



# Dual Mass Flywheel

Technology / Failure Diagnosis  
Special Tool / User Instructions



**SCHAEFFLER**  
AUTOMOTIVE AFTERMARKET



## 1 History



### From conventional torsion damping to dual mass flywheel

The rapid development of vehicle technology over the last few decades has brought ever higher-performance engines paralleled by an increased demand for driver comfort. Weight-saving vehicle concepts and wind tunnel-optimised bodies now allow other sources of noise to be perceptible to the driver. In addition, lean concepts, extremely low-speed engines and new generation gear-boxes using light oils contribute to this.

Since the middle of the 1980s, this advancement has pushed the classic torsion damper as an integral part of the clutch driven plate to its limits. With the same or even less installation space available, the classic torsion damper has proved inadequate to outbalance constantly increasing engine torques.

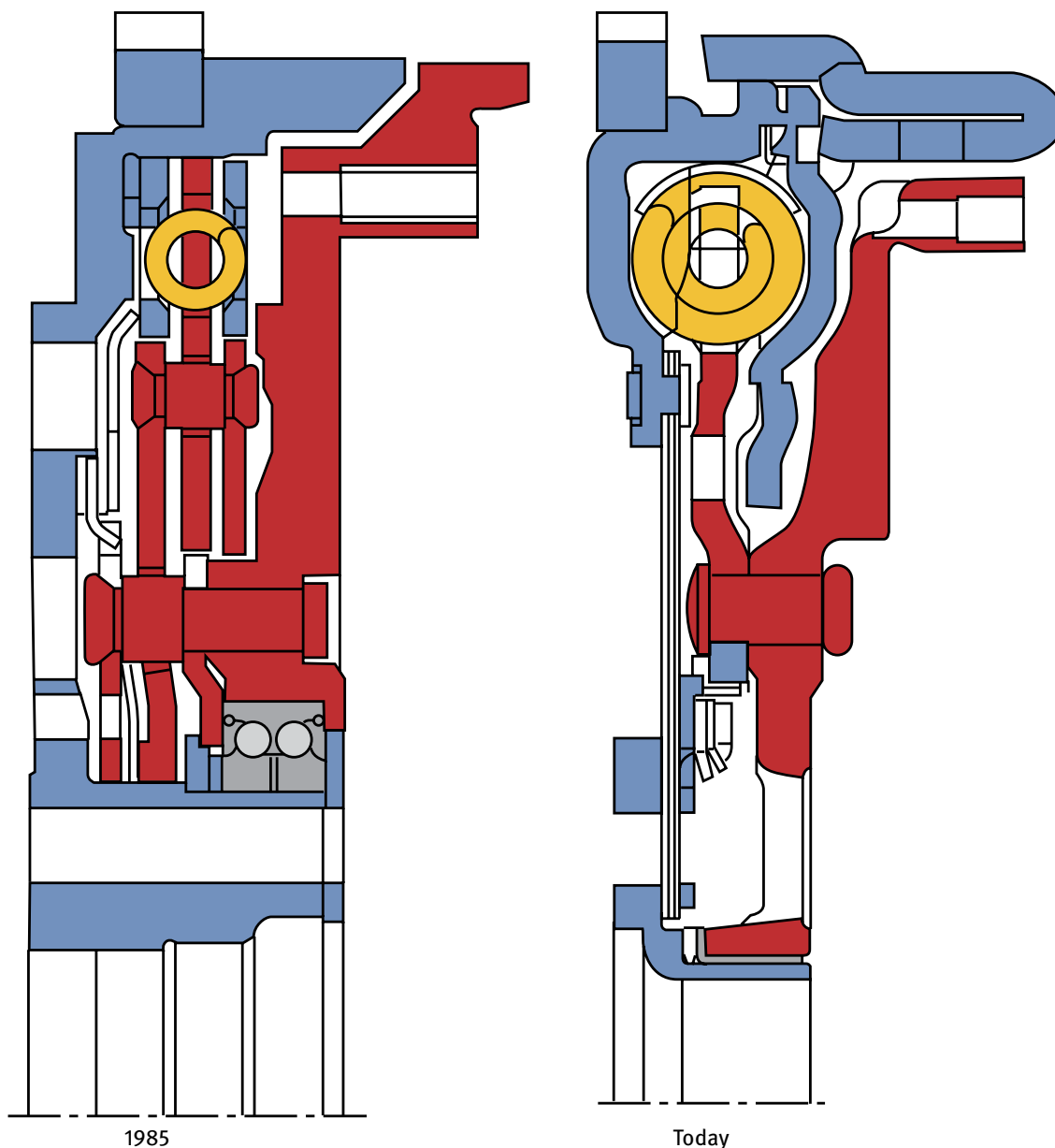
Extensive development by LuK resulted in a simple, but very effective solution – the dual mass flywheel (DMF) – a new torsion damper concept for the drive train.



The configuration of the springs in the first-generation DMF was identical to conventional torsion dampers, where the pressure springs are mounted in a radial direction close to the centre and can therefore provide only limited spring capacity. This design was sufficient to isolate vibration in 6-cylinder engines, as these produce low resonance speeds.

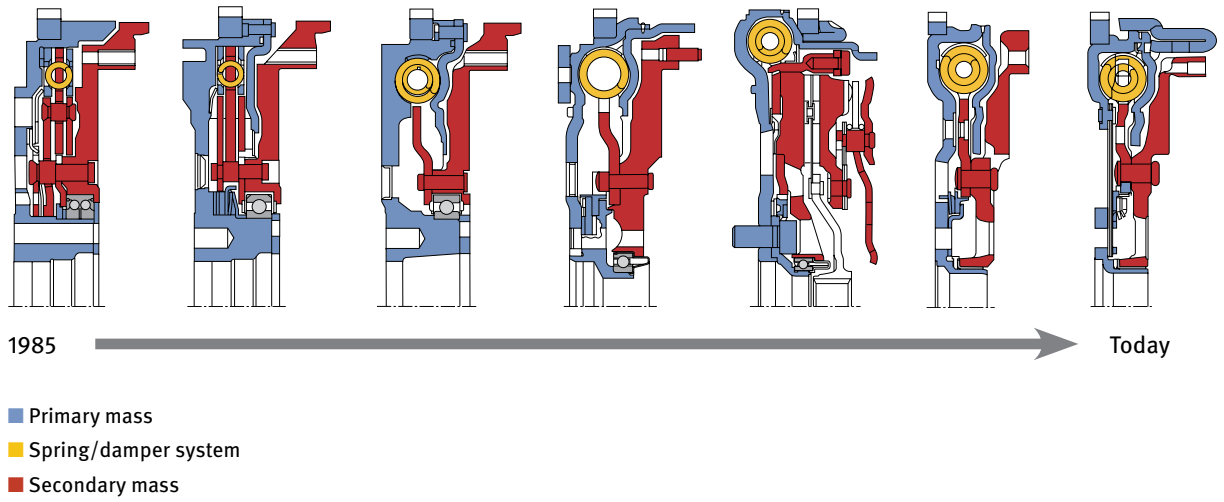
In contrast, 4-cylinder engines induce higher irregularities and consequently higher resonance speeds. Repositioning of the springs towards the outer edge and the use of high-pressure spring diameters increased the damper capacity fivefold without requiring more space.

### DMF function diagram

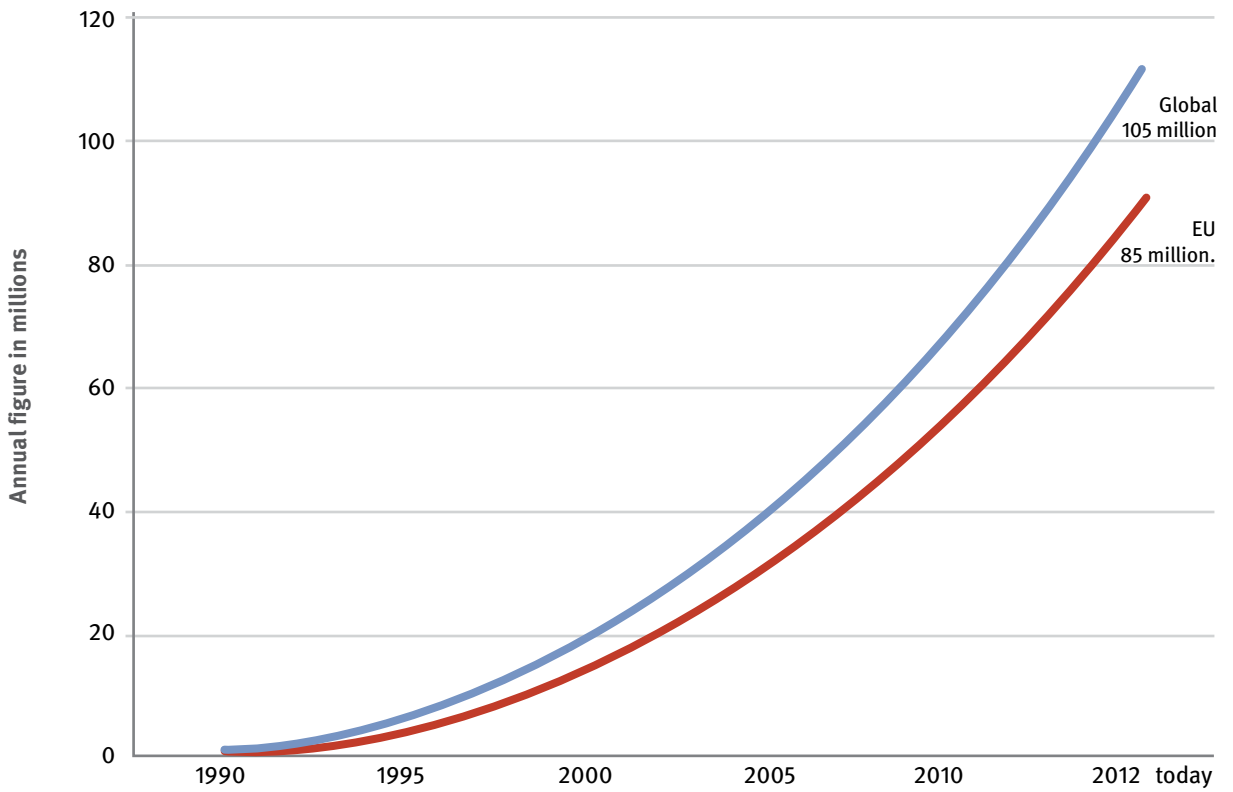


- Primary mass
- Spring/damper system
- Secondary mass

### DMF – Milestones in technology



### Vehicles fitted with DMF – figures from 1990 to today



## 2 Dual mass flywheel – DMF

### 2.1 Why DMF?

The periodic combustion cycles of a 4-stroke engine create torque fluctuations which causes torsional vibration to be passed down the drive train. The resulting noise and vibration, such as gear rattle, body boom and load change vibration, results in a decrease in both cabin and driving comfort. The objective when developing the DMF was therefore to isolate as much of the drive train as possible from the torsional vibration caused by the engine's rotating mass.

Owing to its integral spring/damper system, the DMF almost entirely absorbs this torsional vibration. The result: very good vibration damping.



### 2.2 Design

#### Standard DMF

A standard DMF consists of the primary mass and the secondary mass.

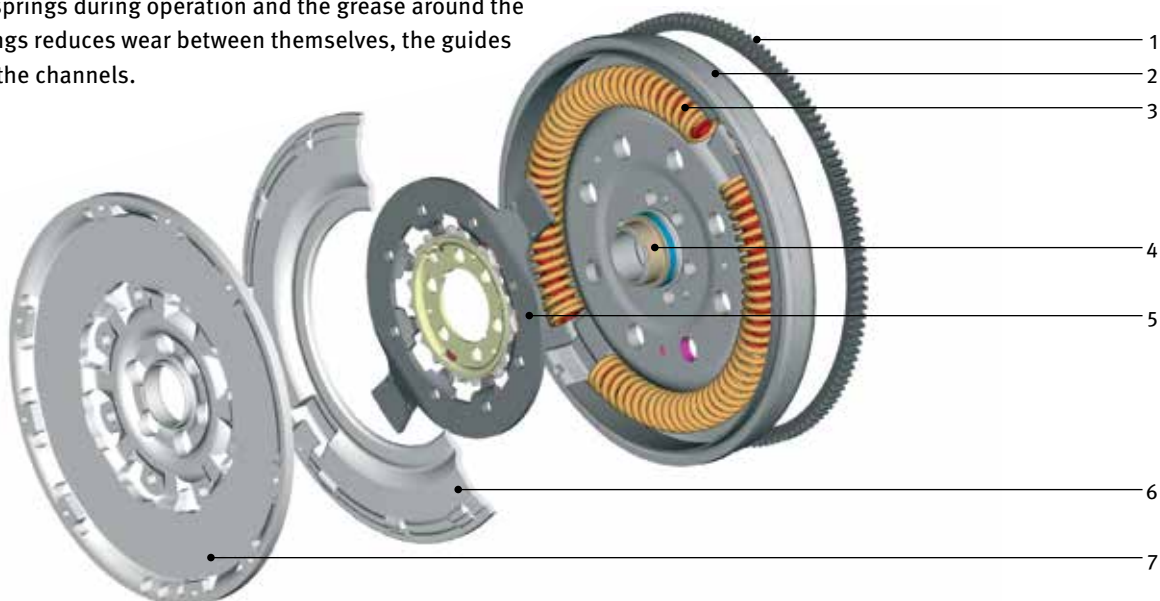
The two decoupled masses are connected via a spring/damper system and supported by a deep groove ball bearing or plain bearing so they can rotate against each other.

The primary mass with starter ring gear is driven by the engine and tightly bolted to the crankshaft. It encloses, together with the primary cover, a cavity which forms the arc spring channel.

At the heart of the spring/damper system are the arc springs. They sit in guides in the arc spring channels and cost-effectively fulfil the requirements of an "ideal" torsion damper. The guides ensure correct guidance of the springs during operation and the grease around the springs reduces wear between themselves, the guides and the channels.

Torque is transferred via the flange. The flange is riveted to the secondary mass with its wings sitting between the arc springs.

The secondary mass helps to increase the mass moment of inertia on the gearbox side. Vents ensure heat is dissipated efficiently. As the DMF has an integral spring/damper system, a rigid clutch disc without a torsion damper is normally used.



- 1 Starter ring gear
- 2 Primary mass
- 3 Arc springs
- 4 Plain bearing

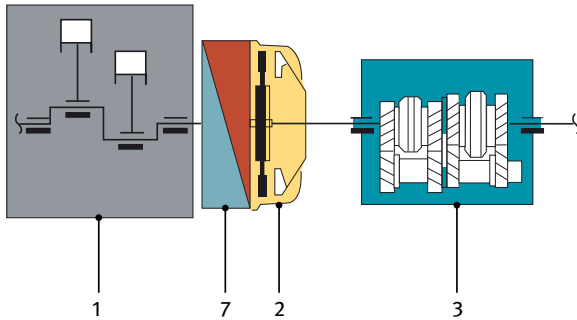
- 5 Flange
- 6 Primary cover (cross section)
- 7 Secondary mass

### 2.3 Function

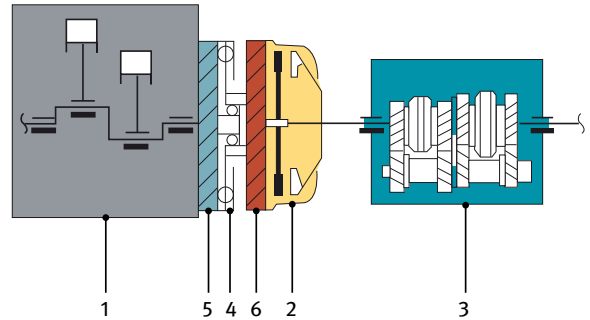
The functioning principle of a DMF is simple, yet efficient. Owing to the additional mass on the transmission input shaft, the vibration torque range, which is normally between 1,200 rpm and 2,400 rpm with original torsion

dampers, is moved to a lower resonance speed range. This ensures excellent damping of engine vibration even at idle speeds.

Working principle of a conventional flywheel

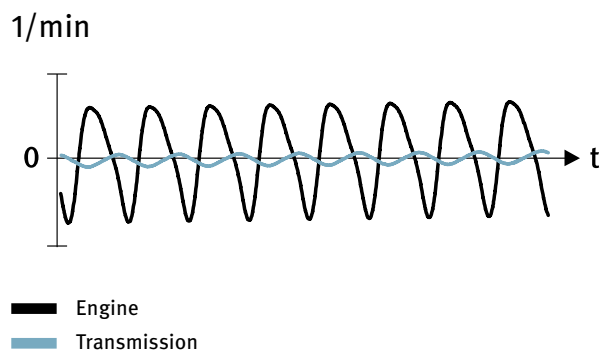
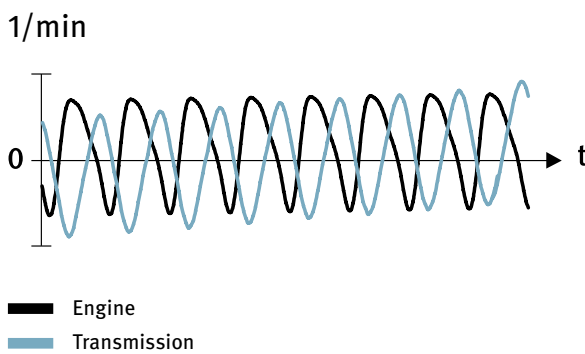


Working principle with a dual mass flywheel



- 1 Engine
- 2 Clutch
- 3 Transmission
- 4 Torsion damper
- 5 Primary mass
- 6 Secondary mass
- 7 Flywheel

### Transfer of torsional vibration



**With a conventional flywheel:** in the design that was previously common, with a conventional flywheel and torsion-damped clutch disc, the torsional vibrations in the idling range are transferred practically unfiltered to the gearbox and cause the gear teeth edges to knock together (gearbox rattle).

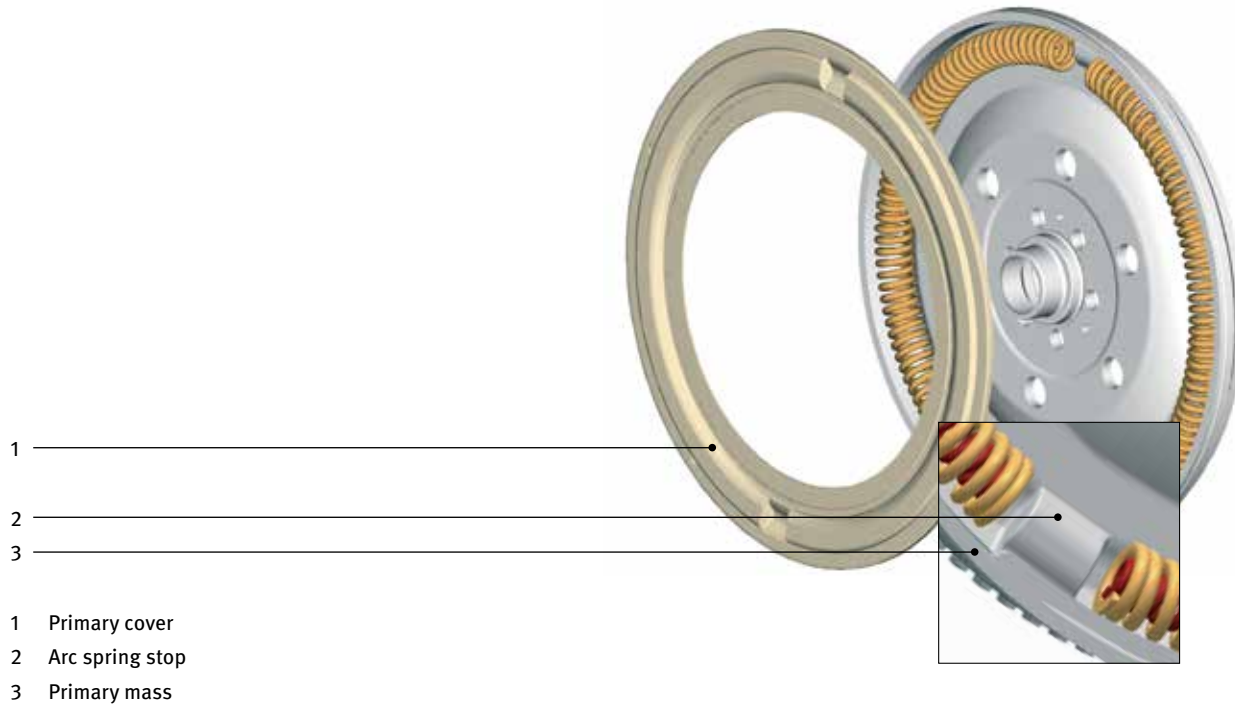
**With a dual mass flywheel:** in contrast, the spring/damper system of the DMF filters out torsional vibration caused by the engine. This prevents gearbox components knocking against each other – rattling does not occur and the driver’s demands for higher comfort are fully met.

### 3 DMF components

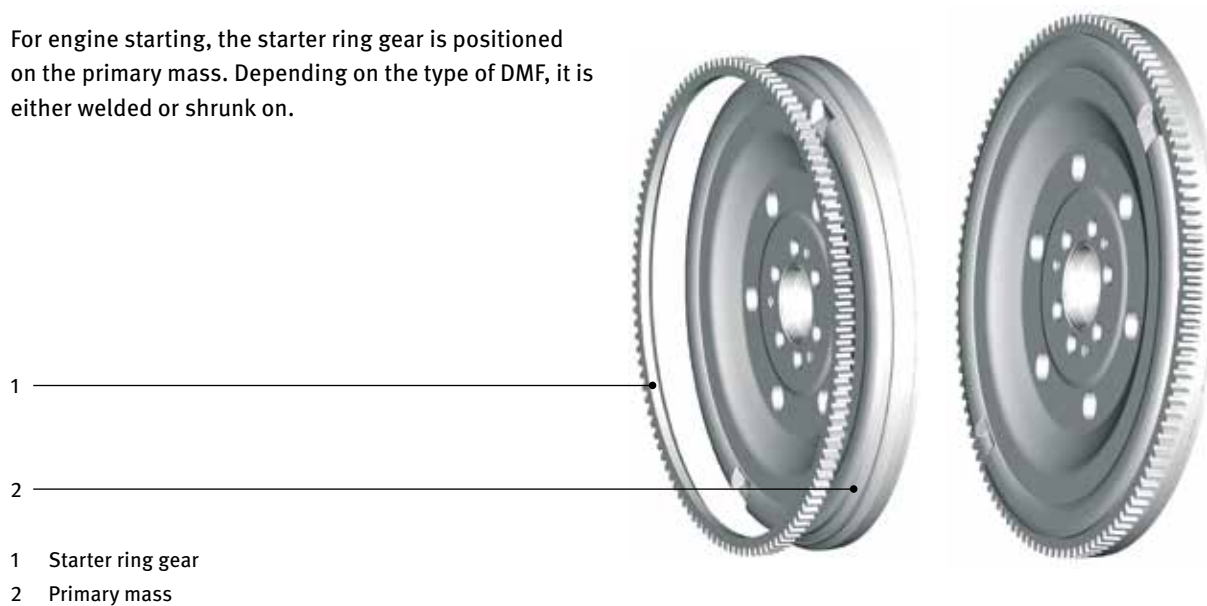
#### 3.1 Primary mass

The primary mass is connected to the crankshaft of the engine. The inertia of the primary mass and the crankshaft combines to form a whole. Compared to a conventional flywheel, the primary mass of the DMF is significantly more flexible, which helps to relieve the

crankshaft load. In addition, the primary mass – together with the primary cover – forms the arc spring channel which is typically divided into two sections, separated by the arc spring stops.

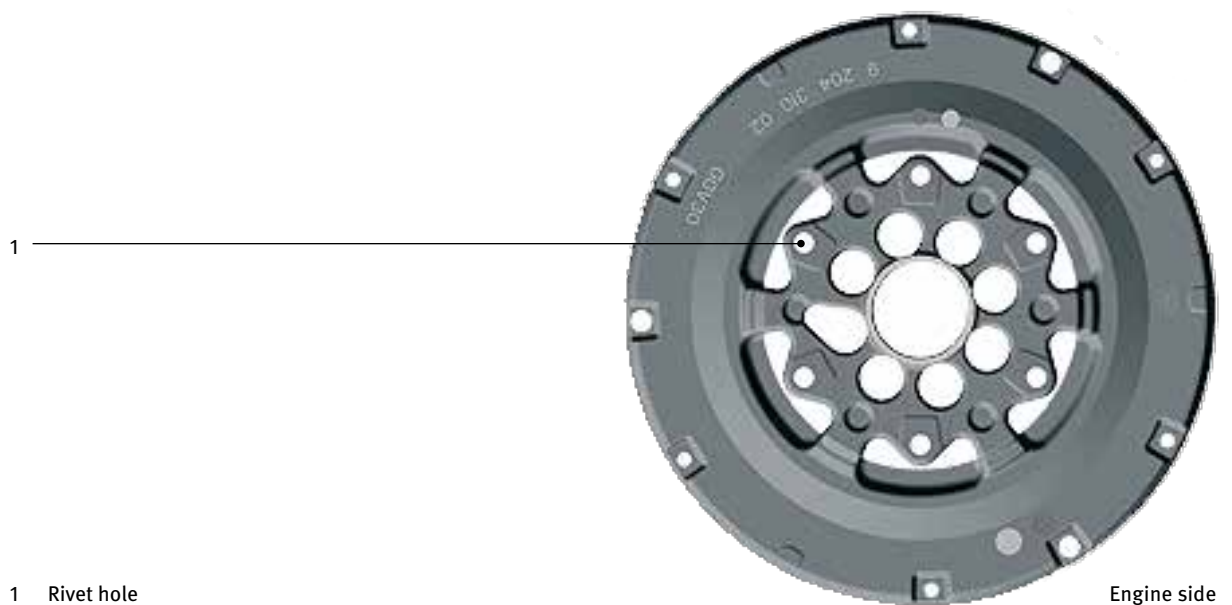
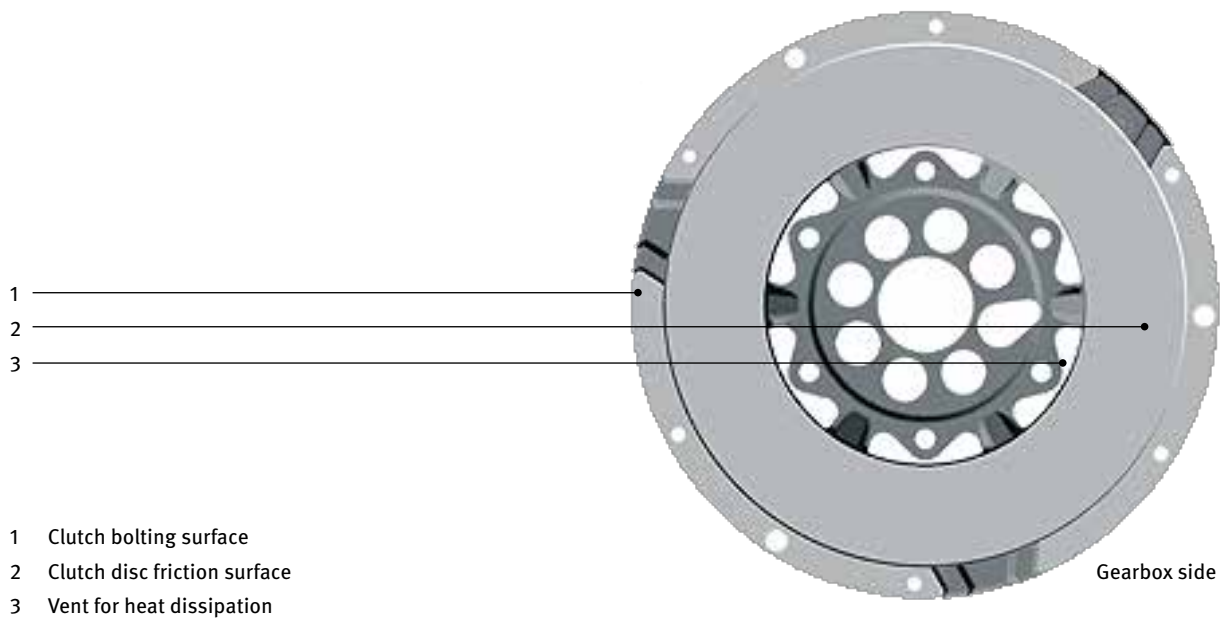


For engine starting, the starter ring gear is positioned on the primary mass. Depending on the type of DMF, it is either welded or shrunk on.



### 3.2 Secondary mass

The engine torque is transferred from the primary mass to the secondary mass via the arc springs and the flange. Thanks to the bearing between the primary and secondary mass, independent radial movement of the masses is possible. As with a rigid (single-mass) flywheel, the power output is through the clutch, which is bolted to the secondary mass. The crucial difference, however, is that the engine torque is now largely free of rotational vibration, i.e. it is modulated. Because of this, a clutch disc with torsion damping can be dispensed with in most cases if a DMF is used.

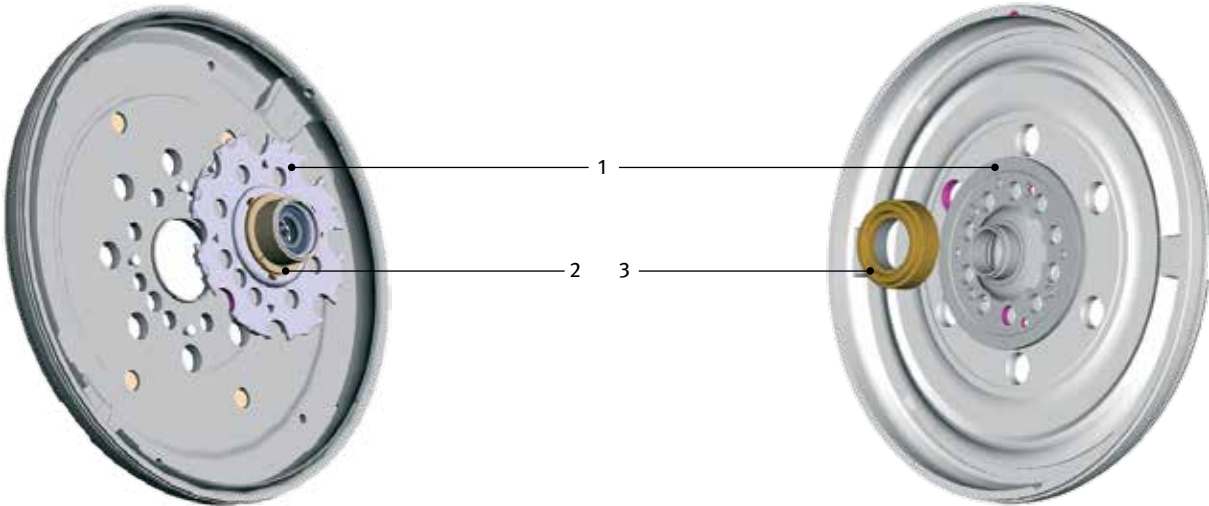




### 3.3 Bearing

The bearing in the primary mass serves as a rotating connection with the secondary mass. It not only has to absorb the weight-related radial forces of the secondary

flywheel and the clutch, but also the axial forces generated by the release force when disengaging.



- 1 Bearing tower
- 2 Plain bearing
- 3 Ball bearing

### Types of bearings

Two different types of bearings can be used on a DMF:



#### Ball bearing

When development of the DMF started, large ball bearings could be used because of the relatively simple design of the internal components. However, the constantly rising demands on the rotary vibration damping made additional components necessary in the DMF. For this reason, further construction space had to be created. This led to a systematic reduction of the diameter of the ball bearing. Small ball bearings allow the space-neutral integration of additional rotary vibration dampers and, in this way, increase the efficiency of the DMF.

#### Plain bearing

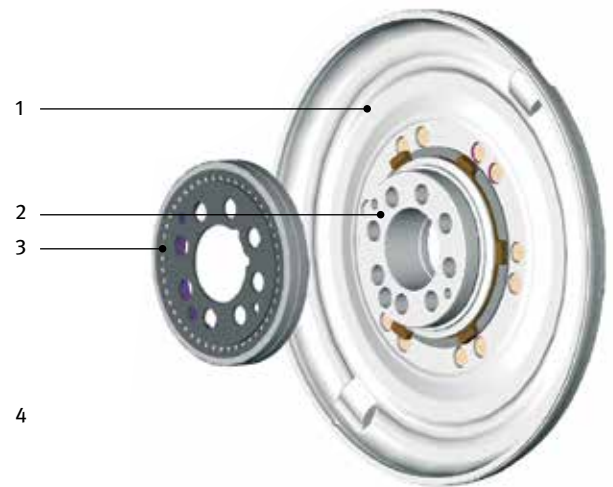
In comparison with ball bearings, plain bearings take up less space and are more simply designed. In spite of their low manufacturing costs, they can be universally used and, if necessary, can be designed to allow axial motion.



### 3.3 Bearing

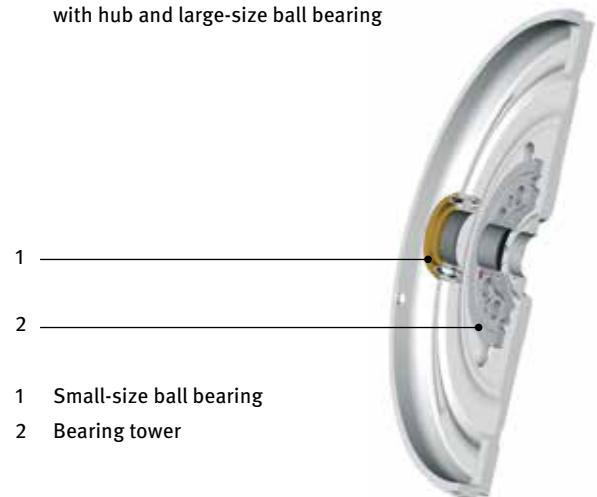
#### Large and small ball bearing

The primary mass is fitted with a turned hub on which the large-size ball bearing is fitted.



- 1 Primary mass with bearing seat on hub
- 2 Hub
- 3 Large-size ball bearing
- 4 Cross section – primary mass with hub and large-size ball bearing

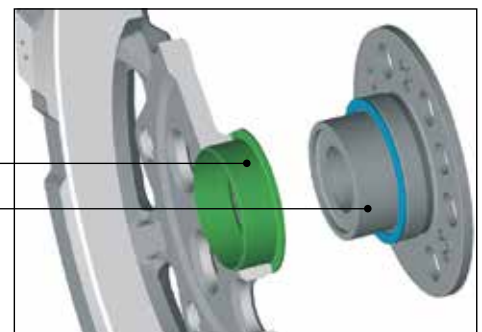
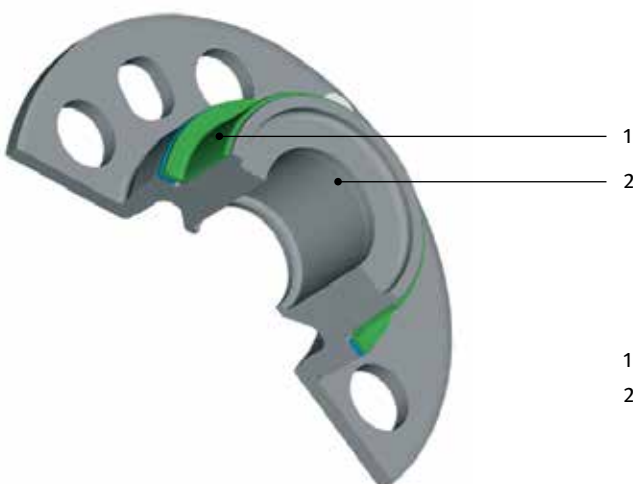
A hub flange with the bearing seat (turned or drawn) is mounted onto the primary mass. The bearing seat can be adjusted to mount a small ball bearing – as shown here – or a plain bearing.



- 1 Small-size ball bearing
- 2 Bearing tower

#### Plain bearing

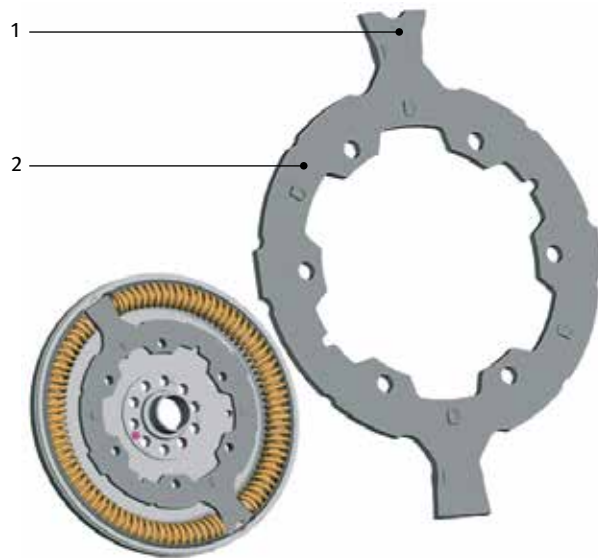
In comparison with ball bearings, plain bearings take up less space and are more simply designed. In spite of their low manufacturing costs, they can be universally used and, if necessary, can be designed to allow axial motion.



- 1 Coated plain bearing bushing
- 2 Bearing tower on bearing flange

### 3.4 Flange

The task of the flange is to transfer torque from the primary mass via the arc springs to the secondary flywheel; in other words, from the engine to the clutch. The flange is tightly riveted to the secondary mass with its wings (arrows) sitting between the arc spring channel of the primary mass. The gap between the arc spring stops in the arc spring channel is big enough to enable the flange to rotate.



- 1 Flange wings
- 2 Flange

### Flange designs

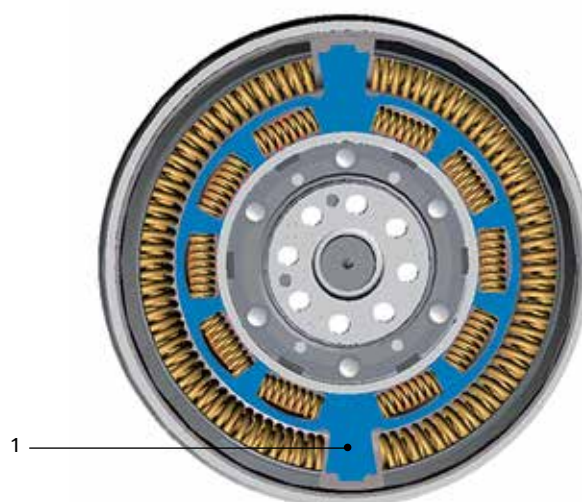
#### Rigid flange

The rigid flange is riveted directly to the secondary mass. This allows the use of flange wings with different symmetries, which has a positive effect on the isolation of vibration. The simplest form is the symmetrical flange, where pull and push sides are identical. Thus, load is applied on the arc springs via both outer and inner areas of the end coil.



#### Flange with internal damper

The key function of the DMF is to isolate the transmission from the vibration generated by the engine. In order to compensate for the constantly increasing engine torques while the installation space remains the same, the wind-up curves of the arc springs must rise more steeply. Consequently, their vibration damping capacity deteriorates. Using friction-free internal dampers helps to improve vibration elimination during acceleration. Both the flange and the side panels are designed with spring apertures which house straight pressure springs. The excellent vibration damping characteristics of the DMF with internal damper are guaranteed even in the highest torque ranges.



- 1 Flange with spring aperture

### 3.4 Flange

At high engine speeds, the resulting centrifugal forces press the arc springs to the outside against the guides and the coils are disabled. Consequently, the arc spring stiffens and spring action is partly lost. In order to maintain sufficient spring action, straight pressure springs are mounted in the flange. Owing to their lower mass and mounting position on a smaller radius, these springs are subject to a lower centrifugal force. Additionally, the convex shape of the upper edge of the spring windows helps to minimise friction. This ensures that neither friction nor the effective spring rate will increase as engine speeds go up.

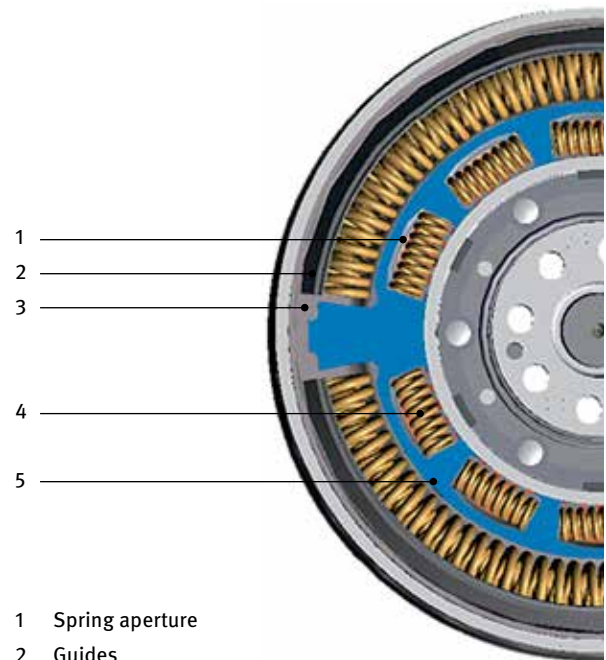
#### Flange with friction clutch

When an attempt is made to adjust the engine speed very quickly to the speed of the gearbox input shaft, sudden peak loadings occur, so-called impacts. In this way, for example, an impact may be caused by a sudden engagement, leading to stalling of the engine. Here, the arc springs are briefly fully compressed, leading to a disproportionate increase in the loading on the flange. In the case of rigid flanges and those with internal damping, frequent impacts may lead to material deformation, culminating in breakage of the flange wings.

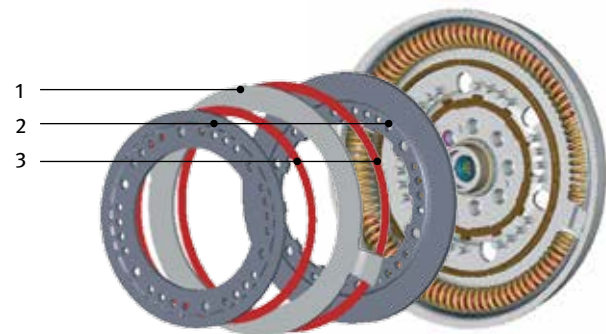
One way to compensate for impacts and minimise material damage is a flange with a friction clutch. In this case, the flange is designed as a diaphragm spring. It is pre-tensioned and positioned by two riveted retaining plates with a thin friction lining. In cross-section, this forms a fork-shaped fixture which allows slipping of the flange. In the case of an impact, the flange can now rotate in the retaining plates. The surplus energy is dissipated as friction heat. In this way, the load on the flange wings is minimised.

#### Note:

This overload protection is only designed for brief peak loads in normal driving. Permanent overloading, e.g. when towing an excessive trailer load or due to performance enhancement (chip tuning), leads to premature wear on the friction clutch. As a result, the flange is able to transmit less and less engine torque. In extreme cases, the transmission of force in the DMF is reduced to such an extent that the transmittable engine torque is no longer sufficient to drive the vehicle.



- 1 Spring aperture
- 2 Guides
- 3 Arc spring stop in the primary mass
- 4 Pressure spring
- 5 Flange

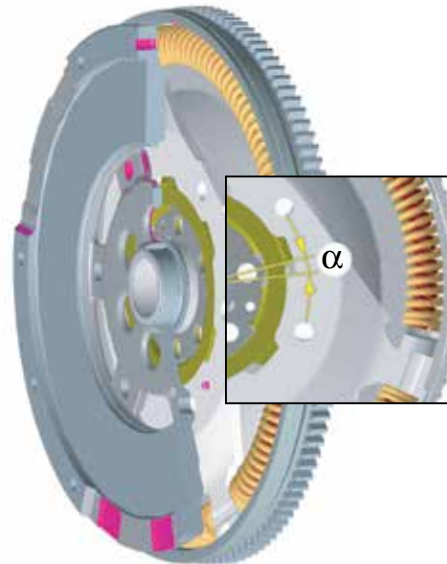


- 1 Flange
- 2 Retaining panel
- 3 Friction lining

On the basis of this failure symptom, the clutch is often replaced, but that does not cure the malfunction in the case of this defect. In order to avoid an incorrect diagnosis in the case of damage, the DMF should also be inspected during the repair. If the bolt holes in the primary and secondary mass are so offset that they prevent removal of the crankshaft bolts, that may indicate a defective flange with friction clutch.

### 3.5 Friction control disc

During the start-up process, the DMF operates briefly in the resonant frequency range. When this happens, the flange wings repeatedly hit the arc springs with unbraked force, producing noise as they do so. An effective countermeasure here is an additional friction device, the friction control plate. This has the effect of delaying the rotation of the flange within a defined working range. As a result, the flange can be rotated over the secondary mass in the range of clearance angle ( $\alpha$ ) without noticeable resistance. Only outside the clearance angle, i.e. at greater angles of rotation, does the additional friction come into effect. In this way, the noises produced when starting up or changing the load can be eliminated.



### 3.6 Arc springs

DMF systems help to improve the noise behaviour of the vehicle by using special torsion damper designs. As a direct result, less noise is generated and fuel consumption is reduced.

In order to make ideal use of the available space, a coil spring with a large number of coils is fitted in a semicircular position. The arc spring lies in the spring channel of the DMF and is supported by a guide. Under operation, the coils of the arc spring slide along the guide and generate friction and thereby damping. In order to prevent wear on the arc springs, the contact surfaces are smeared with grease. The optimised shape of the spring guides helps to reduce friction significantly. Besides improved vibration damping, arc springs help to reduce wear.

Thanks to the diversity of arc spring designs, a DMF system can be manufactured to precisely match the individual load characteristics of each vehicle type. Arc springs of various designs and characteristics are used. The most frequent types are:

- Single-stage springs
- Two-stage springs

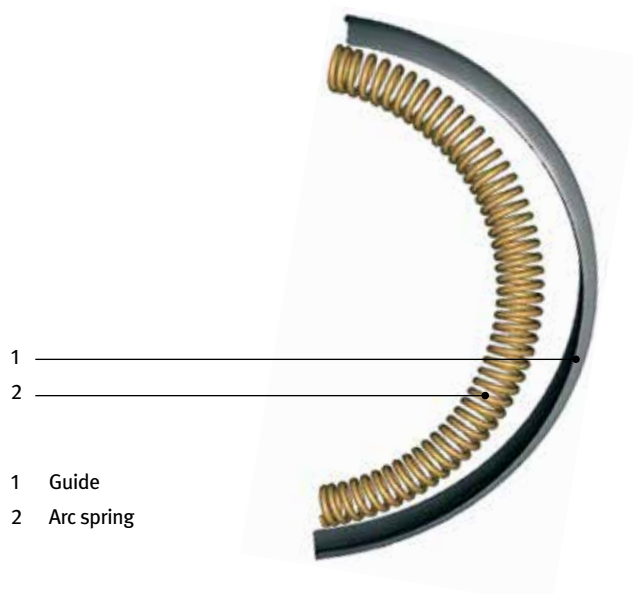
either in a parallel arrangement in one of various different layouts, or in-line arrangement

- Damping springs

In practice, the spring types are applied in various different combinations.

#### Benefits of the arc spring:

- High friction at large rotation angle (start-up process) and low friction at low rotation angle (overrun)
- Lower actuation force (spring rate) because of the flexible space utilisation (in comparison with systems with multiple single springs)
- Impact damping can be integrated (damping spring))



- 1 Guide
- 2 Arc spring

### 3.6 Arc springs

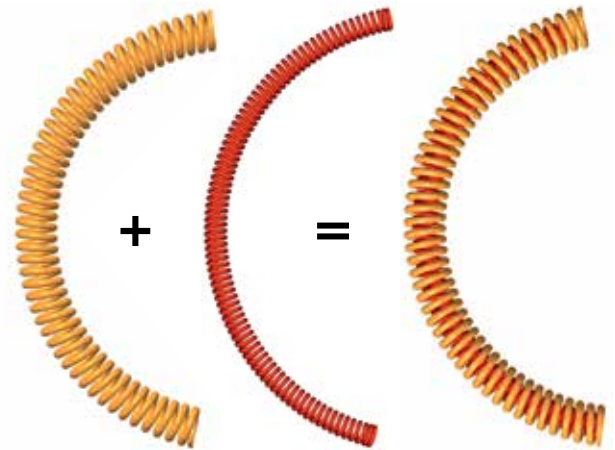
#### Single spring

The basic version of the arc spring is a single spring. This is characterised by its large spring volume and resulting high damping capacity. Because of its simple design, however, it only offers limited possibilities for satisfying rising demands for comfort. For this reason, today's DMFs are seldom fitted with single springs.



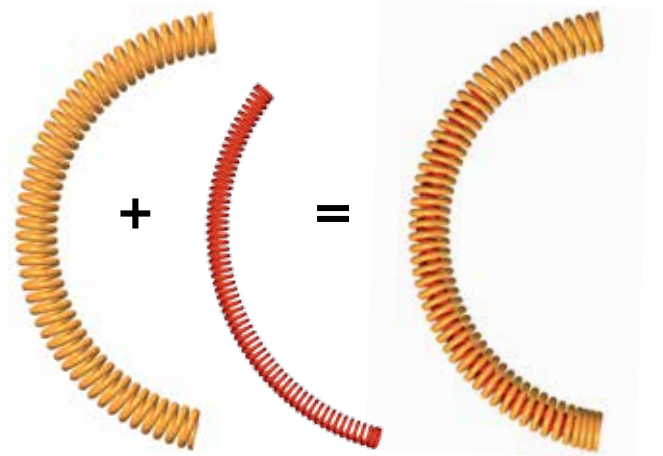
#### Single-step parallel spring

The arc springs in most frequent use today are single-stage parallel springs. It consists of an external and internal spring, of about the same length. The two springs are arranged in parallel. Their individual characteristics add up to the spring set curve.



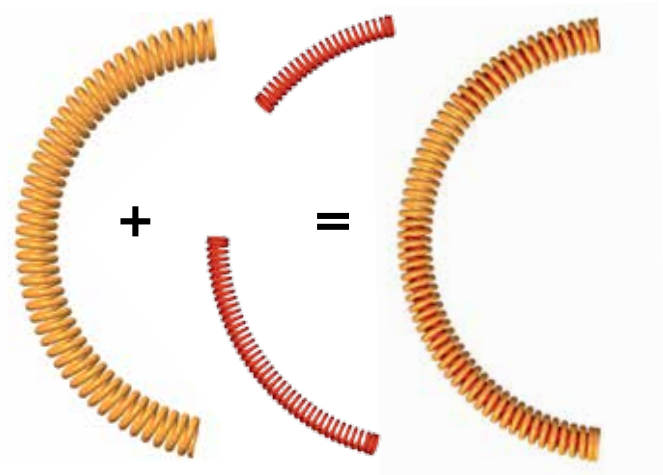
#### Two-stage parallel spring

In two-stage parallel springs, two arc springs are again arranged one inside the other. The internal spring, however, is shorter, thus engaged later. The wind-up curve of the external spring is matched to the requirements of the vehicle when the engine starts. Here, load is applied only on the softer external spring, enabling the system to pass the critical resonance speed range faster. In the higher and maximum torque ranges, load is exerted on the internal spring as well. Both external and internal springs work together in the second stage. The interplay of both springs provides good damping at all engine speeds.



#### Three-stage arc spring

This type of arc spring consists of one external spring and two internal springs of different lengths arranged in-line. This design combines the benefits of the parallel and in-line arrangements and therefore allows for optimum torsion damping at each engine torque.

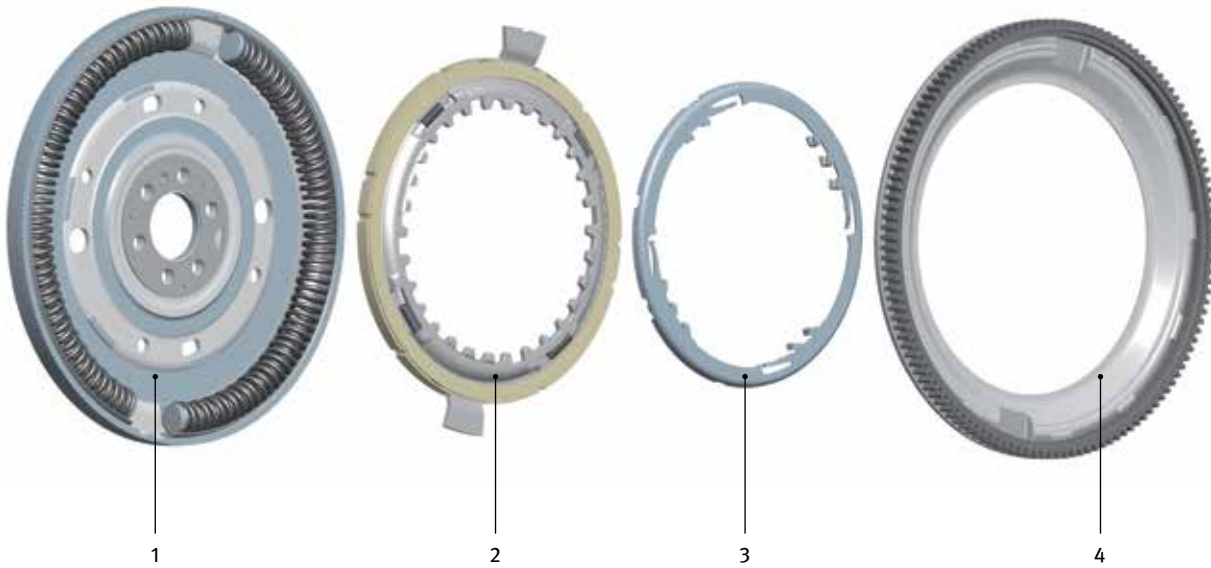


## 4 Special forms of the DMF

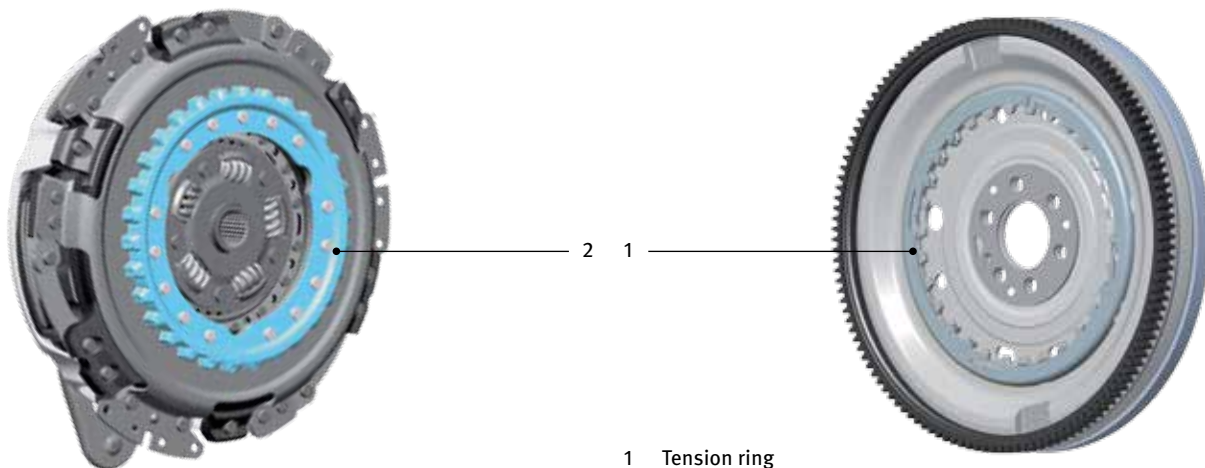
### Damper for the double clutch transmission (DCT)

The flywheel used in the DCT is a special form of the LuK DMF. As in the conventional DMF in manual gearboxes, there is a primary and a secondary side. However the secondary side, in contrast to the conventional DMF, is not a fixed part of the DMF, so it is not designed as a flywheel mass but in the form of a flange. It serves only as a connection between the primary mass and the double clutch.

The secondary mass is replaced in this case by the weight of the double clutch, which is fitted on an input shaft (hollow shaft) of the gearbox. There is also no need for the direct bearing connection of the opposed masses, which is realised in the form of ball or plain bearings in the conventional DMF.



- |   |  |
|---|--|
| <p>1 Primary mass with arc springs</p> <p>2 Flange with internal tooting to engage with the coupling wheel of the double clutch</p> | <p>3 Tension ring</p> <p>4 Cover for primary mass with starter ring gear</p> |
|---|--|



- |   |
|---|
| <p>1 Tension ring</p> <p>2 Coupling ring of the double clutch</p> |
|---|

Another difference from the conventional DMF is the lack of a friction surface on the secondary side. This too is located in the double clutch. There, the central plate bears the friction surfaces for both clutches. Instead of the friction surface on the DMF, an internally toothed flange is used. The coupling ring of the double clutch engages with this flange.

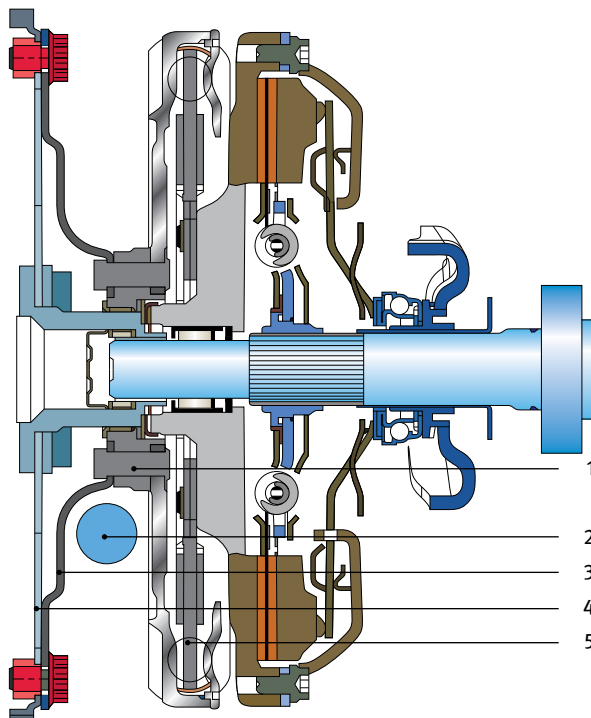
As the two engaging gearwheels would produce noise due to backlash, a tension ring is fitted as a countermeasure. This pre-tensions the two gearwheels so that there is no play between the tooth surfaces. In some models, the tension ring has to be compressed with a special tool before the gearbox is fitted.

## 4 Special forms of the DMF

### Driveplate DMF

Since 2008, a new gearbox generation has been fitted in some Audi models. These gearboxes can be recognised by the different arrangement of the differential. This is now in front of the clutch in the direction of travel. As a result, the power flow to the left drive shaft has to be transmitted straight through the bell housing by a flanged shaft. Because of this, use of a conventional DMF is no longer possible. In order to equip this drive concept with effective flywheel damping, the DMF with driveplate was developed.

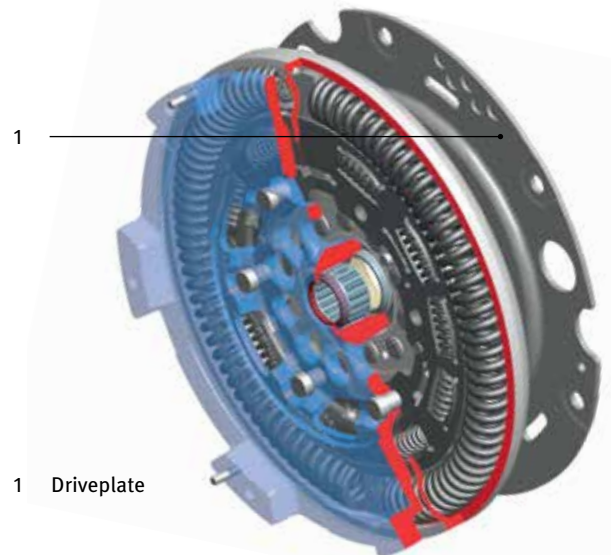
The driveplate is an adapter plate formed from sheet steel, which is riveted on to the DMF at the usual fixing points. The driveplate, like a torque converter in an automatic gearbox, is bolted to the outer radius of the coupling disc on the engine side.



- 1 Riveted joint
- 2 Flanged shaft of the gearbox
- 3 Driveplate
- 4 Engine coupling disc
- 5 DMF

**Note:**

More detailed information on the Audi clutch module is contained in a separate LuK brochure and video.

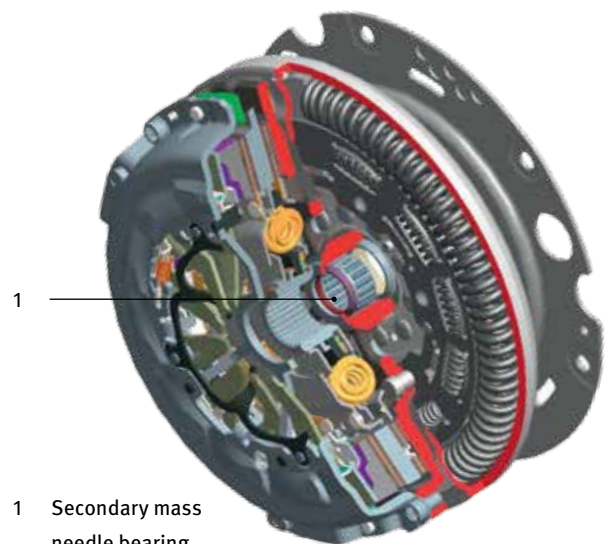


1 Driveplate

**Functions of the Driveplate:**

- It provides the space required for the penetration of the flanged shaft
- It transfers the engine torque via the bolted joint on the coupling disc to the riveted joint on the DMF

Unlike the conventional DMF, the secondary mass has a needle bearing on the gearbox input shaft. This results in a favourable weight distribution between the two flywheels. The internal construction of the DMF is practically identical to that of the other types described.



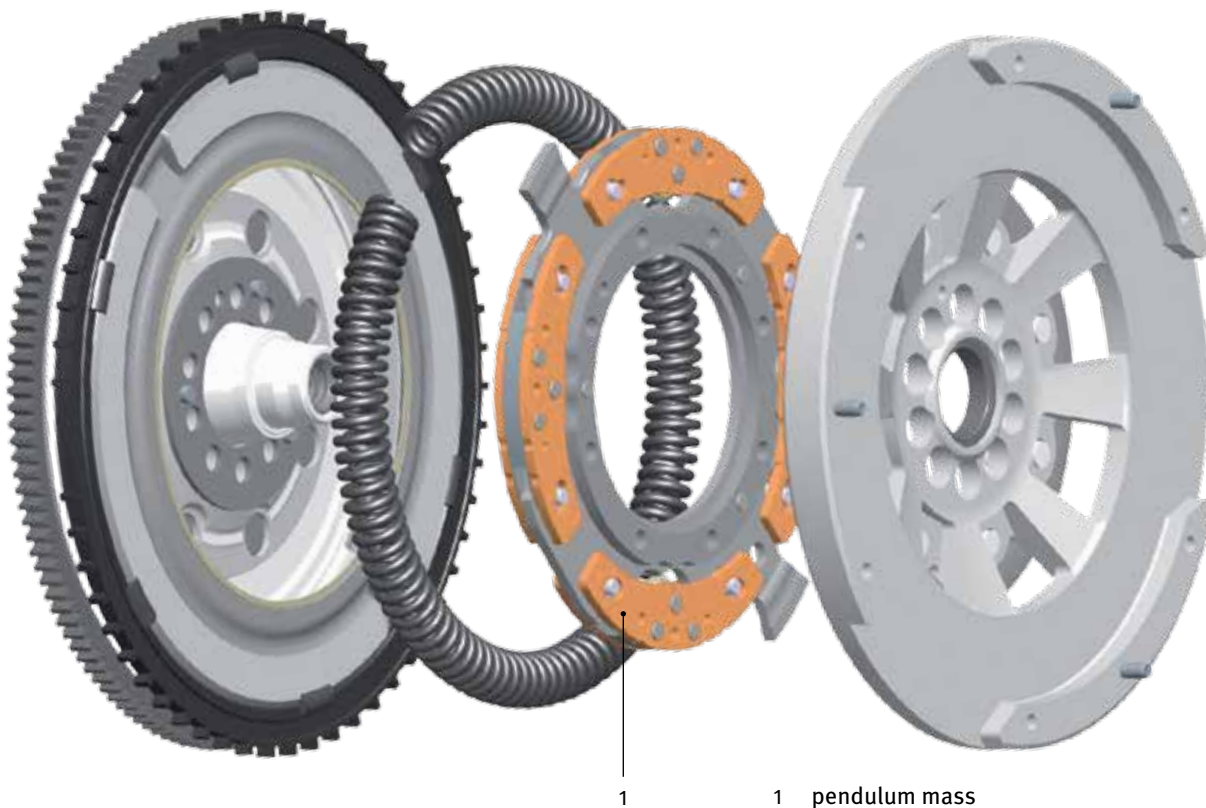
1 Secondary mass needle bearing



### Centrifugal pendulum-type absorber DMF

The DMF with centrifugal pendulum-type absorber has been developed to further increase damping capacity at low engine speeds. Using no additional installation space, a further additional mass (the centrifugal pendulum-type absorber) has been added to the two main masses in the DMF. It consists of three or four double pendulum masses which sit on the DMF flange. They are suspended on two studs which move in kidney-shaped paths in the pendulum masses and in the flange.

Oscillation of the pendulum masses is induced by the ignition frequency of the engine. The pendulum, however, is not directly in the power flow. As a result of inertial torque, the pendulum masses move in opposition to the initial oscillation and, in this way, act as oscillation dampers. The total weight of the pendulum mass is only one kilogram.



The result is optimum oscillation damping at high torques and low engine speeds. This makes a major contribution to reducing fuel consumption and CO<sup>2</sup> emissions.

#### Note:

During installation of the DMF, it is possible for the centrifugal pendulums to move inside. The noises caused by this movement are normal and merely indicate the correct function of the pendulum masses.

#### 4 Special forms of the DMF

##### Damped Flywheel Clutch (DFC)

When replacing the clutch and DMF, the DFC is a proven repair alternative. It consists of a pre-assembled, tuned assembly unit of DMF, clutch disc and clutch pressure plate.

The preassembly of the individual components in the factory saves considerable time in the workshop, as the DFC can be mounted directly on the engine. No clutch assembly work is necessary. Frequent causes of faults, such as incorrect assembly or the combination of components from different manufacturers, are avoided.



Clutch assembly comprising clutch pressure and driven plates



Secondary mass with flange



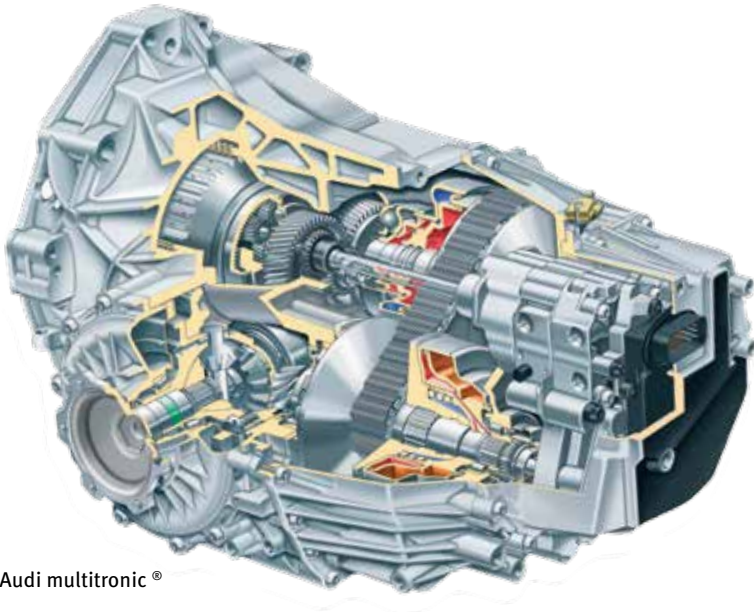
Primary mass



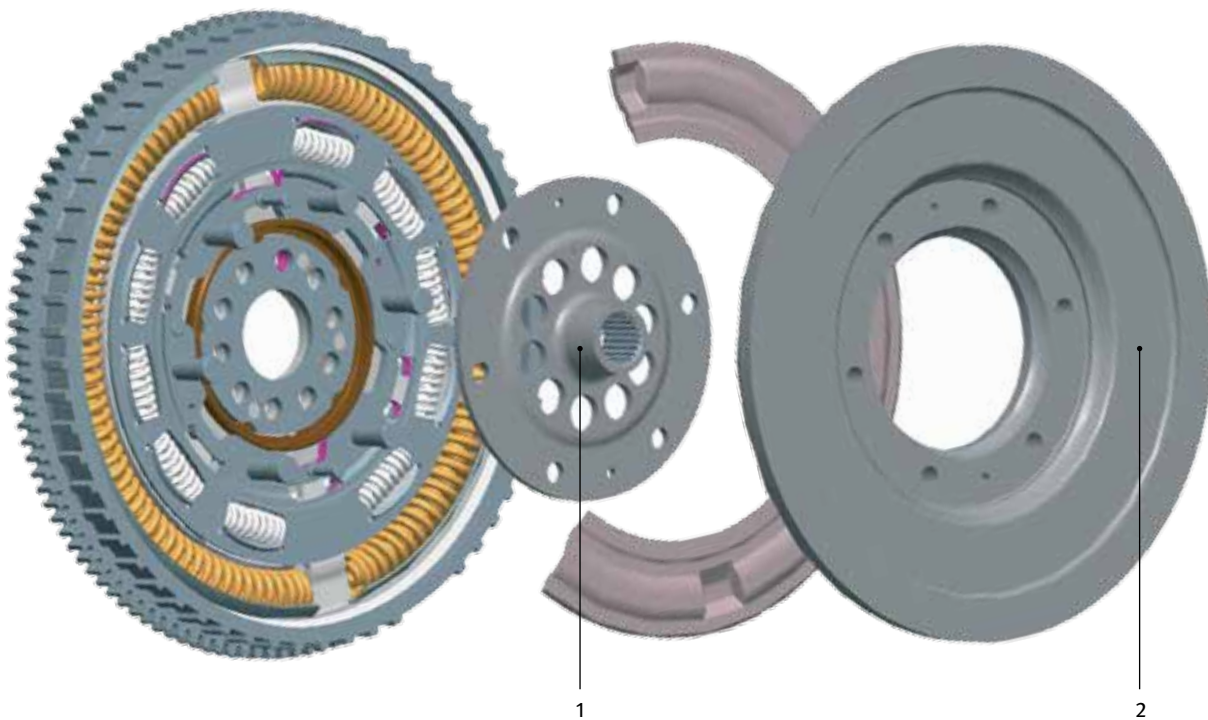
### DMF for Continuously Variable Transmission (CVT)

In a fully automatic gearbox, the torque converter acts, among other things, as a centrifugal oscillation damper in the drive train. CVT gearboxes, however, work without a torque converter. Therefore, the centrifugal damping is provided by a special form of the DMF.

The crucial difference from the DMF designs described above is in the design of the torque output. This does not take place via the friction surface of the secondary mass or via the flange tooting as in the double clutch damper. In the DMF for CVT gearboxes, the engine torque is directly transferred through a central hub, riveted to the flange and the secondary mass, to the form-fit gearbox input shaft.



Audi multitronic®



- 1 Hub
- 2 Additional mass on the secondary mass side

## 5 DMF failure diagnosis

### 5.1 General advice on inspecting the DMF

Always check the DMF when replacing the clutch. A worn and defective DMF can damage the newly installed clutch.

**In the event of a customer complaint, targeted questions help to identify the fault.**

- Which component is not working, what is the customer's complaint?
- When did this problem first occur?
- When does the problem manifest itself?  
From time to time, often, always?
- Under which operating conditions does the problem occur?  
E.g. while driving off, accelerating, shifting up/down, when the vehicle is cold or at operating temperatures?
- Is the engine difficult to start?
- What is the total and annual mileage of the car?
- Are there extraordinary load conditions under which the vehicle operates?  
E.g. towing a trailer, overloading, taxi, fleet vehicle, driving school, is it chip tuned?
- Driving habits?  
City traffic, short-/long-distance driving, motorway driving?
- Have the clutch and transmission required an earlier repair?  
If yes, at what mileage and for what reason?

#### General vehicle inspection

Check the following prior to proceeding with the repair:

- Control unit fault codes (engine, transmission)
- Battery power
- Condition and function of the starter motor
- Tuned engine (chip tuning)?

#### How to handle the DMF correctly

The following instructions provide important information on the correct handling of the DMF.

- A DMF that has been dropped must not be installed!  
Risk of damaged ball or plain bearing, distorted sensor ring, increased imbalance.
- Remachining of the friction surface is not permissible!  
Weakening of the friction surface will result in insufficient burst speed characteristics.
- In the DMF with plain bearings, the secondary mass must not be moved with excessive force (i.e. with a lever or screwdriver) in an axial direction!
- It is not permissible to clean the DMF in a parts washing machine, or to use high-pressure cleaners, steam cleaners, compressed air or any cleaning sprays.

#### Installation

What should be considered when installing a DMF?

- Observe the specifications of the vehicle manufacturer!
- Check the shaft oil seals (engine and transmission side) for oil leaks and replace, if necessary.
- Check starter ring gear for damage and tight fit.
- Always use new fixing bolts.
- Verify that the distance between the speed sensors and the DMF sensing pins/sensor ring is correct  
This varies depending on the vehicle make.
- Ensure the dowel pins are fitted correctly.  
Dowel pins must not be forced into or pushed out of the DMF.  
Dowel pins forced further into the DMF may score the primary mass (noise).
- Use a cloth dampened with solvent to clean the contact surface of the DMF.  
No solvent must penetrate the interior!
- Ensure you use clutch bolts of the required length.  
Bolts which are too long may scrape on the primary flywheel (noise) or block it completely. In addition, the ball bearing may be damaged and displaced from its seating.

## 5.2 Noise

### Special references

The following is permissible on some vehicle makes and models and has no effect on the operation of the clutch components:

- Small trails of grease on the DMF rear face (engine side) leading from the holes towards the flywheel edge.
- The secondary mass can be rotated by several centimetres against the primary mass and does not automatically return to its original position.

On a DMF with a friction control disc a hard knock can be felt and heard.

- Depending on the design, axial play between the primary and secondary masses can be up to 6 mm.
- Each DMF has a tilting clearance.

For ball bearings it can be up to 1.6 mm, and up to 2.9 mm for plain bearings.

Primary and secondary masses must never knock against each other!

### Multi-piece repair solutions

Many vehicle manufacturers choose to equip new models with a DMF – and the trend is growing. This is thanks to the technical benefits provided by the DMF as well as the need for increasing noise comfort while reducing emissions of state-of-the-art engines. The DMF characteristics are precisely attuned to each vehicle and its engine.

The market offers alternative, multi-piece repair solutions to substitute the DMF. These kits typically include:

- Conventional rigid flywheel,
- Clutch pressure plate,
- Clutch driven plate and
- Release bearing.

#### Caution:

**These multi-piece repair solutions do not comply with the vehicle manufacturer's specifications!**

The clutch driven plate used on these applications is not able to provide full damping of the torsional vibration generated by the engine due to its smaller torsional angle in comparison with a DMF. As a result, noise emissions and vibration-induced damage to the power train can occur.

When diagnosing a DMF while it is installed, it is always important to determine whether noise is emitted from adjacent components such as the exhaust system, heat shields, engine mountings, accessories etc.

Additionally, it is important to isolate any noise caused by front-end accessories such as belt tensioning units or A/C compressors. To determine the source of the noise a stethoscope can be used.

Ideally, compare the affected vehicle to a car with identical or similar equipment.

A clicking noise when engaging or shifting gears, and during load changes, can originate in the power train, caused by excessive gear clearance in the transmission, play in the propeller/drive shafts or in the differential. The DMF is not at fault.

When the gearbox is removed, the secondary mass can be rotated against the primary mass. Here, too, noise can be perceived, caused either by the flange hitting against the arc springs or the secondary mass knocking against the friction control disc. Here, too, the DMF is not defective.

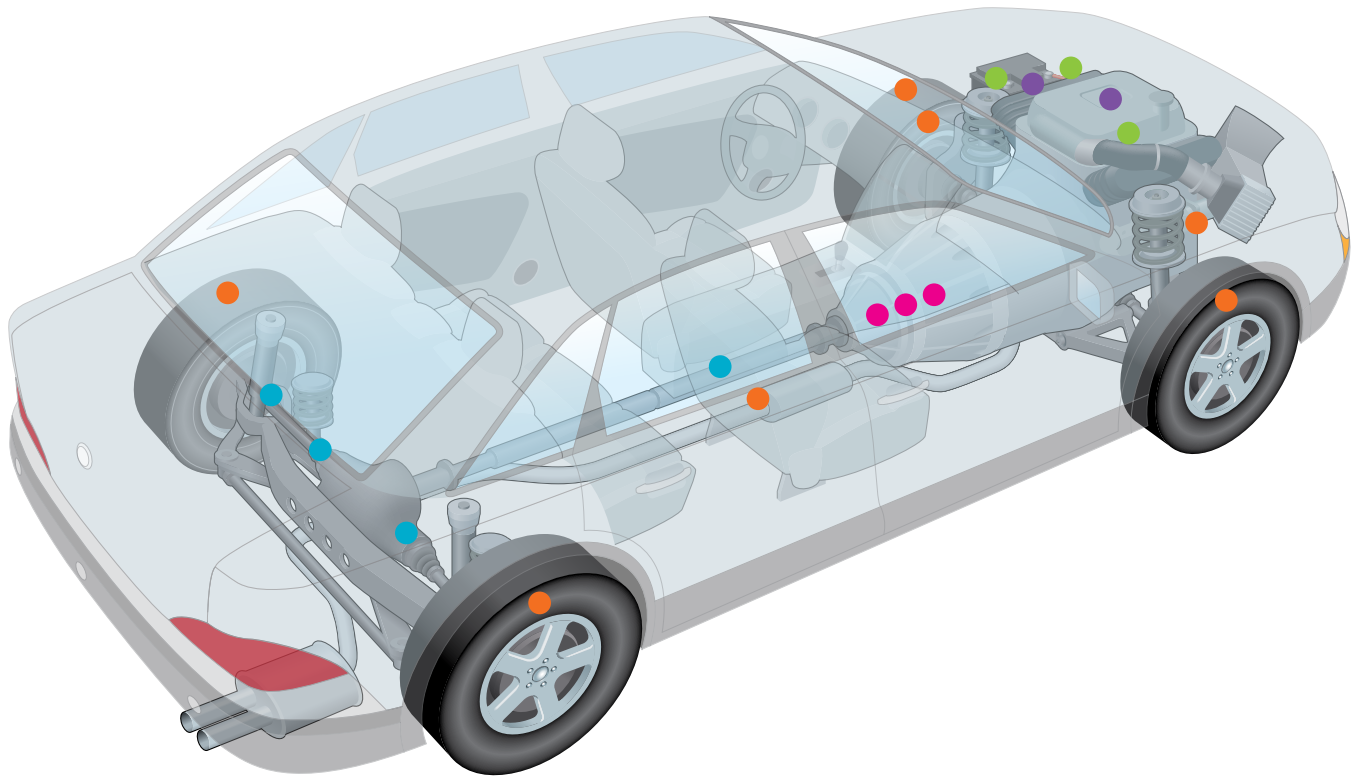
A humming noise can have various causes, for example resonance in the power train or imbalance of the DMF exceeding admissible limits. A DMF can be severely imbalanced if, e.g. the balance weights on the back are missing, or the plain bearing is defective. Whether imbalance is the root cause of a humming noise can be determined quite simply. While stationary, increase the speed of the engine. If vibration increases as engine speeds go up, the DMF is defective. Here, too, it is helpful to compare the vehicle to another car with an identical or similar engine version.

## 5.2 Noise

### Summary of general inspections in the case of noise

The following summary points out possible fault sources which may be erroneously attributed to a defective DMF. Only after an exhaustive inspection should a decision be made to replace the DMF.

LuK Service Info provides additional information for a reliable diagnosis.



● **Rattle when starting/stopping, idling, accelerating and/or in overrun:**

- No gearbox oil, too little or incorrect gearbox oil
- Defective pilot bearing (angular/parallel misalignment between engine and gearbox)
- Gearbox input shaft bearing worn/defective

● **Noise when starting/stopping, idling:**

- Worn/defective engine bearings
- Accessory drive (decoupled belt pulley)
- Engine management (throttle flap)

● **Noise when starting:**

- Battery voltage too low
- Dirty/worn starter
- Worn/defective engine bearings

● **Hum:**

- Worn/defective tyres, suspension, exhaust unit, engine and/or gearbox bearings

● **Noise when changing gear or varying load, engagement click:**

- Drive train (gearwheel backlash, play on articulated drive shaft and universal joint shaft, differential and compensating gears)

## 5.3 Chip tuning

Chip tuning is a quick, easy and fairly inexpensive way of increasing engine power output. For a relatively small amount of money you can easily increase the power of an engine by up to 30%. Facts not normally considered are whether the engine is durable enough to withstand the higher outputs, e.g. thermal overloading, and also if the rest of the drive train can withstand the increase in torque/performance.

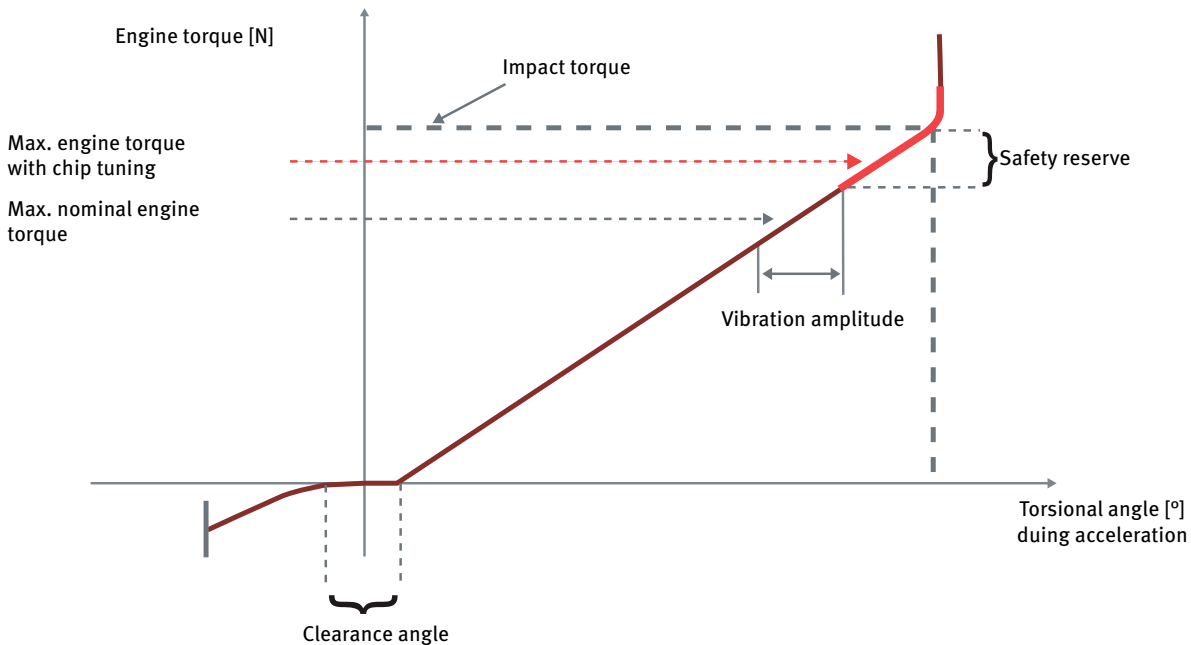
Usually the torsion damper system of a dual mass flywheel, just like the remaining parts of the drive train, is designed for the engine for which it is intended. In many cases the safety reserve of the DMF is used up or exceeded by a torque increase, sometimes by more than 30%. As a consequence, the arc springs can already be completely compressed during normal driving, which deteriorates noise insulation and can cause the vehicle to jolt.

As this is the case at half of the firing frequency, very high loads are quickly produced and transferred not only

to the DMF, but also to the transmission, which could result in damage to drive shafts and the differential. Damage can range from increased wear to a catastrophic failure resulting in a huge repair bill. The operating point of the DMF is shifted towards its security reserve by the increase in the power of the engine. During driving, the DMF is permanently overloaded by the higher engine torques. This causes the damper springs in the DMF to operate “fully loaded” more often than they are designed to and can destroy the DMF!

It is true that many tuners give a warranty on the vehicle when increasing power output. But what about when the warranty period is over? The increase in output can damage other components in the drive train slowly but continuously. Sometimes these components will fail at a later date (after expiration of any warranty given!), which means the repair costs have to be paid by the customer.

### Arc spring curve – during acceleration (example)



#### Important!

Chip tuning and the resulting performance enhancement lead to an invalidation of both the vehicle warranty and insurance.

## 5.4 Visual inspection/damage patterns

### 1. Clutch driven plate

#### Description

- Clutch disc burnt

#### Cause

- Thermal overload of the clutch driven plate occurring, e.g. when the wear limits were exceeded

#### Effect

- Thermal load applied on the DMF

#### Remedy

- Perform a visual inspection for signs of thermal discolouration on the DMF

#### For damage assessment refer to:

- Low/mean/high thermal load (page 24)
- Very high thermal load (page 25)



### 2. Between primary and secondary mass

#### Description

- Burnt residues of abraded clutch facing at the DMF's outer edge or in the ventilation holes

#### Cause

- Thermal overload of the clutch driven plate

#### Effect

- Residues of the abraded friction material can penetrate into the arc spring channel and cause malfunction

#### Remedy

- Replace DMF



### 3. Alignment of primary and secondary mass

#### Description

- Bolts concealed by secondary mass
- DMF blocked

#### Cause

- Friction coupling in flange defective
- Arc springs or flange defective

#### Effect

- No power transmission
- Noises
- No damping

#### Remedy

- Replace DMF





#### 4. Friction surface

##### Description

- Scoring

##### Cause

- Worn-out clutch

→ Clutch lining rivets score on friction surface

##### Effect

- Limited power transmission capability
- The clutch is unable to generate the required torque
- Damage to the DMF friction surface

##### Remedy

- Replace DMF



#### 5. Friction surface

##### Description

- Localised, dark hot spots

→ Sometimes many spots

##### Effect

- DMF subjected to high thermal load

##### Remedy

- No remedial measures required



#### 6. Friction surface

##### Description

- Cracks

##### Cause

- Thermal overload

##### Effect

- Loss of the DMF's operational reliability

##### Remedy

- Replace DMF



## 5.4 Visual inspection/damage patterns

### 7. Ball bearing

#### Description

- Grease leakage
- Bearing seized
- Sealing cap missing or discoloured (brown) due to overload

#### Cause

- Thermal overload or mechanical damage/overload

#### Effect

- Degradation of bearing lubrication  
→ DMF fails

#### Remedy

- Replace DMF



### 8. Plain bearing

#### Description

- Damaged or destroyed

#### Cause

- Wear and/or mechanical impact

#### Effect

- DMF is defective

#### Remedy

- Replace DMF



### 9. Plain bearing

#### Description

- Worn out

→ In relation to the diameter, the maximum radial bearing clearance for a new part is 0.04 mm, with an admissible increase throughout its service life of up to 0.17 mm

#### Cause

- Wear and tear

#### Effect

- Less than 0.17 mm: none
- Greater than 0.17 mm: increased tilting of the secondary flywheel

#### Remedy

- Replace DMF if bearing clearance is greater than 0.17 mm



### 10. Low thermal load

#### Description

- Friction surface slightly discoloured (gold/yellow)
- No tarnish at the outer edges of the DMF or in the rivet area

#### Cause

- Thermal load

#### Effect

- None

#### Remedy

- No remedial measures required



### 11. Moderate thermal load

#### Description

- Friction surface discoloured blue due to temporary thermal load (220 °C)
- No discolouration in the rivet area

#### Cause

- Discolouration of the friction surface is a normal occurrence during operation

#### Effect

- None

#### Remedy

- No remedial measures required



### 12. High thermal load

#### Description

- Tarnish in rivet area and/or at the outer diameter; no tarnish on the friction surface
- The DMF was in continued operation after high thermal load had occurred

#### Cause

- High thermal load (280 °C)

#### Effect

- Depending on the duration of the thermal load applied, the DMF may become defective

#### Remedy

- Replace DMF



## 5.4 Visual inspection/damage patterns

### 13. Very high thermal load

#### Description

- DMF discoloured blue/purple at the side or on the back and/or is visibly damaged, e.g. cracks

#### Cause

- Very high thermal load

#### Effect

- DMF is defective

#### Remedy

- Replace DMF



### 14. Friction control disc

#### Description

- Friction control disc melted

#### Cause

- High thermal load inside the DMF

#### Effect

- Limited operational reliability of the DMF

#### Remedy

- Replace DMF



### 15. Primary mass

#### Description

- Secondary mass scores the primary mass

#### Cause

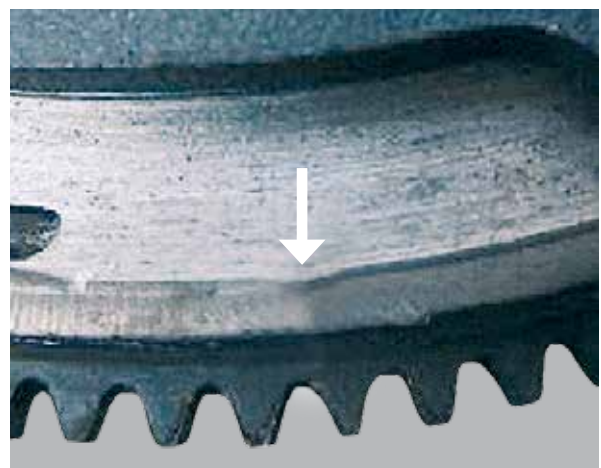
- Friction ring of the plain bearing worn out

#### Effect

- Noise emission or starter motor operation impaired

#### Remedy

- Replace DMF



## 16. Starter ring gear

### Description

- Starter ring gear heavily worn

### Cause

- Defective starter

### Effect

- Noise occurring during engine start

### Remedy

- Replace DMF
- Perform starter function test



## 17. Sensor ring

### Description

- Sensor ring teeth distorted

### Cause

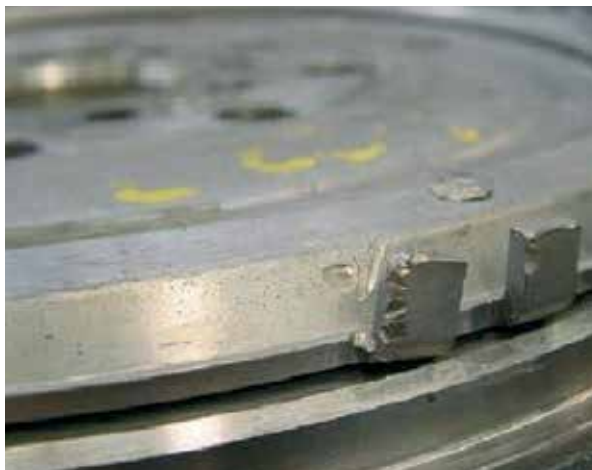
- Mechanical damage

### Effect

- Engine runs unevenly

### Remedy

- Replace DMF



## 5.4 Visual inspection/damage patterns

### 18. Minor grease egress

#### Description

→ Slight trails of grease leaking from the openings or seal caps

#### Cause

- Because of the design, small amounts of grease seepage is permissible

#### Effect

- None

#### Remedy

- No remedial measures required



### 19. Heavy grease leakage

#### Description

- Grease egress greater than 20 g

→ Housing covered with grease

#### Effect

- Lack of lubrication of the arc springs

#### Remedy

- Replace DMF



### 20. Balance weights

#### Description

- Loose or missing

→ Indicated by clearly visible welding spots

#### Cause

- Incorrect handling

#### Effect

- DMF out of balance

→ Loud humming

#### Remedy

- Replace DMF



## 6 Description and shipment of the DMF special tool

A 100% functional test includes, among other things, testing the characteristics of the arc springs in the DMF during compression. The testing must be performed at a special test facility as it cannot be carried out with standard workshop equipment. However, the LuK DMF Special Tool 400 0080 10 allows you to perform the most important measurements – freeplay angle and rock – in

a workshop environment. The freeplay angle is the angle at which the DMF's primary and secondary masses can be rotated against each other until load is exerted on the arc springs. Tilting clearance occurs when the rotating masses of the DMF are tilted towards or away from one another.



Item no. 400 0080 10

In addition, your assessment of the DMF's operational reliability should be based on the following criteria:

- Grease leakage
- Condition of the friction surface (e.g. signs of thermal load/thermal cracks)
- Noise behaviour
- Condition of the clutch
- Loading condition of the vehicle (towing a trailer, driving school, Taxi, etc.)

If in doubt, always replace the DMF along with the clutch. Further information on the design, function and failure diagnosis methods of a DMF can be found in the LuK technical brochure and on the DVD "Dual Mass Flywheel – Technology & Failure Diagnosis".



- |   |                               |   |                        |
|---|-------------------------------|---|------------------------|
| 1 | DTI stand                     | 6 | DTI gauge              |
| 2 | Slotted bar                   | 7 | Degree gauge           |
| 3 | Ring gear locking dog spacers | 8 | Ring gear locking dogs |
| 4 | Adapters                      | 9 | Instruction CD         |
| 5 | Degree gauge locking bar      |   |                        |



## 7 DMF function tests

The LuK special tool allows you to perform the following tests on the DMF:

- Measuring the freeplay angle
- Measuring the rock

These tests, in combination with a visual inspection to check grease egress, thermal load, clutch condition, etc., allow for a reliable assessment of the DMF's operational condition.

The freeplay angle is the angle at which primary and secondary mass can be rotated against each other until load is exerted on the arc springs. The measuring points are both end stops in the left-hand and right-hand direction of rotation. The measured freeplay serves as a wear indicator.

**Caution:**

Some DMFs have a friction control disc that can be felt as a hard stop in one direction. In this case apply greater force to rotate the secondary mass a few more millimetres until spring resistance can be felt, and then allow it to return. This also rotates the friction control disc in the DMF.

The term “rock” describes the clearance between the two DMF masses which allows them to be tilted towards and away from each other.

**Caution:**

Please note especially Chapter 5.1 “General advice”.

## 7.1 Which test suits which DMF?

On DMFs with an even number of threaded holes to secure the clutch pressure plate, the slotted bar can be mounted centrally, making it possible to determine the freeplay angle using a degree gauge. As this measuring method can be used on almost all DMF types, it should be the preferred method – see Chapter 7.2.



There are a few DMF types with an odd number of threaded holes for the clutch pressure plate, making it impossible to mount the slotted bar centrally. In this case, the freeplay angle must be measured by counting the teeth of the starter ring gear – see Chapter 7.3.



The above distinction makes no difference when measuring rock – see Chapter 7.4.

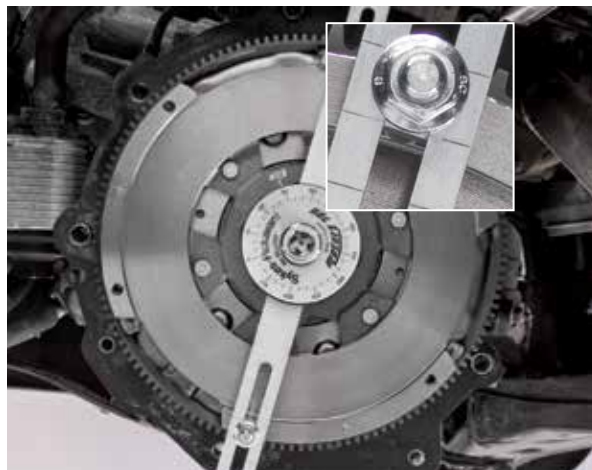
## 7.2 Freeplay measurement with degree gauge

1. Remove the gearbox and clutch according to the manufacturer's instructions.
2. Screw the appropriate adapters (M6, M7 or M8) into two vertically opposing clutch bolt holes on the DMF and torque down.



3. Centralise the slotted bar on the adapters by using the graduations and tighten the nuts.

The degree gauge must be positioned centrally on the DMF.



4. Lock the DMF using the locking dogs and, if necessary, appropriate spacers to align the locking tool flush with the starter ring gear.

If the distance exceeds the size of the provided spacers, use additional washers.



## 7.2 Freeplay measurement with degree gauge

If the locking tool can only be mounted to a hole with a dowel fitted, use the adaptor sleeve provided over the dowel.



5. Bolt the dial gauge stand to the engine block using a suitable bolt, i.e. a gearbox bolt and, if required, the adaptor sleeve can be used in a similar way to the locking tool.



The same bolt can be used to fasten the locking dogs and the dial gauge stand if required.



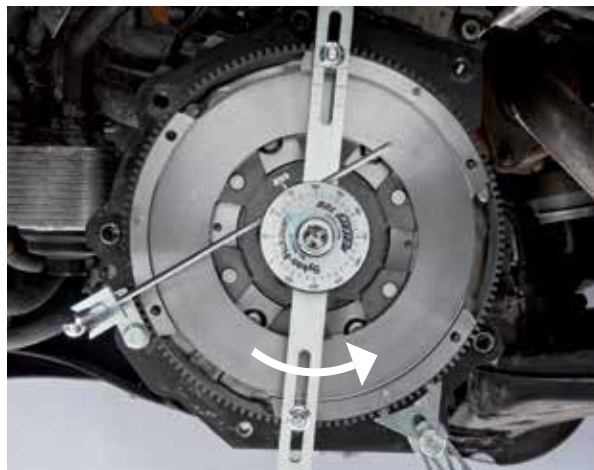
- Fit the degree gauge locking bar to the degree gauge and the dial gauge stand and tighten the knurled screw.



- Use the slotted arm to rotate the secondary mass anticlockwise until the arc spring force can be felt.

**Caution:**

Some DMFs have a friction control disc that can be felt as a hard stop in one direction. In this case apply greater force to rotate the secondary mass a few more millimetres until spring resistance can be felt, and then allow it to return. This also rotates the friction control disc in the DMF.



- Slowly release the slotted arm, allowing the arc springs to relax. Set the degree gauge pointer to "0".



## 7.2 Freeplay measurement with degree gauge

9. Use the slotted arm to rotate the secondary mass clockwise until the arc spring force can be felt.



10. Slowly release the slotted arm, allowing the arc springs to relax. Read off the degree gauge and compare the measurement against the rated value – see rated value table in Chapter 8.



### 7.3 Freeplay measurement by counting starter ring gear teeth

1. Remove the gearbox and clutch according to the manufacturer's instructions.
2. Screw the appropriate adapters (M6, M7 or M8) into two approximately vertically opposing clutch bolt holes on the DMF and torque down.



3. Centralise the slotted bar on the adapters by using the graduations and tighten the nuts.

As there is an odd number of clutch bolt holes, the slotted arm cannot be fixed centrally on the DMF.



4. Lock the DMF using the locking dogs and, if necessary, appropriate spacers to align the locking tool flush with the starter ring gear.

If the distance exceeds the size of the provided spacers, use additional washers.



### 7.3 Freeplay measurement by counting starter ring gear teeth

If the locking tool can only be mounted to a hole with a dowel fitted, use the adapter sleeve provided over the dowel.



5. Use the slotted arm to rotate the secondary mass anticlockwise until the arc spring force can be felt.

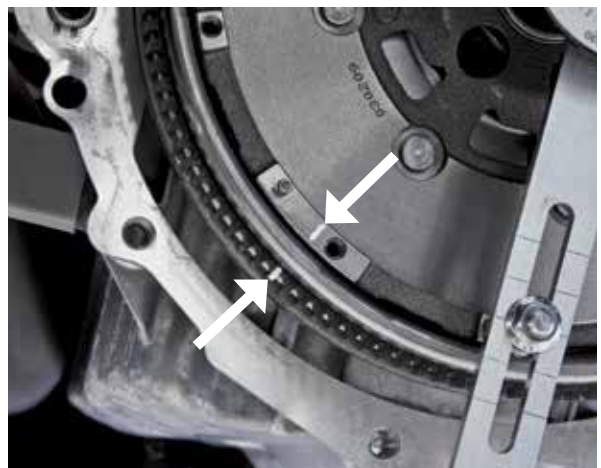
**Caution:**

Some DMFs have a friction control disc that can be felt as a hard stop in one direction. In this case apply greater force to rotate the secondary mass a few more millimetres until spring resistance can be felt, and then allow it to return. This also rotates the friction control disc in the DMF.



6. Slowly release the slotted arm, allowing the springs to relax.

Mark the secondary mass and primary mass/starting ring gear with a line.

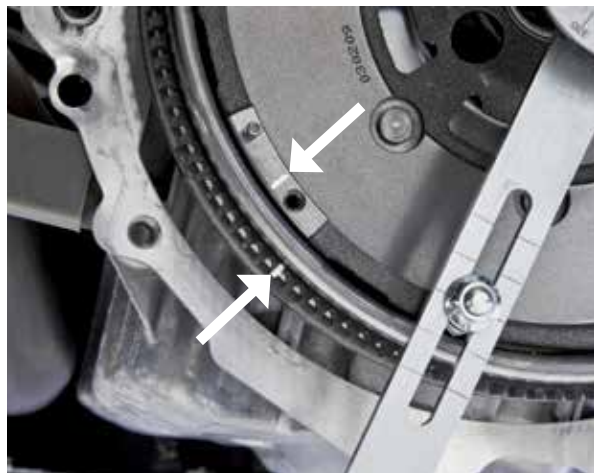




7. Rotate the secondary mass clockwise until the arc spring force can be felt. Slowly release the slotted arm, allowing the arc springs to relax.



8. Count the number of teeth of the starter ring gear between the original mark and its current position and compare against the rated value – see rated value table in Chapter 8.



## 7.4 Rock measurement

1. Fit the dial gauge and arm to the dial gauge stand.



2. Centralise the dial gauge on the adapter and set to the required preload.

**Caution:**

The measurement should be done gently. Applying too much force will result in inaccurate measurements and could damage the DMF.



3. Gently push the slotted arm towards the engine (using your thumb, for example) until resistance can be felt.

Keep the slotted arm in this position while setting the dial gauge to "0".



4. Pull the lever gently in the opposite direction (using your finger, for example) until resistance can be felt. Read off the dial gauge and compare the measurement against the relevant rated value – see rated value table in Chapter 8.



## 8 Bolts for DMFs and DFCs



Professional replacement of DMFs or compact DMFs (DFC) should also include the use of new bolts.

### Why do the DMF/DFC bolts need to be replaced?

Due to continuous, strong, alternating loads, specially designed bolts are used to secure flywheels. These are usually stretch bolts or bolts with micro-encapsulation. Stretch bolts have an anti-fatigue shaft that only covers around 90% of the thread core diameter.

When tightened to the torque specified by the vehicle manufacturer (in some cases plus a fixed angular value) the stretch bolt becomes an elastic bolt. The resulting torque is greater than the external force acting on the flywheel during operation. The elasticity of the stretch bolt means it can be stretched right up to the elastic limit.

As they do not possess these properties, normal set screws would break after a certain amount of time due to material fatigue, even if they were of a strong design.

Bolts with micro-encapsulation (these can also be stretch bolts) seal off the clutch chamber from the crankshaft chamber filled with engine oil. This is necessary because the threaded holes in the crankshaft flange are open to the crankcase.

These coatings also have adhesive and gripping properties, eliminating the need for any further bolt retaining devices.

Bolts that have already been used must not be used again. Experience has shown that these snap when they are tightened. In addition, their sealing and gripping properties are no longer effective.

Due to the aforementioned reasons, Schaeffler Automotive Aftermarket GmbH & Co. KG supplies DMFs/DMCs complete with the necessary bolts and also offers sets of bolts that can be ordered separately.

### Why are not all DMFs supplied with the necessary bolts?

The required bolts are already supplied with some of the approx. 350 different articles that make up the delivery range. However, for many DMFs, different bolts are required depending on the vehicle model.

For this reason, all DMFs have their own reference/order code, which indicates whether or not the bolts are included in the delivery.

In cases where the bolts are not included in the delivery of a DMF, Schaeffler Automotive Aftermarket GmbH & Co. KG offers sets of bolts appropriate for the vehicle on which the DMF will be used.