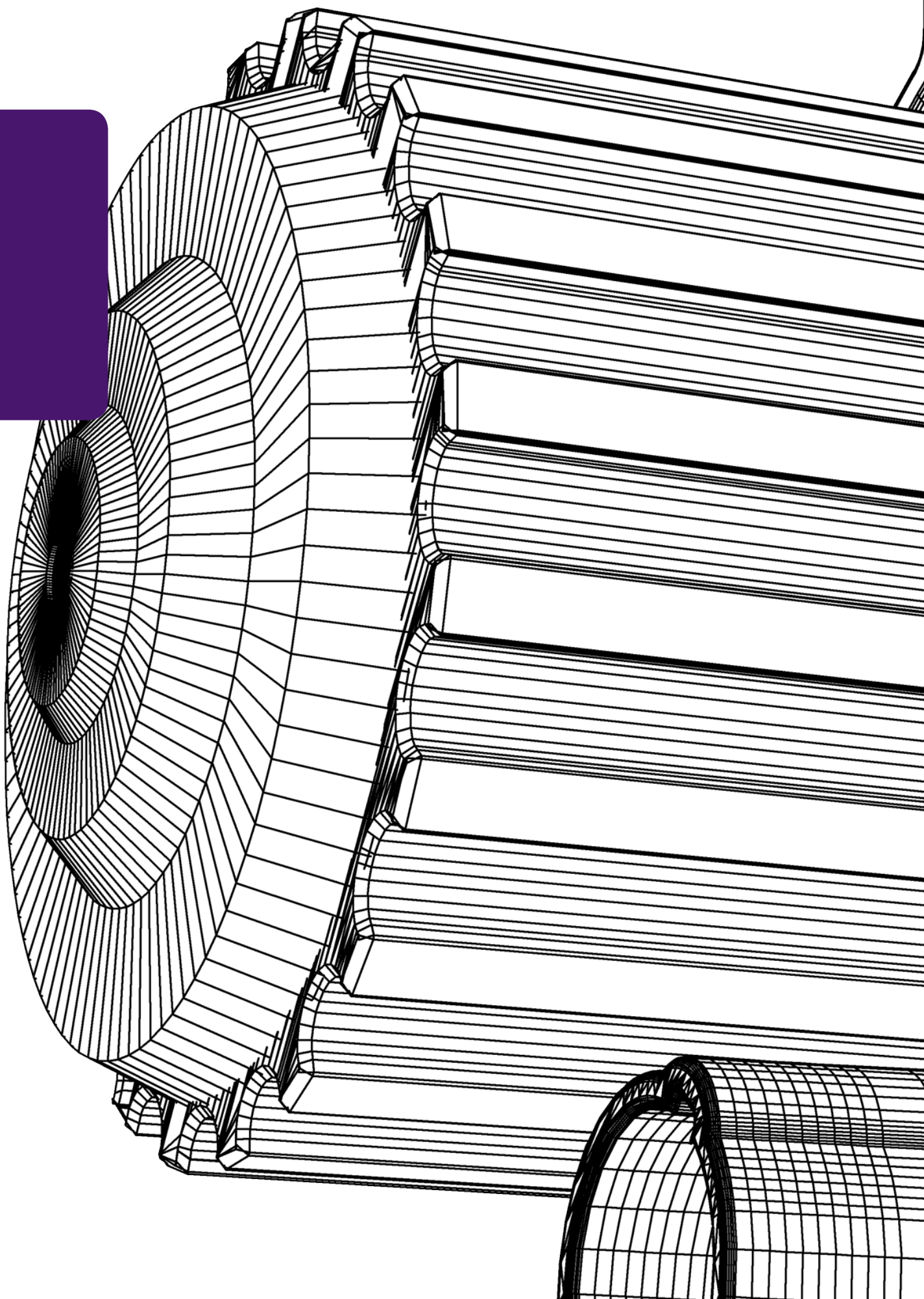


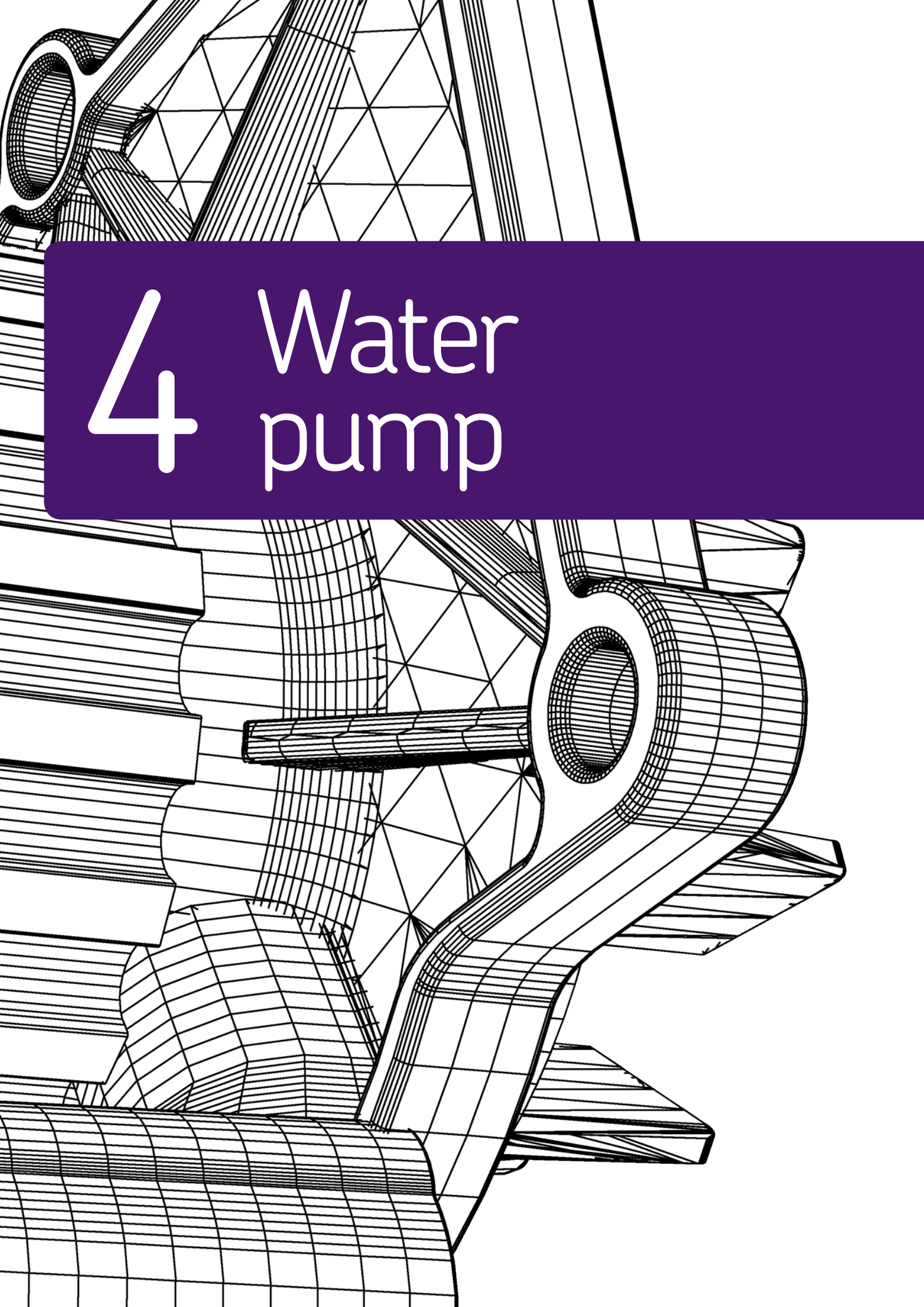
Freewheel alternator pulley tools VKN 350/351

SKF offers 2 toolset kits (VKN 350 and VKN 351) that allow the correct removal and installation of the freewheel alternator pulley without damaging surrounding components. These kits cover 98% of the freewheel alternator pulleys available in the marketplace.

Like the VKN 300, the FAP tools come in a plastic carry case that is easy to store and include fitting instructions.

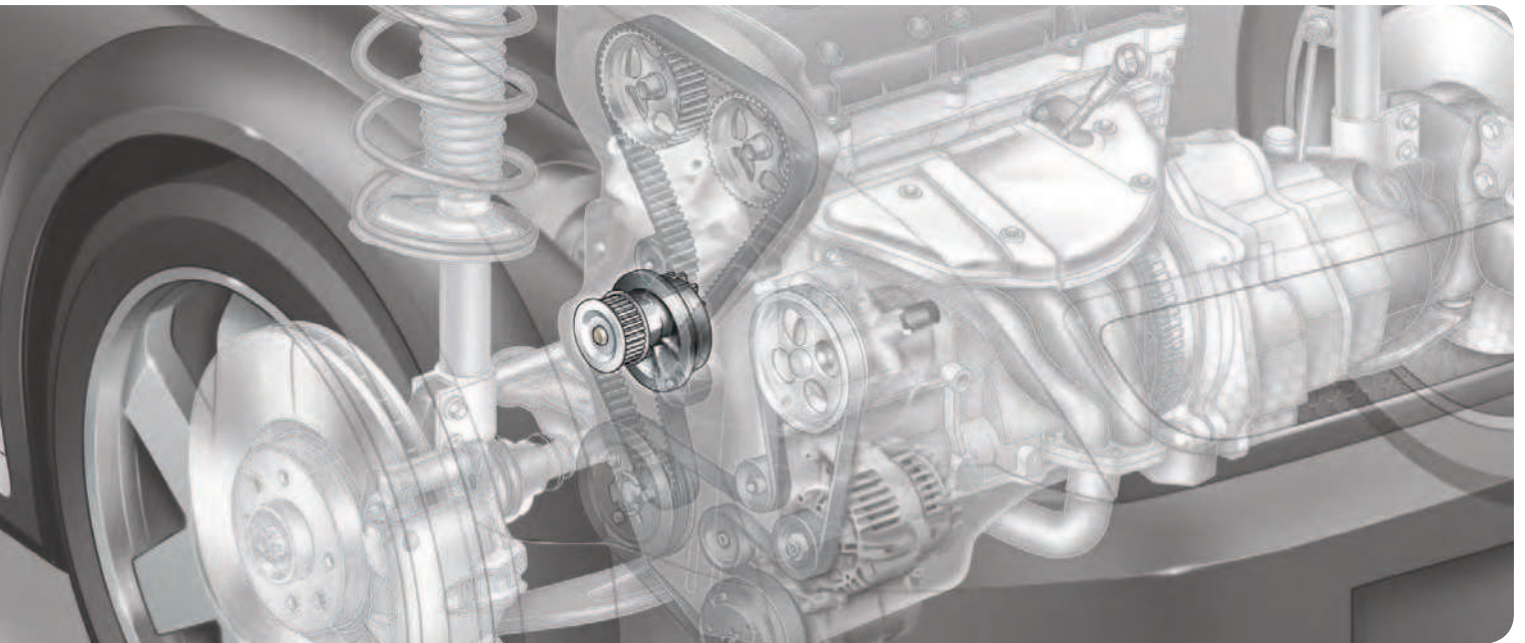




A detailed technical line drawing of a water pump assembly. The drawing shows various components including a central shaft, a pump housing with a circular inlet/outlet, and a curved discharge pipe. The drawing uses isometric projection and includes hatching for shading. A purple rectangular banner is overlaid on the upper left portion of the drawing.

4 Water pump

4.1. Water pump technology



The water pump (typically a belt-driven centrifugal pump) is the heart of the automotive cooling system. The pump circulates coolant through the system while the engine is running to maintain the engine's optimal temperature.

The "body" of the water pump is the collector of all the water pump components. It contains the volute, which encases the effective pumping system. It can contain draining holes (for vapor and liquid) and draining tanks to collect the physiological loss. **Note:** It's absolutely normal that with a new fitted water pump the seals have to run in and during the first minutes or kilometers some cooling fluid drops can be observed at the draining hole.

Water pump



Water pump pulley

The pulley on the water pump turns the pump impeller via a spindle.



Spindle

The spindle runs in bearings that are protected from coolant by a seal.



Seal

The seal separates the so-called “wet zone” and the “dry zone” in the water pump to avoid any risk of leakage and bearing failure. It is a key component of the water pump.



Gasket

The gasket allows the metal housing of the water pump to be fit to the engine block.

Note: If no gasket is included, paste is used to seal the water pump to the engine block. Applying the right amount of paste is crucial to avoid damaging the internal seal of the pump.



Metal impeller

Impeller

The impeller is specifically designed on each engine pump arrangement to allow the best flow of coolant through the system.

Two materials are used for the impeller: metal and polyphenylene sulfide (PPS). Today PPS impellers are most commonly used.



PPS impeller

Advantages of a metal impeller:

- Traditional material: cast iron, brass, folded steel sheet
- Long life span
- Shock resistant

Disadvantage:

- Flow rate limitation

Advantages of a PPS impeller:

- Allows for accurate flow rates
- Adapted to complex design
- Life span equivalent to metal
- Usually used by VAG group, Mercedes, BMW

Disadvantage:

- Vulnerability to shocks

4.1.1. Understanding water pump designs

Mechanical water pump design

Together with a conventional thermostat or electrically operated water valves the water pump maintains the perfect engine temperature.

In addition to keeping the engine temperature stable, the coolant also affects other areas of the vehicle such as the oil passing through the heat exchanger and the EGR (exhaust gas recirculation) valve.



Spindle bearings

Today most water pumps are belt driven, either by the engine timing belt or an accessory drive belt which means the spindle bearings have to resist high revolutions combined with the tensioner on the belt.

Depending on the application different types of ball bearings can be found. Sometimes even a combined solution with both roller and taper is applied.

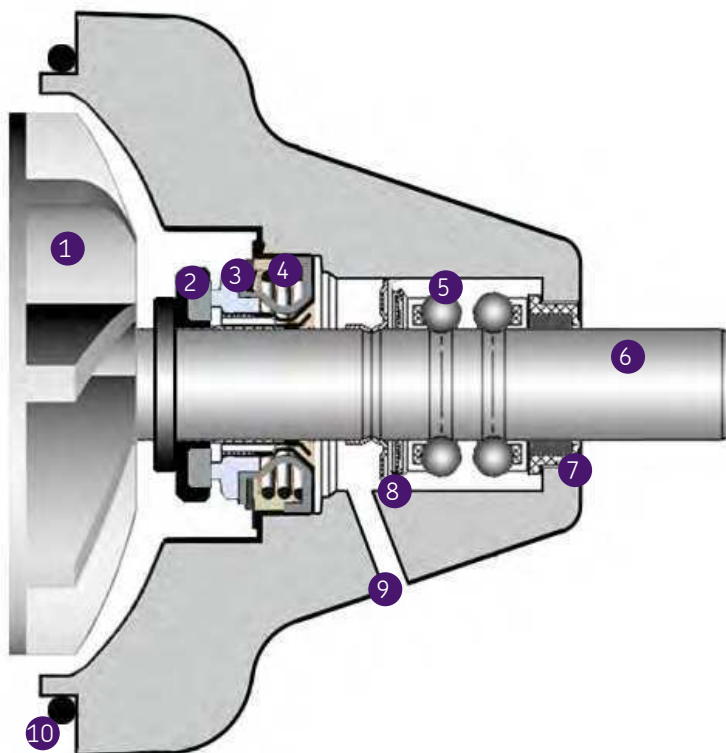


Seals

The seal separates the “wet and dry” area of the water pump. It is important to understand that in order to function correctly, the seal needs the correct and clean coolant. Dirt or other small particles can harm the seal and drastically reduce the life span of the water pump.

During normal operation, the seal can sometimes lose a very small amount of liquid due to evaporation. Some pumps are therefore fitted with “evaporation” tanks to catch this liquid.

- 1 Impeller
- 2 Seal ring
- 3 Dynamic seal
- 4 Seal spring
- 5 Double row ball bearing
- 6 Spindle
- 7 Outer bearing seal
- 8 Inner bearing seal
- 9 Drain hole
- 10 Housing O-ring seal



Electric water pump design

In the future, more and more engines will be equipped with electric water pump solutions, either as the main pump or an additional water pump. On hybrid cars the electric water pump also cools the High Voltage Inverter.

Advantages of the electric water pump solution:

- Can be installed anywhere in the engine bay (maximum flexibility)
- Improved fuel efficiency as the electric pump will only be active when needed
- Pump speed can be regulated independently of the engine speed; especially important for cars with turbo units that need to be cooled down after engine stops
- Lower emission levels during warming up phase –catalytic converter works earlier

4.1.2. Understanding the role of the coolant

The water pump uses centrifugal force to send coolant out into the system while it spins, drawing coolant from its center continuously.

The pump inlet is located close to the center so that coolant returning from the radiator strikes the pump vanes, which then fling the coolant to the outer parts of the pump to enter the engine. Coolant leaving the pump first flows through the engine block and cylinder head, then through the radiator and finally back to the pump.

Extremely polluted cooling fluid can damage other parts and lead to internal engine defects. Most likely extreme pollution is caused by a slightly leaking cylinder head gasket or internal leakage from a water cooled EGR valve.

The ceramic seal inside the water pump is especially sensitive and relies heavily on clean, correctly mixed coolant. This mixture 'lubricates' the seal, just as oil in your engine lubricates the moving components of the engine. Ceramic seals will leak to begin with. This is natural, and will stop within a few kilometers, or within minutes. This process is the 'bedding' in of the seal.

Flushing the system

A car's cooling system needs to be clean to operate at peak efficiency. As time goes on, the car's radiator builds solid deposits that can clog the cooling system. A quick, inexpensive radiator flush can keep the system in shape.

Wait until the engine has cooled to room temperature to completely flush the cooling system. Particles and dirt in the system will harm the seal of the new water pump! Remember that thoroughly flushing takes time since the heating radiator is also included in the cooling circuit.



Main roles of the coolant:

- Protects the engine from freezing and boiling
- Allows a normal working temperature (90-100 °C), cools down the engine
- Lubricates the seals
- Prevents rust
- Allows efficient heat transfer from the engine to the air passing through radiator
- Prevents cooling system corrosion, cavitation and foaming



Blue

Permanent liquid -25 °C/
-30 °C/-35 °C

Advantages:

- High boiling point – good engine cooling
- Anti-corrosion additives –protects all parts including aluminum

Composition:

- Mono ethylene glycol,
- Demineralized water
- Corrosion inhibitors



Yellow

Permanent liquid type D

Advantages:

- High stability
- Temperature resistance
- Anti-corrosion power
- Ageing performance

Composition:

- Mono ethylene glycol
- Demineralized water
- Corrosion inhibitors, organic type.



Green

Permanent liquid -25 °C/
-35 °C/Universal

Advantages:

- High stability
- Temperature resistance
- Anti-corrosion power
- Aging performance

Composition:

- Mono ethylene glycol
- Demineralized water
- Corrosion inhibitors, organic type.



Pink

Permanent liquid -25 °C
universal/type G12++/G13

Advantages:

- Protection against overheating in summer and freezing in winter
- Improvement of efficiency and longevity of the cooling system
- For high power density motors, equipped with lightweight aluminum radiators

Composition:

- Mono ethylene glycol
- Demineralized water
- Corrosion inhibitors, organic type.

Instructions for cooling replacement

Emptying the system

- Remove the cap from the bottle of coolant and the radiator cap.
- Start draining the radiator by disconnecting the bottom hose.
- Open the drain valve (where fitted) on the radiator.
- Open the bleed screw (where fitted) from the engine block.
- Use your automotive technical documentation for locating all of the water drain screws in the engine block and cooling system.
- Let the system completely drain.

Flush the system

- With the exception of the engine block – close all of the bleed screws.
- Unclip and pull off the top radiator hose and insert your garden water hose.
- Flush until the water runs clear through the bottom hose.
- Re-attach the bottom hose and rinse until the water runs clear through the engine block drain hole.

Coolant replacement

- Replace the drain cap on the engine block.
- Reposition all hoses.
- Close the screw or drain valve on the radiator.
- Remove the fasteners on the header tank.
- Suspend the header tank on the open bonnet.
- Open the various purge screws on the system, except those on the engine block which must be closed.
- Begin to fill the circuit slowly by pouring the coolant into the suspended header tank.
- Close the screw when a jet of coolant liquid flows freely and no air bubbles are present (ie. no bubbles or hiss due to the presence of air in the system). The bleed screws must be closed, starting with the one located at the lowest point of the system.



Never mix coolants!

The mixing of different types of coolant can lead to major technical issues, as well as creating a dangerous chemical mix which may be hazardous!

4.2. Inspecting, diagnosing and fixing damage

The cooling system is one of the most critical operating systems in the modern automobile. A broken or damaged water pump can result in very serious engine damage due to overheating.

After flat tires and running out of fuel, cooling system problems are the **number one cause** of highway breakdowns.

The engine in a car runs best at a temperature of around 90-100 °C (194-212 °F). When the engine is too hot, damage will occur. When the engine is too cold, components wear out faster, and the engine is less efficient and emits more pollution.

Water pumps have been constantly improved throughout the years, but due to the aggressive operating environment of the engine, a water pump replacement will most likely be performed during the life of a vehicle.

If the driving belt fails, the water pump cannot function, which makes it crucially important to check the status of the belt during every maintenance session.

Important Tips

Safety precautions

- Follow the **correct sequence** of the repair as provided by the car manufacturer.
- Disconnect the car's battery.
- Take special care when working on cars with start-stop systems.
- Adhere to **safety guidelines of your garage** and properly support the vehicle.
- Download and print all available support material. Check the SKF website to access SKF specific fitting instructions, technical bulletins, engine diagrams or additional service information.

Inspection

- **Look for** signs of leakage
- **Feel for** too much free play of the water pump pulley

! Before you start

Always follow the vehicle manufacturer's procedures for removal and replacement.
Support the vehicle as per garage Health and Safety guidelines.

Failure to follow these guidelines could result in injury or property damage.
SKF disclaims all liability due to failure to follow these instructions.

Pay extra attention when working on cars with a start-stop system!

Take the right safety measurements before starting work on a car with a start-stop system. Some cars are well safeguarded and the ECM will detect an open engine hood or door, but on others an unexpected restart may occur while working in the engine compartment. Even differences in system approach within one single Vehicle brand can be found. Isolate the battery as described by the car manufacturer or take out the ignition key to be on the safe side.

Repair

- Use the **correct parts and kits**.
- Make sure you have considered all interrelated components. Keep in mind that in many cases the timing belt is driving the water pump, which is integrated in the cylinder block. It is strongly advised to **replace the complete timing system** (timing belt together with all tensioners and pulleys) if the water pump is driven by the timing belt. See calculation example below.
- Make sure you have **considered the main possible causes** of future failure: too much paste around the fitting area (if no gasket is included), mixing coolants and not flushing the system thoroughly.
- Follow manufacturer's recommendations on flushing and dilution of the mixture for the specific region/engine. Also **follow the recommended procedure** for filling and bleeding the engine to avoid causing an air blockage in the cooling system.
- Replace all of the coolant – **do not just top up**. Mixing cooling fluids could create a dangerous chemical mix which may be hazardous! Many times this is indicated by calcium deposits inside the water pump

- Always use the cooling fluid specification as described by the vehicle manufacturer. The wrong specification could even lead to "eat away" on light alloy engine components like the cylinder head. For one brand sometimes several different cooling fluids are applied.
- **Do not start the engine without coolant** as there is a high risk of damaging the water pump dynamic seal.

Customer care

- Show them the **damaged components** or pictures you took during the repair. Customers understand better when shown what was wrong rather than just hearing about it.
- Explain the **advantages of having used a complete kit** and taken out other parts at the same time. Highlight the costs of labor you have saved them by doing so.
- Educate them about **always respecting the vehicle manufacturer's service intervals**, both regarding mileage and time.

Replace the water pump at the same time as the timing belt:

First repair	Timing belt kit	27%	Complete repair	Timing belt kit with water pump	38%
	Labour cost	32%		Labour cost	36%
Second repair	Water pump kit	14%		Total costs	74%
	Labour cost	27%		Customer savings	up to 30%
	Total costs	100%			

All numbers are rounded off and based on customer estimates. Your particular cost savings may vary.

1

Damage

Leakage at the flange and/or at the seal

**Likely cause**

Using too much paste to fit the pump on the engine block.

Solution

If the pump has no gasket **limit the use of sealing paste**. On water pumps with a rubber O-ring or gasket do not use any paste at all.

2

Damage

Leakage at the flange and/or at the seal

**Likely cause**

Using too much paste to fit the pump on the engine block.

Solution

If the pump has no gasket **limit the use of sealing paste**. On water pumps with a rubber O-ring or gasket do not use any paste at all.

3

Damage

Leakage of the water pump due to chemical reactions in the cooling system

**Likely cause**

- Mixing different types of coolants or using wrong type of coolant
- Partly refilled with tap water (see also some rust marks).

Solution

Carefully flush the system, replace the water pump and fill cooling system with cooling fluid as described by the car manufacturer.

4

Damage

Contamination of bearing seal on the impeller side

**Likely cause**

Oil contamination and impurities in the cooling system resulting in failure of the mechanical water pump seal.

Solution

You have to trace the root cause; check engine for internal oil leakage! Search for possible suspects like: cracks in the cylinder head gasket or even the cylinder head itself, internal leakage of a heat exchanger. Then thoroughly flush the system and replace the water pump.

5

Damage

Leakage at the flange and/or at the seal

**Likely cause**

Using too much paste to fit the pump on the engine block.

Solution

If the pump has no gasket **use only a small amount of paste**. On water pumps with a rubber O-ring or gasket do not use any paste at all.

6

Damage

Broken impeller, overheated engine (cooling no longer occurs)

**Likely cause**

Incorrect (extremely high) timing belt tension can break the impeller.

Solution

Set correct timing belt tension.

7

Damage

Leakage, pollution near the drain hole

**Likely cause**

Polluted dynamic seal due to use of improper cooling liquid (wrong mix, wrong type, too much water, expired coolant etc) or polluted cooling circuit.

Solution

Use the right coolant, flush the system thoroughly.

8

Damage

Signs of cavitation on pump body and impeller close to bolt hole

**Likely cause**

Incorrect installation of the bolt has caused air to be infiltrated into the bolt hole. Paste was left in the bolt hole causing a cavity for air to infiltrate.

Solution

Clean bolt hole and fit new pump correctly on the engine block.

9

Damage

Blocked water pump during rotation, rust on the impeller, bearing failed

**Likely cause**

Incorrect tension of the timing belt causing excessive radial load on the shaft, that damages the bearing race ways. As a result the impeller has come in contact with the pump body due to the misalignment of the shaft. The bearing closest to the pulley is more damaged by the radial load.

Solution

Set the right tension on the timing belt.

10

Damage

Discolored pattern on water pump pulley

**Likely cause**

Incorrect pulley alignment, belt is running to one side of the pulley. Misalignment might have been caused by using an incorrect tool like a screwdriver to put the belt in position.

Solution

Use the right tools. Watch out for misaligned pulleys.

11

Damage

Timing belt particles on the inner flange of the water pump pulley

**Likely cause**

Incorrect pulley alignment, belt is running to one side of the pulley. Misalignment might have been caused by using an incorrect tool like a screwdriver to put the belt in position.

Solution

Use the right tools. Watch out for misaligned pulleys.

12

Damage

Cracked mounting hole

**Likely cause**

The technician did not follow the proper procedure when installing the pump.

Solution

First loosely tighten all the bolts, then tighten them in a specific order and torque as explained in the technical automotive documentation.

13

Damage

Cracked ceramic ring

**Likely cause**

The ceramic ring is broken due to thermic shock (cold liquid being introduced to a hot circuit or water pump is run without cooling liquid) or due to incorrect coolant mixture.

Solution

Do not fill up with cold water and use the right cooling fluid.

14

Damage

Noisy water pump, leakage

**Likely cause**

Excessive deposits calcareous phenomenon (poor mixture of glycol or additive in the cooling liquid). This has led to damage of the internal dynamical seal, causing noise.

Solution

Replace water pump, use correct fluid.

15

Damage

Rust/water pump leakage

**Likely cause**

Rust is an indication of poor mixture of glycol or additive in the cooling liquid. Additionally, there could be a burnt smell from the pump, a lot of sealing paste inside and dark solid oil that is burnt. The car has most likely overheated, causing damage to the water pump and, consequently leakage.

Solution

Replace pump, use correct fluid, use correct amount of paste.

16

Damage

Cavitation, corrosion of alloy

**Likely cause**

Incorrect coolant or air in the cooling circuit. The air bubbles are projected towards the surface by the impeller.

Solution

Replace pump, bleed the system (be sure no air bubbles are left).

17

Damage
Blisters**Likely cause**

Operating temperature is too high.

Solution

Check and possibly replace thermostat and thermo switch (switches the electric fan unit on/off).

18

Damage

The belt guide of the teeth pulley has become loose. Also belt residue visible on the pulley teeth

**Likely cause**

- The belt was not aligned correctly and the engine force has torn away a part of the pulley belt guide.
- This can also be seen when belt tension is too high.

Solution

Check alignment of the timing belt and replace both the water pump and the timing belt.

19

Damage

Water pump leakage; removal of the pump body reveals ceramic seal is cracked

**Likely cause**

Thermic shock due to filling a hot cooling system with high volume of cold water.

Solution

Always wait for the cooling system to reach room temperature.

20

Damage

Pump body removal reveals impaired sealing surfaces

**Likely cause**

Use of improper cooling liquid (wrong mix, wrong type, too much water, expired coolant) or polluted cooling circuit (not flushed).

Solution

Use the right coolant, flush the system thoroughly.

21

Damage

Failure due to overload

**Likely cause**

The bearing has been running misaligned or overloaded (probably due to excessive belt tension) causing fatigue and failure of the bearing raceways.

Solution

Set the belt tension correctly, check pulley alignment.

22

Damage

Water penetration/rust

**Likely cause**

Use of improper cooling liquid (wrong mix, wrong type, too much water, expired coolant), polluted cooling circuit (not flushed) or dry running.

Solution

Use the right coolant, flush the system thoroughly.

23

Damage

Waterpump blocked, cannot rotate and discolored heat signs on the pulley.

**Likely cause**

Strongly overtensioned timing belt has resulted in excessive radial stress on the bearings. Impellor has come in contact with the pump body. Damage can also be observed when the wrong part for the vehicle is installed.

Solution

Replace water pump and belt; set the belt tension correctly.

24

Damage

Cavitation damage

**Likely cause**

- Too much paste used
- Pump area not thoroughly cleaned

Solution

- Use the correct amount of paste
- Always remove old gasket or paste material and clean the bolt holes

4.3. Parts and kits by SKF

At SKF we have more than 760 water pump kits with OE quality parts available. Our offer covers more than 96% of the car park in Europe and includes popular European and Asian applications on recent and older vehicles.



Water pump kits (VKPA)

SKF always uses the same technical specifications as the OE pump, to provide the same duration and performance.



Water pump kit

Water pump kit with components (VKPC/VKPA)

- Premium water pump for maximum performance
- Spindle with high load capacity
- Gasket included, if applicable



Timing belt kit with water pump

Timing belt kit with water pump (VKMC)

- Premium water pump for maximum performance
- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary
- High-class camshaft seals/timing cover seals in OE specification design, if applicable



Auxiliary belt kit with water pump

Auxiliary belt kit with water pump (VKMC)

- Premium water pump for maximum performance
- The correct belt for your application in trusted OE quality
- Premium quality tensioners and idler pulleys
- Nuts, bolts, screws and other fasteners where necessary



The SKF AquaMax water pump

The SKF AquaMax water pump provides superior cooling flow over a standard water pump. On modern turbo engines a perfect flow is most important to safeguard sufficient cooling capacity when the engine has to operate under severe conditions like towing a trailer on mountain roads. Under these conditions the engine has to deliver a high torque during a longer period and cooling capacity is crucial.

SKF AquaMax design advantages:

- Spindles with optimum capacity loads
- Latest silicone carbide mechanical seal components to cover latest engine coolants, speeds and temperature needs
- Flow and pressure rates correlated and revised to the engine and application
- Mechanical seals eliminating premature leaks

The benefits

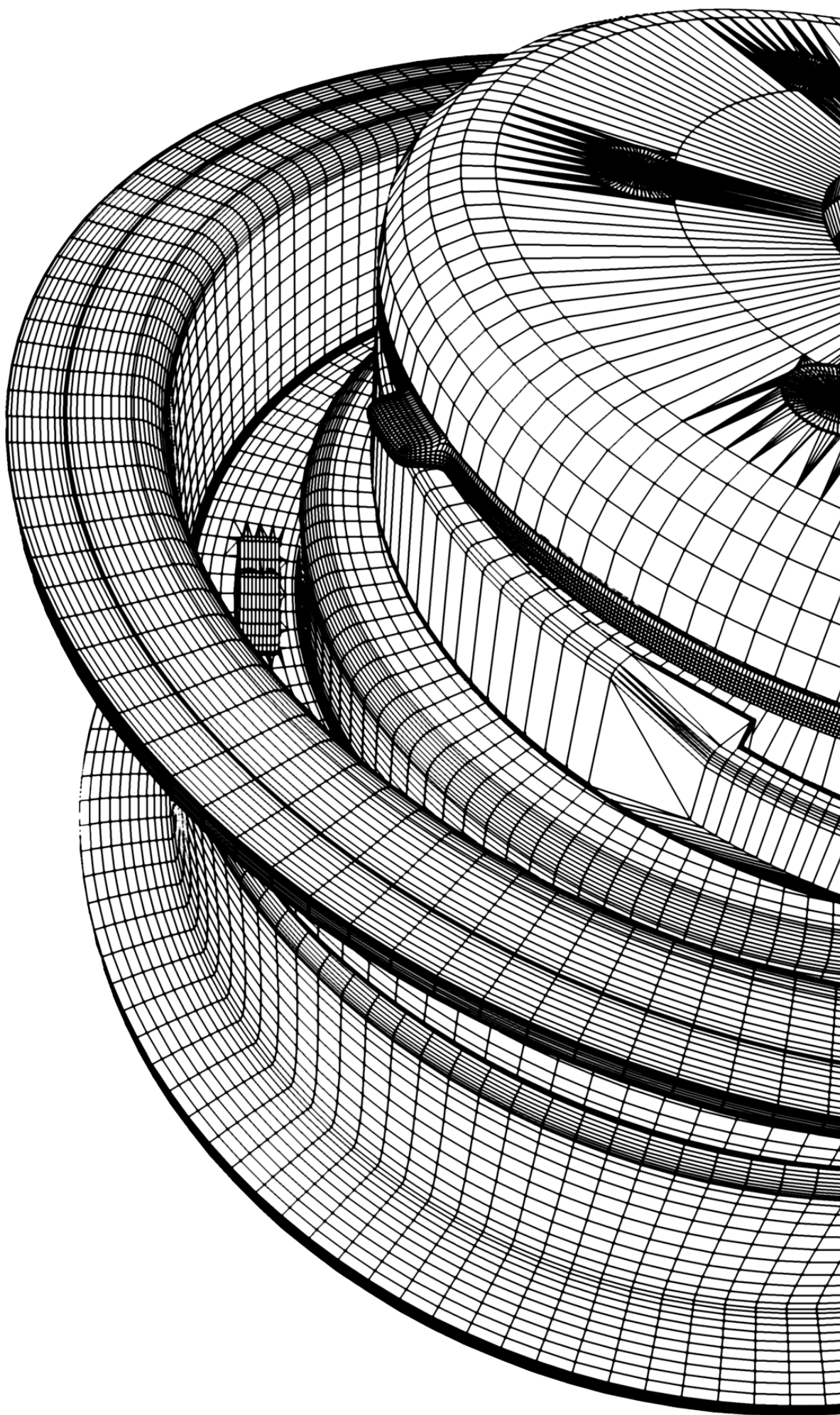
- Optimum cooling efficiency
- Strong focus on sustainability: reduced fuel consumption and reduced CO₂ emissions



Spindle bearings

To comply with OE specifications, SKF has bearings with exactly the same technical features. Roller dimension, size and quantity of the balls, quantity of grease are designed to replicate the genuine part exactly.







5 Case studies

Did you know:

The SKF Pole Position program provides detailed technical and vehicle specific bulletins. Each one focuses on a specific SKF product, identifies possible issues that can arise and shows practical tips for correctly removing and installing that product on the relevant vehicles. So far, over 20 000 technicians have joined and take advantage of the Pole Position program.

Go to your country specific SKF VSM website (www.vsm.skf.com → “Garage Area”) to download the latest bulletins or contact your local SKF representative for more information about the program.

Pole Position

VAG

VKMC 01259

of a timing belt kit with water pump

Timing belt kits VKMC 01259-1 and VKMC 01259 -2
000.

“Good as his tools” – a truism for the automotive

Systems on today's engines require the use of special
After repair, the engine's power, fuel economy and
ed. While using the right tools, these factors are also
em set-up:

Complete kit for the engine being serviced, including water
the timing system, hydraulic unit if required, plus all nuts,
require replacement.

For complete auxiliary kit. When replacing the timing system,
ould always replace the auxiliary belt as well. (This complies
e manufacturer's recommendations for renewing the
at the same replacement interval as the timing system).

Vibration Damper: Always check condition and if in doubt,

/ under-tensioned? Always check your settings
vehicle manufacturer's recommendations.

anticlockwise? Check the directional arrow on the
(if applicable). Rotating in the wrong direction can
ct wrap angle and lead to belt over-heating and
ng in engine damage.



VKN 1000



Note: Some engine manufacturers recommend renewing the TVD at the same replacement interval as the auxiliary and timing system.

Applications – VKMC 01259	
Model	Engine
A3, A3 Quattro, A3 Sportback	2.0 TDI – 16V
Passat, Jetta III, Passat, Touran	2.0 TDI – 16V
	2.0 TDI – 16V



Case study 1

GM 1.7 CDTi engine (also found on the Honda)

Problem: broken timing belt



Analysis

We investigated several options in detail to find the cause for the ripped belt. Upon checking the tensioner it became clear that its set up was wrong. The tensioner spring was jammed under the tensioner back plate which can be seen from the typical marks on the back of the tensioner and the broken spring.

Such a set up causes misalignment of the tensioner pulley and the timing belt will “grind away” on one side. In the end the timing belt will snap. In the case of a broken spring the belt tension will slacken in a split second and the belt will jump over a number of teeth which will immediately cause serious engine damage.

Lesson to learn

On this type of tensioner it is always crucial to check the setting of the spring when tightening the tensioner to the engine block.

Case study 2

Volkswagen 1.4 -16V engine (found on many VAG)

Problem: broken tensioner bolt



Figure 1



Figure 2



Figure 3



Figure 4

Analysis

This engine has a somewhat special construction where the inlet camshaft is driven by a separate small timing belt. Correct installation is crucial to carrying out a professional job on engines like this one.

As shown in (→ **Fig. 2**) rubber deposits are visible on the back plate of the tensioner. This means that the timing belt was not aligned well and started moving towards the tensioner back plate and friction occurred (→ **Fig. 4**).

In this case it is clear that during the installation procedure the setup of the tensioner went wrong. The back plate has been badly bent and damaged. This results in misalignment and incorrect tension.

Lesson to learn

A broken tensioner bolt never comes alone, there is always a reason behind it. Therefore always check the surrounding components to investigate why a bolt might have snapped off.

Case study 3

Renault 1.2-16V engine (also found on a wide range of Dacia and Nissan vehicles)

Problem: timing system and tensioner were completely destroyed and expensive engine damage has occurred.



Analysis

After a detailed investigation it became clear that the specific fitting instructions provided by the car maker or SKF were not followed and the tensioner was rotated in the wrong direction during the set up. This means that the belt tension initially seemed correct but by moving the tensioner in the wrong direction the belt and tensioner came into contact with a sharp edge of the engine block.

As a result the belt wore away and excessive heat was generated. Finally the timing belt broke.

Lesson to learn

Always check the specific fitting instructions and make sure that the tensioner is moving in the correct direction.

Case study 4

VAG 1.9 TDI engine

Problem: cracked auxiliary system tensioner

Note: This kind of damage can also be found on several other engine types.



Analysis

Cracks or a completely broken casting are clear indicators of unusually strong engine vibrations.

Lesson to learn

Before replacing the tensioner always check the components that are most likely causing these strong vibrations:

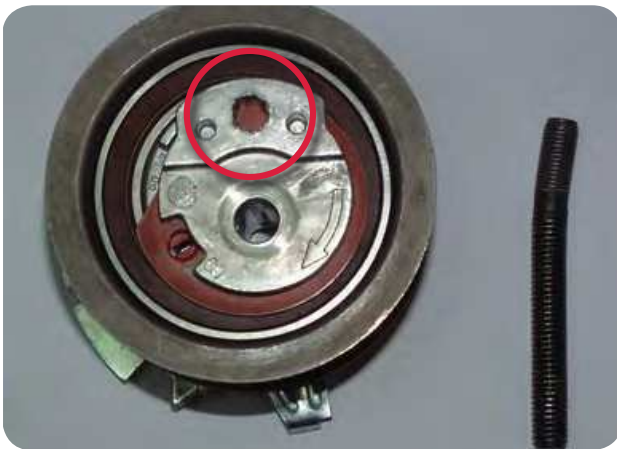
- Freewheel alternator pulley is blocked or a solid pulley was fitted in an earlier, unprofessional repair
- Active crankshaft damper is defective or a non-damping counterfeit part was fitted in an earlier, unprofessional repair
- If the car is equipped with a dual mass flywheel, check for vibrations and noises at idling

Remember: simply replacing the broken tensioner and not solving the real root cause makes no sense, after a short period of time the damage will occur again!

Case study 5

VAG TDI engine

Problem: bent tensioner stud



Analysis

A bent tensioner stud is the result of setting the torque too high instead of at an angle of 90 degrees. The alignment will be wrong and the back plate tab will not sit correctly into the engine block.

The polished pattern around the stud hole shows that the tensioner moved away from its initial position. The dented area around the Allen key hole also shows that the wrong tool was used.



Lesson to learn

Always use the correct sized Allen key to set the tension and follow the arrow on the tensioner which shows the right direction to put tension on the system.

The image above shows how the back plate tab should be inserted into the engine block.

6. The SKF service offer

Technical training and helpline through eXponentia

eXponentia SAS is a partnership between global leading automotive industry suppliers: SKF, Tenneco (Monroe, Walker) and TRW.

eXponentia offers technical expertise, training and a helpline for mechanics to handle the increase in the technical complexity of today's vehicles.

For more information, visit: www.eXponentia.org



“Pole Position” Program for mechanics

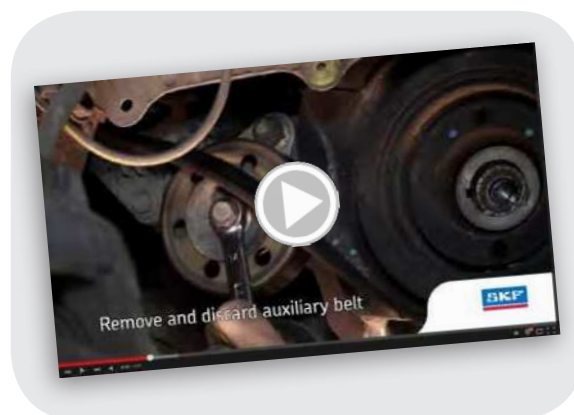
This program provides technical and vehicle specific information bulletins to help identify installation problems and make repairs safer and more efficient.



Educational videos

SKF provides extra support to mechanics with step-by-step installation videos to help carry out repairs. All videos are available at:

www.youtube.com/SKFAftermarket



Digital information

SKF provides product data and pictures, engine diagrams, installation videos, technical bulletins, fitting instructions and more with access through the following channels:

- **QR codes on SKF parts boxes** – scan the QR-code on the box with your smartphone and get instant access to the online information.
- **SKF online catalogue at vsm.skf.com** – search all SKF parts according to your needs; updated every quarter and completed with technical bulletins, engine diagrams and fitting instructions.
- **iPhone app “SKF Automotive parts search”** – access the online catalogue directly from your iPhone to find the correct part for a specific engine or car model.



Notes

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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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Any cost savings and revenue increases in this publication are based on results experienced by SKF customers and do not constitute a guarantee that any future results will be the same.

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