

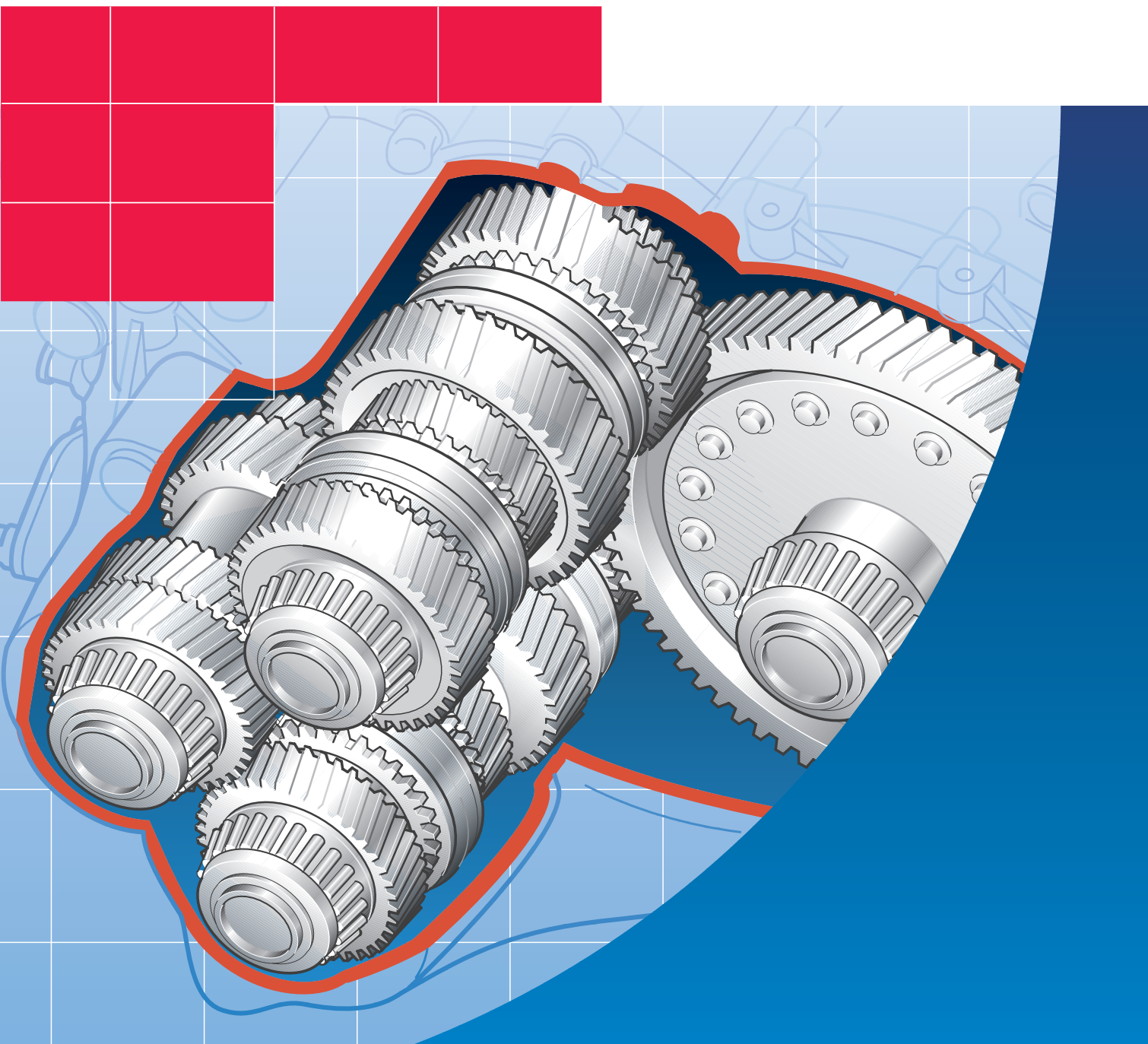
Service.



## Self-Study Programme 205

# 6-speed manual gearbox 02M

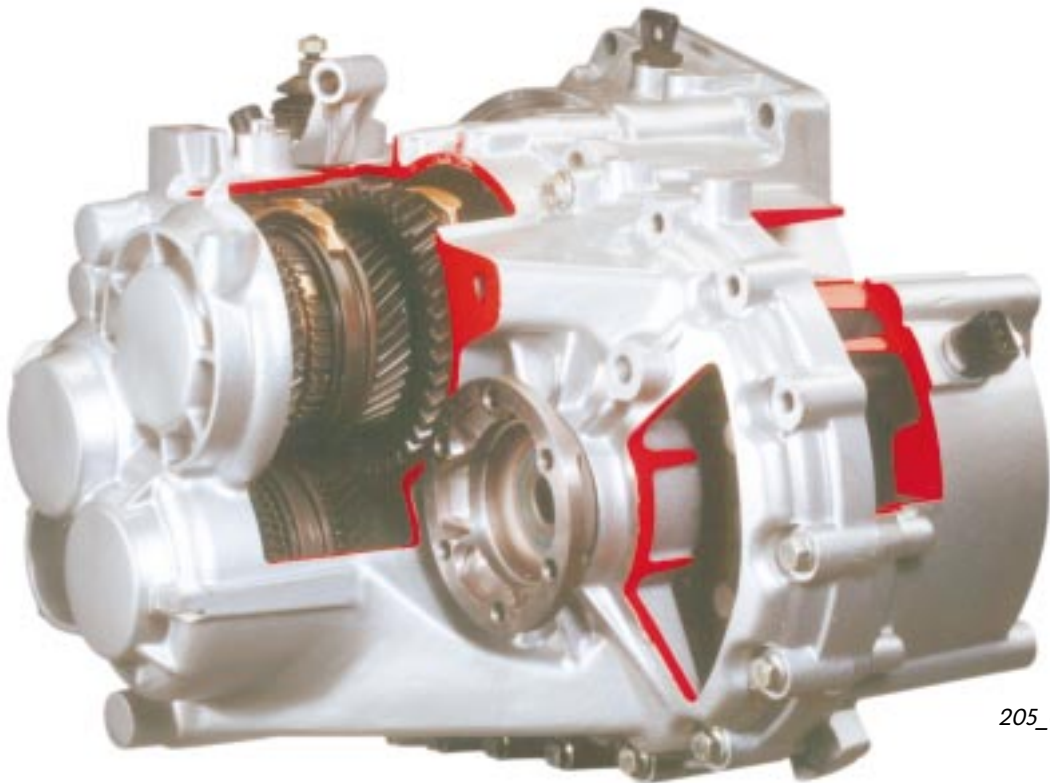
Design and Function



Adapting modern automobiles to meet the rapidly growing demands on driving comfort, environmental compatibility and driving performance calls for advanced improvements in gearbox technology. Adding more gears means smoother running and enables the gearbox to be adapted better to the characteristics of the various engines; it also contributes indirectly to reducing exhaust emissions by enabling torque to be utilised more effectively.

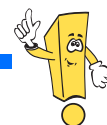
6-speed manual gearbox 02 M is a new development. It is a compact gearbox with six forward gears for A-platform vehicles with transversely mounted engine.

A compact 6-speed gearbox was realised by using two output shafts and one input shaft. In this booklet, we will explain to you the new gearbox and the technology used.



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**NEW**



**Important Note**



**The Self-Study Programme is not a Workshop Manual.**

Please always refer to the relevant Service Literature for all inspection, adjustment and repair instructions. Service Literature.

# Contents



**Introduction** ..... 4



**Gearbox mechanism**..... 7



Installation angle..... 7

Design..... 8

Power transfer ..... 12

**Cable-operated gearshift mechanism**..... 14

**Service** ..... 20



**Sensors** ..... 22



**Test your knowledge**..... 24



# Introduction

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## How many gears does a car need?

There are many reasons for introducing gearboxes with more than five forward gears. Most importantly, it is a way to match the gearbox and the engine even better than before. A second major reason is that the gearbox can help make modern vehicles more environmentally friendly.

### Why a 6-speed gearbox?

6-speed gearboxes have the following advantages over 5-speed gearboxes:

- More driving comfort (e.g. through smoother running),
- Better environmental compatibility (low fuel consumption = lower exhaust emissions),
- Better torque utilisation (the engine runs more in the “efficient torque” band),
- 6-speed gearboxes allow engines with a high power output to be driven sportily.

Depending on the engine type used, a distinction is drawn between two modes:

- A sporty mode for engines with high power output to quickly transfer high input torque,
- A comfortable mode for exceptionally smooth running, which is achieved thanks to more balanced and even transfer of input torque.

### What engines will be equipped with this gearbox in model year 1999?

- 1.9-ltr. 66kW TDI engine
- 1.9-ltr. 85kW TDI engine
- 1.9-ltr. 110kW TDI engine
  
- 1.8-ltr. 132kW 5V turbocharged engine
- 1.8-ltr. 165kW 5V turbocharged engine
- 2.3-ltr. 125kW V5/4V engine
- 2.8-ltr. 150kW VR6/4V engine



## Specifications

- Gearbox designation: 02 M
- Forward gears: 6
- Reverse gears: 1
- Maximum input torque: 350 Nm
- Method of installation: Transverse mounting
- Gear oil: DEA DES-5080
- Weight: 48.5 kg (front-wheel drive)  
68 kg with angle drive (four-wheel drive)

## Ratios and layouts

We do not intend to present all the possible variants here, as this would be beyond the scope of this booklet. Instead, we will explain the principle by which the gearbox ratio is calculated using two examples:

	Engine			
	2.8-ltr. 150kW VR6 / 4V		1.9-ltr. 85kW TD	
	Ratio	Overall ratio	Ratio	Overall ratio
1st gear/drive pinion set I	41 : 12 = 3.417	14.351	41 : 11 = 1 : 3.818	12.363
2nd gear/drive pinion set I	40 : 19 = 2.105	8.841	40 : 19 = 1 : 2.105	6.816
3rd gear/drive pinion set I	40 : 28 = 1.429	6.002	39 : 29 = 1 : 1.345	4.360
4th gear/drive pinion set I	37 : 34 = 1.088	4.470	35 : 36 = 1 : 0.972	3.147
5th gear/drive pinion set II	34 : 31 = 1.097	3.640	32 : 33 = 1 : 0.970	2.537
6th gear/drive pinion set II	31 : 34 = 0.912	3.024	29 : 36 = 1 : 0.806	2.108
Reverse gear/drive pinion set II	<b>(30 : 12) * (23 : 14) = 4.107</b>	<b>13.620</b>	<b>(31 : 11) * (23 : 14) = 4.630</b>	<b>12.108</b>
Ratio, drive pinion set I	63 : 15 = 4.200		68 : 21 = 3.238	
Ratio, drive pinion set II	63 : 19 = 3.316		68 : 26 = 2.615	
Mode	sport		comfort	

For a gearbox with two output shafts, the overall ratio comprises two factors: firstly, the ratio of the input shaft to the output shaft (you will find this value in the table under Ratio). Secondly, the ratio between the output shaft and the differential.

For reverse gear, the ratio of the reverse shaft must still be taken into consideration, so the ratio comprises two values.

The ratio for a particular gear multiplied by the ratio for a particular drive pinion set gives the overall ratio for the gear. This value is printed in bold in the table.

# Introduction

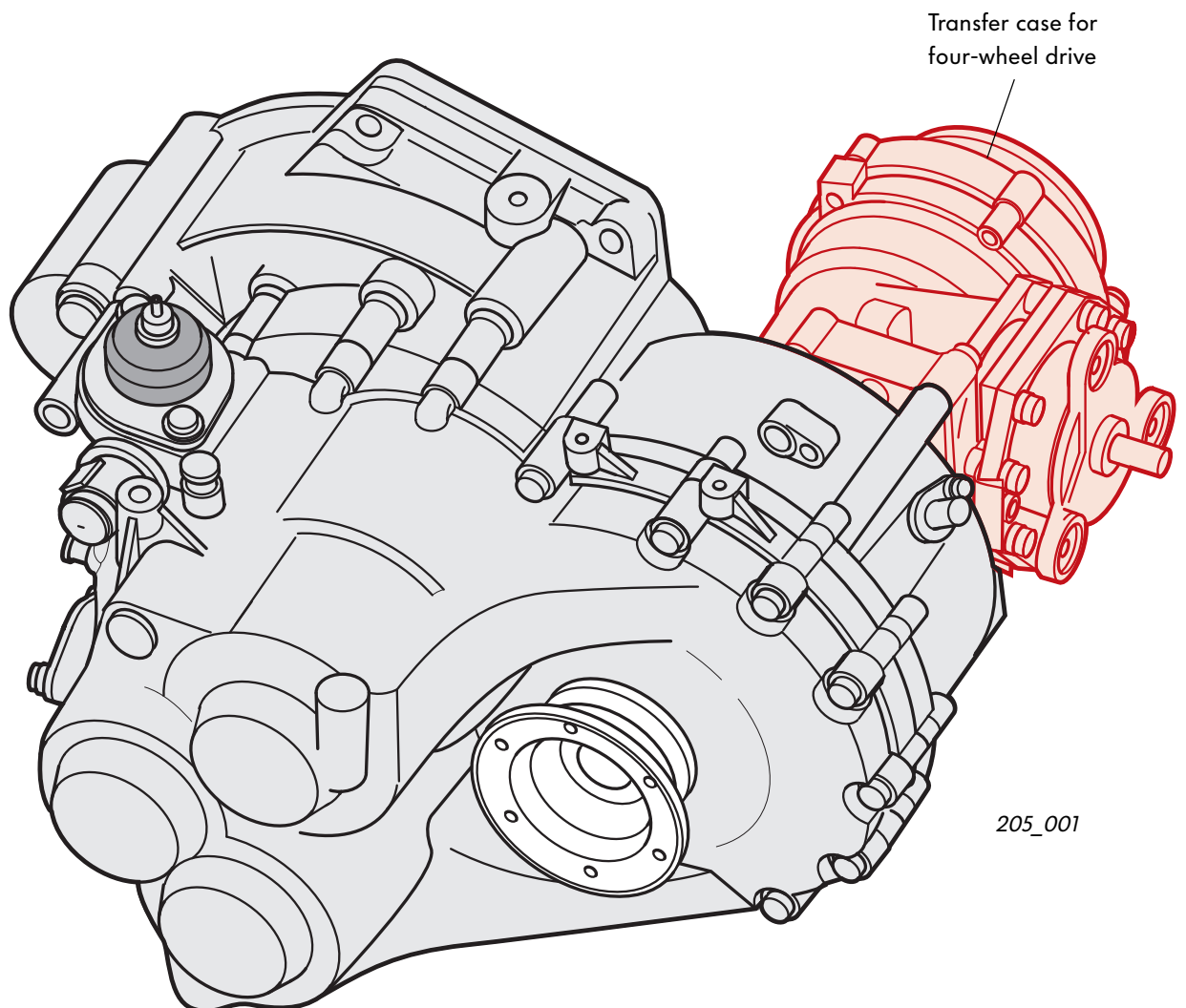


## Gearbox versions

There are two different gearbox versions:

- The version for vehicles with front wheel drive and
- the version for vehicles with four-wheel drive.

The 4-wheel-drive version of the gearbox has an additional transfer case for driving both the front and rear axles.



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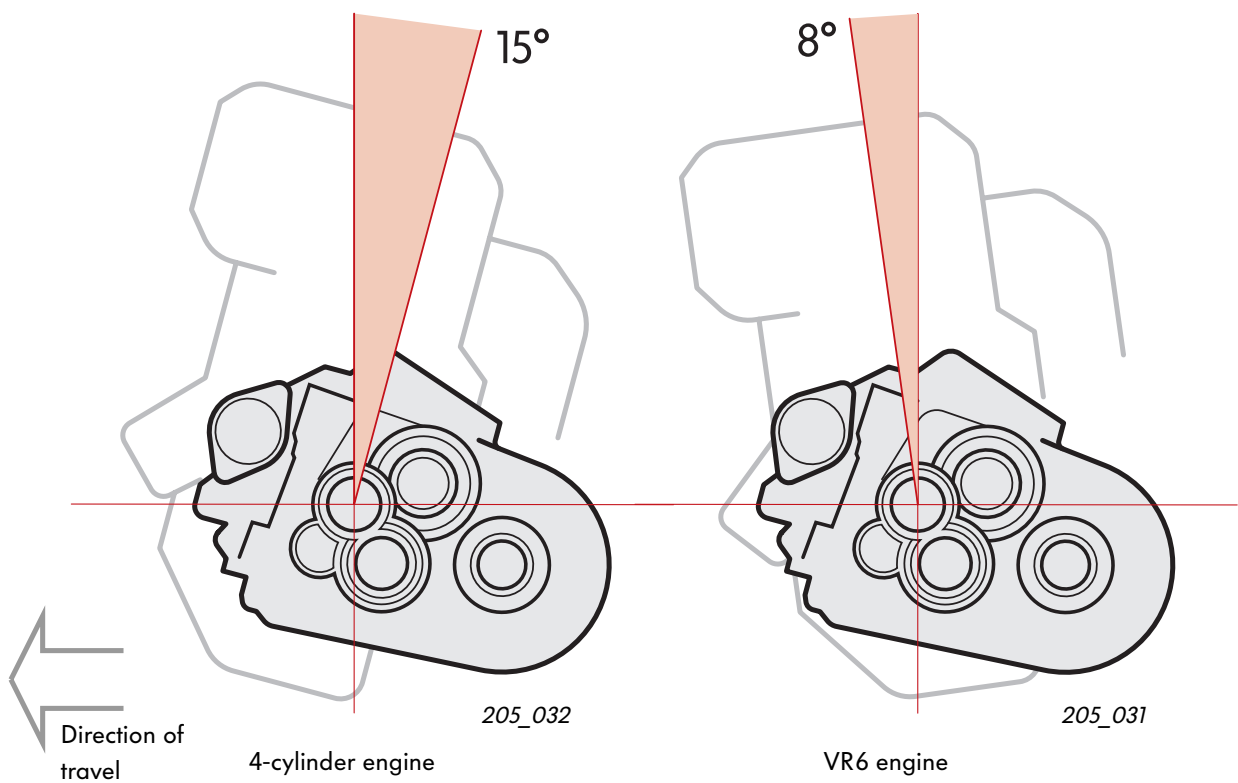
## The installation angle

of the gearbox is dependent on the engine type being used.

Two different installation positions are possible:

- tilted back by  $15^\circ$  for 4-cylinder engines and
- tilted forward by  $8^\circ$  for VR6 engines.

The term "installation angle" describes the angle at which the bolt holes on the engine flange are offset to match the engine's angle of tilt. The gearbox itself is not tilted.





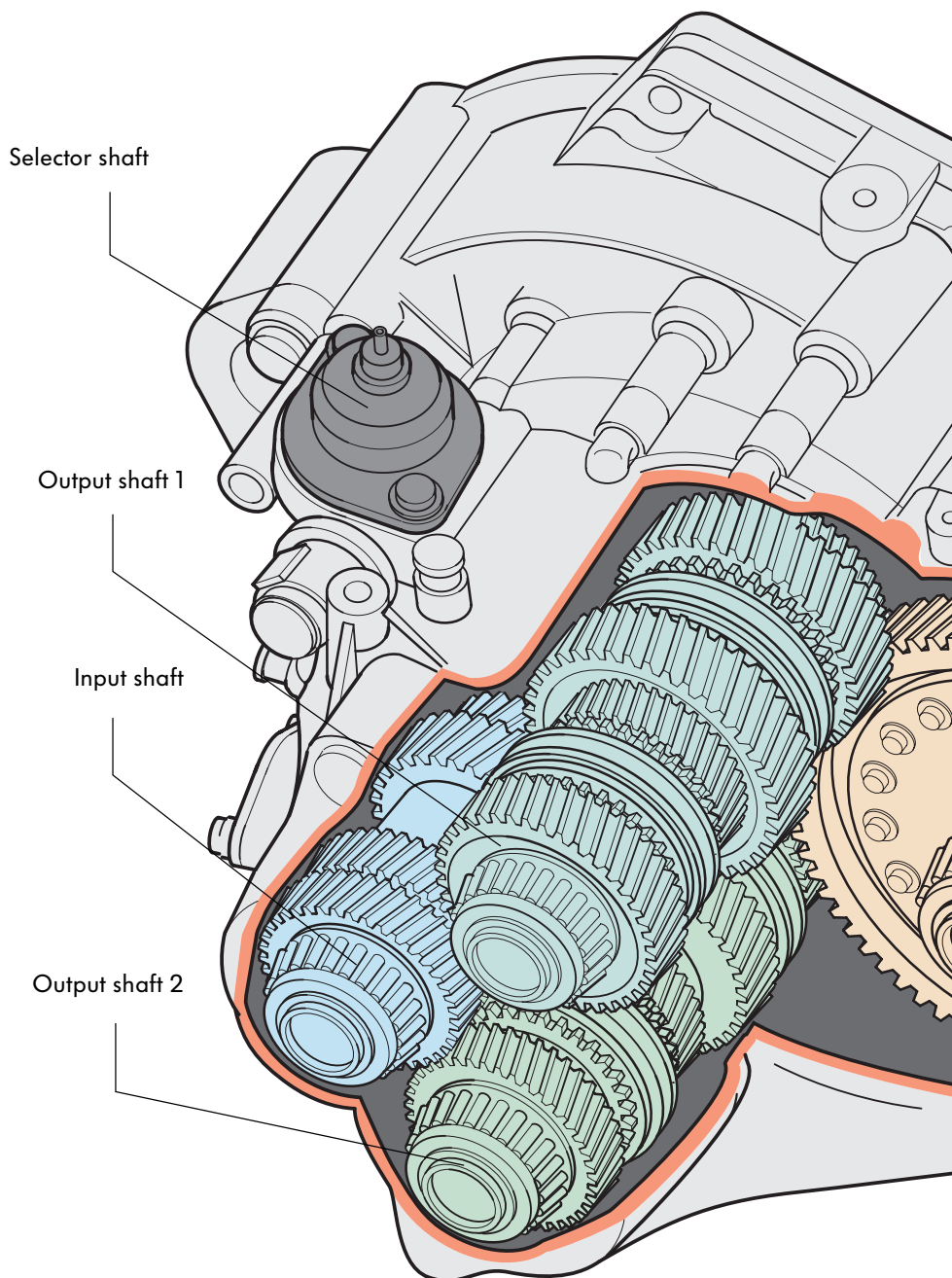
# Gearbox mechanism

## Design

In a conventional gearbox, an input shaft transfers drive force to an output shaft on which the various gears are positioned. The more gears there are lined in row on such a drive shaft, the longer it will be.

For the so-called short gearbox, one of which is manual gearbox 02 M, VW uses two output shafts - on which the gears are arranged - instead of one.

This reduces the installation length considerably.



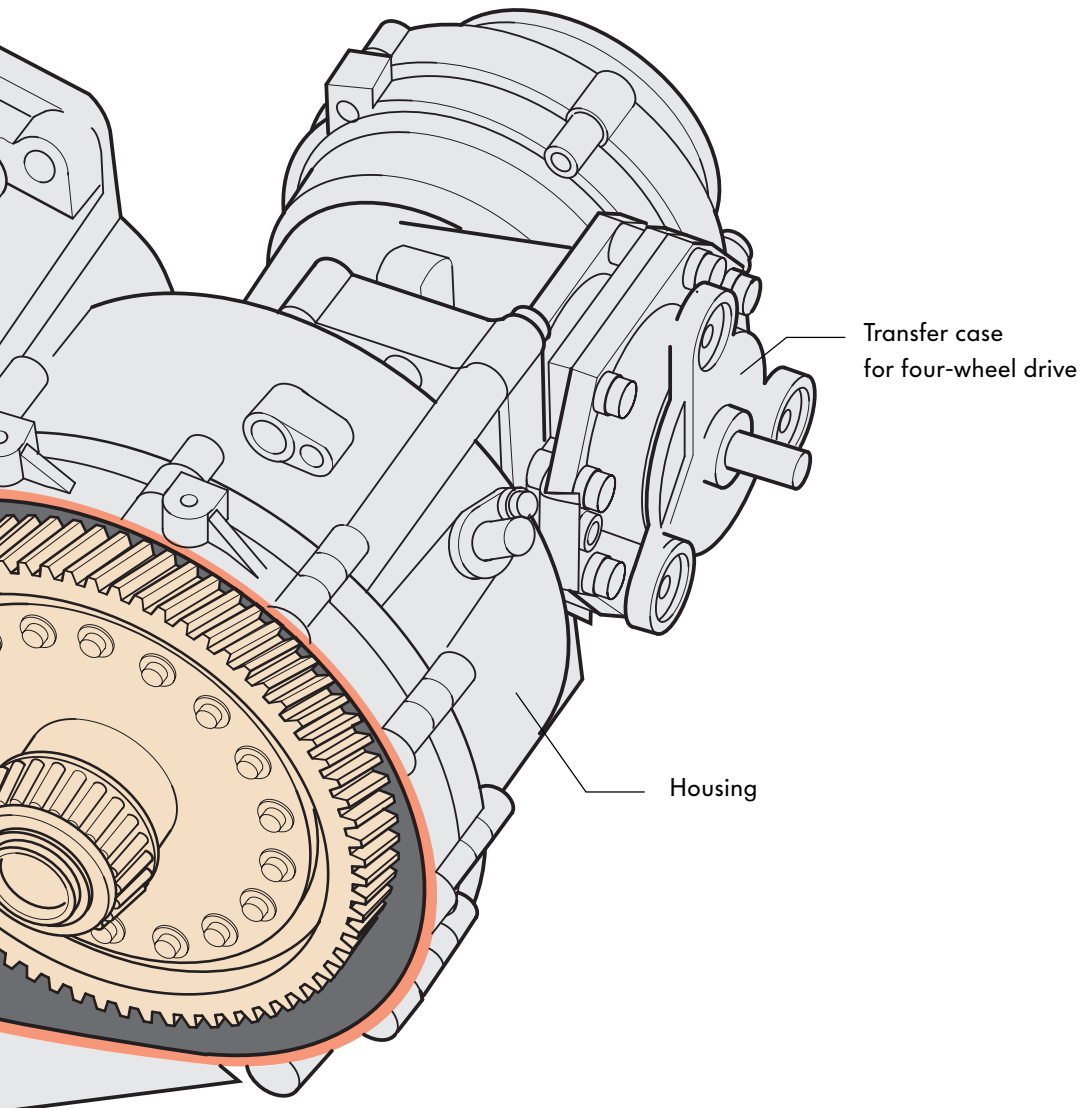


Manual gearbox 02 M has one input shaft and the two output shafts, TW1 and TW2.

The gears are arranged on both output shafts as follows:

- TW1: Forward gears 1 to 4
- TW2: 5th and 6th gear and reverse

The reverse gear comprises a reverse shaft with two gears via which the direction of rotation is reversed. (In the illustration below, the reverse shaft is hidden by the input shaft.)

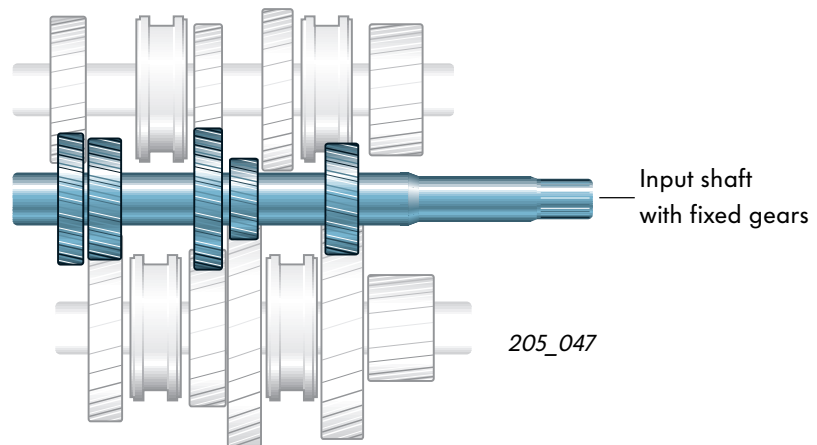


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# Gearbox mechanism

## Design of input shaft

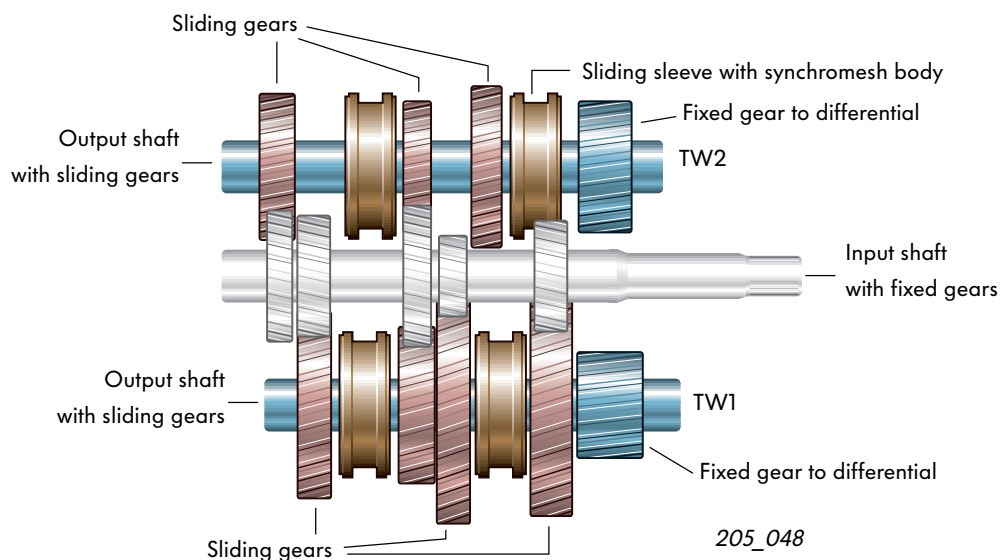
The gear wheels of the input shaft are designed as fixed gears, i.e. they are permanently linked to the input shaft.



## Design of output shafts TW1 and TW2

The gear wheels run in needle bearings and can rotate on the output shaft. This is why they are also known as sliding gears. Only when the appropriate gear has been selected is the sliding gear connected to the fixed gear of the output shaft via a sliding sleeve and a synchromesh body.

The sliding gears of the output shaft are continuously in mesh with the matching fixed gears of the input shaft, i.e. the sliding gears also rotate continuously. As the sliding gears - with the exception of the idler of the engaged gear - are not permanently linked to their output shaft, they transfer no torque to the output shaft in this state.



## Double gearing

Replacing the conventional output shaft with two shorter output shafts alone is not enough to achieve a short, compact design. It is still necessary to find a way to transfer torque to both output shafts without requiring more components.

In the case of manual gearbox 02 M, this problem is solved by means of double gearing. In a double gearing arrangement, a fixed gear of the input shaft is linked to a sliding gear of TW1 and a sliding gear of TW2. In this way, two gears can be driven by only one fixed gear on the input shaft.

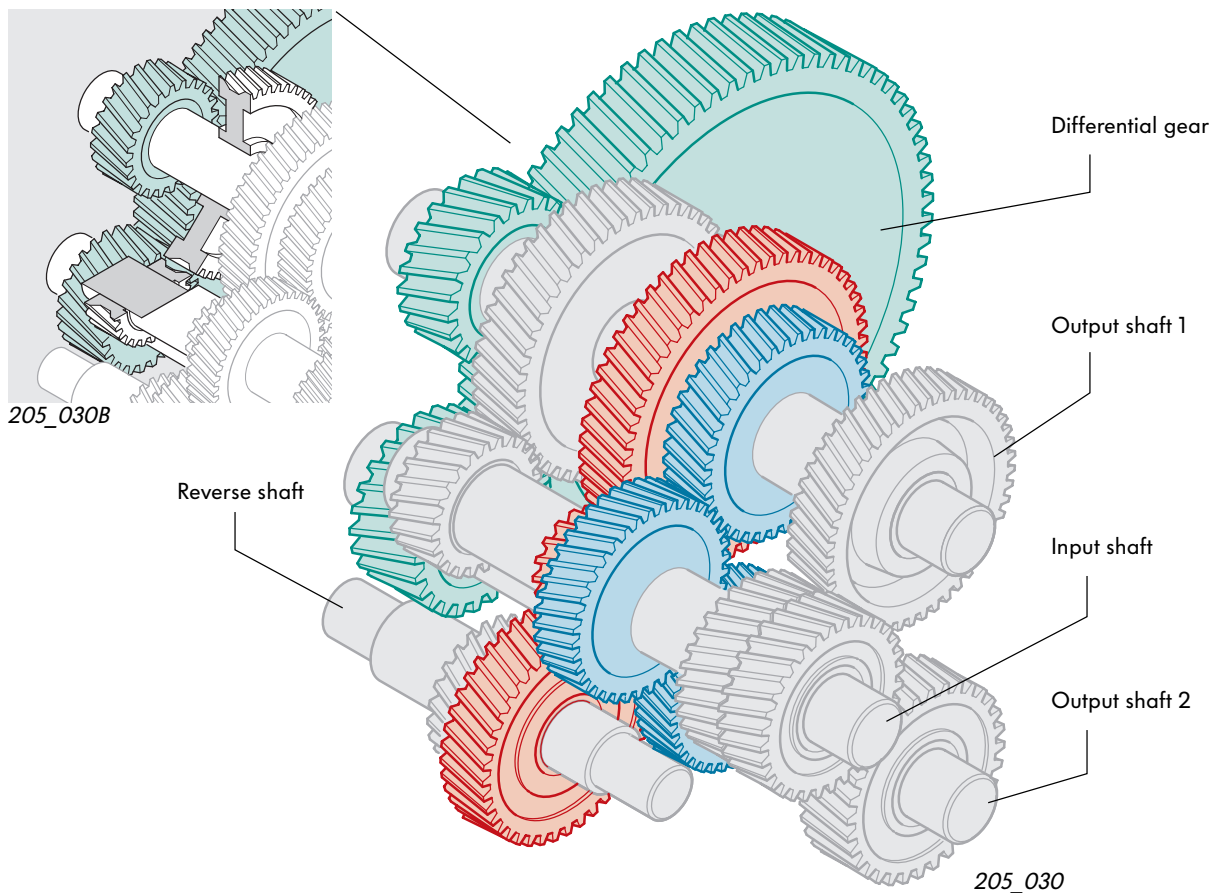
To achieve different ratios, opposed sliding gears have different diameters and therefore different numbers of teeth.

Gears of the TW2 have a larger diameter than the gears of the TW1.

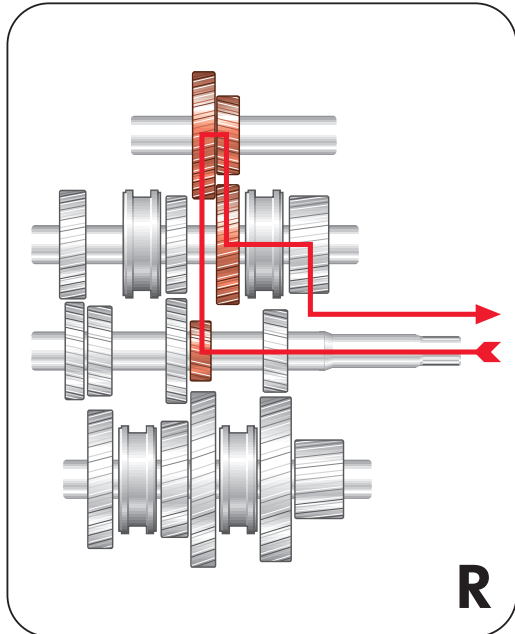
This results in a 25% speed differential between the output shafts.

Manual gearbox 02 M has three double gearings:

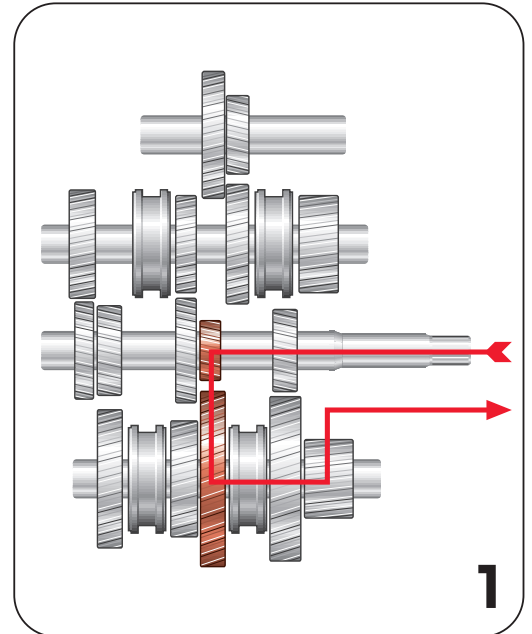
- Sliding gear wheel, 1st gear, on TW1 and reverse shaft with the the input shaft (red),
- Sliding gear wheel, 4th gear, on TW1 and sliding gear 6th gear on TW2 with the input shaft (blue) and
- TW1 and TW2 with the differential gear (green).



# Gearbox mechanism



205\_010

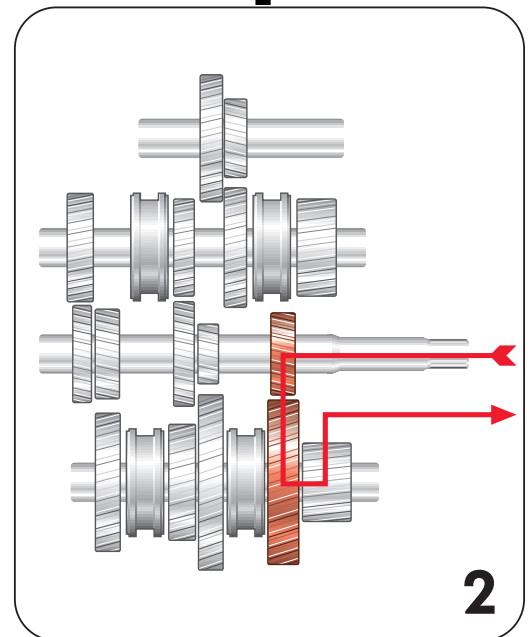


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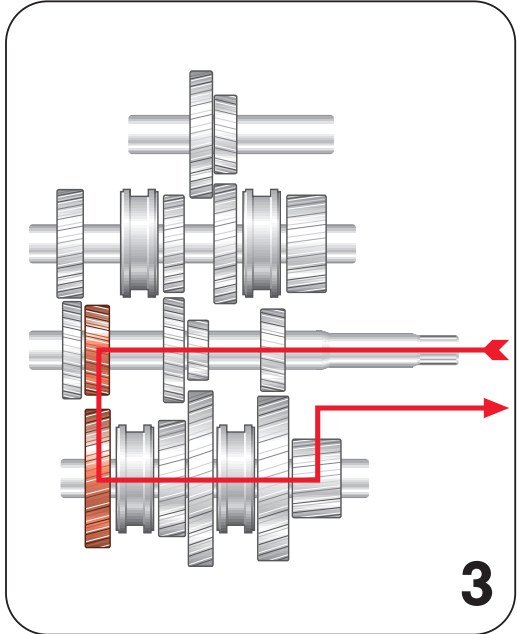
## Power transfer

Since gearbox O2M has two output shafts, power is either transferred via the one shaft or via the other shaft to the differential, depending on what gear is selected.

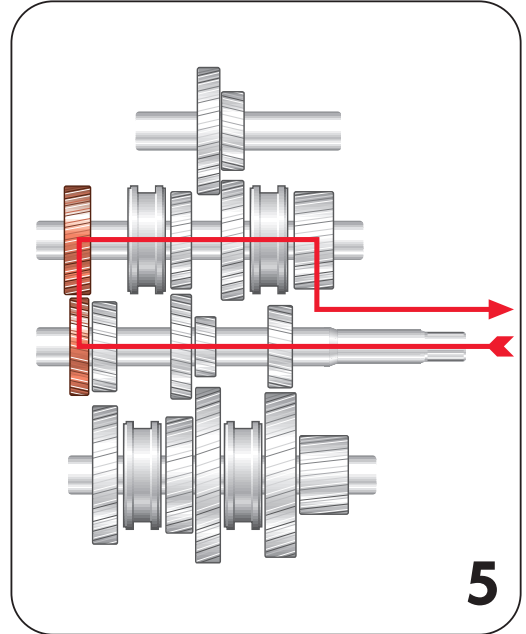
Taking the selection diagram for the sake of clarity, the individual gears can be assigned to the power transfers shown in the figure on the right.



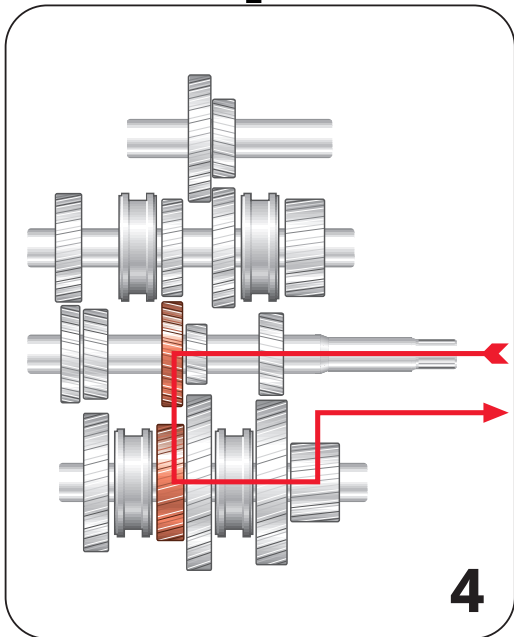
205\_012



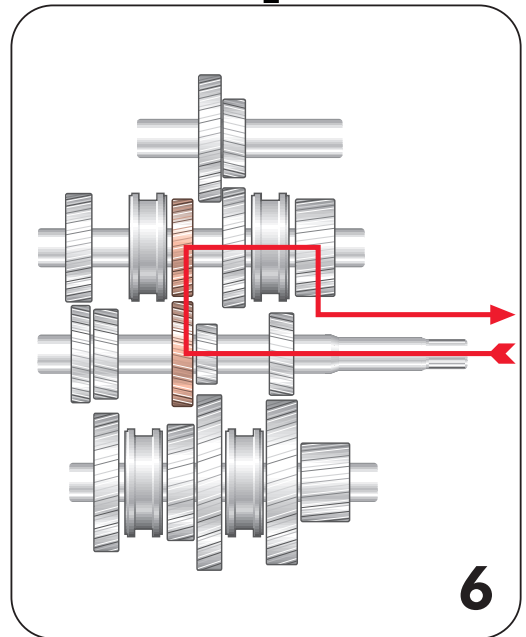
205\_013



205\_015



205\_014

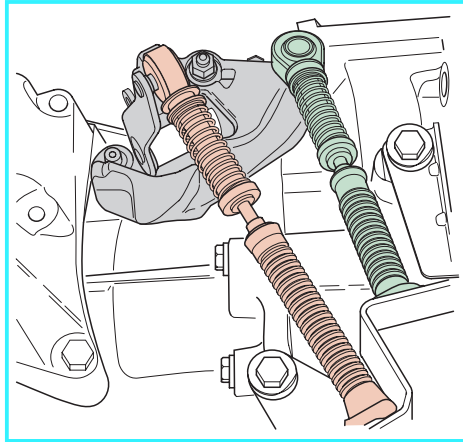


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# Cable-operated gearshift mechanism

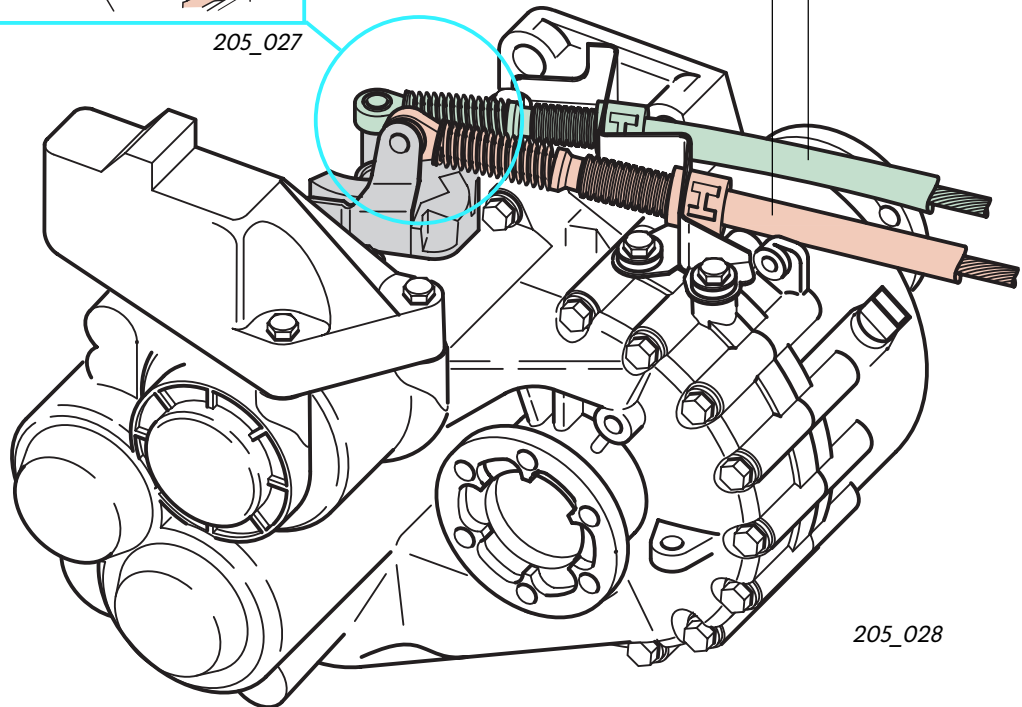
## The two selector cables of the cable-operated gearshift mechanism

establish the connection between the gear lever and gearbox 02 M.



Mechanism for transferring the motion of the selector cables to the selector shaft.

205\_027



Selector cable

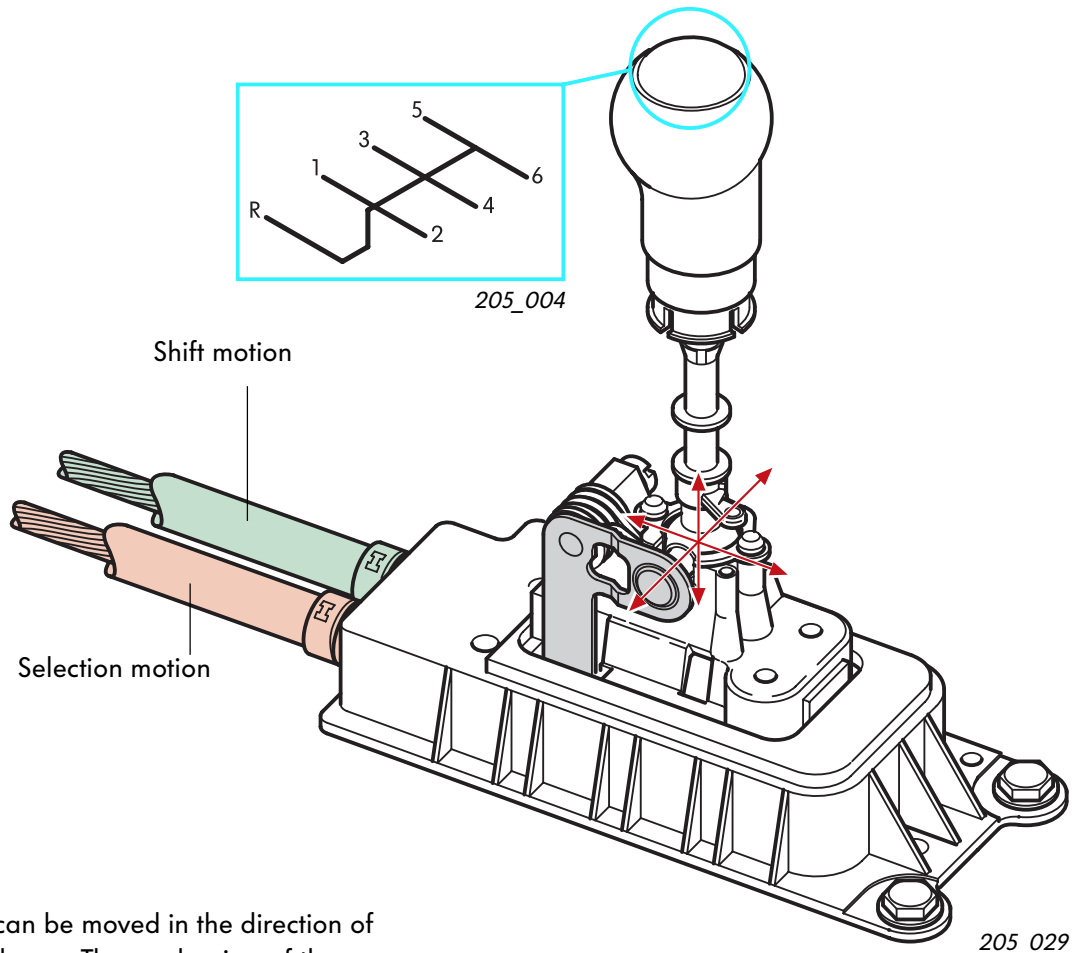
Gear selector cable

205\_028

The two selector cables transmit the motions of the gear lever to the gearbox selector shaft. The mechanism shown above translates the movement of the selector cables into a movement of the selector shaft in the gearbox.

## Gear lever

The position of the gears is in accordance with the VW standard, except that an extra gear has been added to fill a previously unallocated space.



The gear lever can be moved in the direction of the three spatial axes. The mechanism of the gear lever splits the gearshift operation of the driver.

- A part of the mechanism transfers the right/left motion of the gear lever to the selector cable. With this operation, the driver selects the gate to be selected.
- The other part of the mechanism transfers the forward/reverse motion to the gear selector cable. With this operation, the driver engages the desired gear.





# Cable-operated gearshift mechanism

## Selecting a gear

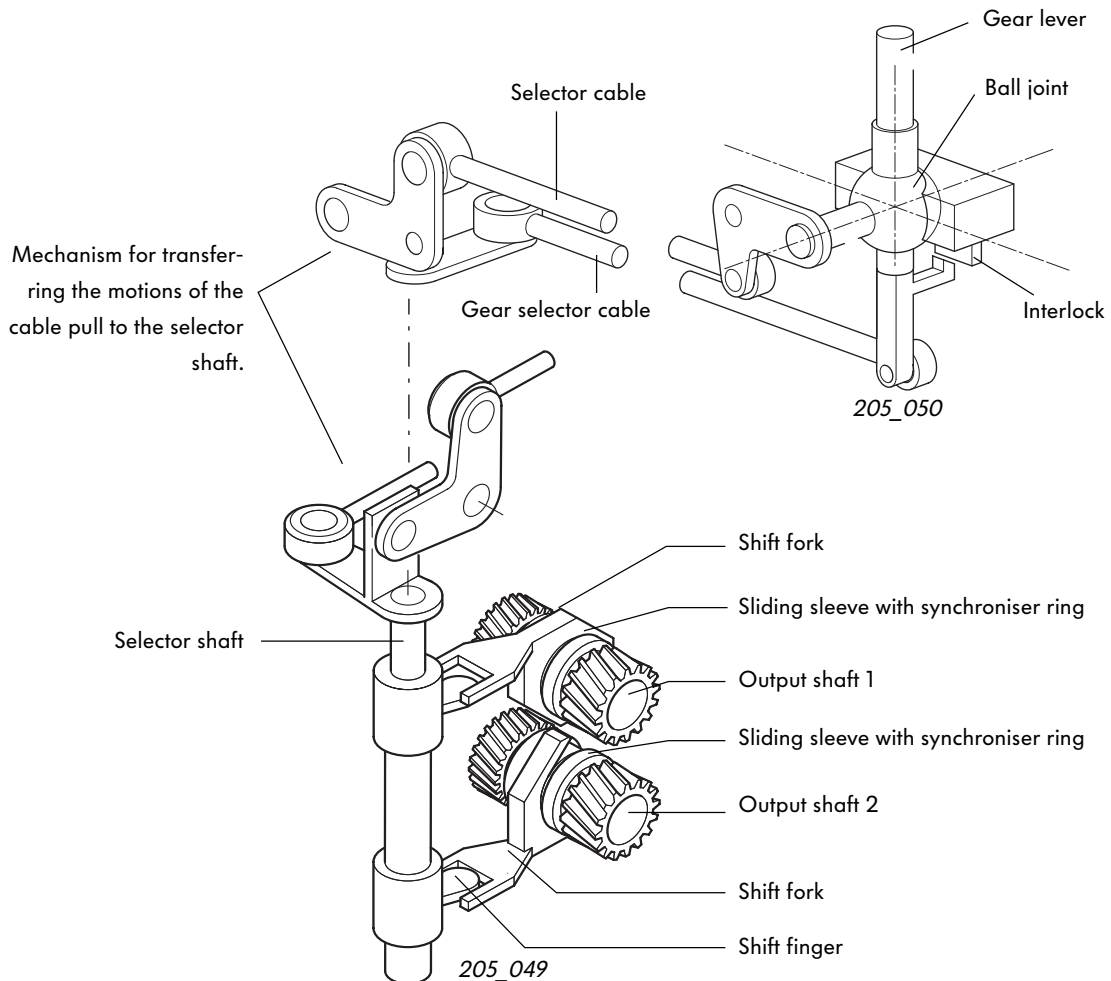
In essence, gear selection consists of three components of the selector mechanism and gearbox:

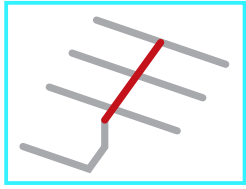
- The gear lever mechanism translates the driver's operations.
- The selector cables transfer the operation of the selector lever mechanism to the gearbox selector shaft.
- The selector shaft mechanism on the gearbox. This mechanism selects and engages the gear wheel of the gear selected.

We will explain to you the sequence of operations when selecting a gear by means of three examples.

For the sake of clarity, we will split the selection sequence into

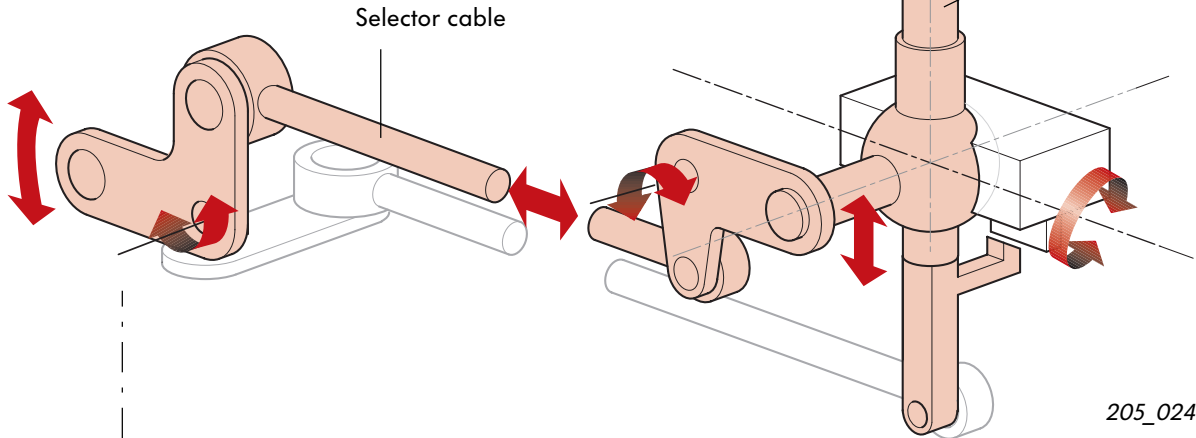
- operations outside the gearbox and
- operations inside the gearbox





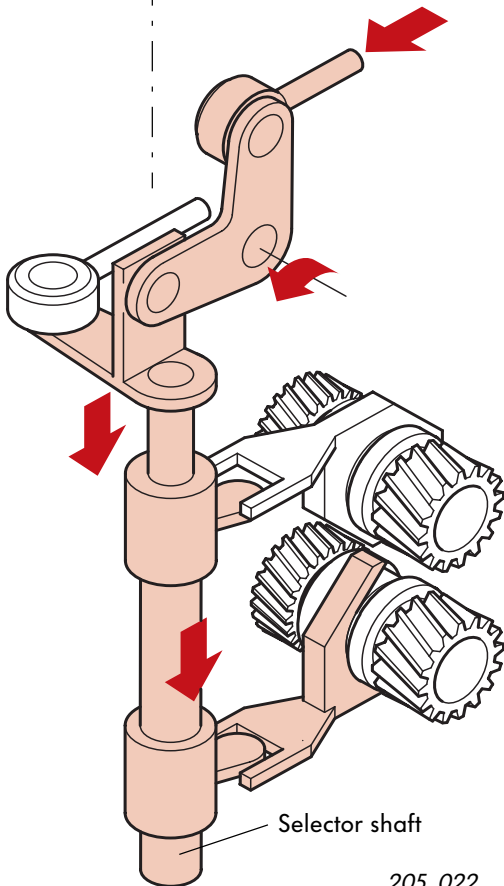
Left/right motion of the gear lever

205\_045



205\_024

The gear lever mechanism transfers the right/left motion of the gear lever to the selector cable. The gearbox mechanism translates the motion of the gear selector cable into an up/down movement of the selector shaft.

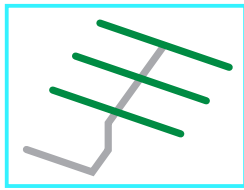


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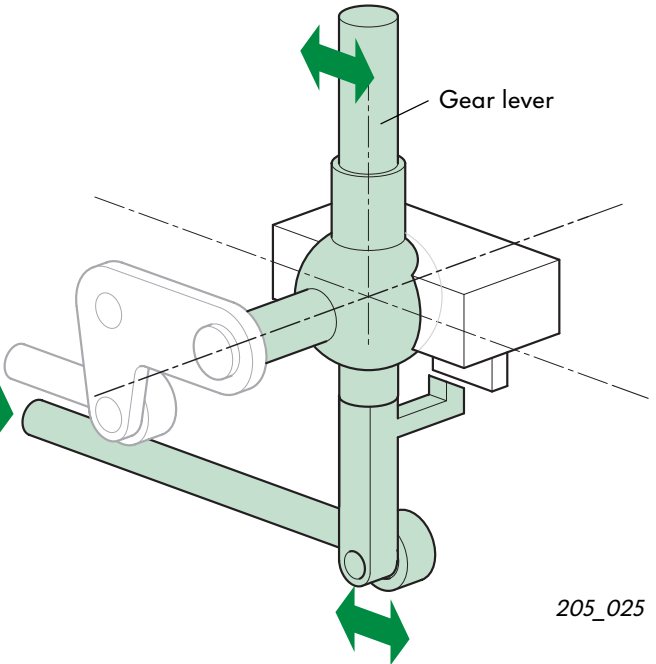
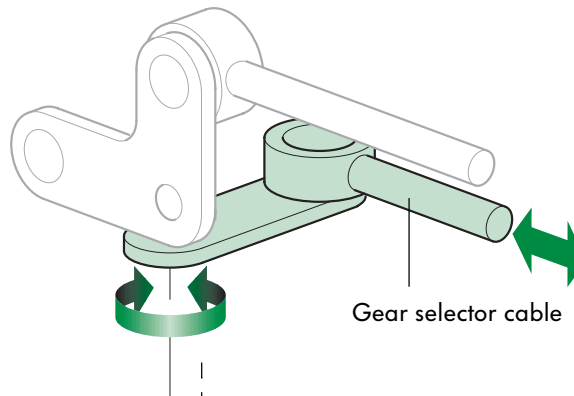
In the gearbox, this up/down motion causes the shift finger on the selector shaft to move upwards or downwards. The shift finger for the selected gear pair then reaches into the cutout in the relevant shift fork.



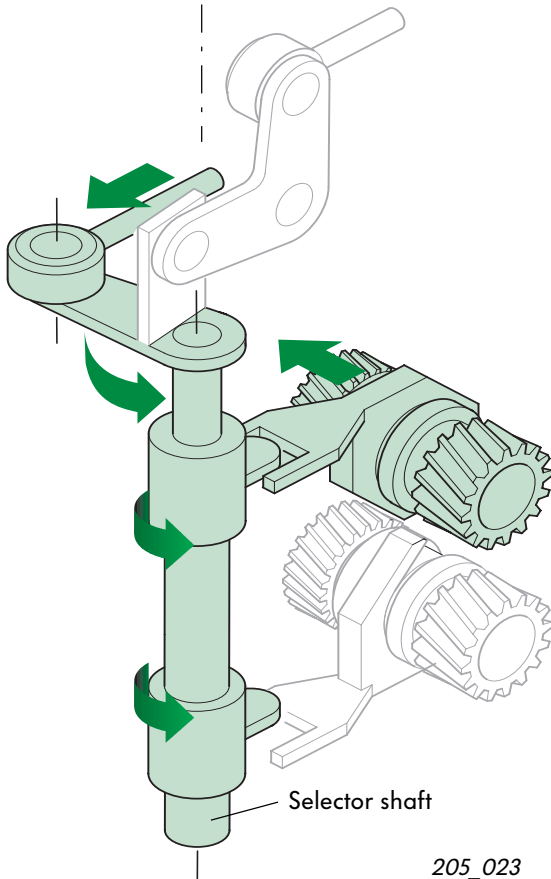
# Cable-operated gearshift mechanism



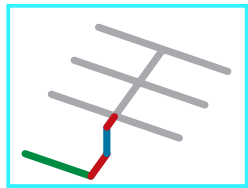
Forward and reverse motion of gear lever.



The forward and reverse motions of the gear lever is transferred to the shift cable. The gearbox mechanism translates the motion of the gear selector cable into a rotational motion of the selector shaft.

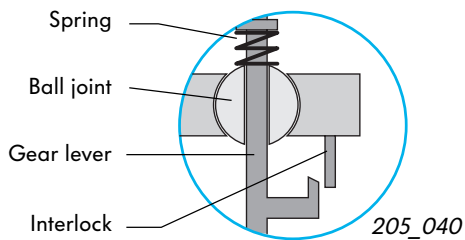
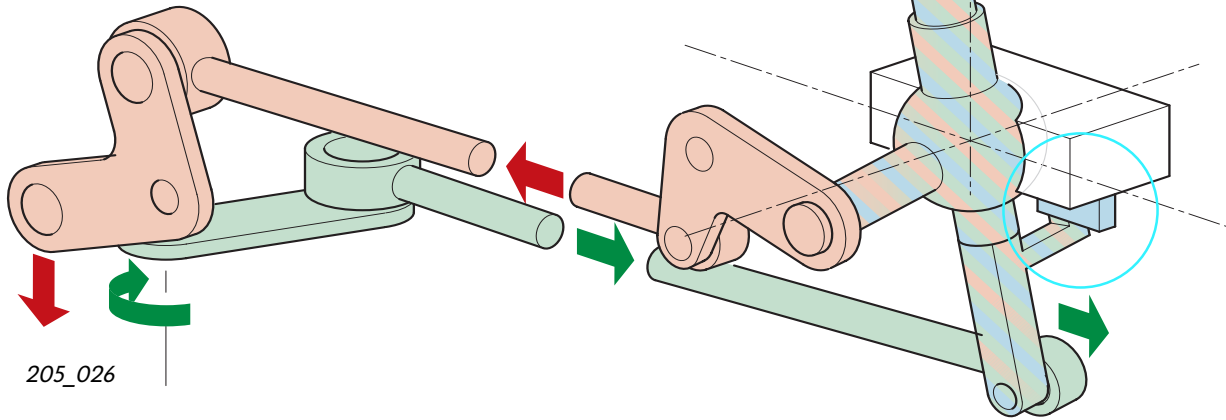


In the gearbox, this rotational motion of the selector shaft causes the shift finger which has engaged in the cutout in the shift fork to move the shift fork and gear change sleeve sideways. The gear change sleeve links the gear wheel of the selected gear to the output shaft. The selected gear is then selected.



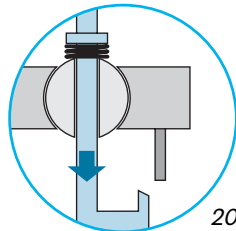
205\_046

### Selecting reverse gear



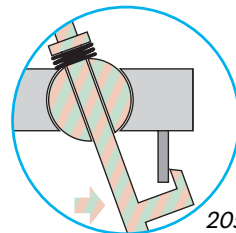
205\_040

Selecting reverse gear represents a special case, since an interlock must first be cancelled in order to engage this gear.



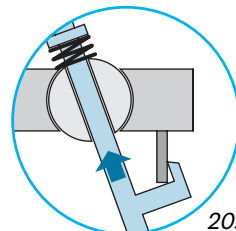
205\_041

Press down the interlock against the force of the spring and the gear lever will slide down through the ball joint.



205\_042

Only then can the interlock be cancelled in order to engage reverse by moving the gear lever to the left and forwards.



205\_043

A spring pulls the gear lever back up.

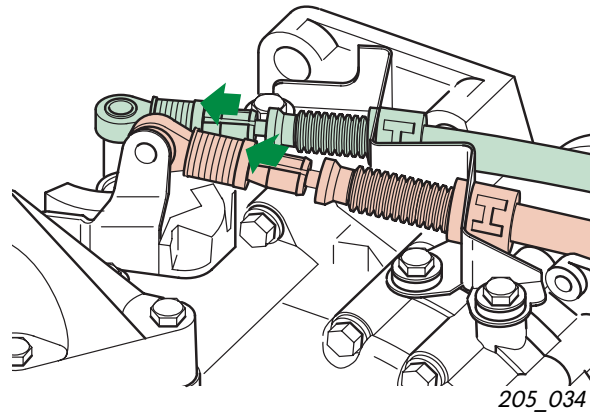


# Service

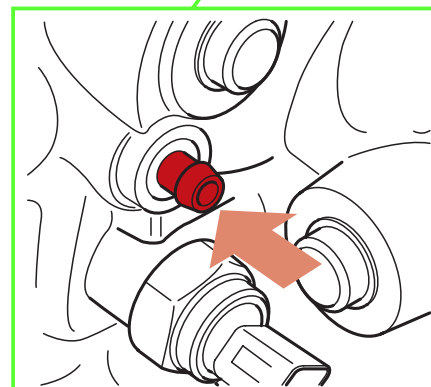
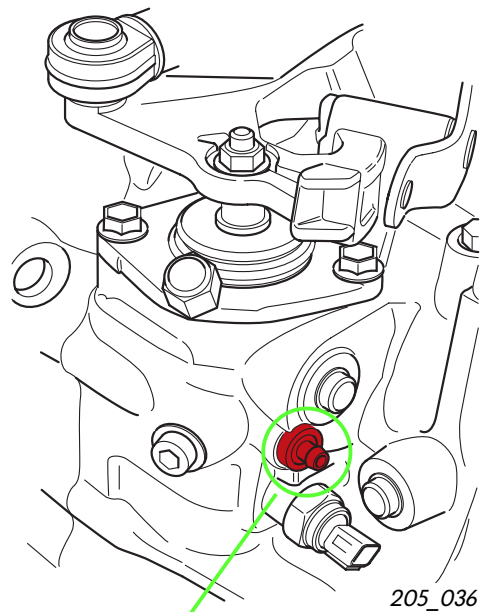
## Adjusting the cable-operated gearshift mechanism

The procedure for adjusting the cable-operated gearshift mechanism has been simplified:

- Pull the spring at both ends of the cable pull back.
- Fix the springs by a rotational motion with the plastic nuts (arrows).

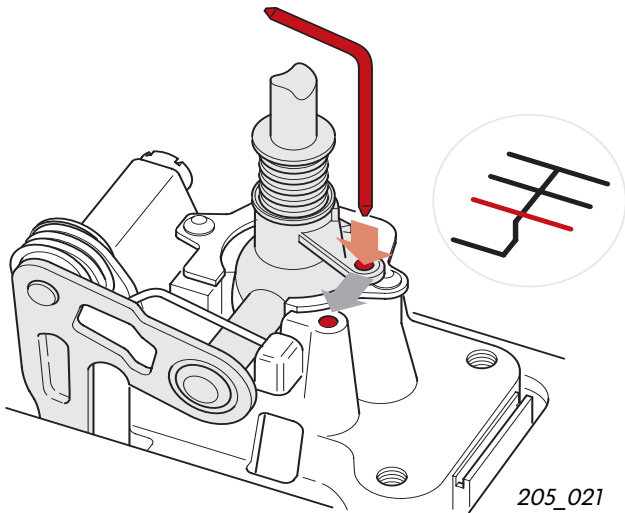


- Attached to the gearbox housing is an adjusting pin which fixes the selector shaft in a predefined position. Move the selector shaft by hand into the gate of first and second gear and then press the adjusting pin into the gearbox housing. The gearbox pin latches home in this position and locates the selector shaft.

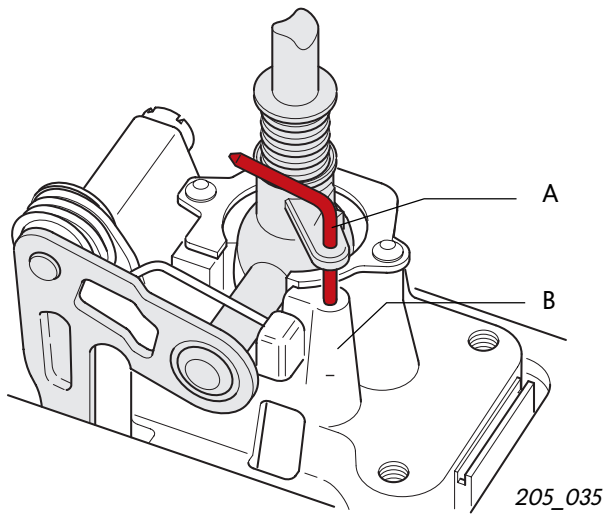


Push in the setting pin



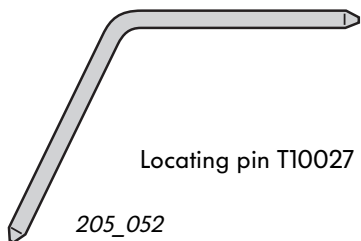


- You still have to move the gear lever into the first and second gear positions. In the figure, you can see two guide holes: one on the gear lever and one in the housing.



- To fix the gear lever in place, pass locating pin T10027 through bore A into bore B when they are exactly one above the other.

- Now you can let the springs on the selector cables snap back into place. Detach the adjusting pin from the gearbox housing and pull the locating pin T10027 back out.



# Sensors

Gearbox 02 M is equipped with two sensors:

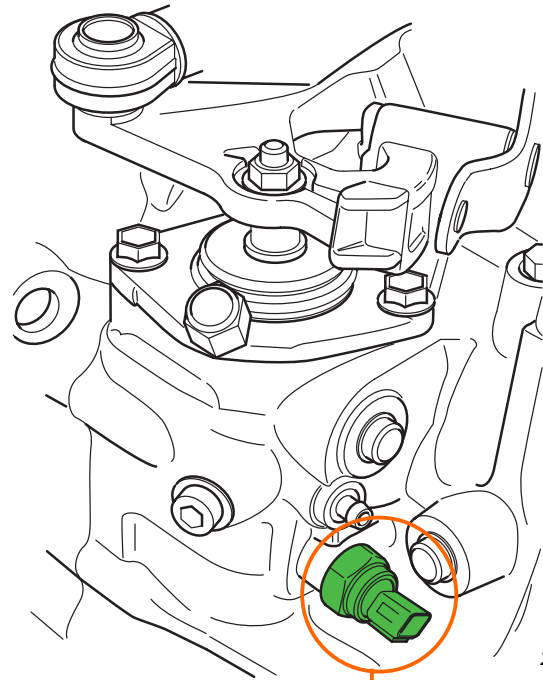
- Switch for the reversing lights F4
- Speedometer sender G22

## Switch for reversing lights F4

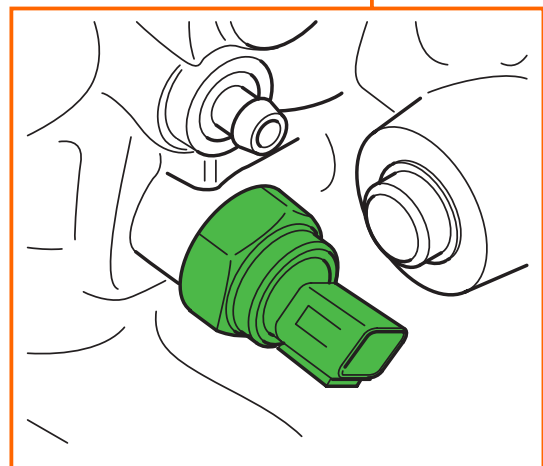
The reversing light switch is activated when the selector shaft engages the reverse gear. The reversing light switch has a two-pin connector and is arranged below the adjusting pin for the selector mechanism.

### Task

When engaging reverse, the electrical circuit to the reversing lights is closed via this switch.



205\_037



205\_003



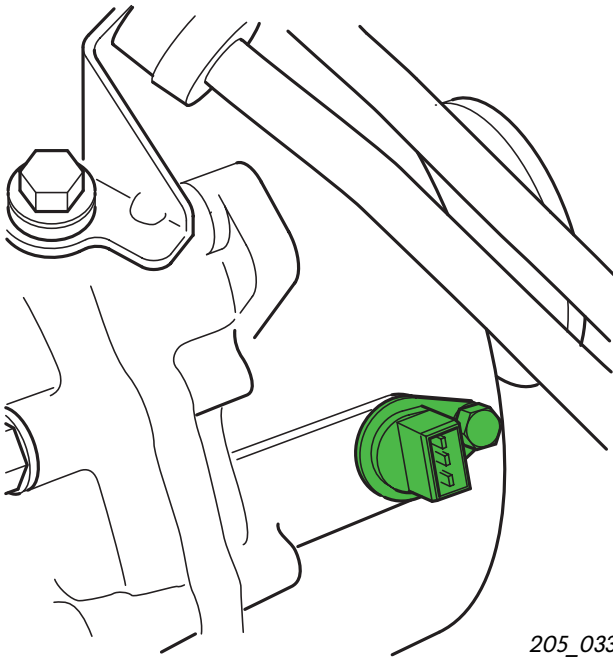


## Speedometer sender G22

The speedometer sender is bolted to the gearbox housing and scans a sender wheel on the differential.

### Task

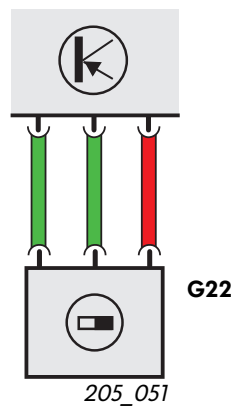
It records the vehicle's road speed for the control unit with display unit in the dash panel insert.



### Effects of failure

If the sender fails, the speed limiter cuts in earlier.

### Electrical circuit



# Test your knowledge

1. What are the advantages of a 6-speed gearbox?

- a) greater smoothness
- b) higher speed
- c) better environmental compatibility

2. Why does the O2M have two output shafts?

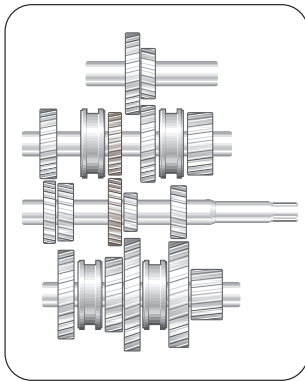
.....

3. How are the gears arranged on output shafts TW1 and TW2?

TW1: .....

TW2: .....

4. Show the power train for the 6th gear in the drawing.



205\_017

5. Explain the concept of “double gearing”?

.....  
.....

6. Arrange the following steps for setting the cable-operated gearshift mechanism in the correct order:

- a) Press in the adjusting pin into the gearbox housing.
- b) Let the springs on the both selector cables snap back into place.
- c) Move the gear lever in the correct position and fix in place with a pin.
- d) Pull the locating pin out of the gear lever.
- e) Move the selector shaft into the adjustment position by hand.
- f) Pull the spring back out of the selector cables.
- g) Remove the adjusting pin from the gearbox housing.

Solution:

.....





# Notes

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**Solutions:**

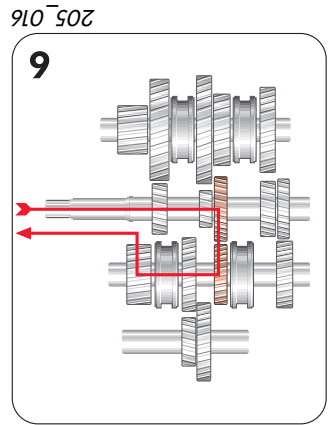
1. a, c

2. Because installation length is saved by using two short output shafts in comparison with only one long output shaft.

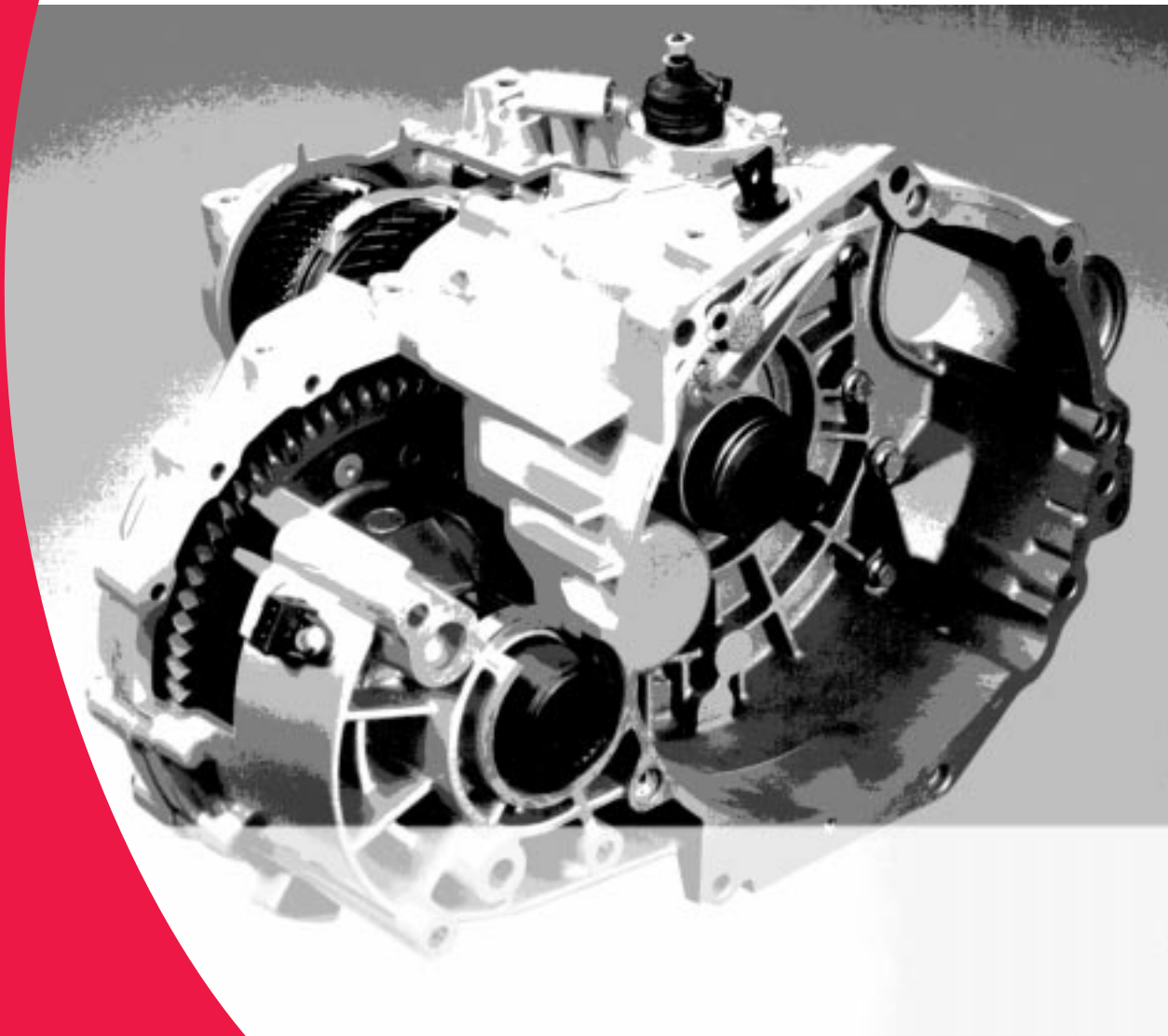
3. TW1: 1st, 2nd, 3rd and 4th gear

TW2: 5, 6th gear and reverse

4.




- 5. With double gearing, one gear of the input shaft is in mesh with both a gear of the first output shaft and a gear of the second output shaft. However, only one gear is engaged at any given time.
- 6. f, e, a, c, b, g, d.



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