F10 Powertrain

Edited for the U.S. market by:
BMW Group University
Technical Training
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BMW Service

General information

Symbols used

The following symbol / sign is used in this document to facilitate better comprehension and to draw attention to particularly important information:

Contains important safety guidance and information that is necessary for proper system functioning and which it is imperative to follow.

Information status and national-market versions

The BMW Group produces vehicles to meet the very highest standards of safety and quality. Changes in terms of environmental protection, customer benefits and design make it necessary to develop systems and components on a continuous basis. Consequently, this may result in differences between the content of this document and the vehicles available in the training course.

As a general principle, this document describes left-hand drive vehicles in the European version. Some controls or components are arranged differently in right-hand drive vehicles than those shown on the graphics in this document. Further discrepancies may arise from market-specific or country-specific equipment specifications.

Additional sources of information

Further information on the individual topics can be found in the following:

- in the Owner's Handbook
- in the integrated service technical application

Contact: conceptinfo@bmw.de

The information in the document is part of the BMW Group technical training course and is intended for its trainers and participants. Refer to the latest relevant BMW Group information systems for any changes/supplements to the technical data.

Information status: **December 2009**

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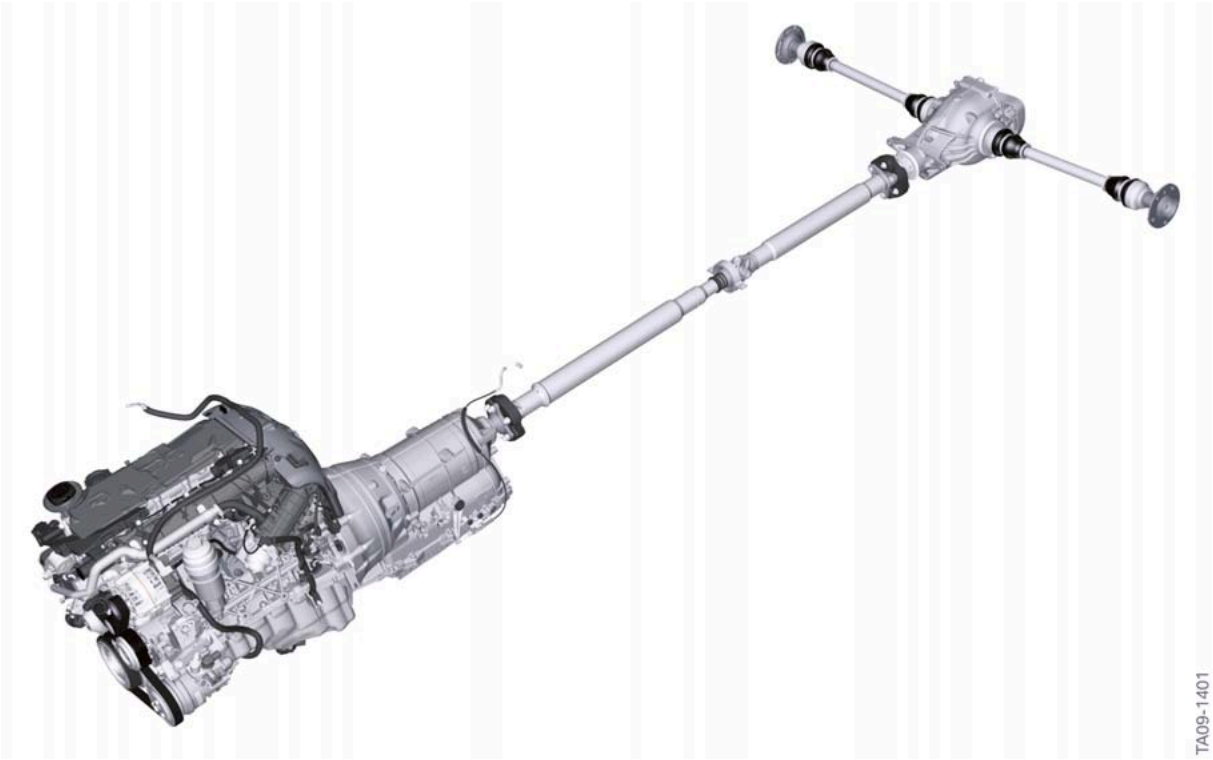
1. Drive Train Variants



F10 Drive.

1.1. Models

1.1.1. gasoline engines

	535i	550i
Engine	N55B30M0	N63B44O0
Power [kW] HP	[225] 300	[300] 400
Torque [Nm] lb-ft	[400] 300	[600] 450
US exhaust emission standard	ULEVII	ULEVII
Manual transmission	GS6-45BZ	GS6-53BZ
Automatic transmission	GA8HP45Z	GA8HP70Z
Rear axle differential	Rear diff 205AL	HAG 225AL

1.2. Additional information

For the descriptions of the engines and the eight-gear automatic transmission, refer to the following information bulletins:

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1. Drive Train Variants

- Information bulletin for N52 engine
- Information bulletin for N55 engine
- Information bulletin for N63 engine
- Information bulletin for GA8HP automatic transmission.

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2. Engines

2.1. N52 engine

N52 engine

Highlights

- Magnesium-aluminum composite crankcase
- Valvetronic II
- Volume controlled oil pump
- Electric coolant pump.
- Three-stage intake manifold (DISA)
- Magnesium cylinder head cover
- Single-belt drive
- Exhaust manifold in lightweight construction.

2.1.1. Technical data

		N52B30M1 E60, 528i	N52B30O2 F10, 528i
Type		R6	R6
Valves per cylinder		4	4
Engine control system		MSV80	MSV90
Displacement	[cm^3]	2996	2996

F10 Powertrain
2. Engines

		N52B30M1 E60, 528i	N52B30O2 F10, 528i
Stroke/bore	[mm]	88.0/85.0	88.0/85.0
Output at engine speed	[kW] HP [rpm]	[170] 230 6500	[190] 240 6600
Torque at engine speed	[Nm] lb-ft [rpm]	[270] 200 2750	[310] 230 2600 – 3000
Compression ratio	[ε]	10.7 : 1	10.7 : 1
Fuel grade		ROZ 91 – 98	ROZ 91 – 98
Exhaust emission standard		-	ULEVII
Acceleration 0-100 km/h/62mph (Automatic transmission)	[s]	7.6	6.7

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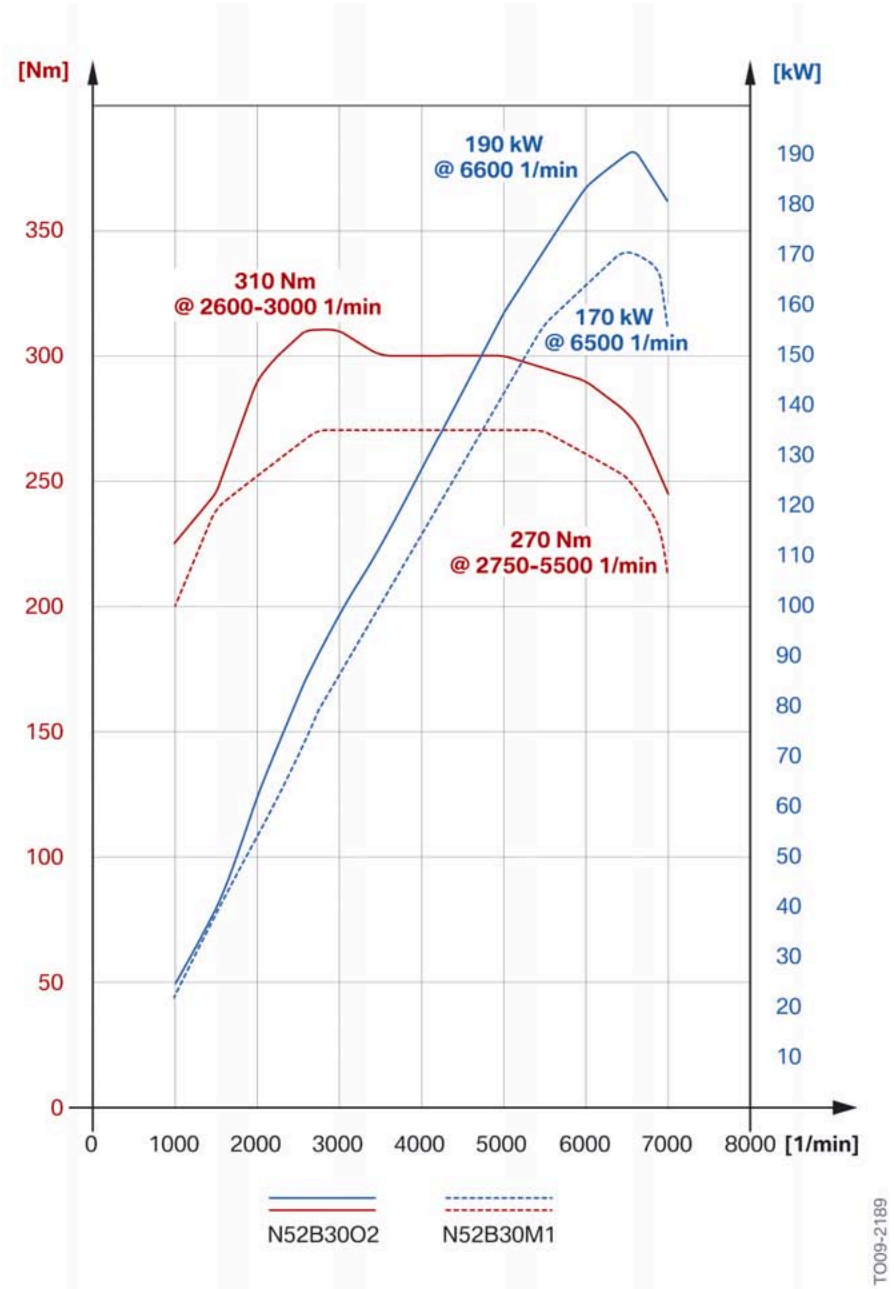
2. Engines

2.1.2. Full load diagram



Full load diagram, E60 528i with N52B30M1 engine compared to F10 528i with N52B30O2 engine.

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2. Engines

2.2. N55 engine

N55 engine

The N55 engine is the successor to the N54 engine. Technical updates and modifications have made it possible to use only one exhaust turbocharger. The technical data have remained nearly identical, with reduced cost and improved quality.

Highlights

- Single turbocharger (TwinScroll)
- Air-gap-insulated exhaust manifold six in two; catalytic converter close to the engine
- Direct fuel injection with central injector position (solenoid valve injectors)
- Third generation Valvetronic
- Digital Motor Electronics (MEVD17.2 Bosch) engine mounted, integrated into the intake manifold, FlexRay-compatible
- Lightweight construction crankshaft
- Map-controlled oil pump (volume control)
- Standardized single-belt drive across all series
- Initial start-up in F07, afterwards use across all series.

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2. Engines

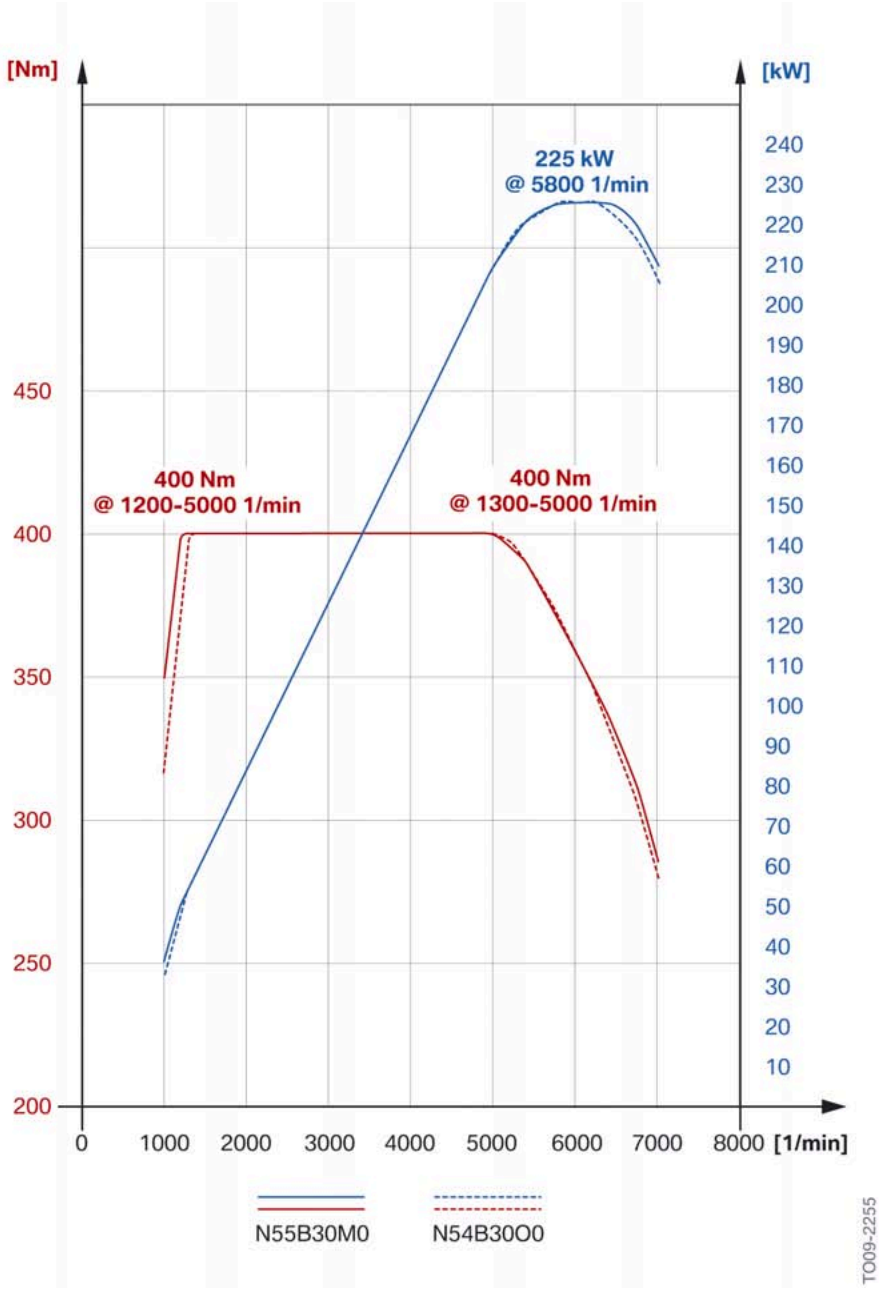
2.2.1. Technical data

		N54B30O0 E60, 535i	N55B30M0 F10, 535i
Type		R6	R6
Valves per cylinder		4	4
Engine control system		MSD80	MEVD17.2
Displacement	[cm^3]	2979	2979
Stroke/bore	[mm]	89.6/84.0	89.6/84.0
Output at engine speed	[kW] HP [rpm]	[220] 300 5800	[225] 300 5800
Torque at engine speed	[Nm] lb-ft [rpm]	[407] 300 1400 – 5000	[400] 300 1200 – 5000
Compression ratio	[ε]	10.2 : 1	10.2 : 1
Fuel grade		ROZ 95 – 98	ROZ 91 – 98
Exhaust emission standard		-	ULEVII
Acceleration 0-100 km/h/62mph (Manual/automatic transmission)	[s]	5.9/6.0	6.0/6.1

2.2.2. Full load diagram

Compared to the predecessor, the outstanding feature of the N55 engine is its lower fuel consumption with equivalent power and torque data.

F10 Powertrain
2. Engines



Full load diagram, E60 535i with N54B30O0 engine compared to F10 535i with N55B30M0 engine.

F10 Powertrain

2. Engines

2.3. N63 engine

N63 engine

The N63 engine is the successor of the N62 engine and the world's first engine with optimized package thanks to the placement of the turbochargers and the main catalytic converters. In order to obtain performance goals with the optimum package and weight, the two turbochargers and the catalytic converters have been placed in the engine V-space between the cylinder banks, which meant reversing the positions of the intake and outlet ports. This arrangement allows short pipe lengths and large cross-sections, which in turn minimizes the pressure losses on the intake and exhaust side.

Highlights

- Use across all series (E71/E72/F01/F02/F04/F07/F10)
- Twin turbochargers placed in the engine V-space
- Catalytic converters close to the engine
- Direct fuel injection piezo-electric injectors
- MSD85 Digital Motor Electronics, liquid-cooled with FlexRay connection
- Indirect charge air cooling

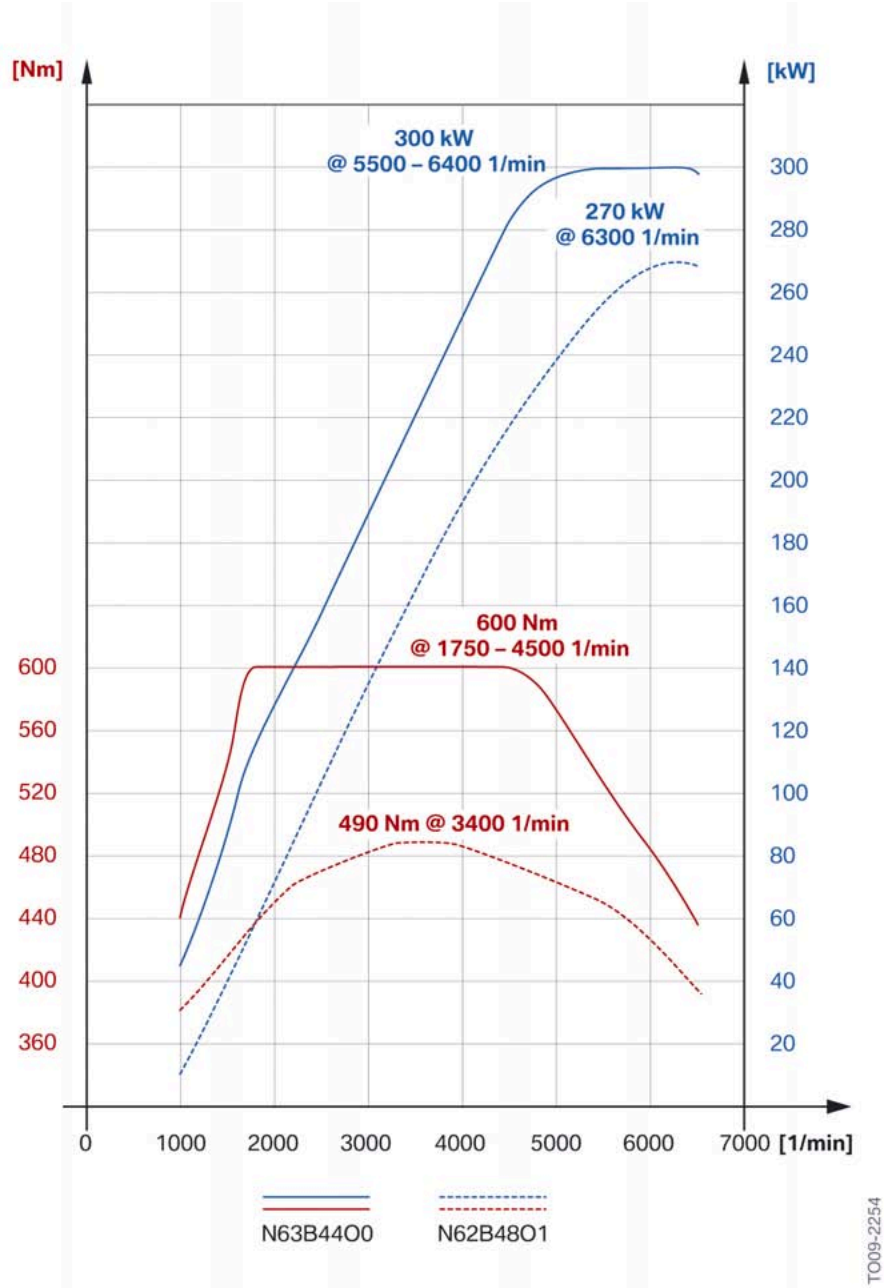
F10 Powertrain
2. Engines

2.3.1. Technical data

		N62B48O1 E60, 550i	N63B44O0 F10, 550i
Type		V8	V8
Valves per cylinder		4	4
Engine control system		ME9.2.3	MSD85
Displacement	[cm^3]	4799	4395
Stroke/bore	[mm]	88.3/93.0	88.3/89.0
Output at engine speed	[kW] HP [rpm]	[270] 367 6300	[300] 400 5500 – 6400
Torque at engine speed	[Nm] lb-ft [rpm]	[490] 361 3400	[600] 450 1750 – 4500
Compression ratio	[ε]	10.5 : 1	10.0 : 1
Fuel grade		ROZ 91 – 98	ROZ 91 – 98
Exhaust emission standard		-	ULEVII
Acceleration 0-100 km/h (Manual/automatic transmission)	[s]	5.2/5.3	-/5.0

2.3.2. Full load diagram

Compared to its naturally aspirated predecessor, the N62 engine, an outstanding feature of the N63 engine is its significantly higher overall power and more ample torque curve due to twin turbocharging.



Full load diagram, E60 550i with N62B48O1 engine compared to F10 550i with N63B44O0 engine.

2.4. Engine type and engine identification

2.4.1. Engine type

In the technical documentation, the engine type is used to ensure the unambiguous identification of engines. Frequently, however, only an abbreviation is used. This short form is used to assign an engine to an engine family.

F10 Powertrain
2. Engines

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW Motorsport BMW M GmbH Third-party engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e. g. N12) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N55) V8 engine (e.g. N63) V12 engine (e.g. N74) V10 engine (e.g. S85)
3	Change of the engine block concept	0 1 – 9	Engine block Changes, e.g. combustion process
4	Operating method or fuel and, where applicable, installation position	B D H	Gasoline, longitudinal installation Diesel, longitudinal installation Hydrogen
5 + 6	Displacement in 1/10 liter	30	3.0 liters
7	Power class	K U M O T S	Smallest Lower Center Upper (standard) Top Super
8	Revision relevant to approval	0 1 – 9	New development Revision

2.4.2. Engine identification

To ensure clear identification and classification, the engines have an identification mark on the crankcase.

This engine identification is also necessary for approval by authorities. The N55 engine is accompanied by a further development of this identification and a reduction from the former eight characters to seven characters. The engine number is located on the engine below the engine identification. This consecutive number, in conjunction with the engine identification, permits unique identification of each individual engine.

F10 Powertrain

2. Engines

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW Motorsport BMW M GmbH Third-party engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e. g. N12) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N55) V8 engine (e.g. N63) V12 engine (e.g. N74) V10 engine (e.g. S85)
3	Change of the engine block concept	0 1 – 9	Engine block Changes, e.g. combustion process
4	Operating method or fuel and, where applicable, installation position	B D H	Gasoline, longitudinal installation Diesel, longitudinal installation Hydrogen
5 + 6	Displacement in 1/10 liter	30	3.0 liters
7	Type approval requirements (Changes that require a new type approval)	A B – Z	Standard Depending on requirements, e.g. ROZ87

F10 Powertrain

3. Manual Transmission

3.1. Description

In the technical documentation, the transmission designation is used to ensure the clear identification of transmissions. Frequently, however, only an abbreviations are used. Thus we frequently speak of the K transmission or G transmission. For the correct designation, refer to the following table.

Position	Meaning	Index	Explanation
1	Description	G	Transmission
2	Transmission type	S	Manual transmission
3	Number of gears	1 – 9	Number of forward gears
4	Transmission type	- X S W D Y	Manual transmission Four-wheel drive with manual transmission Sequential manual transmission Four-wheel drive with sequential manual transmission Twin-clutch gearbox Four-wheel drive with twin-clutch gearbox
5 + 6	Transmission type	17 26 37 45 53	I transmission D transmission H transmission K transmission G transmission
7	Gear set	B D S P	Gasoline engine gear ratio Diesel engine gear ratio (w)* Sport gear ratio Gasoline engine gear ratio overhauled
8	Manufacturer	G J R Z H	Getrag Jatco GMPT ZF In-house part

3.2. Variants

Model	Engine	Manual transmission	
535i	N55B30M0	K	GS6-45BZ
550i	N63B44O0	G	GS6-53BZ

3.3. K manual transmission

The K manual transmission is a six-gear inline manual transmission in reduction gear design.

Highlights

F10 Powertrain
3. Manual Transmission

- Six gears with optimized ratios
- Intermediate mounting
- Dry sump lubrication
- Fuel consumption reduction (-2 % compared to G manual transmission)
- Weight reduction (-11 kg compared to G manual transmission)
- Synchronization with carbon friction linings
- Use of life-time oil filling
- Zero-gear sensor for automatic engine start-stop function.

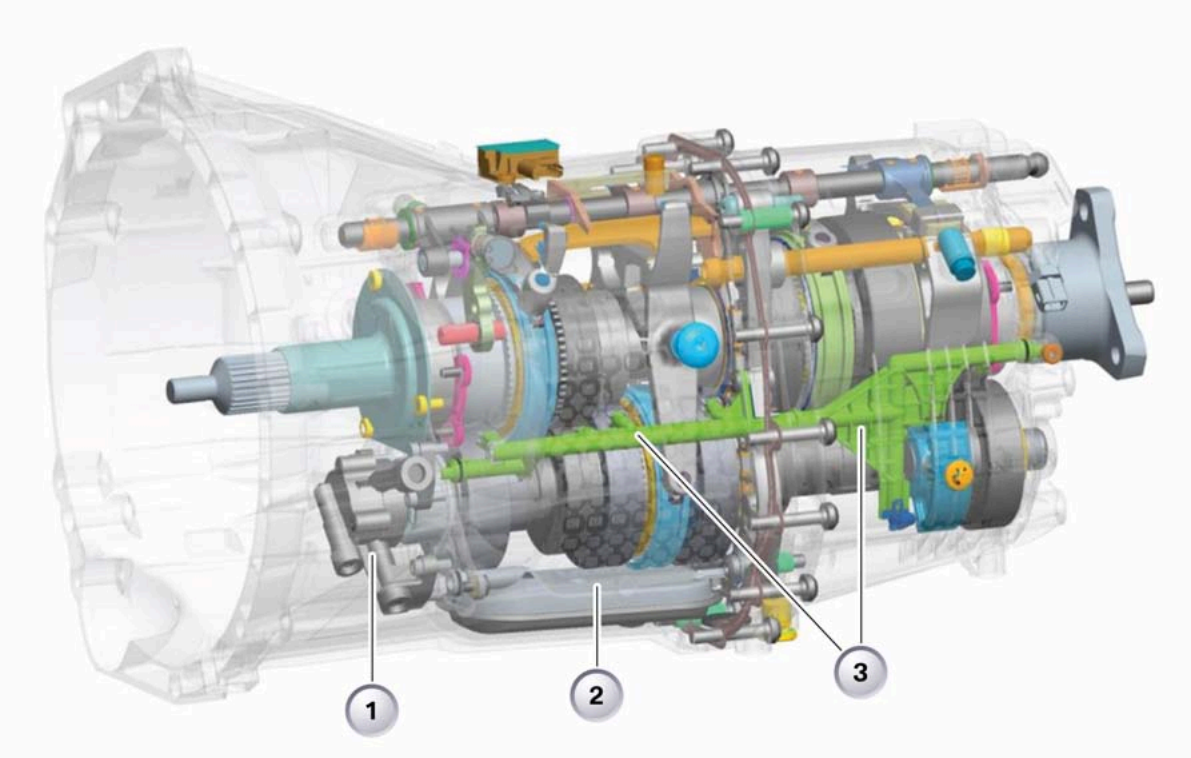
Instead of the G transmission used with the N63 engine the smaller, lighter and more cost-efficient K transmission is installed with the N55. The weight advantage is up to 11 kg. This transmission is smaller and lighter due mainly to the intermediate mounting of the main shafts and a modified gear set design.

Another advantage is the significantly improved shifting comfort and the low fuel consumption due to low drag losses and high efficiency.

The shift quality is increased substantially by:

- Using a newly developed carbon friction lining in the synchronizer units
- A newly developed and very low-friction gearshift
- The low drag loss of the gear set
- Limiting excessive shift travel

F10 Powertrain
3. Manual Transmission



"K" 6 speed manual transmission (GS6-45BZ)

Index	Explanation
1	Oil pump with pressure relief valve
2	Oil filter
3	Oil injector pipe

To keep the drag loss low, dry sump lubrication is used for the first time. Compared to conventional splash lubrication, this prevents the gear set from splashing about in the oil sump, which causes losses. An additional decrease in losses is attained with the use of redesigned radial shaft seals.

3.3.1. Intermediate mounting

In manual transmissions with reduction gear design, the main shaft is pushed away from the counter shaft by the gearing forces. This causes a deviation of the ideal gear contact pattern, which substantially impairs the strength of the gears and causes noise.

Therefore, in the K transmission, the location of the countershaft significantly restricts the shafts from bending. In this way, higher torque can be transmitted, compared to conventional transmissions, while at the same time reducing gear noise.

F10 Powertrain
3. Manual Transmission

3.3.2. Dry sump lubrication

Conventional manual transmissions normally use splash lubrication. During this process, the gears on the countershaft dip into the transmission oil and distribute it throughout the transmission in a disorderly manner as the gear set rotates. Often, additional equipment such as oil partition plates or oil grooves are required to bring the oil to the gears, the bearings or to the synchronizers.

In the K transmission, a dry sump type lubrication system is used (for the first time on a BMW).

The dry sump system consists of:

- An oil filter
- An oil pump
- A fuel injection pipe

Using less energy than a splash lubrication system, the dry sump system lubricates the gears, the bearings and the synchronizers in a more targeted manner. The controlled oil flow also results in an improved temperature balance, as the cooling air is routed directly from the vehicle underbody to the filter intake opening. This provides continuous cooling of the transmission oil.

The oil filter also improves the oil quality and thus the load-carrying capacity of the gear train.

3.3.3. Synchronization

In first and second gear, triple-cone synchronizers are used. In the other gears, single-cone synchronizers are installed. To improve shift quality, these are equipped with a newly developed carbon friction lining.

3.3.4. Connection dimensions

The connection dimensions for the transmission mounting have been taken over from previous series applications. In this way, the integration into the vehicle environment has been simplified greatly, as it is possible continue using existing peripherals.

3.3.5. Technical data

		K transmission GS6-45BZ
Engine applications in the F10		N55B30M0
Maximum drive torque	[Nm]	470
Axle distance	[mm]	80
Weight with oil	[kg]	43.3
Transmission length	[mm]	646
1st gear ratio		4.110
2nd gear ratio		2.315
3rd gear ratio		1.542

	K transmission GS6-45BZ
4th gear ratio	1.179
5th gear ratio	1.000
6th gear ratio	0.846
Reverse gear ratio	3.727
Final drive ratio	3.231

3.4. G manual transmission

The G manual transmission is of the highest precision, operational smoothness and shifting comfort. Due to the total spread, the transmission offers the best possible utilization of the engine performance. The short shift travel of 55 mm contributes to the transmission shifting comfort.

Highlights

- Slip suppression to prevent clutch slipping
- Start-up speed limitation to minimize the friction work of the clutch (in conjunction with N63 engine)
- External transmission oil cooling (in conjunction with N63 engine)
- Use of long-term oil.

To prevent potential overloading of the clutch a slip suppression system is used. This system enables acceleration under full load without the possibility of the clutch slipping. A speed sensor on the intermediate shaft and the crankshaft sensor calculate the clutch slip; if necessary, the engine torque can be reduced to limit clutch slip.

A start-up speed limitation is used with the N63 engine. This limits the engine speed while the vehicle is at a standstill, depending on the mode of the Dynamic Stability Control DSC, to 3500 – 5500 rpm. This prevents a overheating of the drive plate during the starting process.

The external transmission oil cooling is used with the N63 engine, guarantees reliable operation, even under extreme conditions. A transmission oil pump pumps the transmission oil through the transmission oil cooler. A transmission oil temperature sensor is installed in the transmission, which switches the transmission oil pump on (transmission oil temperature > 130 °C/266°F) and off (transmission oil temperature < 110 °C/230°F).

3.4.1. Technical data

		G transmission GS6-53BZ
Engine applications in the F10		N63B44O0
Maximum drive torque	[Nm]	600
Axle distance	[mm]	94.96
Weight with oil	[kg]	57.6

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3. Manual Transmission

		G transmission GS6-53BZ
Oil quantity	[l]	2.2
Transmission length	[mm]	669
1st gear ratio		4.055
2nd gear ratio		2.396
3rd gear ratio		1.582
4th gear ratio		1.192
5th gear ratio		1.000
6th gear ratio		0.872
Reverse gear ratio		3.677
Final drive ratio		3.08

3.5. Gearshift mechanism

F10 Gear selector switch

Highlights

F10 Powertrain
3. Manual Transmission

- Further development of the typical BMW gearshift
- Improved shifting force curve and shifting precision
- New design of the gearshift arm, matched to the innovative center console design
- New, sporty design with one-piece gearshift lever knob with leather cover
- New leather material "Dakota" with improved durability and appearance
- Ergonomically matched center console and gearshift lever knob position
- Gearshift rod is orbital riveted rather than welded.

The gearshift rod direct connection to the transmission has been maintained.

F10 Powertrain

4. Automatic Transmission

4.1. Description

In the technical documentation, the transmission designation is used to ensure the unambiguous identification of the transmission. Frequently, however, only an abbreviation is used. This short form is used to assign a transmission to a transmission family. For example, we often talk about the GA8HP transmission family, which consists of several transmissions such as the GA8HP45Z, the GA8HP70Z and the GA8HP90Z.

Position	Meaning	Index	Explanation
1	Description	G	Transmission
2	Transmission type	A	Automatic transmission
3	Number of gears	6 8	Six forward gears Eight forward gears
4	Transmission type	HP L R	Hydraulic planetary gear train Designation by GMPT Designation by GMPT
5 + 6	Transferable torque	19 26 32 45 (ZF) 45 (GMPT) 70 90 390	300 Nm gasoline engine 600 Nm gasoline engine 720 Nm gasoline engine 450 Nm gasoline engine, 500 Nm diesel engine 350 Nm gasoline engine 700 Nm gasoline engine and diesel engine 900 Nm gasoline engine 390 Nm, 4th gear 410 Nm gasoline engine
7	Manufacturer	G J R Z H	Getrag Jatco GMPT ZF In-house part

4.2. Variants

Model	Engine	Transmission	Torque converter
528i	N52B30O2	GA8HP45Z	NW235TTD
535i	N55B30M0	GA8HP45Z	NW235TTD
550i	N63B44O0	GA8HP70Z	NW250TTD

4.3. GA8HP transmission

In the F10, the new automatic transmissions GA8HP45Z and GA8HP70Z with eight forward gears and one reverse gear is used.

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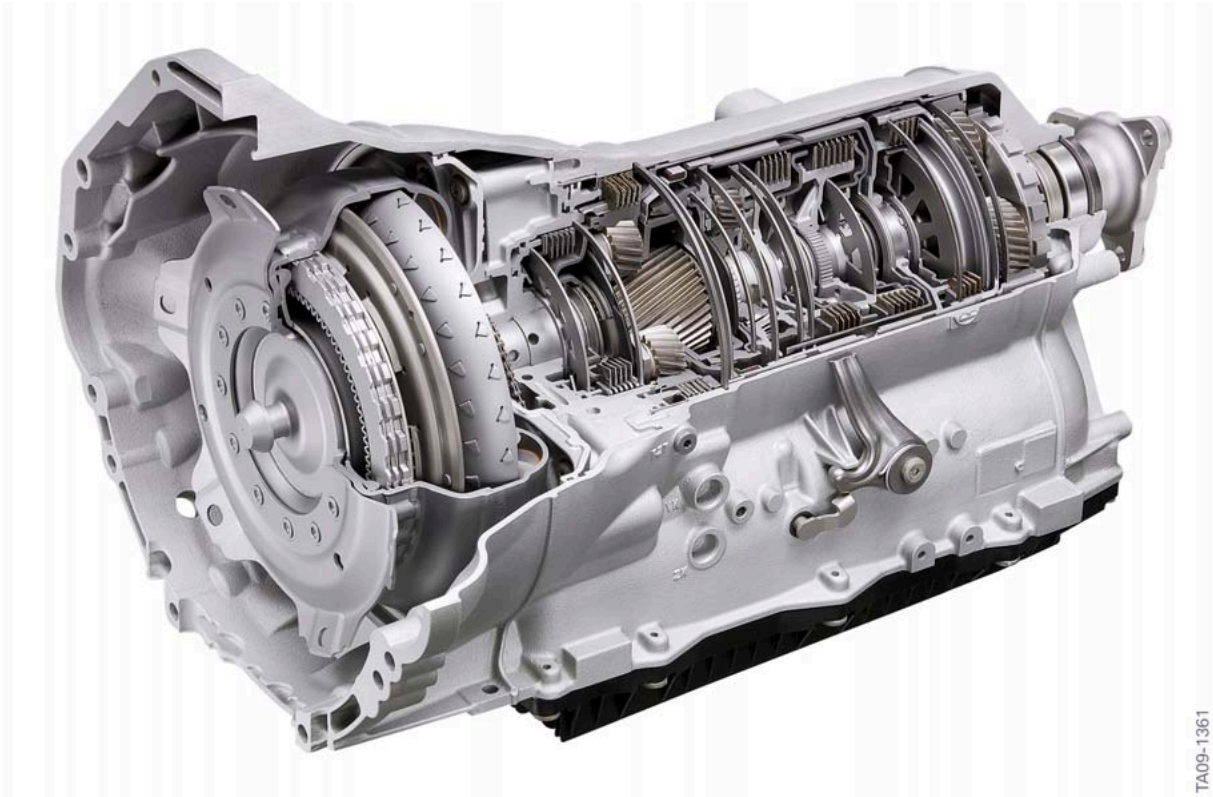
4. Automatic Transmission



Highlights

- Significantly enhanced gearshifts spontaneity
- Greater driving and shifting comfort as a result of a closer gear ratio
- Higher precision control of the converter lockup clutch at low engine loads
- High power transmission of the converter lock-up clutch
- Reduced fuel consumption (-5 to -6 %).

The GA8HP45Z and GA8HP70Z are new developments and will gradually replace the established 6-speed automatic transmissions GA6HP19Z TU and GA6HP26Z TU. The overall gear ratio has been increased from 6.04 to 7.07; the gear to gear ratios have are now closer, thus also reducing the differences in speed when shifting gear. The weight of the transmission has been reduced significantly using a plastic oil pan and other light weight components.

The Electronic Transmission Control (EGS) control unit is integrated in the control unit framework of the electronic immobilizer EWS. This provides better protection against theft.

The operation takes place using the gear selector switch or the shift paddles (option 2TB, sport automatic transmission, via the steering column switch cluster SZL).

In the converter, second-generation mechanical torsional vibration dampers are used:

- Turbine torsional vibration damper (TTD)
- Double-damper converter (ZDW) (Used on diesel X5 and E90 models).

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4. Automatic Transmission

The function and structure of the torque converter are described in the “E70 Automatic transmission” training material available on TIS and ICP.

The vibration isolation reduces the proportion of slip on the converter lockup clutch and enables a larger operating range with the converter lockup clutch closed. This reduces the fuel consumption by 5% to 6% in the consumption cycle (KV01) compared to the TU 6-speed automatic transmission used until now.

4.3.1. Technical data

		GA8HP45Z	GA8HP70Z
Maximum power (with gasoline engines)	[kW]	250	380
Maximum power (with diesel engines)	[kW]	180	240
Maximum torque (with gasoline engines)	[Nm]	450	700
Maximum torque (with diesel engines)	[Nm]	500	700
Maximum permitted engine speed, 1st - 7th gear	[rpm]	7200	
Maximum permitted engine speed, 8th gear	[rpm]	5700	
Maximum permitted engine speed, reverse gear	[rpm]	3500	
1st gear ratio		4.714	
2nd gear ratio		3.143	
3rd gear ratio		2.106	
4th gear ratio		1.667	
5th gear ratio		1.258	
6th gear ratio		1.000	
7th gear ratio		0.839	
8th gear ratio		0.667	
Reverse gear ratio		3.295	3.317

4.4. Gear selector switch

The F10 has the familiar gear selector switch from the F01.

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4. Automatic Transmission

F10 Gear selector switch

F10 Powertrain

5. Rear Axle Differential

5.1. Description

Position	Meaning	Index	Explanation
1 – 3	Transmission type	HAG	Rear axle differential
4 – 6	Size	205 225	Crown wheel pitch circle ø in mm
7	Housing	A	aluminum
8	Transmission type	L	Low friction

5.2. Versions

Model	Transmission	Rear axle differential	Gear ratio i
528i	GA8HP45Z	Rear diff 205AL	3.385
535i	GS6-45BZ	Rear diff 205AL	3.231
535i	GA8HP45Z	Rear diff 205AL	3.077
550i	GS6-53BZ	HAG 225AL	3.08
550i	GA8HP70Z	HAG 225AL	2.813

5.3. Rear axle final drive lightweight construction

Like the F01, the F07 has the new HAG 205AL and HAG 225AL rear axle final drives with aluminum housing.

F10 Rear axle final drive lightweight construction

Highlights:

- Lower weight
  Rear axle differential 205AL: 23.6 kg (incl. oil)

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5. Rear Axle Differential

Rear axle differential 225AL: 29.7 kg (incl. oil)

- Greater power transmission
- Better efficiency

F10 Powertrain

6. Driveshaft and Axle Shafts

6.1. Driveshaft

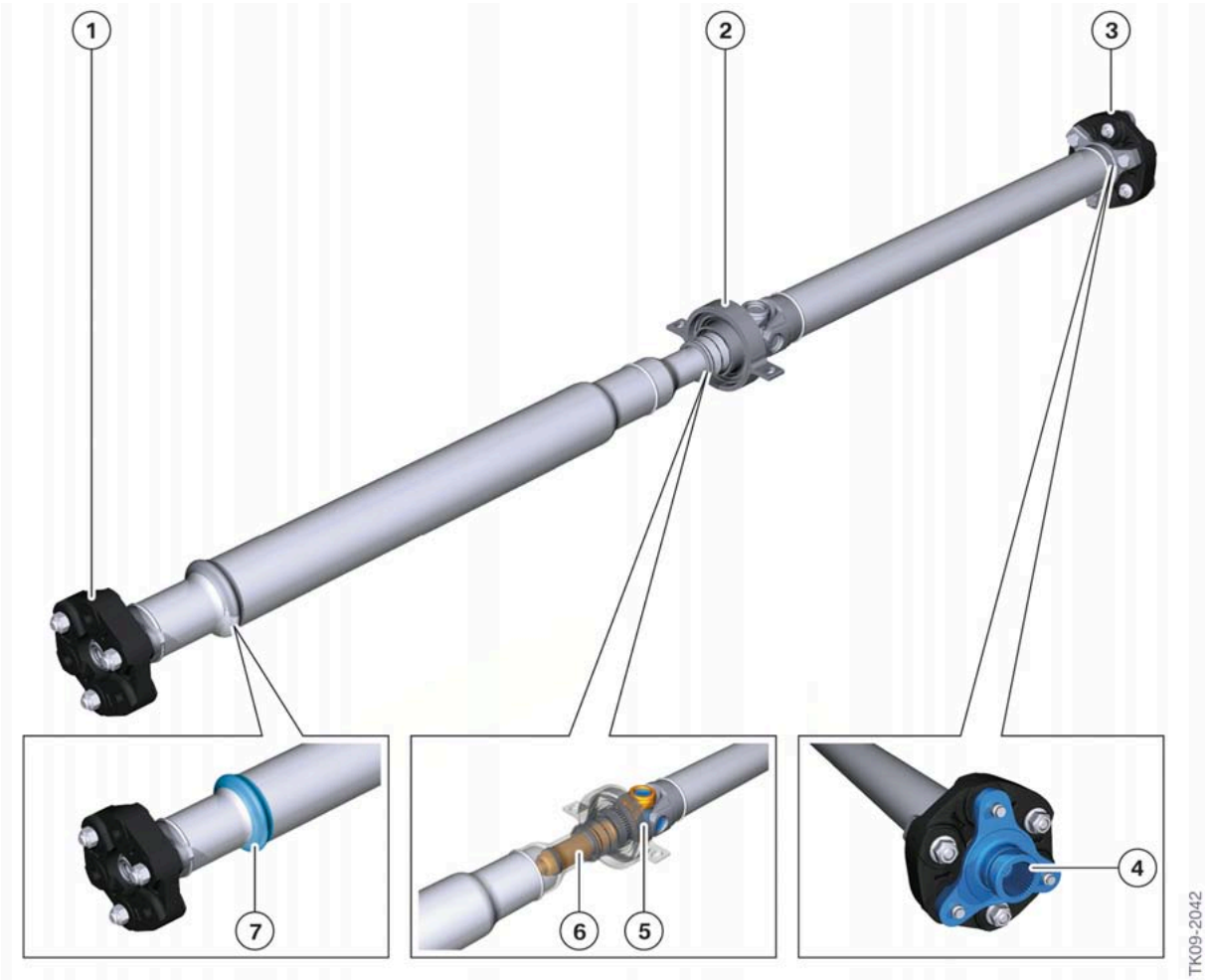
6.1.1. Overview

Each engine-transmission configuration uses a steel driveshaft that is specially adapted to the individual torque requirement.

The main focal points in the design of the driveshaft of the F10 were the torque transfer and comfort requirements with minimal acoustics and vibrations.

The joints, shaft divisions and shaft diameters have been specified in such a way that they do not pass on any disruptive noises or vibrations to the connection points at the body.

On the F10, the driveshafts are connected to the automatic transmission and rear differentials exclusively by means of flexible discs. This minimizes the high-frequency tooth meshing noises on the rear differential.



F10 Propeller shaft

Index	Explanation
1	Flexible disc (on automatic or manual transmission)
2	Center bearing
3	Flexible disc (on rear axle differential)
4	Push-fit connection
5	Universal joint
6	Slide piece connection
7	Crash function

6.1.2. Crash function

The driveshaft absorbs some of the impact energy in the event of a head-on collision. Improvements have been made to the properties of this crash function, which are integrated into the front driveshaft tube. The compression force under which the front driveshaft tube is meant to deform has been further reduced with no effect on torque transfer capability.

6.2. Axle Shafts

6.2.1. Description

Position	Meaning	Index	Explanation
1 + 2	Joint type	VL	VL disc joint
3 – 7	Description	2600i 3300i 4100i	Identification of the size/power transmission

6.2.2. Versions

Model	Transmission	Rear axle differential	Output shaft
528i	GA8HP45Z	Rear diff 205AL	VL-2600i
535i	GS6-45BZ	Rear diff 205AL	VL-3300i
535i	GA8HP45Z	Rear diff 205AL	VL-3300i
550i	GS6-53BZ	HAG 225AL	VL-4100i
550i	GA8HP70Z	HAG 225AL	VL-3300i

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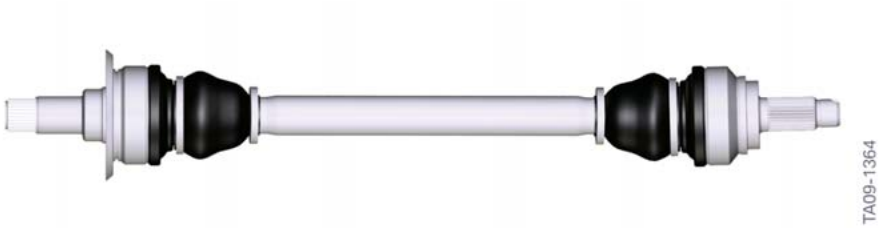
6. Driveshaft and Axle Shafts

6.2.3. Overview



F10 Output shaft

The F10 has output shafts inserted at the wheel and axle differential ends.

The design of the journal at the rear axle differential end depends on the size of the rear axle differential. The journal at the wheel hub end comes in only the one size.

Due to the position of the rear axle differential, the axle shafts on the left and right have different overall lengths.

The shaft between the two joints is designed as a torsionally rigid hollow shaft.

Bayerische Motorenwerke Aktiengesellschaft
Händlerqualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany