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Rexroth GTM Planetary Gearboxes

Project Planning Manual

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Record of Revisions

Description	Release Date	Notes
DOK-GEAR**-GTM*****-PR01-EN-P	10/2003	First edition

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1 Introduction to the Product



Fig. 1-1: Mounting example: GTM Planetary gearbox on an MKD motor

Fields of application In combination with the drive and control systems of BOSCH REXROTH, GTM planetary gearboxes, provide a low-cost automation system for various sectors of industry. They are well-suited for use with gear racks or toothed belts in handling systems with high speed and accelerations (e.g.: loaders, robots).

The low-backlash, ground and matched gearing permits the execution of exact positioning tasks. Furthermore, the gearboxes are suited for S1-operation-required for use in printing sector.

Gradation

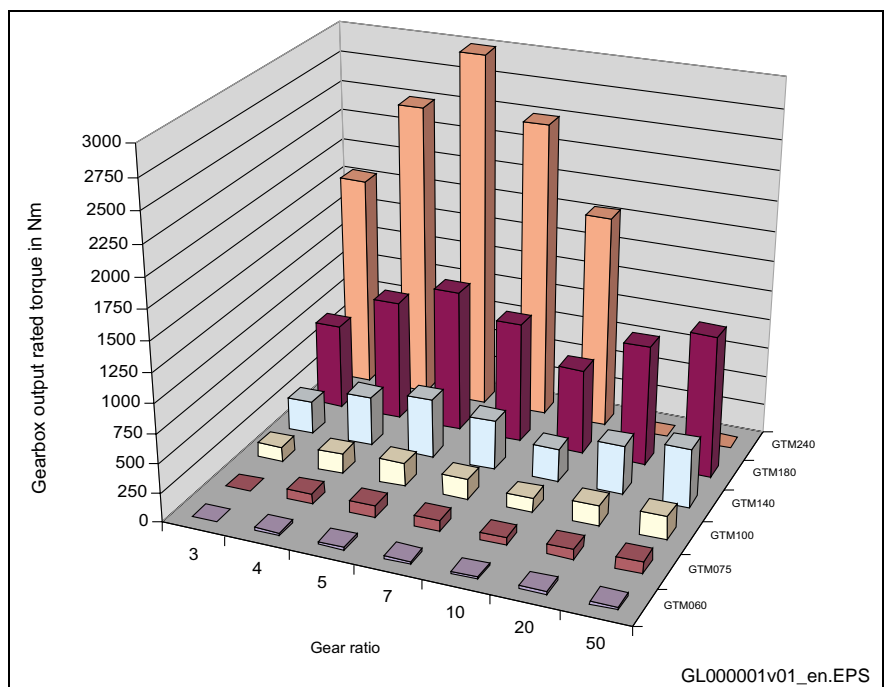


Fig. 1-2: Nominal torque gradation of the GTM planetary gearboxes.

Mode of functioning The GTM series of planetary gearboxes offers a coaxial input and output. The output shaft of the motor is connected to the sun gear with a compression clamp coupling. This sun gear drives the planetary gears, which revolve within the ring gear. The planetary gears are fixed in the planetary carrier, which acts as the output. By dividing the load among the planetary gears, a balanced force splitting occurs. This allows for a very compact gearbox with a high power density.

High operational reliability

- Maintenance-free operation through lifetime lubrication
- Use under adverse environmental conditions is possible thanks to the completely enclosed IP65 design.
- Viton seals on the input and output provide safe and effective protection.
- Hermetically sealed housing
- Power transfer free from backlash-free torque transmission via the compression coupling.

High power

- High accuracy through use of ground, gears and low backlash.
- High torsional rigidity by optimized planetary gears supported on both sides with stable needle bearings.
- High efficiency, low temperature and minimum power loss made possible by using the smallest possible seal diameters.
- Low running noise by optimized gear profiles.
- High emergency stop torque made possible by internal transferred power.
- High dynamic because of low inertia
- Low weight through to compact design

Easy to mount to machine

- The high radial-load capability and tilt resistance makes it possible to directly mount a pinion or pulley.
- The design of the output shaft with a solid shaft shoulder makes axial tightening of output elements simple.
- The gearbox can be mounted in any position due to the bearing design and its pumping action, a sufficient lubrication supply is always ensured.
- Flange mounting is permitted in all installation positions because of the B05 design (EN 60034-7:1996-06).
- The output elements can be mounted in two different ways:
 - Compression fitting on the smooth shaft (standard), or
 - Connection by means of an output shaft with keyway

1.1 About this Documentation

This document contains safety regulations, technical data, and operating instructions for gearboxes. The individual chapters can be subdivided into the following focal points:

Chapter	Title	Content
1	Introduction to the Product	General information
2	Important Instructions on Use	Safety
3	Safety Notes	
4	Dimensioning and Selection	Product description (for planners and machine constructors)
5	Notes Application	
6	Technical Data	
7	Dimensional Details	
8	Type Codes	Practical (for operating and maintenance personnel)
9	Handling, Transport and Storage	
10	Assembly	
11	Startup, Operation, and Maintenance	
12	Ordering Data	General information
13	Appendix	
14	Service and Support	
15	Index	

Fig. 1-3: Document structure

Standards

This documentation refers to German, European and international technical standards. Documents and sheets on standards are subject to copyright protection and may therefore not be passed on to third parties by Bosch Rexroth. If necessary, please contact your local authorized sales outlet or, in Germany, contact:

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Feedback

Your experiences are an essential part of the process of improving both product and documentation.

Please do not hesitate to inform us of any mistakes you detect in this documentation or of any modifications you might desire. We would appreciate your feedback.

Please send your remarks to:

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2 Important Instructions on Use

2.1 Intended Use

Introduction

Bosch Rexroth products are designed and manufactured using state-of-the-art technology. Before they are delivered, they are checked for their operational safety.

The products may only be used as intended. If they are not used as intended, situations may arise resulting in injuries to property and persons.

Note: For damage caused by products not being used as intended, Bosch Rexroth gives no warranty, assumes no liability, and will not pay for any damages. Any risks resulting from the products not being used as intended are the sole responsibility of the user.

Before using Bosch Rexroth products, the following requirements must be fulfilled so as to ensure that they are used as intended:

- Anyone handling one of the products in any manner must read and understand the appropriate safety instructions and the intended use.
- Regarding hardware components, the product concerned must be left in its original state, i.e. it is not permitted to modify it structurally. Software products may not be decompiled; their source codes may not be altered.
- Damaged or defective products may not be installed or put into operation.
- It must be ensured that the products are installed according to the instructions mentioned in the documentation.

Fields of Use and Application

Typical application ranges of the GTM planetary gearboxes are:

- Handling and mounting systems,
- Packaging and food-processing machines,
- Printing and paper-processing machines and
- Machine tools

Controlling and monitoring of the motor/-gearbox combination may require connection of additional sensors and actuators.

Note: The gearboxes may only be used with the accessories specified in the documentation. Components which are not expressly named may neither be mounted nor connected.

The motors may be operated only in the expressly specified component configurations and combinations and with the software and firmware specified in the appropriate functional description.

Any drive controller must be programmed before startup, in order to ensure that the motor executes the functions specific to the particular application.

The gearboxes may only be operated under the assembly, mounting and installation conditions, in the position of use, and under the environmental conditions (temperature, degree of protection, humidity, EMC) specified in this documentation.

2.2 Non-Intended Use

Any use of the planetary gearboxes outside of the fields of application mentioned above or under operating conditions and technical data other than those specified in this documentation is considered to be “non-intended use”.

Planetary gearboxes may not be used if . . .

- they are subjected to operating conditions which do not comply with the environmental conditions described above (e.g. operation under water, under extreme variations in temperature or extreme maximum temperatures is not permitted),
- the intended application is not explicitly released by Bosch Rexroth. Please be absolutely sure to also observe the statements made in the general safety instructions.

3 Safety Instructions for Electric Drives and Controls

3.1 Introduction

Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

Do not attempt to install or start up this equipment without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation of the equipment prior to working with the equipment at any time. If you do not have the user documentation for your equipment, contact your local Bosch Rexroth representative to send this documentation immediately to the person or persons responsible for the safe operation of this equipment.

If the equipment is resold, rented or transferred or passed on to others, then these safety instructions must be delivered with the equipment.



WARNING

Improper use of this equipment, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

3.2 Explanations

The safety instructions describe the following degrees of hazard seriousness in compliance with ANSI Z535. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions.

Warning symbol with signal word	Degree of hazard seriousness according to ANSI
 DANGER	Death or severe bodily harm will occur.
 WARNING	Death or severe bodily harm may occur.
 CAUTION	Bodily harm or material damage may occur.

Fig. 3-1: Hazard classification (according to ANSI Z535)

3.3 Hazards by Improper Use



DANGER

**High voltage and high discharge current!
Danger to life or severe bodily harm by electric shock!**



DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!



WARNING

High electrical voltage due to wrong connections! Danger to life or bodily harm by electric shock!



WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!



CAUTION

Surface of machine housing could be extremely hot! Danger of injury! Danger of burns!



CAUTION

Risk of injury due to improper handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock or incorrect handling of pressurized systems!



CAUTION

Risk of injury due to incorrect handling of batteries!

3.4 General Information

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Only persons who are trained and qualified for the use and operation of the equipment may work on this equipment or within its proximity.
 - The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
 - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and equipment on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The equipment is designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Use only safety features and applications that are clearly and explicitly approved in the Project Planning Manual.
For example, the following areas of use are not permitted: construction cranes, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, transport of hazardous goods, nuclear applications, applications sensitive to high frequency, mining, food processing, control of protection equipment (also in a machine).
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
The machine and installation manufacturer must
 - make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
 - make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.

- Operation is only permitted if the national EMC regulations for the application are met.
The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.
- Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

3.5 Protection Against Contact with Electrical Parts

Note: This section refers to equipment and drive components with voltages above 50 Volts.

Touching live parts with voltages of 50 Volts and more with bare hands or conductive tools or touching ungrounded housings can be dangerous and cause electric shock. In order to operate electrical equipment, certain parts must unavoidably have dangerous voltages applied to them.



DANGER

High electrical voltage! Danger to life, severe bodily harm by electric shock!

- ⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain or repair this equipment.
 - ⇒ Follow general construction and safety regulations when working on high voltage installations.
 - ⇒ Before switching on power the ground wire must be permanently connected to all electrical units according to the connection diagram.
 - ⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the ground wire is not permanently connected to the points of the components provided for this purpose.
 - ⇒ Before working with electrical parts with voltage higher than 50 V, the equipment must be disconnected from the mains voltage or power supply. Make sure the equipment cannot be switched on again unintended.
 - ⇒ The following should be observed with electrical drive and filter components:
 - ⇒ Wait five (5) minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
 - ⇒ Never touch the electrical connection points of a component while power is turned on.
 - ⇒ Install the covers and guards provided with the equipment properly before switching the equipment on. Prevent contact with live parts at any time.
 - ⇒ A residual-current-operated protective device (RCD) must not be used on electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.
 - ⇒ Electrical components with exposed live parts and uncovered high voltage terminals must be installed in a protective housing, for example, in a control cabinet.
-

To be observed with electrical drive and filter components:



DANGER

**High electrical voltage on the housing!
High leakage current! Danger to life, danger of
injury by electric shock!**

- ⇒ Connect the electrical equipment, the housings of all electrical units and motors permanently with the safety conductor at the ground points before power is switched on. Look at the connection diagram. This is even necessary for brief tests.
- ⇒ Connect the safety conductor of the electrical equipment always permanently and firmly to the supply mains. Leakage current exceeds 3.5 mA in normal operation.
- ⇒ Use a copper conductor with at least 10 mm² cross section over its entire course for this safety conductor connection!
- ⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. Otherwise, high voltages can occur on the housing that lead to electric shock.

3.6 Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 0 and 50 Volts on Rexroth products are protective low voltages designed in accordance with international standards on electrical safety.



WARNING

**High electrical voltage due to wrong
connections! Danger to life, bodily harm by
electric shock!**

- ⇒ Only connect equipment, electrical components and cables of the protective low voltage type (PELV = Protective Extra Low Voltage) to all terminals and clamps with voltages of 0 to 50 Volts.
- ⇒ Only electrical circuits may be connected which are safely isolated against high voltage circuits. Safe isolation is achieved, for example, with an isolating transformer, an opto-electronic coupler or when battery-operated.

3.7 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of the connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily injury and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.



Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

- ⇒ Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. Unintended machine motion is possible if monitoring devices are disabled, bypassed or not activated.
- ⇒ Pay attention to unintended machine motion or other malfunction in any mode of operation.
- ⇒ Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
 - use safety fences
 - use safety guards
 - use protective coverings
 - install light curtains or light barriers
- ⇒ Fences and coverings must be strong enough to resist maximum possible momentum, especially if there is a possibility of loose parts flying off.
- ⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the machine if the emergency stop is not working.
- ⇒ Isolate the drive power connection by means of an emergency stop circuit or use a starting lockout to prevent unintentional start.
- ⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone. Safe standstill can be achieved by switching off the power supply contactor or by safe mechanical locking of moving parts.
- ⇒ Secure vertical axes against falling or dropping after switching off the motor power by, for example:
 - mechanically securing the vertical axes
 - adding an external braking/ arrester/ clamping mechanism
 - ensuring sufficient equilibration of the vertical axes

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!
- ⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
 - maintenance and repair work
 - cleaning of equipment
 - long periods of discontinued equipment use
- ⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such equipment cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

3.8 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated near current-carrying conductors and permanent magnets in motors represent a serious health hazard to persons with heart pacemakers, metal implants and hearing aids.



WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- ⇒ Persons with heart pacemakers, hearing aids and metal implants are not permitted to enter the following areas:
- Areas in which electrical equipment and parts are mounted, being operated or started up.
 - Areas in which parts of motors with permanent magnets are being stored, operated, repaired or mounted.
- ⇒ If it is necessary for a person with a heart pacemaker to enter such an area, then a doctor must be consulted prior to doing so. Heart pacemakers that are already implanted or will be implanted in the future, have a considerable variation in their electrical noise immunity. Therefore there are no rules with general validity.
- ⇒ Persons with hearing aids, metal implants or metal pieces must consult a doctor before they enter the areas described above. Otherwise, health hazards will occur.
-

3.9 Protection Against Contact with Hot Parts



CAUTION

**Housing surfaces could be extremely hot!
Danger of injury! Danger of burns!**

- ⇒ Do not touch housing surfaces near sources of heat!
Danger of burns!
 - ⇒ After switching the equipment off, wait at least ten (10) minutes to allow it to cool down before touching it.
 - ⇒ Do not touch hot parts of the equipment, such as housings with integrated heat sinks and resistors.
Danger of burns!
-

3.10 Protection During Handling and Mounting

Under certain conditions, incorrect handling and mounting of parts and components may cause injuries.



CAUTION

Risk of injury by incorrect handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock!

- ⇒ Observe general installation and safety instructions with regard to handling and mounting.
 - ⇒ Use appropriate mounting and transport equipment.
 - ⇒ Take precautions to avoid pinching and crushing.
 - ⇒ Use only appropriate tools. If specified by the product documentation, special tools must be used.
 - ⇒ Use lifting devices and tools correctly and safely.
 - ⇒ For safe protection wear appropriate protective clothing, e.g. safety glasses, safety shoes and safety gloves.
 - ⇒ Never stand under suspended loads.
 - ⇒ Clean up liquids from the floor immediately to prevent slipping.
-

3.11 Battery Safety

Batteries contain reactive chemicals in a solid housing. Inappropriate handling may result in injuries or material damage.



Risk of injury by incorrect handling!

- ⇒ Do not attempt to reactivate discharged batteries by heating or other methods (danger of explosion and cauterization).
- ⇒ Never charge non-chargeable batteries (danger of leakage and explosion).
- ⇒ Never throw batteries into a fire.
- ⇒ Do not dismantle batteries.
- ⇒ Do not damage electrical components installed in the equipment.

Note: Be aware of environmental protection and disposal! The batteries contained in the product should be considered as hazardous material for land, air and sea transport in the sense of the legal requirements (danger of explosion). Dispose batteries separately from other waste. Observe the legal requirements in the country of installation.

3.12 Protection Against Pressurized Systems

Certain motors and drive controllers, corresponding to the information in the respective Project Planning Manual, must be provided with pressurized media, such as compressed air, hydraulic oil, cooling fluid and cooling lubricant supplied by external systems. Incorrect handling of the supply and connections of pressurized systems can lead to injuries or accidents. In these cases, improper handling of external supply systems, supply lines or connections can cause injuries or material damage.



Danger of injury by incorrect handling of pressurized systems !

- ⇒ Do not attempt to disassemble, to open or to cut a pressurized system (danger of explosion).
- ⇒ Observe the operation instructions of the respective manufacturer.
- ⇒ Before disassembling pressurized systems, release pressure and drain off the fluid or gas.
- ⇒ Use suitable protective clothing (for example safety glasses, safety shoes and safety gloves)
- ⇒ Remove any fluid that has leaked out onto the floor immediately.

Note: Environmental protection and disposal! The media used in the operation of the pressurized system equipment may not be environmentally compatible. Media that are damaging the environment must be disposed separately from normal waste. Observe the legal requirements in the country of installation.

Notes

4 Dimensioning and selection

4.1 Dimensioning

Applications for GTM planetary gearboxes are characterized by the following curves:

- Triangular speed curve with pause interval
- Operation with constant speed and pause interval
- Operation with trapezoidal speed curve and pause interval
- Continuous operation (S1)

The speed-time curves define the dimension criteria.

Triangle operation with pause interval

This operation is characteristic for all highly-dynamic feeds. These are often found in roll-feed mechanisms in the sheet metal, paper, plastic and packaging industries.

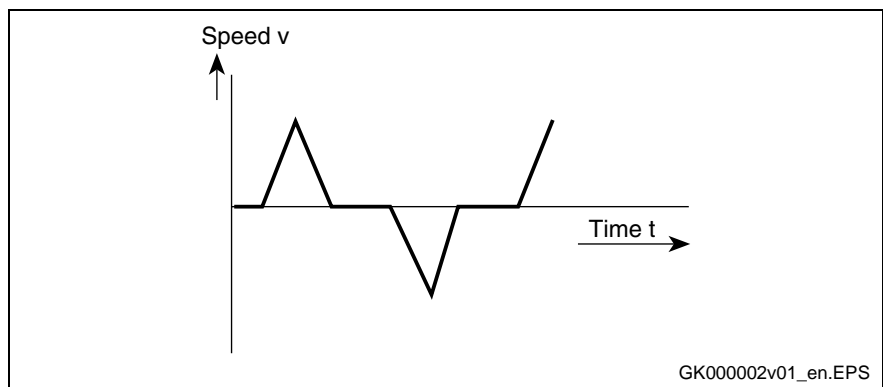


Fig. 4-1: Triangulare operation

The dimensioning of this operation is mainly made according to the necessary maximum torque M_{\max} and the effective torque M_{eff} .

Constant speed with pause interval

This operation is characteristic for all highly-dynamic feeds. These are often found in winding machines, drive rolls and in portioning devices in the sheet-metal, paper, plastic or packaging industries.

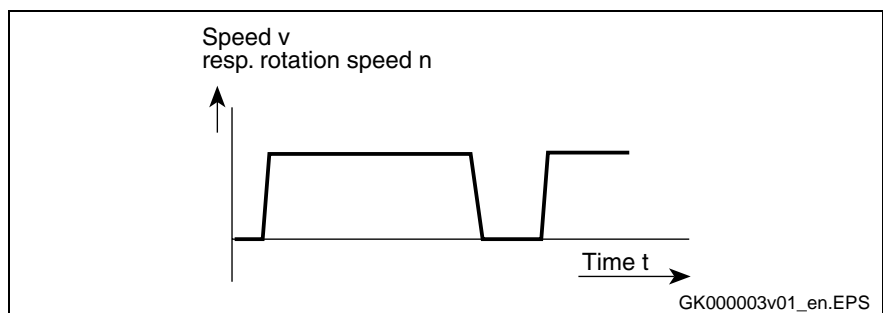


Fig. 4-2: Operation with constant speed with pause intervals

The dimensioning of this operational mode is mainly made according to the necessary continuous torque M_{dN} and the average velocity V_{middle} or the mean speed n_{mittel} .

Triangle operation with pause interval

This mode of operation is characteristic for the most highly-dynamic feeds. They can be found in loaders and handling systems in nearly all industry sectors.

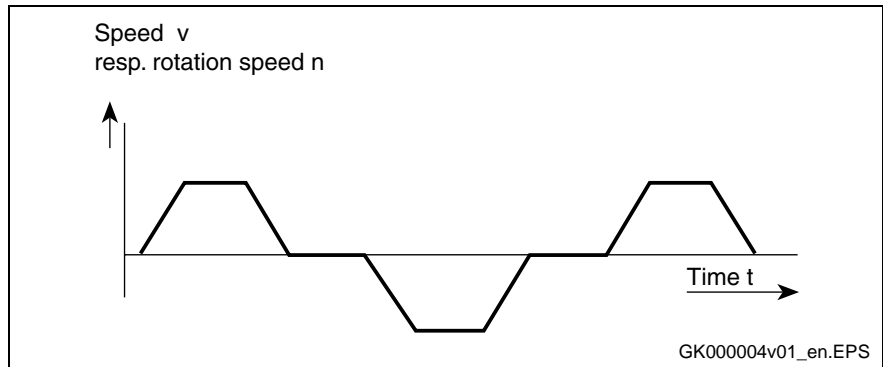


Fig. 4-3: Trapezoidal operation

The dimensioning of this operational mode is mainly made according to the necessary maximum torque M_{\max} in the acceleration phase, the effective torque M_{eff} over the total cycle-time and the middle speed v_{mittel} resp. the middle speed n_{mittel} .

Constant speed without pause interval (S1)

This mode of operation is characteristic for drives in printing machines.

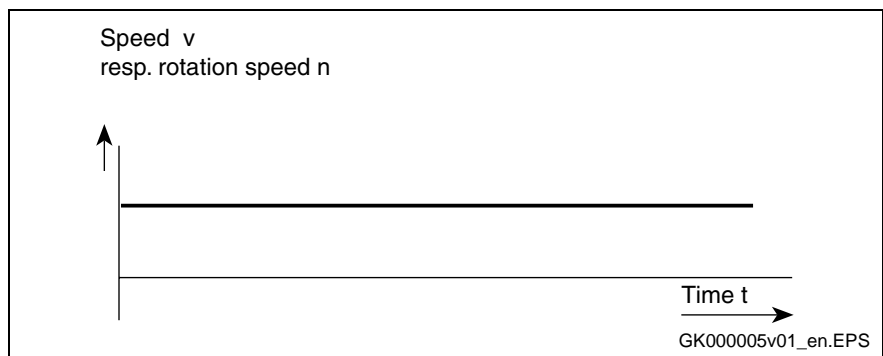


Fig. 4-4: Constant speed operation

The dimensioning is made according to the necessary continuous torque M_{dN} and the velocity v or the speed n .

4.2 Selection

Drive-determined sizes The selection of the suitable motor/-gearbox combination, operating with a drive-control device, is to be taken the following into consideration:

- Frictional torque
- Starting torque
- Processing torque
- Accelerating torque
- Effective speed
- Necessary speed
- ON time

Dimensioning criteria The motor/-gearbox combination must fulfill the following conditions:

- The necessary speed has to be able to be reached.
- The continuous torque rating of the motor/-gearbox combination has to be higher than the effective load torque.
- The maximum operating torque has to be higher than the sum of the frictional, starting and processing torque.
- The maximum torque has to be higher than the sum of the frictional, starting and processing torque.
- The required acceleration time has to be within the limit of the relevant drive selection lists.
- The ON time of the GTM planetary gearboxes has to be smaller than 60% of the specified technical data in S4 and S5-operation.
- The cycles of the operation modes S4 and S5 should not exceed 1,000 cycles per hour. If higher cycle rates are necessary, the GTM gearbox must be derated accordingly (see Fig. 5-3).

Note: It must be ensured that

- the maximum motor torque is smaller than the maximum gearbox-input torque.
 - the maximum motor speed is less than the maximum permissible gearbox-input speed.
-

5 Notes Regarding Application

5.1 Conditions for Use

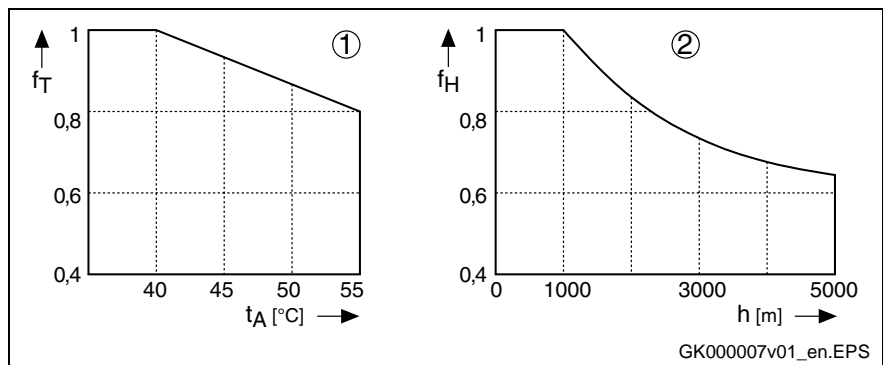
**Maximum ambient temperature,
maximum elevation**

The power data as stated in the selection data will be reached at the following conditions:

Ambient temperature 0..+ 40°C

Elevation: 0...1,000 m above sea level

The power data must be reduced according to the diagram below at deviating conditions. If deviating ambient temperatures and higher setup elevations occur at the same time, the power data has to be multiplied with both factors.



- 1: Utilization at an ambient temperature of more than 40°C.
2: Utilization at elevations over 1,000 m.

Fig. 5-1: Utilization at higher ambient temperature and higher setup elevation

Protection Class

According to DIN EN 60529-1:2000-09, the AC motor with mounted planetary gearbox GTM is protected by the housing against

- contact of parts under load or moving parts
- penetration of firm parts and water

AC motors and mounted GTM servo gearboxes have IP 65 protection class

- for the housing of motor and gearbox
- for the output shaft of the gearbox
- for the power and encoder connection on the motor at professional mounting.

The **first code number** defines the degree of protection against contact and penetration of foreign particles. The code number 6 means

- Protection against penetration of dust (dust-proof)
- Complete protection against contact.

The **second code number** defines the degree of protection against water. The code number 5 means

- Protection against a water jet from a nozzle directed against the housing from all directions (jet water)

Housing paint

The housings are primed and can additionally painted with up to 40 µm of paint.

The prime protects against

- weather, yellowing and chalking
- diluted acid and alkali

The primer can, however, peel when the primer is exposed to repeated steam cleaning.

Operation S5 (intermittent operation)

GTM planetary gearboxes are suitable for the intermittent operation (intermittent operation with braking) according to EN 60034-1. The duty cycle should herewith not surpass 60%.

$$ED = \frac{T_A + T_B + T_{Br}}{T_s} \cdot 100\% \leq 60\%$$

A cycle during intermittent operation consists of an acceleration and a decelerating.

The specified data of the gearboxes in the chapter “Technical data” are valid for 1,000 cycles per hour.

For more than 1,000 cycles per hour, the technical data have to be reduced by a factor (see Fig. 5-3).

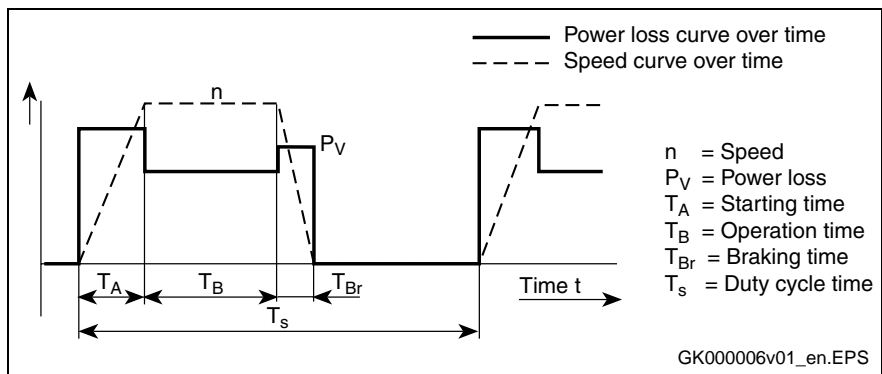


Fig. 5-2: Operation S5 (intermittent operation with electrical braking)

Reducing at higher cycles

Are higher cycles than 1.000 cycles per hour needed, the following reduced technical data, regarding torque and power are valid.

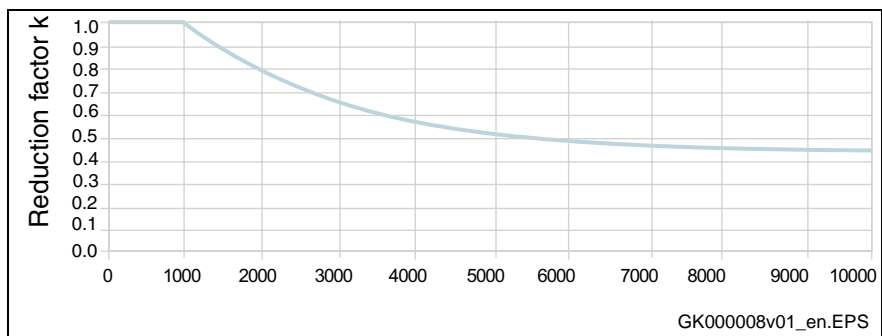


Fig. 5-3: Reducing factor at higher cycles

Continuous Operation (S1)

GTM planetary gearboxes are suited for S1 operation according to EN 60034-1.

5.2 Mechanical features

Construction, installation position GTM Rexroth planetary gearboxes are manufactured for flange mounting. The installation positions can be done as described in Fig. 5-4 according to EN 60034-7:1996-06

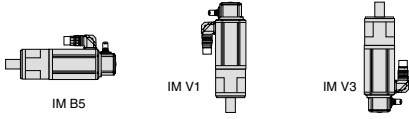
Gearbox Construction	Permittable Construction according to EN 60034-7:1996-06	!!! !!! Important Installation Note!!!
B05		<p>Vertical installation position IM V3 When installing IM V3 (vertically, output shaft upwards) dam of liquid on the drive shaft has to be avoided, as liquid can penetrate into the gearbox over a longer period of time.</p>

Fig. 5-4: Allowable installation positions

The output shafts are available in the following variants:

- **Smooth output shaft (standard)**

For a smooth adhesive shaft-hub connection.

Therewith, a higher smooth running and a free of clearance connection between shaft and hub.

Note: We recommend using output shafts with friction shaft-hub connections.

or

- **Output shaft with key according to DIN 6885-1:1968-08**

for a smooth adhesive shaft-hub connection.

This connection mode is suitable for uni-directional/-constant speed applications. This requires additional axial fixation of the hub. Therefore, the gearbox output shaft has a centering hole with a thread (see dimension sheet).

Caution! Half key balanced according to DIN ISO 8821

Shaft loading To properly check the shaft loading, the axial and radial shaft loads have to be checked separately:

The radial shaft load must be checked with respect to

- the point of application of force and
- the average speed

Please see the diagrams in chapter 6.2 "Permissible shaft loading". All ratings are based on an a rated bearing time of 30,000 operation hours (bearing calculation according to DIN ISO 281:1993-01).

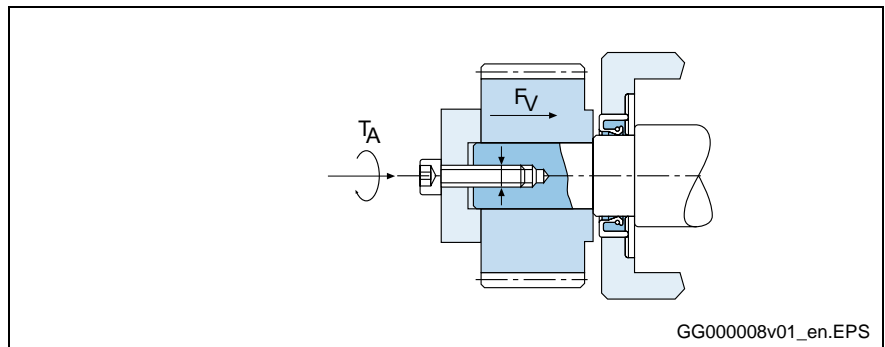
The axial shaft loading is also described in the chapter 6.2 "Permissible shaft loading".

Assembly of output elements The output shaft of the GTM gearboxes is fitted with a shoulder, which is well-suited for the support of axial forces, especially for keyed connections.

The proper tightening torque (T_A), and pully preload forces (F_V), for mounting the output unit can be found in the following table.

Size (one stage & two stage)						
	GTM060	GTM075	GTM100	GTM140	GTM180	GTM240
Thread	M5	M8	M12	M16	M20	M20
T_A [Nm]	5,5	23	79	195	390	390
F_V [kN]	6,5	17	40	75	120	120

Fig. 5-5: Tightening torque, and preload of output shaft



T_A : Tightening torque
 F_V : Preload

Fig. 5-6: Output shaft

5.3 Combination possibilities of GTM planetary gearboxes with AC-motors

The following table shows the combination possibilities of GTM planetary gearboxes with Bosch Rexroth AC-Servo motors.

Planetary gearbox	Motor type						
	MKD	MHD	MKE	MHP	2AD	ADP	ADF
GTM060	MKD025 MKD041	MHD041	MKE035 MKE037 MKE045 MKE047	MHP041	Not possible		
GTM075	MKD041 MKD071	MHD041 MHD071	MKE045 MKE047	MHP041 MHP071			
GTM100	MKD071 MKD090	MHD071 MHD090 MHD093 MHD095	MKE096 MKE098	MHP071 MHP090 MHP093			
GTM140	MKD071 MKD090 MKD112	MHD071 MHD090 MHD093 MHD095 MHD112 MHD115	MKE096 MKE098 MKE116 MKE118	MHP071 MHP090 MHP093 MHP112 MHP115			
GTM180	MKD112	MHD093 MHD095 MHD112 MHD115 MHD131	MKE116 MKE118	MHP093 MHP112 MHP115	2AD100 2AD101 2AD104 2AD132 2AD134	ADP104 ADP134	ADF100 ADF104 ADF132 ADF134
GTM240		MHD131			2AD132 2AD134 2AD160 2AD164	ADP134 ADP164	ADF132 ADF134

Fig. 5-7: Possible motor/-gearbox combination with GTM planetary gearboxes

Note: The AC-motors must have a smooth drive shaft to mount the GTM gearboxes.

6 Technical Data

6.1 Technical data for intermittent and continuous operation

Ratio-dependent data

Description	Symbol		Ratio i	GTM060	GTM075	GTM100	GTM140	GTM180	GTM240
Max. input speed Nm	$n_{in, max}$	one-stage	3	x	x	4000	3200	2500	2000
			4	5000	5000	4000	3200	2500	2000
			5	6300	6300	5000	4000	3200	2500
			7	8000	8000	6300	5000	4000	3000
		two-stage	10	10000	10000	8000	6300	5000	3500
			20	6300	6300	5000	4000	3200	x
			50	10000	10000	8000	6300	5000	x
Max. input torque ¹⁾ Nm	$M_{in, max}$	one-stage	3	x	x	73.3	186.7	480	1000
			4	12.5	42.5	85	210	510	1250
			5	10	40	80	200	480	1200
			7	7.1	24.3	48.6	120	291.4	714.3
		two-stage	10	4	11	22	56	144	300
			20	2.5	8.5	17	42	102	x
			50	1	4	8	20	48	x
Max. output speed Nm	$n_{out, max}$	one-stage	3	x	x	1333	1067	833	667
			4	1250	1250	1000	800	625	500
			5	1260	1260	1000	800	640	500
			7	1143	1143	900	714	571	429
		two-stage	10	1000	1000	800	630	500	350
			20	315	315	250	200	160	x
			50	200	200	160	126	100	x
Max. output torque ¹⁾ Nm	$M_{out, max}$	one-stage	3	x	x	220	560	1440	3000
			4	50	170	340	840	2040	5000
			5	50	200	400	1000	2400	6000
			7	50	170	340	840	2040	5000
		two-stage	10	40	110	220	560	1440	3000
			20	50	170	340	840	2040	x
			50	50	200	400	1000	2400	x
For more technical data - see next page									
1) at max. 1.000 cycles/h									

Description	Symbol		Ratio i	GTM060	GTM075	GTM100	GTM140	GTM180	GTM240
Nominal initial speed rpm	n _{in, nenn}	one-stage	3	x	x	2300	1800	1300	800
			4	3000	3000	2500	2000	1500	1000
			5	4000	4000	3000	2500	2000	1200
			7	5000	5000	4000	3000	2500	1500
			10	6000	6000	5000	4000	3000	2000
		two-stage	20	4000	4000	3000	2500	2000	x
			50	6000	6000	5000	4000	3000	x
Nominal input torque Nm	M _{in, nenn}	one-stage	3	x	x	40	93.3	240	600
			4	6.25	21.3	42.5	105	255	625
			5	5	20	40	100	240	600
			7	3.6	12.1	24.3	60	145.7	357.1
			10	2	6	12	28	72	180
		two-stage	20	1.25	4.25	8.5	21	51	x
			50	0.5	2	4	10	24	x
Nominal output torque Nm	M _{out, nenn}	one-stage	3	x	x	120	280	720	1800
			4	25	85	170	420	1020	2500
			5	25	100	200	500	1200	3000
			7	25	85	170	420	1020	2500
			10	20	60	120	280	720	1800
		two-stage	20	25	85	170	420	1020	x
			50	25	100	200	500	1200	x
Moment of inertia ²⁾ Kg cm ²	J	one-stage	3	x	x	2.8	8.2	36	128
			4	0.16	0.55	2	6.75	24.5	97.6
			5	0.16	0.47	1.64	5.54	18.8	76.4
			7	0.15	0.41	1.36	4.59	14.5	59.9
			10	0.14	0.38	1.22	4.1	12.3	51.1
		two-stage	20	0.12	0.47	1.56	5.29	6.95	x
			50	0.1	0.47	1.44	4.96	5.45	x

2) Moment of inertia of the gearbox referred to the input of the gearbox

Fig. 6-1: Ratio-dependent data

General Data

Description	Symbol	Unit		GTM060	GTM075	GTM100	GTM140	GTM180	GTM240
Backlash ³⁾	$\Delta\varphi$	arcmin	one-stage	≤ 6 (≤ 3)	≤ 6 (≤ 3)	≤ 4 (≤ 2)	≤ 4 (≤ 2)	≤ 4 (≤ 2)	≤ 4 (≤ 2)
			two-stage	≤ 8 (≤ 6)	≤ 8 (≤ 6)	≤ 6 (≤ 4)	≤ 6 (≤ 4)	≤ 6 (≤ 4)	≤ 6 (≤ 4)
Torsional rigidity ⁴⁾	D	Nm/ arcmin	one-stage	3.5	8.2	24	48	148	340
			two-stage						x
Efficiency	η	%	one-stage	≥ 97					
			two-stage	≥ 94					
Lifetime	L_h	h	one-stage	$> 20,000$					
			two-stage						
Lubrication			one-stage	Filled for life - closed system					
			two-stage						
Permittable ambient temperature	T_{Um}	°C	one-stage	0...45°C					
			two-stage						
Permittable gearbox housing temperature	T_G	°C	one-stage	-10°C...+90°C					
			two-stage						
Noise level	L_p	dB (A)	one-stage	≤ 63	≤ 68	≤ 68	≤ 72	≤ 72	≤ 72
			two-stage						x
International Protection Class (Ingress Protection)			one-stage	IP 65					
			two-stage						
Weight	m	kg	one-stage	1.6	2.9	5.7	11.5	27	62
			two-stage	2.2	3.8	7.5	15	35	x
3) at gearbox output with 3% of the nominal output torque applied and the gearbox input side blocked									
4) torsional rigidity of the gearbox output with the input side blocked									

Fig. 6-2: General Data

Note: The GTM planetary gearboxes are designed for the indicated specified permittable technical data. With regard to the operating safety it is only allowed to use the gearboxes in this case under view of all operating factors. Any sort of overload of the gearbox is classified as non-intended use. Any changes made to the gearbox voids all liability on the part of Bosch-Rexroth for any damages.

6.2 Technical data for increased lifetime

The technical data described in chapter 6.1 are based on a calculated gearbox-lifetime of $L_h = 20,000$ hours.

If a gearbox-lifetime of more than 20,000h is required, the technical data described in chapter 6.1 regarding torque and speed have to be reduced by the following diagram.

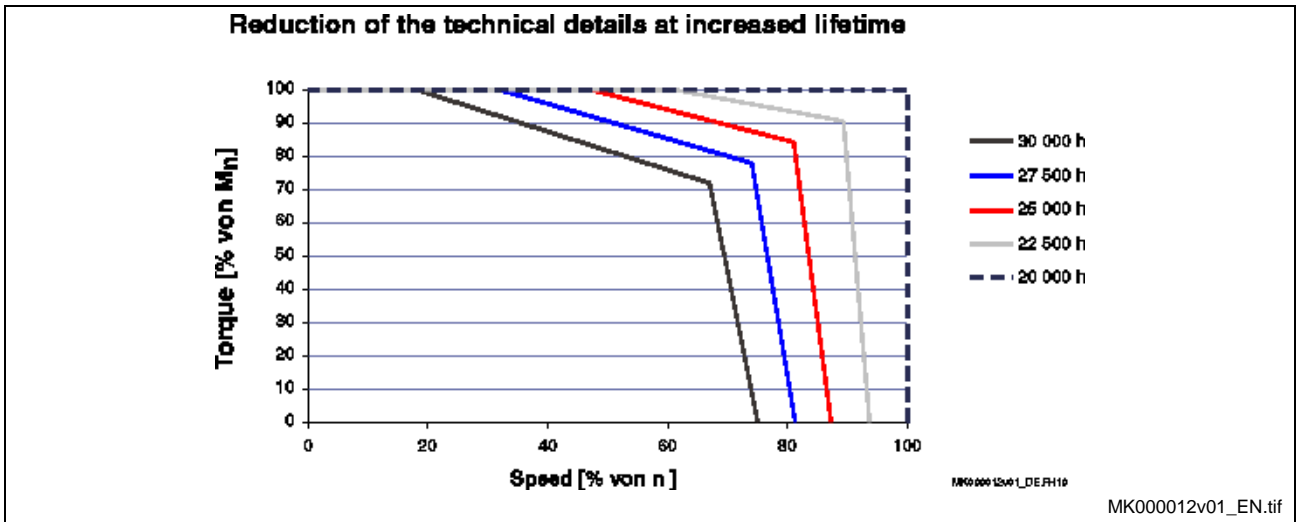
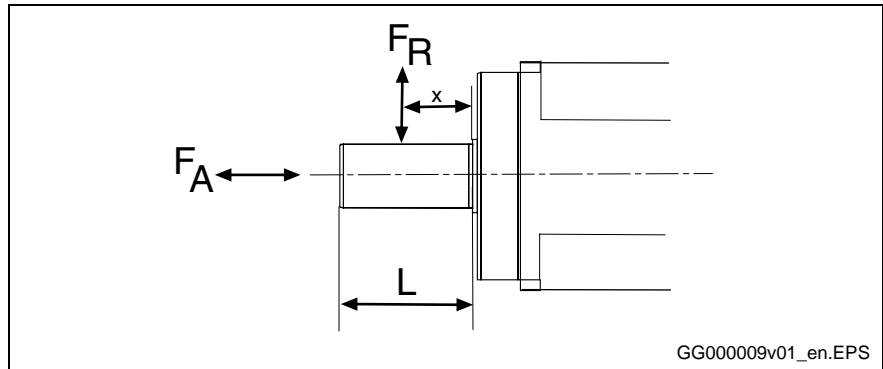


Fig. 6-3: Reduction of the technical data at increased lifetime

6.3 Permittable shaft loading



F_A : permittable axial force

F_R : permittable radial force

X : Distance between shaft shoulder on the output shaft and point of application of the radial force

n_{2m} : average output speed of the cycle

Fig. 6-4: permittable shaft load of the GTM

$$n_{2m} = \frac{n_{2a} * t_a + n_{2b} * t_b + \dots + n_{2n} * t_n}{t_a + t_b + \dots + t_n}$$

Basis of design: The GTM gearboxes are designed for an L_{10h} bearing life of 30,000 hours. Radial forces F_{Ref} which lie over the value of the diagram, decrease the nominal bearing-lifetime as follows:

$$L_{10h} = 30000 * \left(\frac{F_R}{F_{Ref}} \right)^{\frac{10}{3}}$$

GTM060

Permittable radial force F_R :

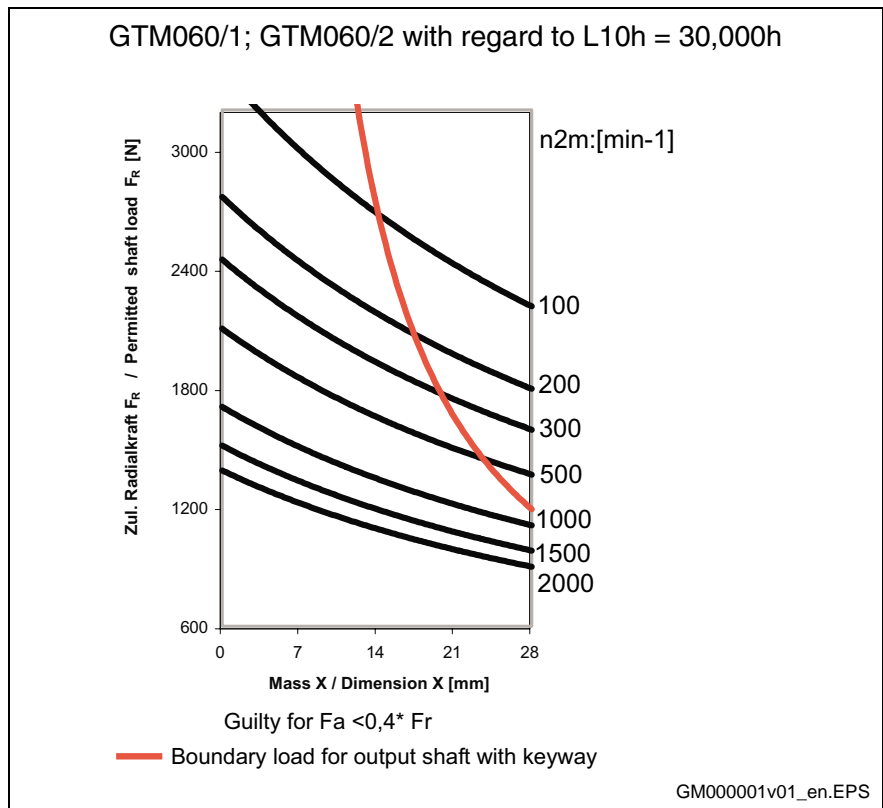


Fig. 6-5: Permittable radial force F_r GTM060

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

GTM075

Permittable radial force F_R :

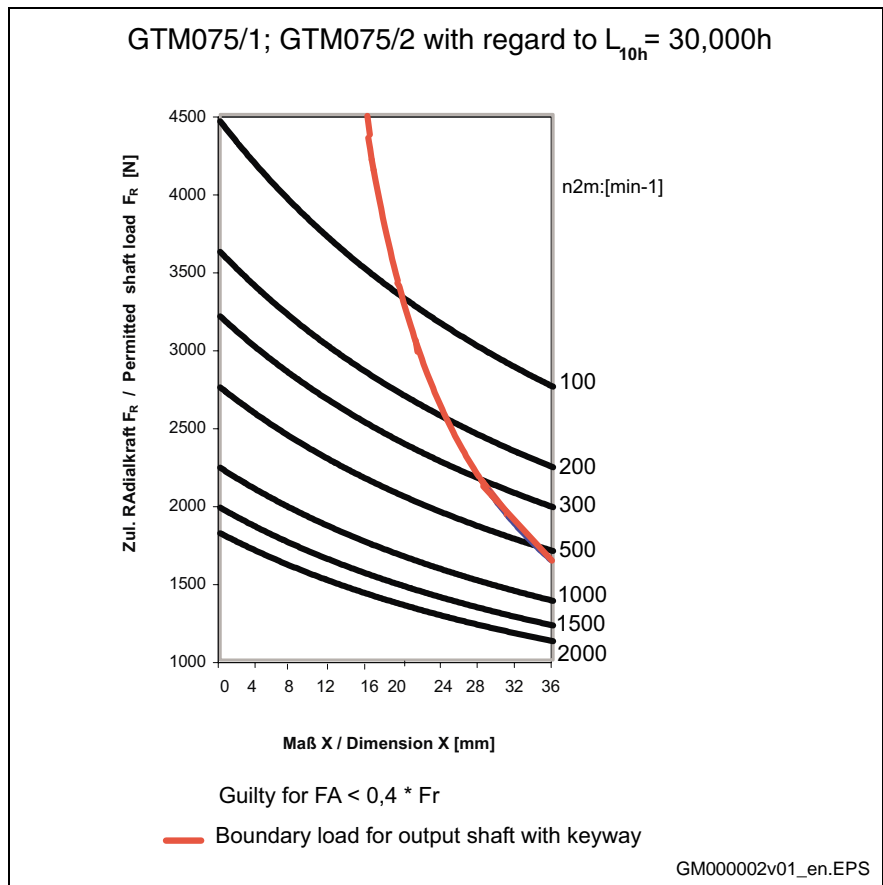


Fig. 6-6: Permittable radial force F_r GTM075

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

GTM100

Permittable radial force F_R :

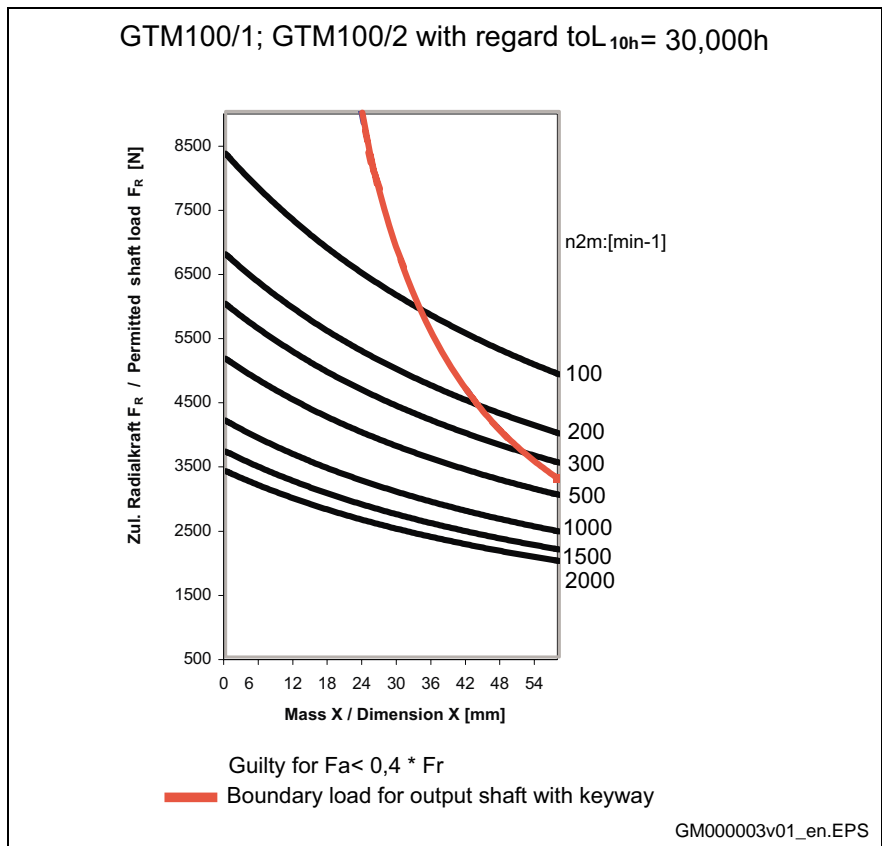


Fig. 6-7: Permittable radial force F_r GTM0100

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

GTM140

Permittable radial force F_R :

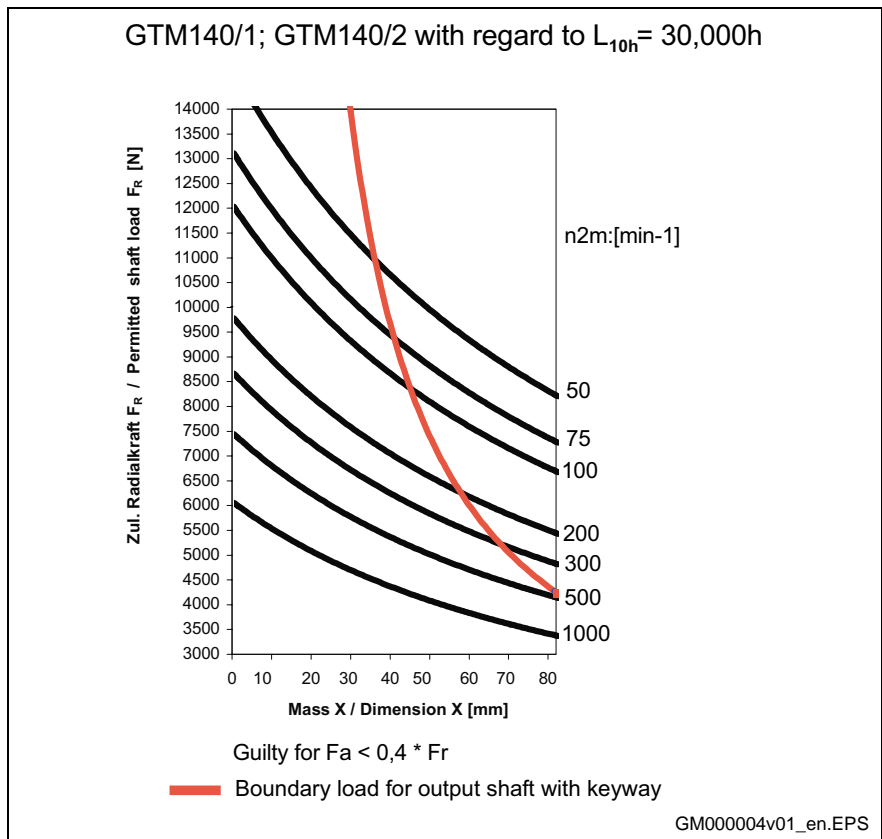


Fig. 6-8: Permittable radial force F_r GTM0140

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

GTM180

Permittable radial force F_R :

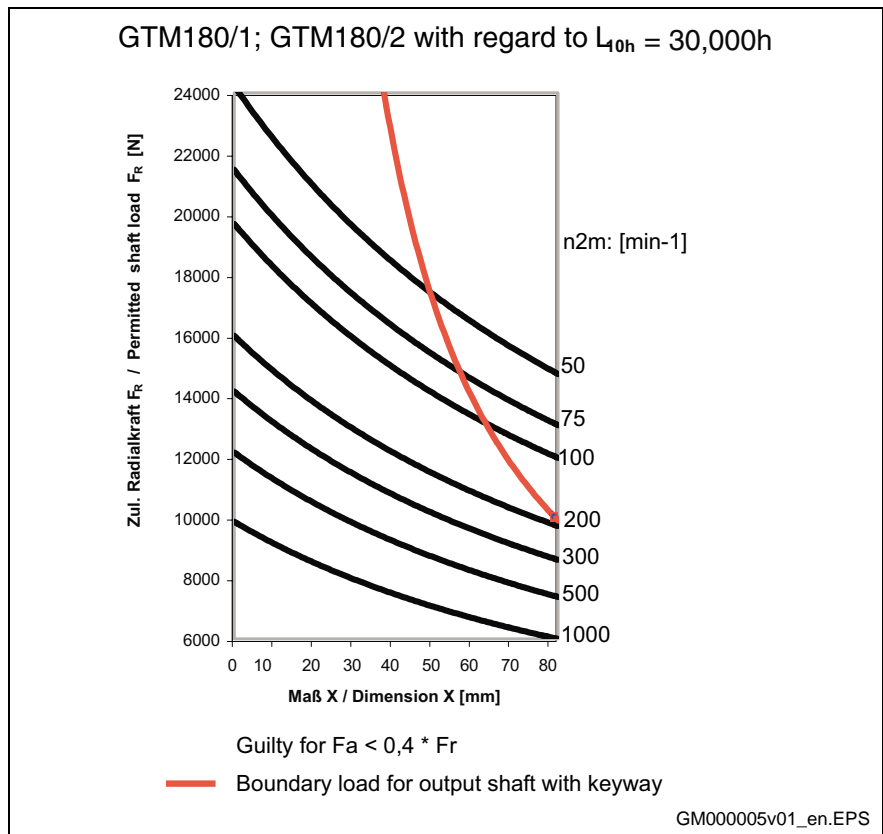


Fig. 6-9: Permittable radial force F_r GTM0180

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

GTM240

Permittable radial force F_R :

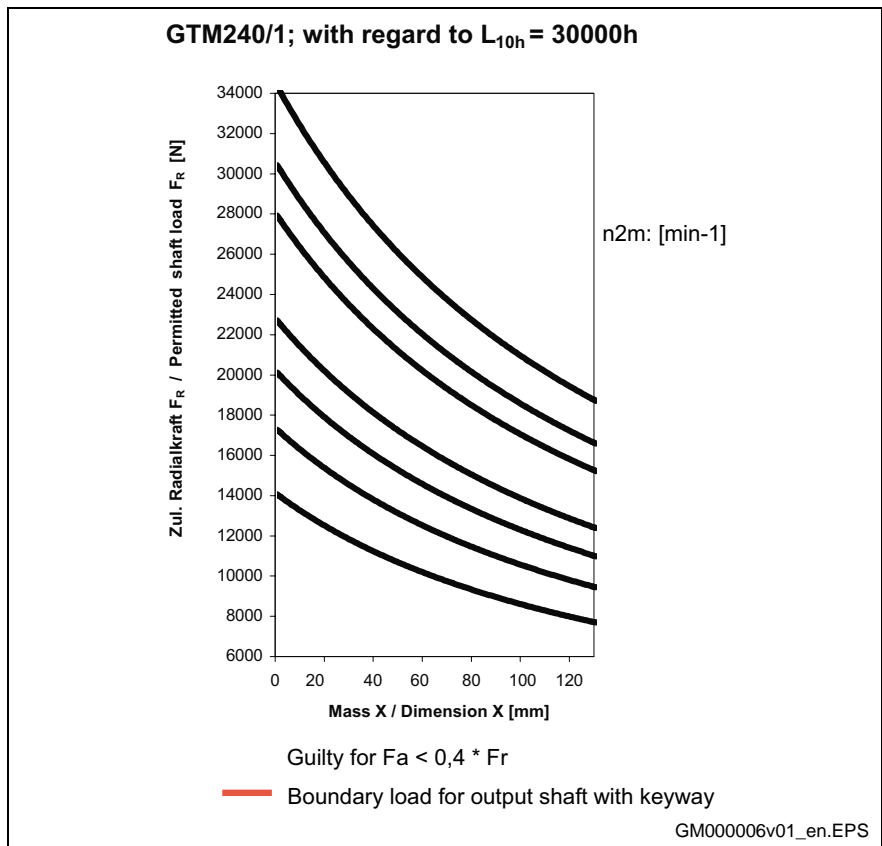


Fig. 6-10: Permittable radial force F_r GTM0240

Permittable axial force:

$$F_A < 0,4 * F_R$$

F_a : permittable axial force
 F_r : permittable radial force

If higher axial forces occur, the individual lifetimes of the bearings must be calculated individually.

7 Dimensional Details

7.1 GTM060

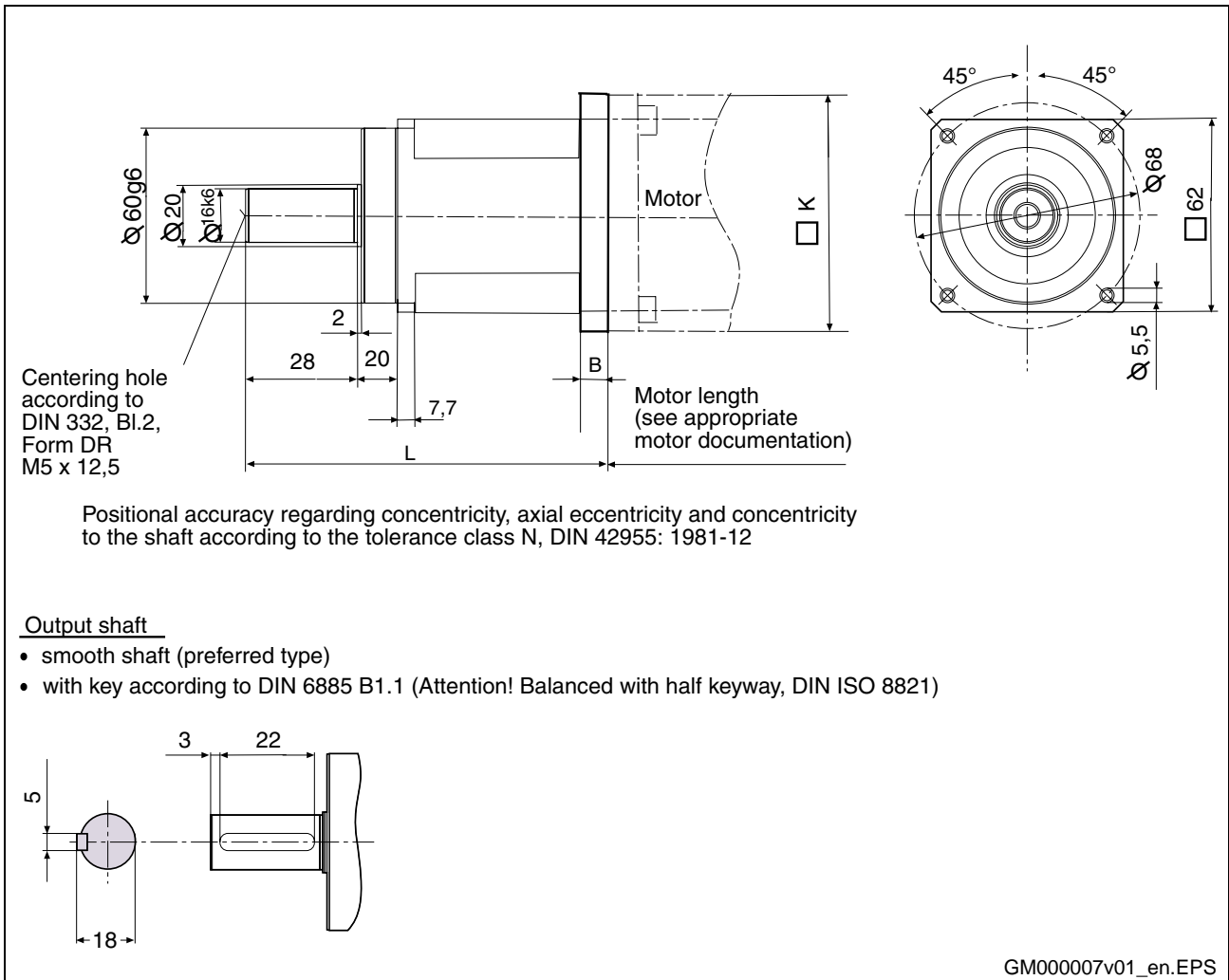


Fig. 7-1: Dimensional details of the one and two-stage GTM060 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾ [mm]
	L [mm]	B [mm]	L [mm]	B [mm]	
MKD025	130	19	153	19	62
MKE035 MKE037	130	19	153	19	62
MHD041 MHP041 MKD041	130	19	153	19	82
MKE045 MKE047	130	19	153	19	92

1) biggest flange size

Fig. 7-2: GTM060 dimensions - one and two-stage gearboxes

7.2 GTM075

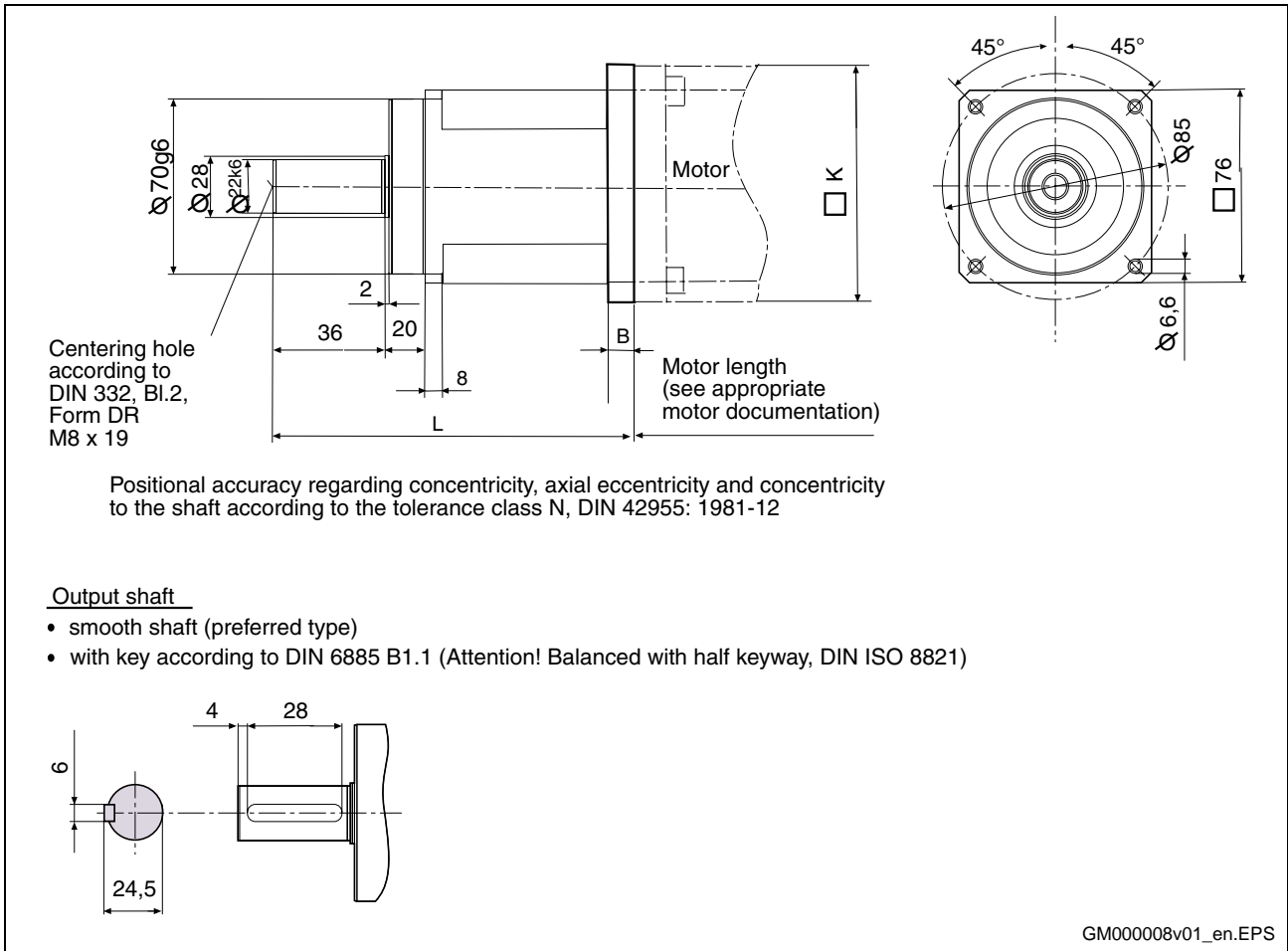


Fig. 7-3: Dimensional details of the one and two-stage GTM075 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾ [mm]
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	
MHD041 MHP041 MKD041	155.7	26	183	26	82
MKE045 MKE047	155.7	26	183	26	90
MHD071 MHP071 MKD071	155.7	26	183	26	115

1) biggest flange size

Fig. 7-4: GTM075 dimensions - one and two-stage gearboxes

7.3 GTM100

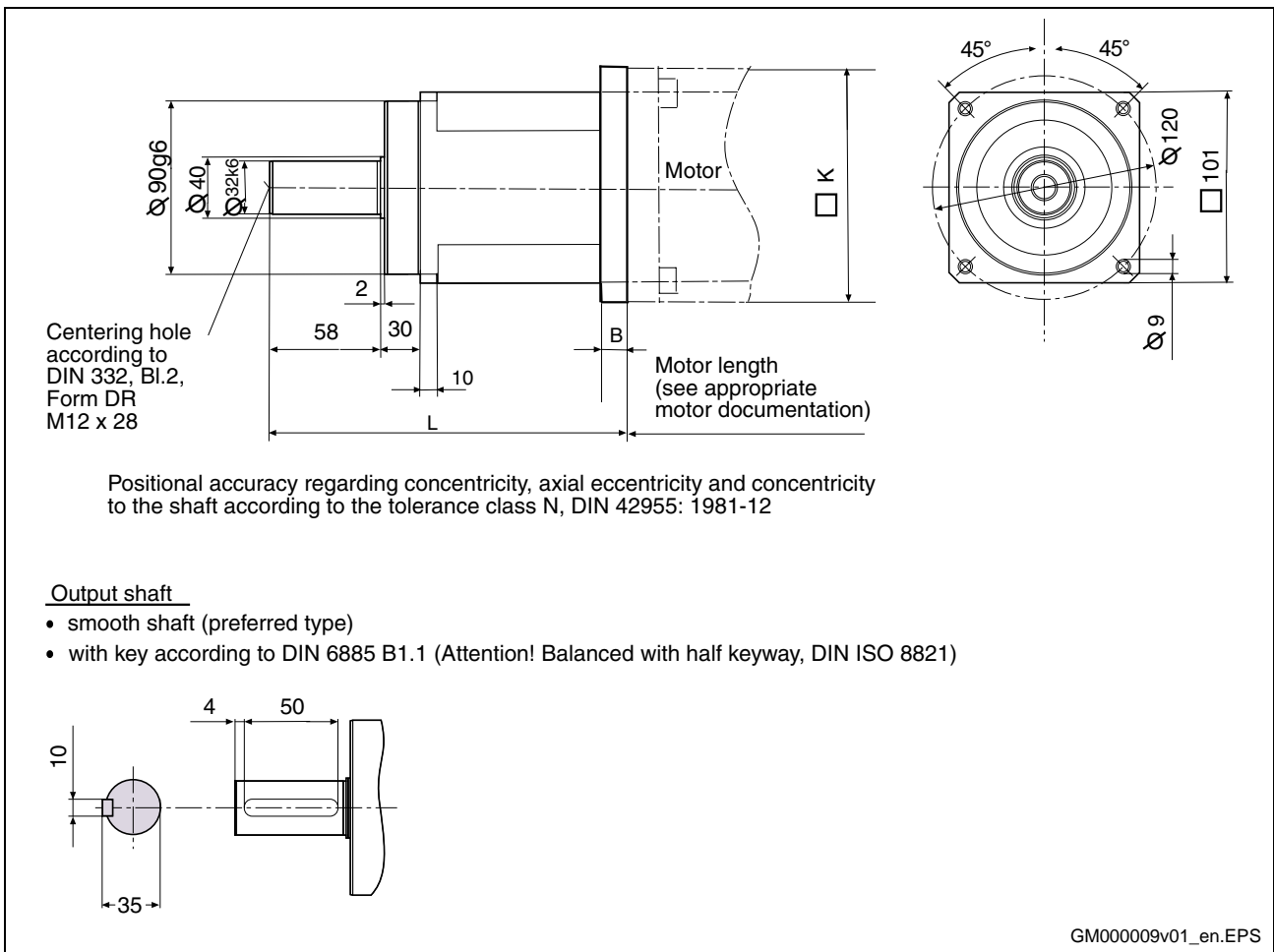


Fig. 7-5: Dimensional details of the one and two-stage GTM100 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	[mm]
MHD071 MHP071 MKD071	193.1	27.5	235	27.5	115
MHD090 MHP090 MKD090	193.1	27.5	235	27.5	140
MHD093 MHP093	203.1	37.5	245	37.5	150
MHD095	203.1	37.5	245	37.5	150
MKE096 MKE098	193.1	27.5	235	27.5	144

1) biggest flange size

Fig. 7-6: GTM100 dimensions - one and two-stage gearboxes

7.4 GTM140

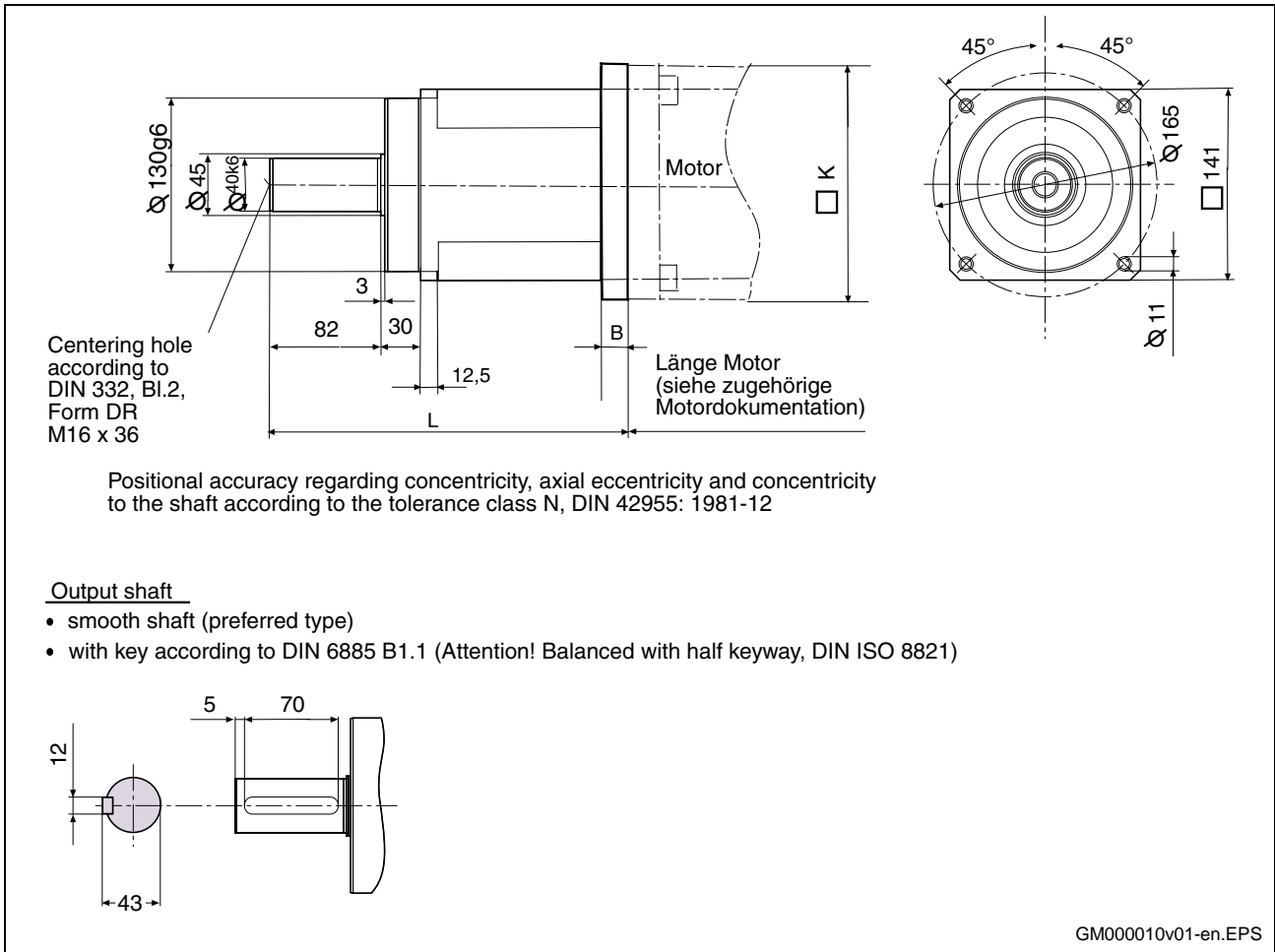


Fig. 7-7: Dimensional details of the one and two-stage GTM140 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	[mm]
MHD071 MHP071 MKD071					
MHD090 MHP090 MKD090	245.6	29	296	29	141
MHD093 MHP093	245.6	29	296	29	150
MHD095	245.6	29	296	29	150
MKE096 MKE098	245.6	29	296	29	144
MHD112 MHP112 MKD112	245.6	29	296	29	192
For more data see next page					

Connected to motor type	One-stage		Two-stage		o K ¹⁾
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	[mm]
MHD115 MHP115	265.6	49	NN19	NN19	192
MKE116 MKE118	245.6	29	296	29	194

1) biggest flange size

Fig. 7-8: GTM140 dimensions - one and two-stage gearboxes

7.5 GTM180

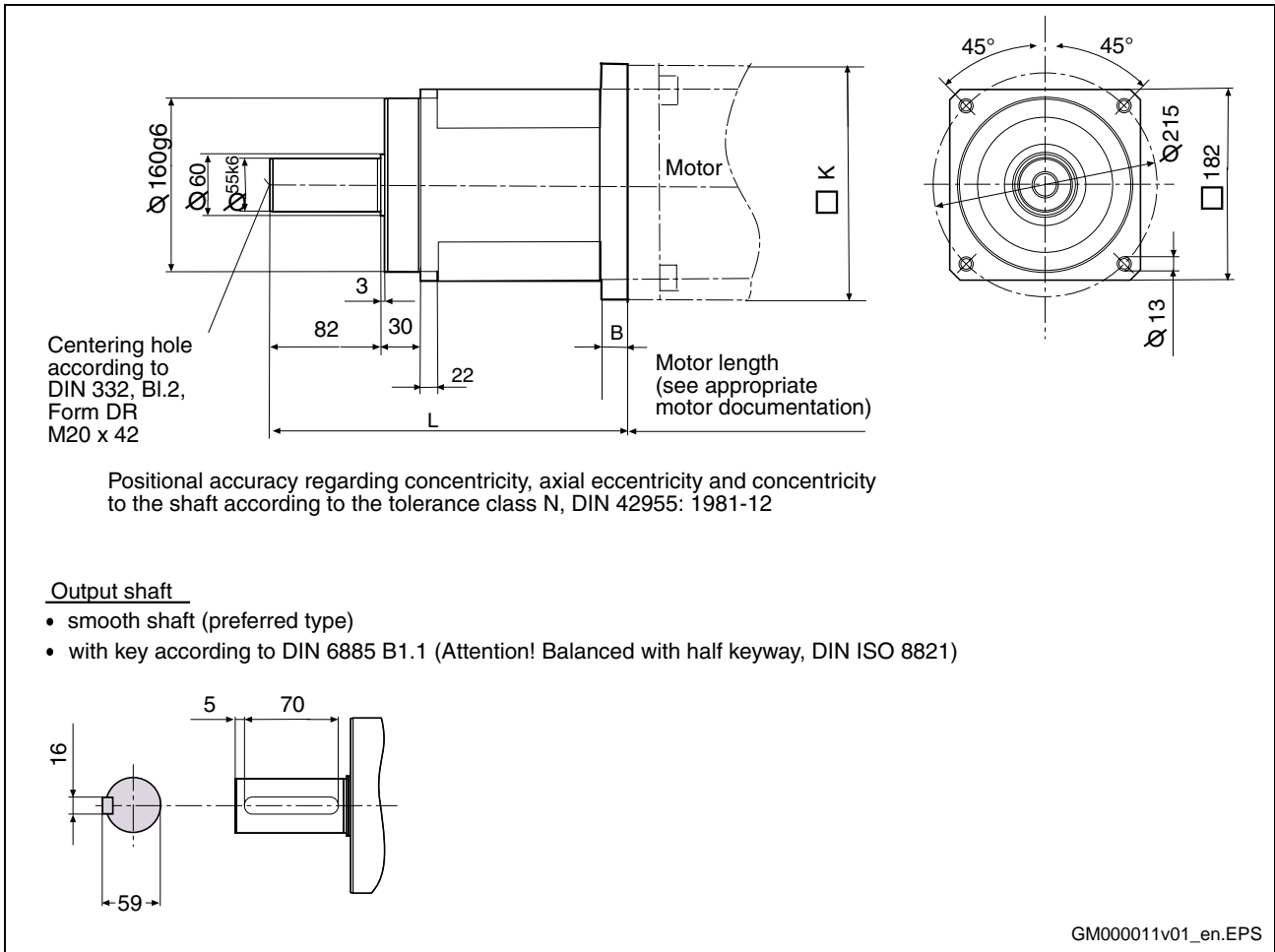


Fig. 7-9: Dimensional details of the one and two-stage GTM180 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾ [mm]
	L [mm]	B [mm]	L [mm]	B [mm]	
MHD093 MHP093	NN16	NN16	335.2	29	150
MHD095	NN16	NN16	335.2	29	150
2AD100 2AD101 2AD104 ADP104	290	32.5	335.2	29	192
ADF100 ADF104	290	32.5	NN08	NN08	192
MHD112 MHP112 MKD112	290	32.5	335.2	29	192
MHD115 MHP115	290	32.5	335.2	49	192

For more data see next page

Connected to motor type	One-stage		Two-stage		o K ¹⁾
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	[mm]
MKE116 MKE118	290	32.5	335.2	29	194
MHD131	318	60.5	Not possible	Not possible	260
2AD132 2AD134 ADF132 ADF134 ADP134	318	60.5	Not possible	Not possible	260

1) biggest flange size

Fig. 7-10: GTM180 dimensions - one and two-stage gearboxes

7.6 GTM240

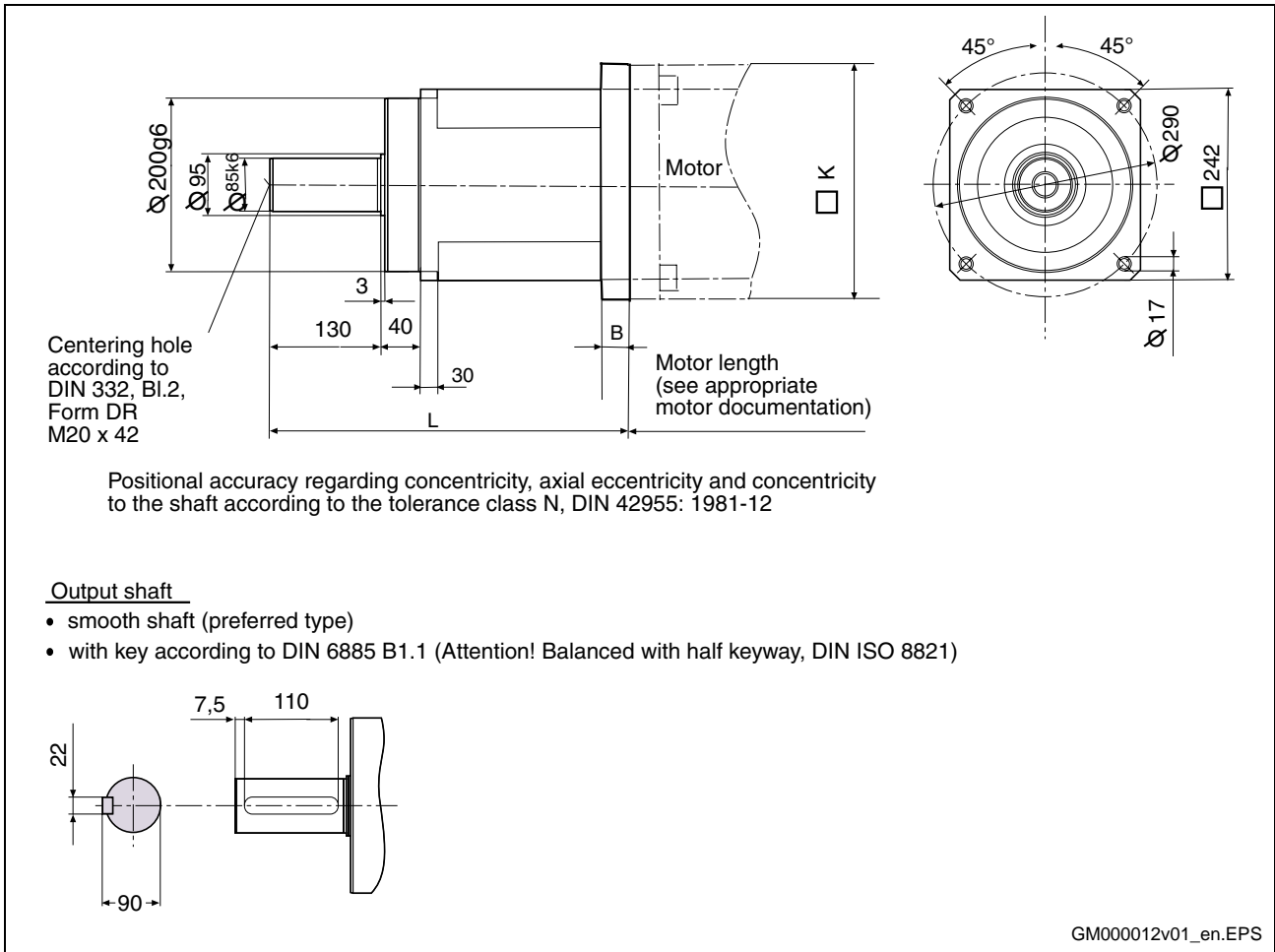


Fig. 7-11: Dimensional details of the one and two-stage GTM240 gearboxes

Connected to motor type	One-stage		Two-stage		o K ¹⁾
	L	B	L	B	
	[mm]	[mm]	[mm]	[mm]	[mm]
MHD131	398.2	43.5	Not possible		260
2AD132 2AD134 ADF132 ADF134 ADP134	398.2	43.5			260
2AD160 2AD164 ADP164 MAD160	398.2	43.5			310

Fig. 7-12: GTM240 dimensions one-stage gearboxes

8 Type codes

8.1 Type codes for the GTM060

Abbrev. Column →	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0			
Example:	G	T	M	0	6	0	-	N	N	1	-	0	0	4	A	-	N	N	0	3																							

1. Product
 - 1.1 GTM = GTM
2. Size
 - 2.1 060 = 060
3. Mounting orientation and operating mode
 - 3.1 arbitrary = NN
4. Gear stages
 - 4.1 single stage = 1
 - 4.2 two stage = 2
5. Transmission ratio
 - 5.1 single stage: 4 5 7 10 e.g., 4:1 = 004
 - 5.2 two stage: 20 50 e.g., 20:1 = 020
6. Output shaft and backlash
 - 6.1 with key = A
 - 6.2 plain = B
 - 6.3 with key, reduced backlash = C
 - 6.4 plain, reduced backlash = D
7. Designation of mounted motor

Product \ Motor size	025	035	037	041	045	047
7.1 MHD	-	-	-	NN03	-	-
7.2 MHP	-	-	-	NN03	-	-
7.3 MKD	NN02	-	-	NN03	-	-
7.4 MKE	-	NN13	NN13	-	NN14	NN14

GT000001v01_en2.EPS

Fig. 8-1: Type codes for the GTM060

8.5 Type codes for the GTM180

Abbrev. Column →	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0				
Example:	G	T	M	1	8	0	-	N	N	1	-	0	0	4	A	-	N	N	0	9																								

- 1. Product**
- 1.1 GTM = GTM
- 2. Size**
- 2.1 180 = 180
- 3. Mounting orientation a. operating mode**
- 3.1 arbitrary = NN
- 4. Gear stages**
- 4.1 single stage = 1
- 4.2 two stage = 2
- 5. Transmission ratio**
- 5.1 single stage: 3 4 5 7 10 e.g., 4:1 ... = 004
- 5.2 two stage: 20 50 e.g., 20:1 ... = 020
- 6. Output shaft and backlash**
- 6.1 with key = A
- 6.2 plain = B
- 6.3 with key, reduced backlash = C
- 6.4 plain, reduced backlash = D
- 7. Designation of mounted motor**

	Motor-size	093	095	100	101	104	112	115	116	118	130	131	132	134
7.1	2AD	-	-	NN09	NN09	NN09	-	-	-	-	-	-	NN11 ^①	NN11 ^①
7.2	ADF	-	-	NN08	-	NN08	-	-	-	-	-	-	NN11 ^①	NN11 ^①
7.3	ADP	-	-	-	-	NN09	-	-	-	-	-	-	-	NN11 ^①
7.4	MAD	-	-	NN09	-	-	-	-	-	-	NN11 ^①	-	-	-
7.5	MAF	-	-	NN08	-	-	-	-	-	-	NN11 ^①	-	-	-
7.6	MHD	NN16	NN16	-	-	-	NN09	NN19	-	-	-	NN15 ^①	-	-
7.7	MHP	NN16	-	-	-	-	NN09	NN19	-	-	-	-	-	-
7.8	MKD	-	-	-	-	-	NN09	-	-	-	-	-	-	-
7.9	MKE	-	-	-	-	-	-	-	NN09	NN09	-	-	-	-

GT000004v01_en3.EPS

Fig. 8-5: Type codes for the GTM180

8.6 Type codes for the GTM240

Abbrev. Column →	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4							
Example:	G	T	M	2	4	0	-	N	N	1	-	0	0	4	A	-	N	N	0	9																															

1. **Product**
- 1.1 GTM = GTM
2. **Size**
- 2.1 240 = 240
3. **Mounting orientation a. operating mode**
- 3.1 arbitrary = NN
4. **Gear stages**
- 4.1 single stage. = 1
5. **Transmission ratio**
- 5.1 single stage: 3 4 5 7 10 e.g., 4:1.... = 004
6. **Output shaft and backlash**
- 6.1 with key. = A
- 6.2 plain = B
- 6.3 with key, reduced backlash. = C
- 6.4 plain, reduced backlash. = D
7. **Designation of mounted motor**

	Motor-size		130	131	132	134	160	164
Product								
7.1	2AD	-	-	NN11	NN11	NN12	NN12	
7.2	ADF	-	-	NN11	NN11	-	-	
7.3	ADP	-	-	-	NN11	-	NN12	
7.4	MAD	NN11	-	-	-	NN12	-	
7.5	MAF	NN11	-	-	-	-	-	
7.6	MHD	-	NN15	-	-	-	-	

GT000007v01_en2.EPS

Fig. 8-6: Type codes for the GTM240

Caution! When combining a GTM gearbox with a MKE-type motor, please contact your responsible sales office, because further information will be necessary, i.e. guidelines and explosion protection.

9 Handling, transport and storage

9.1 Handling

Identifying the Goods

Delivery A single copy of the delivery note is enclosed to each delivery. The delivery note lists all components with their description and their designations. If the contents are distributed among several parcels (transport containers), this is noted on the delivery note, or it can be seen from the freight bill.

Bar code label The packaging of each gearbox, or motor/-gearbox combination has a bar code label providing the following data:

- Description of the gearbox or motor/-gearbox combination
- Customer
- Delivery note number
- Consignment

The bar code label is provided for identification of the contents during processing of the order.

Name plates

Gearbox The gearbox is delivered with a plate. The type label is attached to the gearbox-housing.

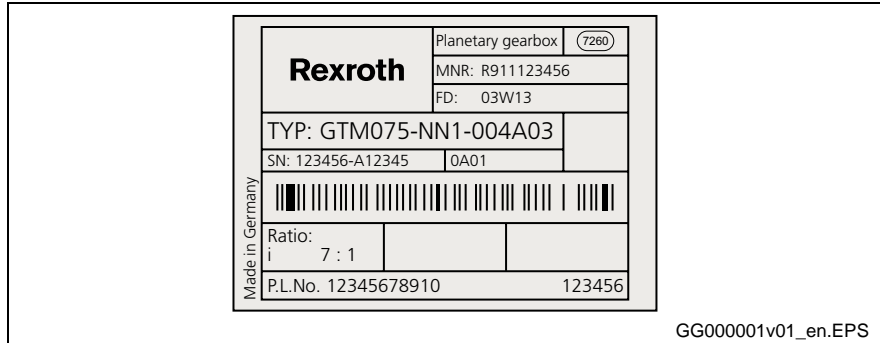


Fig. 9-1: Sample of a GTM name plate

Delivery of a motor/-gearbox combination

The motor is delivered with its own separate name plate. This name plate is attached to the motor housing. In addition, a second name plate is attached using double-side tape onto the original motor name plate. The second name plate can be put where visible on the machine-, if the original name plate on the motor be concealed by parts of the machine.

The type label is provided for

- identification of the motor
- procurement of spare parts in case of a failure,
- service information.

Note: The description of the motor is also stored in the feedback memory.

9.2 Transport

The notes regarding handling, transport and storage printed on the packaging must be observed - especially for delivery of complete motor/-gearbox combinations.

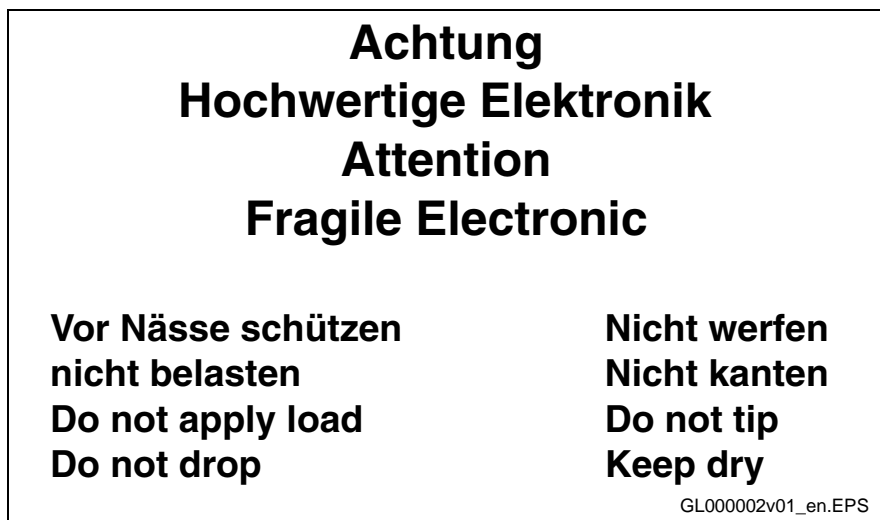


Fig. 9-2: Sample notes for handling, transport and storage on the packaging of a motor/-gearbox combination.

Gearbox The gearboxes are typically delivered in recyclable cardboard boxes with carton for shaped elements. To ensure the best possible corrosion protection of the gearboxes during transport, the gearboxes are additionally protected with special laminated plastic bags. Larger sizes are delivered on pallets.

The GTM gearboxes are filled-for-life with lubrication and are ready for use. The input and output are treated with anticorrosive coating. Remove all the anticorrosive on the gearboxes before mounting them.



Damage

⇒ Do not clean the parts with compressed air. The danger consists that overpressure within the gearbox can occur which negatively influences the function and lifetime of the gearbox.

Motor/-gearbox combination

**WARNING****Damage to motor and loss of warranty possible!**

Any improper storage may cause damage to the motor.
In addition, any warranty claim will expire.

⇒ For that reason, please observe the following instructions.

The following conditions must be kept during transport and handling:

- Use the appropriate means for transport. Take the weight of the components into consideration (weights are specified in the appropriate "Technical Data" chapters of the various motors, and gearboxes and/or on the type label of the motor).
- Transport the units only in horizontal position.
- To lift the motor/-gearbox combinations use a crane and lifting sling belts (see Fig. 9-3).
- Avoid damage to the gearbox flange and the drive shaft.
- Avoid impacts on the gearbox drive shaft.
- Remove the protective cover on the gearbox output shaft just before mounting the motor/-gearbox combination.

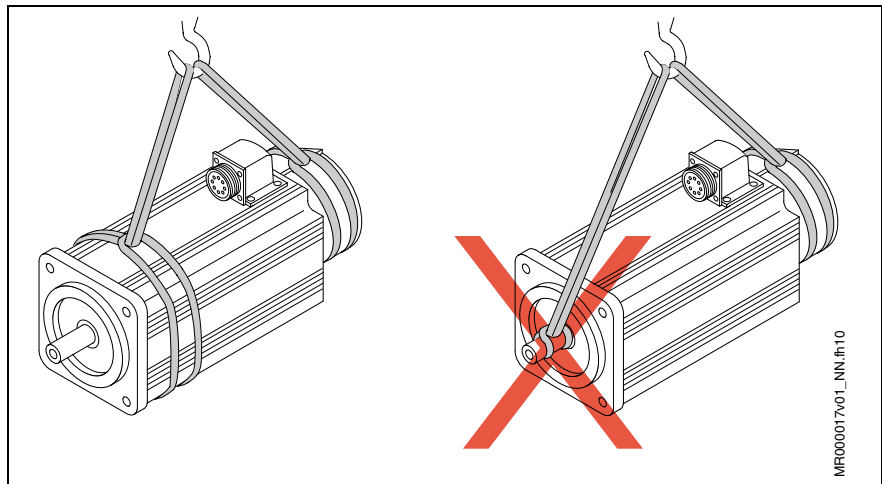


Fig 9-3: Lift a motor

9.3 Storage

Gearbox It is recommended to store the gearboxes in their original packaging in a horizontal position until they are ready for use. For long-term storage, it is recommended to store the gearboxes in a dry environment with temperatures from 0°C to +30°C. The gearboxes can be stored over a period of maximum 2 years under these conditions. We recommend using a FIFO system - "First-in, first-out".

Motor/-gearbox combination



WARNING

Damage to motor and loss of warranty possible!

Any improper storage may cause damage to the motor. In addition, any warranty claim will expire.

⇒ For that reason, please observe the following instructions.

The following conditions must be kept during storage:

- Permissible range of temperature: -20°C to +80°C (only valid for short-term storage-, or transport. For long-term storage please keep a temperature range of 0°C to +30°C.)
- Store motors in dry places which are free from dust and vibrations.
- Store motors horizontally.
- Do not remove the plastic protective sleeve on the output shaft. It protects the shaft from moisture, rust and mechanical damage.

10 Assembly

10.1 Skilled Technical Personnel

Any work on the system on the drives, or on the planetary gearboxes or in their vicinity may only be carried out by properly trained technical personnel. The owner of the system must ensure that all persons carrying out

- installation work,
- maintenance, or
- operational activities

on the system are adequately familiar with the contents of this documentation as well as with all warnings and precautionary measures contained therein. Qualified technical personnel are defined as those who have been trained, instructed or authorized to activate and deactivate, ground and mark electric circuits and equipment according to the safety rules and regulations. Qualified technical personnel must possess appropriate safety equipment and have been trained in first aid.

10.2 Mounting to the motor

Adapter plates make it possible to mount the GTM-series gearboxes onto every Bosch Rexroth servo motor which is mentioned in the type code. The connection between the motor output shaft and gearbox input shaft is established via a compression coupling.

Note: When combining Bosch Rexroth motors with GTM gearboxes always choose motors with smooth shafts.

The motor is centered by using pilot diameter of the Bosch Rexroth motor and the pilot diameter of the gearbox's input flange. The compression couplings are matched to the corresponding motor shaft diameters when necessary by using a slotted. The bushings are factory-installed so that the slots in the bushing line up with the slots in the compression coupling (see Fig. 10-1). This must be confirmed before mounting and any necessary changes must be made before the motor and gearbox are assembled.

Before mounting the servo motors to the gearboxes, all parts have to be closely checked for damage. All parts should slide easily and without any force into one another. Damage on the motor shaft or to the compression coupling of the gearbox can prevent this and must be avoided.

Damage to or contamination on the motor front flange face or on the gearbox flange face can lead to angular misalignment of the motor shaft and the gearbox. This can lead to stress on the connection and will have a negative influence on the life time of the motor and/or the gearbox.

10.2.1 Motor connection

The gearboxes are provided with the proper adapter parts necessary for the stipulated motor type according to the type code in the order. Adapter parts makes it possible for the gearboxes to be mounted on every Bosch Rexroth servo motor listed in the type code.

Note: If adapter parts are removed or altered, every warranty claim expires.

The motor is centered via the pilot diameter of the motor and the pilot diameter of the gearbox.

The connection between motor shaft and gearbox input shaft is established via a compression coupling. The diameter of the compression coupling is adapted to the corresponding motor shaft diameters with a slotted bushing. The slotted bushings are factory-installed so that the slots in the bushings line up with the slots in the compression coupling (see Fig. 10-1). This must be confirmed before mounting and any necessary changes must be made before the motor and gearbox are assembled.

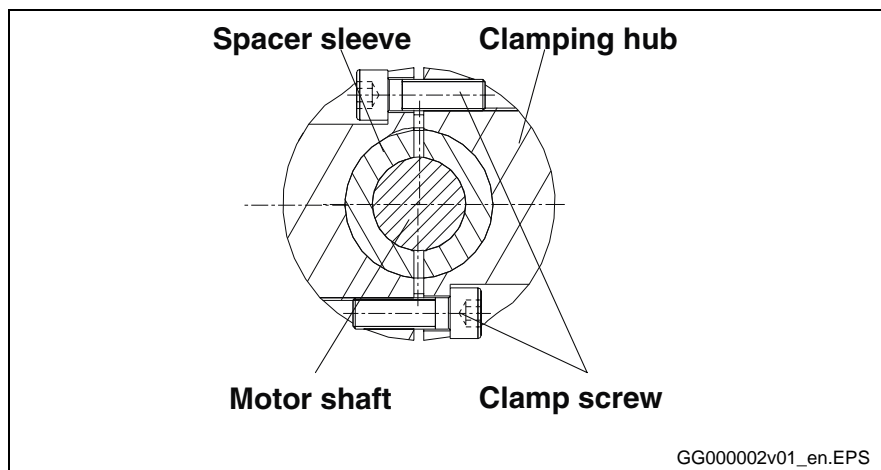


Fig. 10-1: Compression coupling shown with bushing

Note: When combining Bosch Rexroth motors with GTM gearboxes, always choose motors with smooth shafts.

10.2.2 Mounting procedure

The following assembly procedure is recommended:

1. **Clean and check the parts.** Check for damage to the motor shaft, compression coupling bore and any bushing, as well as the faces of motor and gearbox flanges and clean them thoroughly. Do not clean the parts with compressed air. Avoid using aggressive detergents which could damage the seals.

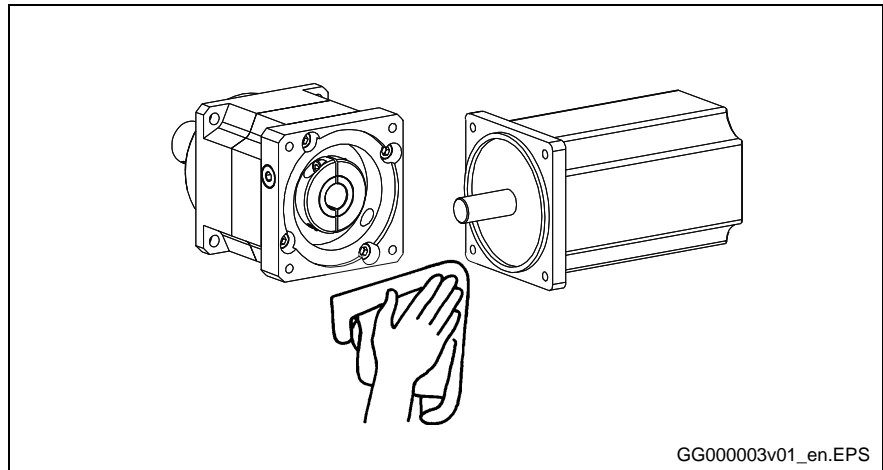


Fig. 10-2: Cleaning of the parts before mounting

2. **Remove cap screws.** Remove the cap screws from the gearbox adapter plate. The removal will allow access to the two screws in the compression coupling. Turn the compression coupling so that the heads of the clamping screws line up with the tapped holes which have now been opened in the gearbox's adapter plate.

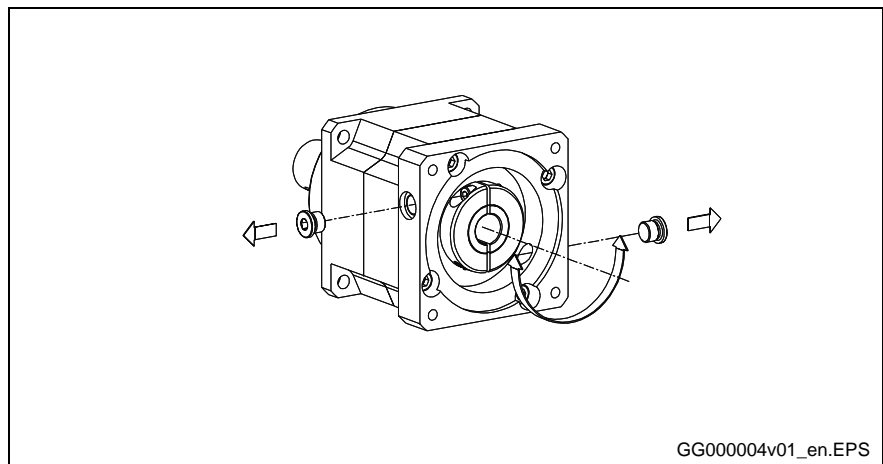


Fig. 10-3: Remove the cap screws

3. **Connect the motor to the gearbox.** Insert the motor shaft into the gearbox coupling until the gearbox's connecting flange and the motor face are fully in contact. It should be possible to accomplish this without excessive force. The gearbox is equipped with an integrated thermal length compensation to compensate for the thermal expansion of the motor shaft. When joining the parts together, the axial force exerted onto the compression coupling must not exceed the value specified in the table below (see Fig. 10-4). The force is exceeded, the compensation for heat expansion of the motor shaft cannot be ensured. This can lead to damage of the motor and/or the gearbox.

Gearbox type	Clamping bolt EN ISO 4762	Wrench size	Tightening torque	Max. axial force on compression coupling
		[mm]	[Nm]	[N]
GTM060	M5-8.8	4	5,5	60
GTM075	M5-12.9	4	9,5	85
GTM100	M6-12.9	5	16	115
GTM140	M8-12.9	6	40	130
GTM180	M10-12.9	8	79	170
GTM240	M16-12.9	14	330	220

Fig. 10-4: Axial force

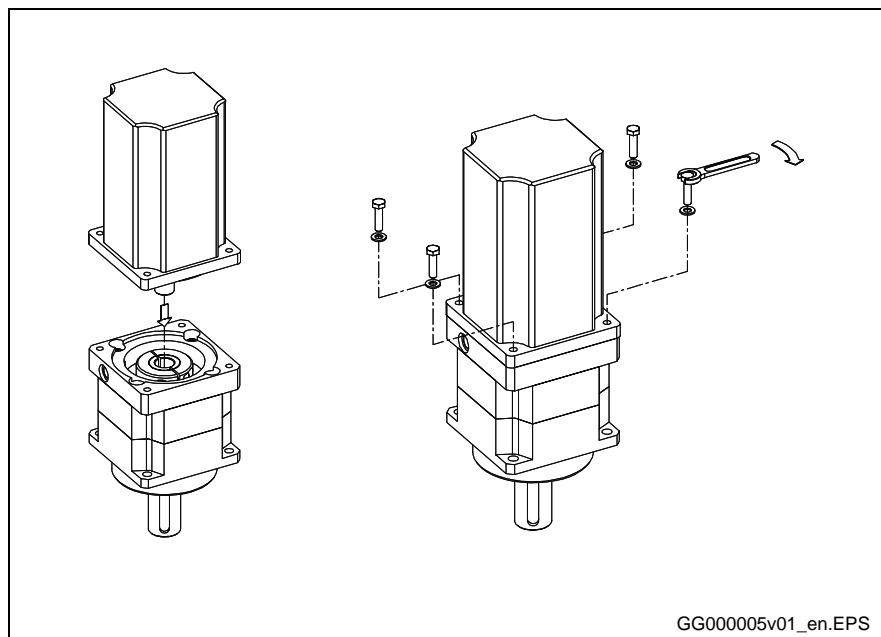


Fig. 10-5: Insert the motor shaft into the gearbox

**CAUTION**

To negate the weight of the motor and/or the gearbox itself, we recommend to perform this mounting in the vertical axis.

4. **Connect the motor to the gearbox.** To assure a proper connection, tighten all fastening bolts with the correct tightening torque using the crossover pattern (see Fig. 10-6).
5. **Tightening the bolts of the compression coupling step-by-step.** To avoid unnecessary binding of the compression couplings, tightening the clamping bolts step-by-step as shown below up to the proper torque.

Tightening torque:

Gearbox type	1. Step	2. Step	3. Step
	see Fig. 10-8 step 1 + 2	see Fig. 10-8 step 3 +4	see Fig. 10-8 step 5 +6
GTM060	Tighten bolts by hand	2.5 Nm	5.5 Nm
GTM075		5 Nm	9,5 Nm
GTM100		8 Nm	16 Nm
GTM140		20 Nm	40 Nm
GTM180		40 Nm	79 Nm
GTM240		165 Nm	330 Nm

Fig. 10-6: Tightening torque:

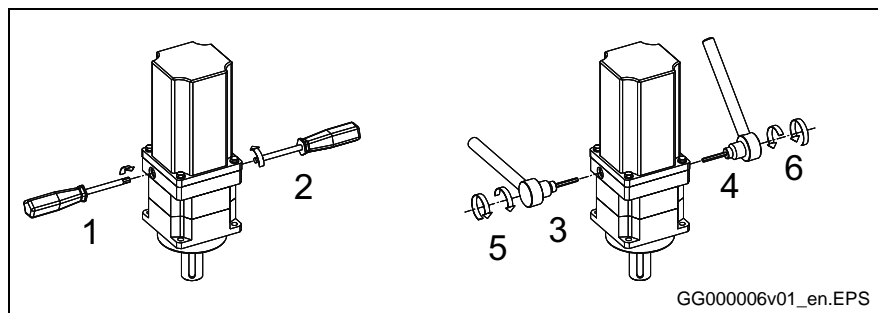


Fig. 10-7: Proper tightening of the clamping bolts.

6. **Reinsert the cap screws.** To ensure an IP 65 sealed drive-system, the cap screws (as described in step 2) have to be reinserted and tightened with the specified torque.

Cap screws DIN 908	Tightening torque [Nm]
M12x1,5	20
M16x1,5	30

Fig. 10-8: Tightening torque - cap screws

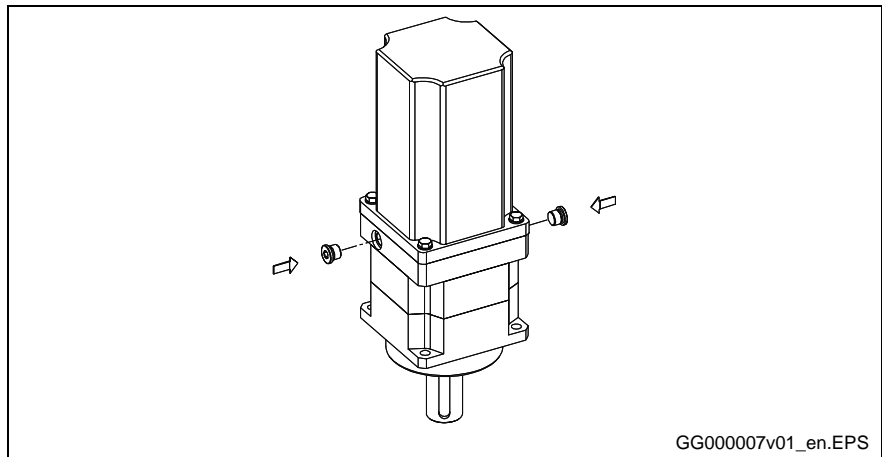


Fig. 10-9: Closing the mounting opening

10.3 Gearbox mounting

Remove the protective cap from the gearbox shaft and thoroughly clean the pilot diameter, the contact surface and the output shaft.

Mounting of the gearbox to machine (or robot, etc.) is to be made via the output pilot diameter of the gearbox and with four through holes on the gearbox housing.

We recommend using ISO 12.9-grade bolts with the proper tightening torques. We also recommend securing the bolts with Loc-Tite.

Gearbox type	Pilot diameter	Bolt size-ISO grade	Tightening torque
	[mm]		[Nm]
GTM060	60	M5-12.9	9,5
GTM075	70	M6-12.9	16
GTM100	90	M8-12.9	40
GTM140	130	M10-12.9	79
GTM180	160	M12-12.9	135
GTM240	200	M16-12.9	330

Fig. 10-10: Flange-mounting data for installing the gearbox on the machine

Assure a nondistorted mount when installing the gearbox. Attached parts, i.e. gears or pulleys have to be mounted on the output shaft without force. In no case should they be mounted by using a hammer. Use only appropriate tools or fixtures.

The maximum-allowable mounting forces are shown in the table below (see Fig. 10-11). Permanent damage of the output bearings can occur when using higher mounting forces.

Gearbox type	Maximum static axial force
	[N]
GTM060	9000
GTM075	11000
GTM100	19000
GTM140	32000
GTM180	50000
GTM240	90000

Fig. 10-11: Maximum static axial force allowed on the output shaft



CAUTION

Make sure that an unhindered circulation of air is available, to avoid an over-temperature situation in the drive-system (gearbox + motor).

11 Startup, Operation, and Maintenance

11.1 Commissioning

The following commission notes refer to the GTM planetary gearboxes as part of a drive-system with motor, drive and control devices.

Preparation

1. Keep the documentation of all used products ready.
2. Log all measures taken in the commissioning log.
3. Check the products for damage.
4. Check all mechanical and electrical connections.
5. Activate the safety and monitoring equipment of the system.



CAUTION

Material damage due to errors in activating motors and moving elements! Unclear operating states and product data!

- ⇒ Do not carry out commissioning if connections, operating states or product data are unclear or faulty!
- ⇒ Do not carry out commissioning if the safety and monitoring equipment of the system is damaged or not in operation.
- ⇒ Damaged products must not be put into operation.
- ⇒ Contact Bosch Rexroth for missing information or support during commissioning!

Execution

When all prerequisites have been fulfilled, proceed as follows:

1. Commission the device controllers and power supplies according to the corresponding descriptions. Note the respective product documentation.
2. Before releasing the setpoint, check whether the set relationship of the maximum motor speed and the present setpoint corresponds to the specifications of the machine.
3. At a low turning speed, check whether the rotation direction of the gearbox and the polarity setpoint correspond to the specifications for the machine.
4. At a low turning speed, check whether the positioning commands of the control systems are executed correctly.
5. Log all measures taken in the commissioning log.

When all steps have been executed correctly, commissioning of the gearbox is complete.



Commissioning of motors, drive controllers and the control may require additional steps. The inspection of the functioning and performance of the systems is not part of the commissioning of the gearbox; instead, it is carried out within the framework of the commissioning of the machine as a whole. Observe the information and regulations of the machine manufacturer.

11.2 Deactivation

In the case of malfunctions, maintenance measures or to deactivate the gearbox-motor unit, proceed as follows:

1. Observe the instructions of the machine documentation.
2. Use the machine-side control commands to bring the drive to a controlled standstill.
3. Switch off the power and control voltage of the drive controller.
4. Switch off the motor protection switch of the motor fan.
5. Switch off the main switch of the machine.
6. Secure the machine against accidental movements and against unauthorized operation.
7. Wait for the discharge time of the electrical systems to expire and then disconnect all electrical connections.
8. Before dismantling, secure the gearbox-motor unit and supply cables against falling or movements before disconnecting the mechanical connections.
9. Document all done measures in the start-up report and machine maintenance plan.

11.3 Dismantling



DANGER

Fatal injury due to errors in activating motors and moving elements!

- ⇒ Do not work on unsecured and operating machines.
- ⇒ Secure the machine against accidental movements and against unauthorized operation.
- ⇒ Before dismantling, secure the gearbox-motor unit and supply cables against falling or movements before disconnecting the mechanical connections.

1. Observe the instructions of the machine documentation.
2. Please heed the safety notes and carry out all steps as described in the anterior instructions in the chapter "11.2 Deactivation".
3. Remove the gearbox-motor unit from the machine and store the unit properly.
4. Document all done measures in the start-up report and machine maintenance plan.

11.4 Maintenance

GTM gearboxes operate without wear within the given operating conditions. However, operation under unfavorable conditions can lead to limitations in availability.

- Observe the information of the machine manufacturer in the machine maintenance plan.
- Log all maintenance measures in the machine maintenance plan.

Measures



DANGER

Danger of injury due to moving elements!
Danger of injury due to hot surfaces!

- ⇒ Do not carry out any maintenance measures when the machine is running.
- ⇒ This work must be carried out only by qualified personnel.
- ⇒ During maintenance work, secure the system against restarting and unauthorized use.
- ⇒ Do not work on hot surfaces.
- ⇒ Protect open supply cables and connections against penetration of pollution.

Bosch Rexroth recommends the following maintenance measures, based on the maintenance plan of the machine manufacturer:

Measure	Interval
Check the mechanical and electrical connections.	According to the guidelines in the machine maintenance plan, but at least every 1,000 operating hours.
Check the gearbox-motor unit for smooth running, vibrations and bearing noises.	According to the guidelines in the machine maintenance plan, but at least every 1,000 operating hours.
Remove dust, chips and other dirt from the gearbox-motor housing, cooling fins and the connections.	Depending on the degree of soiling, but after 6 month operation at the latest. Do it monthly at strong pollution.

Fig. 11-1: Gearbox-motor unit maintenance plan

11.5 Troubleshooting



DANGER

Danger of injury due to moving elements!
Danger of injury due to hot surfaces!

- ⇒ Do not carry out any maintenance measures when the machine is running.
- ⇒ Switch off the control-device and the machine and await the discharging time of the electric systems
- ⇒ During maintenance work, secure the system against restarting and unauthorized use.
- ⇒ Do not work on hot surfaces.
- ⇒ Protect open supply cables and connections against penetration of pollution.

Excess Temperature of Gearbox Housing

Status	The housing temperature of the gearbox climbs to unusually high values.
Possible causes	<ol style="list-style-type: none">1. Original processing cycle has been changed.2. Original drive parameters have been changed.
Countermeasures	<ol style="list-style-type: none">1. Check the layout of the drive for changed requirements. Do not operate any longer at overload. Danger of damage!2. Reset to the original parameters. Check the layout of the drive in the case of changed requirements.

Gearbox-motor unit generates vibrations

Status	Audible or tactile vibrations occur on the gearbox-motor unit.
Possible causes	<ol style="list-style-type: none">1. Driven machine elements are insufficient, not balanced or insufficiently coupled.2. Gearbox-motor bearings worn or defective. Available bearing life time or grease life time elapsed.3. Gearbox-motor fixing are loosened.4. Drive system control loop is instable from a control point of view.
Countermeasures	<ol style="list-style-type: none">1. Check balance of driven machine elements. Check the key and the keyway. In the case of damage, contact Rexroth Service.2. Check the gearbox for damage. In the case of loss, contact Rexroth Service.3. Fasten motor properly and check for damage. In the case of loss, contact Rexroth Service.4. Check parameters of drive system (motor and encoder data). Observe the troubleshooting notes in the documentation for the drive controller.

Specified position is not attained

Status	The positioning command of the control is not precisely executed – or not at all. No malfunction display on the drive controller or the control.
Possible causes	<ol style="list-style-type: none">1. Motor shaft machine element connection loose.2. Motor shaft - gearbox connection loose.3. Gearing defective.
Countermeasures	<ol style="list-style-type: none">1. Check the mechanical connection. Do not continue to use damaged parts.2. Check the mechanical connection. Do not continue to use damaged parts.3. Change of gearbox necessary. In the case of loss, contact Rexroth Service.

12 How to order

The planetary gearbox has to be specified as a sub-item of the AC-motor. It is preferably, to order a complete unit consisting of a GTM planetary gearbox and an AC-servo motor.

Furthermore, make sure when to order the motor with a smooth shaft.

Ordering example:

1	1	AC-motor	
		Type MKD090B-047- GG0	
			↑ smooth shaft
1.1.	1	Planetary gearbox	
		Type GTM140-MO1-005B06-NN06	
		Mounted to Pos. 1	

GTM gearboxes for use on third-party motors"

It is possible to mount the GTM planetary gearboxes on servomotors, which are not delivered by Bosch Rexroth. In such cases, please contact your sales office for further information.

13 Service & Support

13.1 Helpdesk

Unser Kundendienst-Helpdesk im Hauptwerk Lohr am Main steht Ihnen mit Rat und Tat zur Seite. Sie erreichen uns

- telefonisch - by phone:
über Service Call Entry Center
- via Service Call Entry Center

Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

49 (0) 9352 40 50 60

Mo-Fr 07:00-18:00
Mo-Fr 7:00 am - 6:00 pm

- per Fax - by fax:

+49 (0) 9352 40 49 41

- per e-Mail - by e-mail: service.svc@boschrexroth.de

13.2 Service-Hotline

Außerhalb der Helpdesk-Zeiten ist der Service direkt ansprechbar unter

After helpdesk hours, contact our service department directly at

+49 (0) 171 333 88 26

oder - or

+49 (0) 172 660 04 06

13.3 Internet

Unter www.boschrexroth.com finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die **aktuellen** Adressen *) unserer auf den folgenden Seiten aufgeführten Vertriebs- und Servicebüros.



Verkaufsniederlassungen



Niederlassungen mit Kundendienst

Außerhalb Deutschlands nehmen Sie bitte zuerst Kontakt mit unserem für Sie nächstgelegenen Ansprechpartner auf.

*) Die Angaben in der vorliegenden Dokumentation können seit Drucklegung überholt sein.

At www.boschrexroth.com you may find additional notes about service, repairs and training in the Internet, as well as the **actual** addresses *) of our sales- and service facilities figuring on the following pages.



sales agencies



offices providing service

Please contact our sales / service office in your area first.

*) Data in the present documentation may have become obsolete since printing.

13.4 Vor der Kontaktaufnahme... - Before contacting us...

Wir können Ihnen schnell und effizient helfen wenn Sie folgende Informationen bereithalten:

1. detaillierte Beschreibung der Störung und der Umstände.
2. Angaben auf dem Typenschild der betreffenden Produkte, insbesondere Typenschlüssel und Seriennummern.
3. Tel./Faxnummern und e-Mail-Adresse, unter denen Sie für Rückfragen zu erreichen sind.

For quick and efficient help, please have the following information ready:

1. Detailed description of the failure and circumstances.
2. Information on the type plate of the affected products, especially type codes and serial numbers.
3. Your phone/fax numbers and e-mail address, so we can contact you in case of questions.

13.5 Kundenbetreuungsstellen - Sales & Service Facilities

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<p>Vertriebsgebiet Süd Germany South</p> <p>Bosch Rexroth AG Landshuter Allee 8-10 80637 München</p> <p>Tel.: +49 (0)89 127 14-0 Fax: +49 (0)89 127 14-490</p>	<p>Vertriebsgebiet West Germany West</p> <p>Bosch Rexroth AG Regionalzentrum West Borsigstrasse 15 40880 Ratingen</p> <p>Tel.: +49 (0)2102 409-0 Fax: +49 (0)2102 409-406 +49 (0)2102 409-430</p>	<p>Gebiet Südwest Germany South-West</p> <p>Bosch Rexroth AG Service-Regionalzentrum Süd-West Siemensstr.1 70736 Fellbach</p> <p>Tel.: +49 (0)711 51046-0 Fax: +49 (0)711 51046-248</p>	
<p>Vertriebsgebiet Nord Germany North</p> <p>Bosch Rexroth AG Walsroder Str. 93 30853 Langenhagen</p> <p>Tel.: +49 (0) 511 72 66 57-0 Service: +49 (0) 511 72 66 57-256 Fax: +49 (0) 511 72 66 57-93 Service: +49 (0) 511 72 66 57-783</p>	<p>Vertriebsgebiet Mitte Germany Centre</p> <p>Bosch Rexroth AG Regionalzentrum Mitte Waldecker Straße 13 64546 Mörfelden-Walldorf</p> <p>Tel.: +49 (0) 61 05 702-3 Fax: +49 (0) 61 05 702-444</p>	<p>Vertriebsgebiet Ost Germany East</p> <p>Bosch Rexroth AG Beckerstraße 31 09120 Chemnitz</p> <p>Tel.: +49 (0)371 35 55-0 Fax: +49 (0)371 35 55-333</p>	<p>Vertriebsgebiet Ost Germany East</p> <p>Bosch Rexroth AG Regionalzentrum Ost Walter-Köhn-Str. 4d 04356 Leipzig</p> <p>Tel.: +49 (0)341 25 61-0 Fax: +49 (0)341 25 61-111</p>

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<p>Great Britain - Großbritannien</p> <p>Bosch Rexroth Ltd. Electric Drives & Controls Broadway Lane, South Cerney Cirencester, Glos GL7 5UH Tel.: +44 (0)1285 863000 Fax: +44 (0)1285 863030 sales@boschrexroth.co.uk service@boschrexroth.co.uk</p>	<p>Finland - Finnland</p> <p>Bosch Rexroth Oy Electric Drives & Controls Ansatie 6 017 40 Vantaa Tel.: +358 (0)9 84 91-11 Fax: +358 (0)9 84 91-13 60</p>	<p>France - Frankreich</p> <p>Bosch Rexroth SAS Electric Drives & Controls Avenue de la Trentaine (BP. 74) 77503 Chelles Cedex Tel.: +33 (0)164 72-70 00 Fax: +33 (0)164 72-63 00 Hotline: +33 (0)608 33 43 28</p>	<p>France - Frankreich</p> <p>Bosch Rexroth SAS Electric Drives & Controls ZI de Thibaud, 20 bd. Thibaud (BP. 1751) 31084 Toulouse Tel.: +33 (0)5 61 43 61 87 Fax: +33 (0)5 61 43 94 12</p>
<p>France - Frankreich</p> <p>Bosch Rexroth SAS Electric Drives & Controls 91, Bd. Irène Joliot-Curie 69634 Vénissieux - Cedex Tel.: +33 (0)4 78 78 53 65 Fax: +33 (0)4 78 78 53 62</p>	<p>Italy - Italien</p> <p>Bosch Rexroth S.p.A. Via G. Di Vittoria, 1 20063 Cernusco S/N.MI Tel.: +39 02 92 365 1 +39 02 92 365 326 Fax: +39 02 92 365 500 +39 02 92 365 516378</p>	<p>Italy - Italien</p> <p>Bosch Rexroth S.p.A. Via Paolo Veronesi, 250 10148 Torino Tel.: +39 011 224 88 11 Fax: +39 011 224 88 30</p>	<p>Italy - Italien</p> <p>Bosch Rexroth S.p.A. Via del Progresso, 16 (Zona Ind.) 35020 Padova Tel.: +39 049 8 70 13 70 Fax: +39 049 8 70 13 77</p>
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Nordamerika – North America

USA Headquarters - Hauptniederlassung Bosch Rexroth Corporation Electric Drives & Controls 5150 Prairie Stone Parkway Hoffman Estates, IL 60192-3707 Tel.: +1 847 6 45 36 00 Fax: +1 847 6 45 62 01 servicebrc@boschrexroth-us.com repairbrc@boschrexroth-us.com	USA Central Region - Mitte Bosch Rexroth Corporation Electric Drives & Controls Central Region Technical Center 1701 Harmon Road Auburn Hills, MI 48326 Tel.: +1 248 3 93 33 30 Fax: +1 248 3 93 29 06	USA Southeast Region - Südwest Bosch Rexroth Corporation Electric Drives & Controls Southeastern Technical Center 3625 Swiftwater Park Drive Suwanee, Georgia 30124 Tel.: +1 770 9 32 32 00 Fax: +1 770 9 32 19 03	USA SERVICE-HOTLINE - 7 days x 24hrs - +1-800-REX-ROTH +1-800-739-7684
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Südamerika – South America

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Columbia - Kolumbien Refflutec de Colombia Ltda. Calle 37 No. 22-31 Santafé de Bogotá, D.C. Colombia Tel.: +57 1 368 82 67 +57 1 368 02 59 Fax: +57 1 268 97 37 reflutec@neutel.com.co reflutec@007mundo.com			

14 Appendix

14.1 List of Standards

Standard	Version	Title	Conformity
DIN EN 60034-7; VDE 0530 Part 7	1996-06	Rotating electrical machines – part 7: Description for structural shapes and lists (IM code) (IEC 60034-7:1992) German Version: EN 60034-7:1993	EN 60034-7 (1993-01); IEC 60034-7 (1992-12)
89/392/EEC replaced by 98/37/EC	1998-06-22	Directive 98/37/EC of the European Parliament and the Council of June 22, 1998 for adaptaion of the member countries` legal and administrative regulations for machines	
89/336/EEC	1989-05-03	Directive of the Council of May3, 1989 for adaptation of the member countries` regulations on electromagnetic compatibility	
DIN EN 50178; VDE 0160	1998-04	Equipment of power installations with electronic equipment; German version EN 50178:1997	EN 50178(1997-10)
DIN VDE 0100-410; VDE 100 Part 410 IEC 60364-4-41	1997-01	Setting up power installations with rated voltages of up to 1,000V – Part 4: Protective measures; Chapter 41: Protection against electric shock (IEC 60364-4-41: 1992, as amended); German version HD 384.4.41 S2: 1996)	HD 384.4.41 s2 (1996-04); IEC 6036-4-41 (1992-10)
DIN EN 60529; VDE 0470 Part 1	2000-09	Protection classes via housings (IP code) (IEC 60529:1989 + A1: 1999); German version EN 60529:1991 + A1:2000)	EN 60529 (1991-10); EN 60529/A (2000-02); IEC 60529 (1989-11); IEC 60529
DIN ISO 281	1993-01	Rolling bearing; dynamic load rating and rated service life; identical with ISO 281:1990	ISO 281 (1990-12)
DIN 42955	1981-12	True running of the shaft ends, concentricity and even run of the mounting flanges of electrical rotating machines; tolerances, test	IEC 60072 (1971)
DIN 332-1	1986-04	Centre holes 60°; form R, A, B and C	ISO 886 (1975-02) ISO 2540 (1973-04); ISO 2541 (1972-12)
DIN 6885-1	1968-08	Driver connection without pick-up; feather keys, grooves, high shape	
DIN 332-2	1983-05	Centre holes 60° with thread for shaft ends of electrical machines	

Abb. 14-1: List of standards

