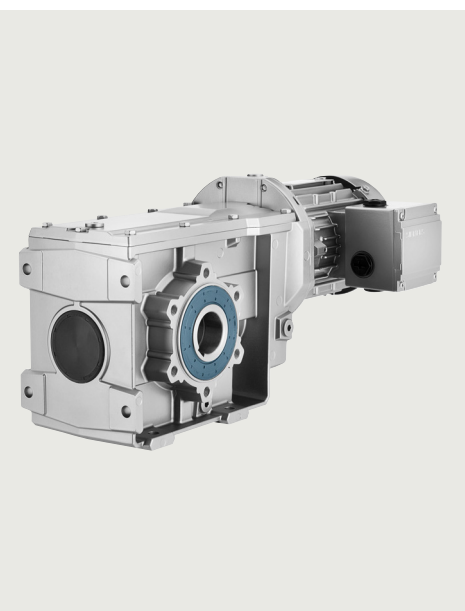


Configuring guide



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Configuring guide

Determining the drive data

Configuring sequence

Overview

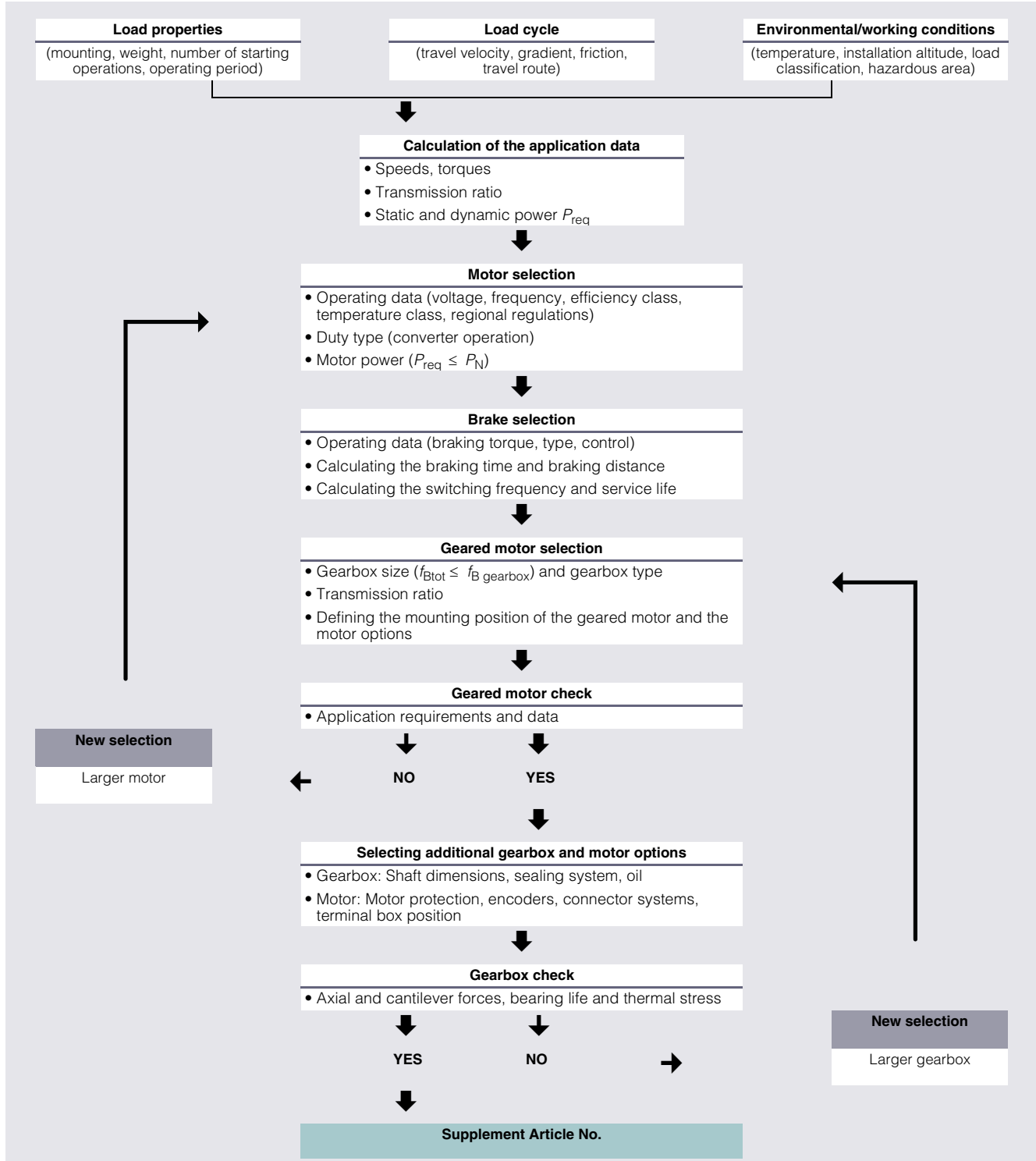
General configuring notes are provided for the standard versions in this catalog.

SIMOGEAR geared motors permit individual solutions to be created for a wide range of drive applications. In order to select the correct drive, specific data for the application must initially be known or determined.

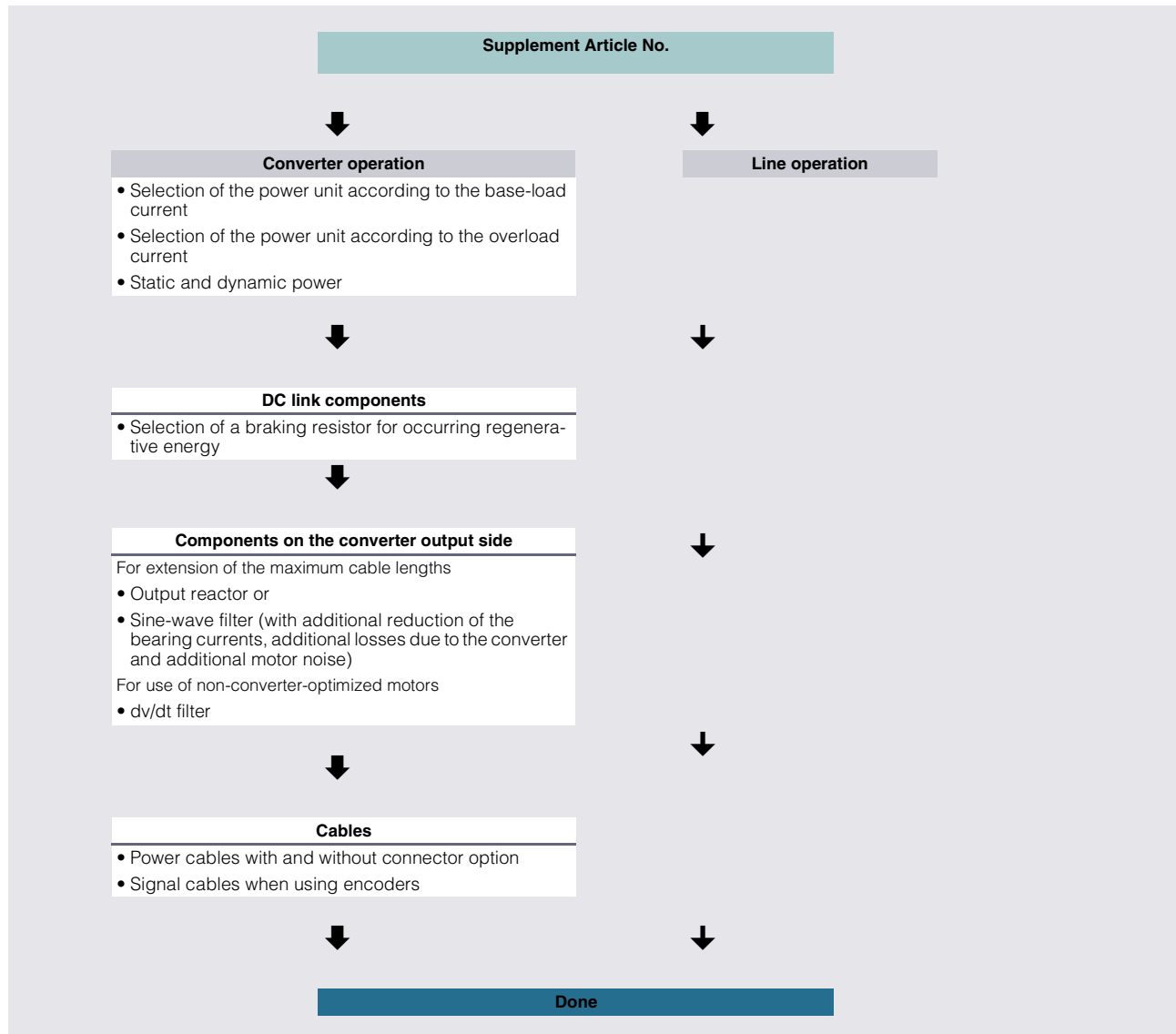
For drives operating under special conditions, e.g. frequent reversing, short-time or intermittent duty, abnormal temperatures, reversal braking, extreme cantilever forces at the gearbox output shaft, etc. please contact your Siemens contact person with all of your technical questions.

More information is available on the internet at:
www.siemens.com/gearedmotors

The flow diagram illustrates the process for selecting and dimensioning a geared motor using a traction drive as an example. However, the specific requirements and constraints associated with the application in question must always be taken into account.



Overview



Configuring guide

Determining the drive data

Checklist

2

General	
Basic version and load data	
Gearbox type:	☐ Helical gearbox ☐ Parallel shaft gearbox ☐ Bevel gearbox ☐ Helical worm gearbox ☐ Worm gearbox
Power rating:	_____ kW
Max. output speed:	_____ rpm
Service factor:	_____
Starting operations/hour:	_____ s/h
Line voltage:	_____ V
Line frequency:	☐ 50 Hz ☐ 60 Hz ☐ For converter operation ☐ Maximum frequency _____ Hz
Operating period/day:	☐ 8 hours ☐ 16 hours ☐ 24 hours
Environmental conditions	
Explosion protection:	☐ EU directive 2014/34/EU (ATEX) ☐ Ex atmosphere gas ☐ Ex atmosphere dust ☐ Category 2 ☐ IIB / ☐ IIC explosion group ☐ IIIB / ☐ IIIC explosion group ☐ Category 3 Temperature class T_____ Max. surface temperature _____ °C
Installation altitude:	_____ m
Air humidity:	_____ % ☐ Outdoor operation ☐ Increased environmental stress
Temperature:	from _____ to _____ °C ☐ Normal environmental stress ☐ Aggressive environmental stress
Brief description of the system: (e.g. sector, conveyor system, etc.)	_____

Gearbox	
Mounting and mounting position	
Mounting position:	☐ M1 ☐ M2 ☐ M3 ☐ M4 ☐ M5 ☐ M6 Terminal box position: _____ ☐ Special mounting position Rotation angle: _____
Mounting type:	☐ Foot-mounted design ☐ Flange-mounted design ☐ Housing flange design ☐ Shaft-mounted design ☐ Foot/flange-mounted design
Shafts	
Design:	☐ Solid shaft with/without feather key ☐ Hollow shaft with feather key ☐ Hollow shaft with shrink disk ☐ Hollow shaft with splines ☐ SIMOLOC assembly system
Shaft dimensions: (d x l)	_____ x _____ mm
Other options: (e.g. axial/radial force)	_____

Motor	
Electrical version	
Motor protection:	☐ PTC thermistor ☐ Winding thermostat ☐ Pt1000 resistance thermometer
Mechanical version	
Degree of protection:	☐ IP55 ☐ IP65 ☐ IP56 Connection type: ☐ Star ☐ Delta
Cooling & ventilation:	☐ Self ventilation ☐ Forced ventilation
Motor plugs:	☐ HAN 10E ☐ HAN K4/4 ☐ Others _____ ☐ HAN Q8 ☐ HAN Q12
Mounted components	
Brake:	☐ Brake ☐ Safety-related brake ☐ Manual brake release Voltage: _____ V
Encoder:	☐ Incremental encoder ☐ Absolute encoder ☐ Prepared for encoder mounting ☐ Functionally safe rotary encoder
Other options:	_____

General options	
Surface treatment	
Surface protection:	☐ C1 ☐ C2 ☐ C3 ☐ C4 ☐ C5 ☐ unpainted ☐ C2 primed ☐ C4 primed ☐ RAL color: _____
Other options:	_____

Basic version**Power rating:** _____**Number of starts/hour:** _____ s/h**Line voltage:** _____ V**Line frequency:** ☐ 50 Hz ☐ 60 Hz ☐ 87 Hz☐ **Maximum frequency:** _____ Hz**Brief description of the system:****Environmental conditions****Installation altitude:** _____ m☐ Outdoor operation ☐ Increased environmental stress**Air humidity:** _____ %☐ Normal environmental stress ☐ Aggressive environmental stress**Temperature:** from _____ to _____ °C**Trolley****Type of trolley:** ☐ Trolley type 1☐ Trolley type 2:☐ Trolley type 3☐ Front running wheel, driven☐ Rear running wheel, driven**Dimensions:** **H** _____ mm (Vertical distance between running wheel axis and center of gravity)**L1** _____ mm (Distance between running wheels)**L2** _____ mm (Horizontal distance between running wheel and center of gravity)**L3** _____ mm (Distance between swivel joints)**S** _____ mm (Center of gravity)**Track****Max. upward gradient:** _____ °**Height difference upward gradient:** _____ mm**Max. downward gradient:** _____ °**Height difference downward gradient:** _____ mm**Min. curve radius:** _____ mm**Design data****Weight of trolley:** _____ kg**Weight of load:** _____ kg**Wheel load** (of driving wheel on rail): _____ N**Distance from shaft shoulder to force application point x** _____ mm**Running wheel diameter:** _____ mm**Running wheel material:** ☐ Polyurethane☐ Other _____**Cyclic duration factor:** _____ %**Deceleration:** _____ m/sec²Upward gradient m/sec²Downward gradient m/sec²**Acceleration:** _____ m/sec²Upward gradient m/sec²Downward gradient m/sec²**Travel velocity:** min. _____ m/sec

max. _____ m/sec

Upward/downward gradient m/sec

Configuring guide

Configuring a gearbox

2

Standards

DIN/ISO	
DIN 743	Output shafts
ISO 281, ISO 76	Bearings
DIN 7190	Interference fits
DIN 6892	Parallel key connection
DIN 3990	Cylindrical gear toothing
DIN 3991	Bevel gear toothing
DIN 3996	Worm gear toothing

Calculation to AGMA available on request.

Gearbox efficiency

The efficiency of the gearbox is determined in part by the gear teeth, the rolling-contact bearing friction and the shaft sealing ring friction.

Helical, parallel shaft and bevel gearboxes

SIMOGear helical, parallel shaft, and bevel geared motors have a very high efficiency. Generally, efficiencies of 96 % (2-stage) and 94 % (3-stage) can be assumed. These gearbox types can be operated with energy-efficient motors to create an excellent solution.

Helical worm and worm gearboxes

The first stage of the helical worm gearbox is designed as a helical stage. With the optimally tuned transmission ratios of the worm stage, the best possible overall efficiency is achieved, which is considerably higher than that of worm gearboxes alone.

Precise efficiency data can be found in the tables in chapter "Helical worm gearboxes".

Owing to the high degrees of efficiency, the SIMOGear helical worm gearboxes are not self-locking.

Run-in period

The tooth flanks on new helical worm and worm gearboxes will not yet be fully smoothed, meaning that the friction angle will be greater and efficiency lower during the run-in period. The higher the transmission ratio, the more pronounced the effect.

The running-in process should take approximately 24 hours of operation at full load. In most cases, the catalog values will then be reached.

Self-locking with worm gearboxes

In respect of restoring torques on worm gearboxes, the efficiency is considerably reduced in comparison to standard efficiency. The restoring efficiency can be calculated as follows: $\eta' = 2 - 1/\eta$. At a standard efficiency of $\eta \leq 0.5$, worm gearboxes are usually self-locking, which is determined by the particular lead angle of the worm gear teeth.

Self-locking only occurs with certain combinations of SIMOGear gearboxes and is not always of benefit, as the associated loss of efficiency is then relatively high, which in turn requires increased motor power.

A worm gearbox is "self-locking while stationary" (static self-locking), if it is not possible to start from stationary when the worm wheel is driving.

A worm gearbox is "self-braking while running" (dynamic self-locking), if it is not possible to continue running when the worm wheel is driving while the gearbox is running – that is, if the running gearbox comes to a stop while the worm wheel is driving.

Shocks can neutralize self-locking.

A self-locking gearbox is therefore no substitute for a brake or backstop. If you want to use the self-locking braking effect for a technical purpose, please contact us.

Efficiency optimization

As a result of the large range of transmission ratios, in many cases, instead of a 3-stage gearbox, a 2-stage SIMOGear gearbox can be used.

This means that the efficiency is improved by approximately 2 % when compared to conventional drives.

Further, the efficiency can be improved by optimizing the mounting position and the input speed.

Splashing losses

For certain gearbox types of construction, the first stage can be completely immersed in the gearbox oil. In the case of large gearboxes with a high input speed, particularly with vertical mounting positions, this may lead to increased splashing losses, which cannot be neglected.

If you wish to use gearboxes such as these, then please contact Siemens. If at all possible, you should choose horizontal types of construction in order to keep splashing losses to a minimum.

Service factor

The service factor f_B is a safety factor for the gearboxes that takes the operating conditions of the drive into account.

The following applies to selecting a suitable drive:

$$f_B \geq f_{B\text{req}}$$

The gearbox size or rated gearbox torque and the resulting service factor are not standardized and depend on the manufacturer.

Service factor (f_B)

The service factor is calculated from the drive data you selected and can be obtained from the [Siemens Product Configurator](#).

Determining the required service factor ($f_{B\text{req}}$)

In normal operation, i.e. with a uniform load provided by the driven machine, small masses to be accelerated, and a low number of switching operations, the service factor of $f_{B\text{req}} = 1$ can be selected.

For operating conditions that deviate from this, the required service factor must be calculated using the following formulas.

For helical, parallel shaft and bevel gearboxes

$$f_{B\text{req}} = f_{B1} \cdot f_{BT}$$

For helical worm and worm gearboxes

$$f_{B\text{req}} = f_{B1} \cdot f_{B2} \cdot f_{BT}$$

Determining the service factor driven machine (f_{B1})

The service factor of the driven machine f_{B1} is determined from the load classification, switching frequency, and operating period per day.

Load groups of driven machines

Load classification	Mass acceleration factor (m_{AF})	Driven machine (examples)
I Almost shock-free	≤ 0.3	Electric generators, belt conveyors, apron conveyors, screw conveyors, lightweight elevators, electric hoists, machine tool feed drives, turbo blowers, centrifugal compressors, mixers and agitators when mixing materials with uniform density
II Moderate shock loads	≤ 3	Machine tool main drives, heavy elevators, slewing gear, cranes, shaft ventilators, mixers and agitators when mixing materials with non-uniform densities, reciprocating pumps with multiple cylinders, metering pumps
III Heavy shock loads	≤ 10	Punching presses, shears, rubber kneaders, machinery used in rolling mills and the iron and steel industry, mechanical shovels, heavy centrifuges, heavyweight metering pumps, rotary drilling rigs, briquetting presses, pug mills

Mass acceleration factor (m_{AF})

The mass acceleration factor m_{AF} is calculated as follows:

$$m_{AF} = \frac{J_X}{(J_{\text{mot}} + J_B + J_Z)}$$

All external moments of inertia are moments of inertia of the driven machine and the gearbox, which are to be reduced to the motor speed.

The conversion is made using the following formula:

$$J_X = J_2 \cdot \left(\frac{n_2}{n_1}\right)^2 = \frac{J_2}{(i)^2}$$

In most cases the relatively insignificant moment of inertia of the gearbox can be ignored.

The mass acceleration factor m_{AF} is calculated as follows with reference to the gearbox and the adapter:

$$m_{AF} = \frac{J_X + J_G + J_{AD}}{(J_{\text{mot}} + J_B + J_Z)}$$

Code	Description	Unit
f_B	Service factor	–
f_{B1}	Service factor driven machine	–
f_{B2}	Service factor short-time duty	–
$f_{B\text{req}}$	Required service factor	–
f_{BT}	Service factor ambient temperature	–
i	Transmission ratio	–
J_2	Moment of inertia of the load referred to the output speed of the gearbox	kgm ²
J_{AD}	Moment of inertia of the adapter referred to the input speed	kgm ²
J_B	Moment of inertia of the brake	kgm ²
J_G	Moment of inertia of the gearbox referred to the input speed	kgm ²
J_{mot}	Moment of inertia of the motor	kgm ²
J_X	Moment of inertia of the load referred to the input speed	kgm ²
J_Z	Additional moment of inertia of a high inertia fan	kgm ²
m_{AF}	Mass acceleration factor	–
n_1	Input speed of the gearbox	rpm
n_2	Output speed of the gearbox	rpm

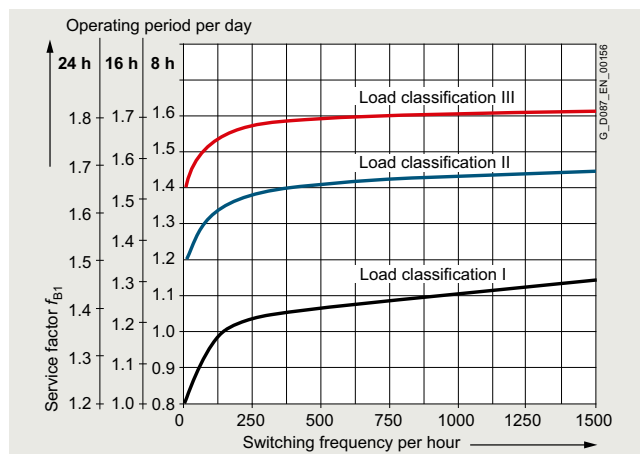


Fig. 2/1 Service factor f_{B1}

Configuring guide

Configuring a gearbox

Service factor

Determining the service factor ambient temperature (f_{BT})

If the drive warms up to an operating temperature above -20 °C at max. 70 % load, $f_{BT} = 1$ can be set.

For helical, parallel shaft and bevel gearboxes

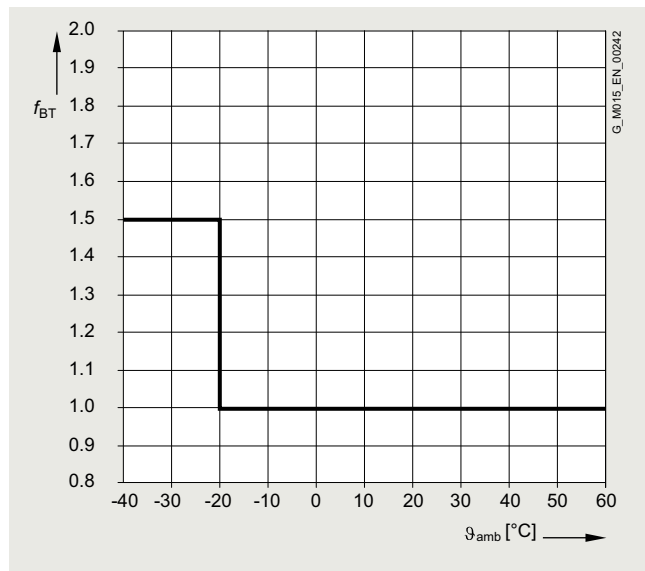


Fig. 2/2 Service factor ambient temperature

For helical worm and worm gearboxes

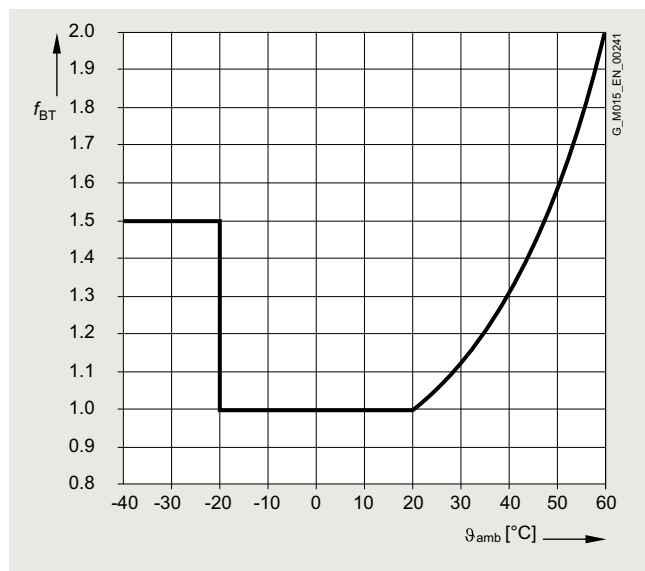


Fig. 2/3 Service factor ambient temperature for worm gearboxes

Determining the service factor short-time duty (f_{B2})

For helical worm and worm gearboxes

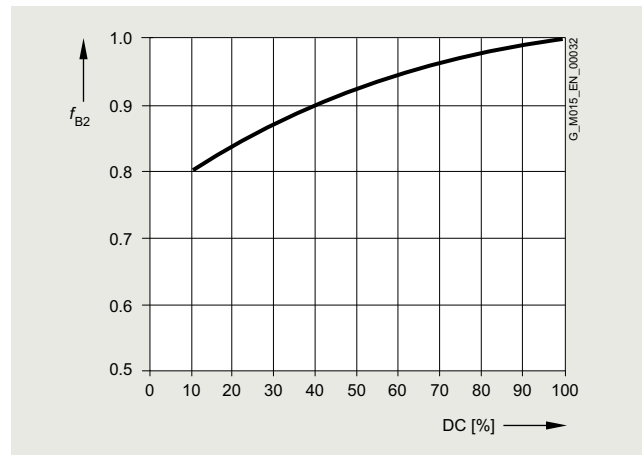


Fig. 2/4 Service factor short-time duty

Note:

When selecting and dimensioning drives with the following special application conditions, please contact Siemens:

- Frequent reversing
- Short-time and intermittent operation
- Abnormal temperatures
- Reversal braking
- Extreme and/or circulating radial forces at the gearbox output shaft
- Fluctuating loads

Torque

Required torque

Once the load situation (drive data) and the service factor have been clarified, then the required output torque can be determined.

$$T_2 = \frac{P_{\text{mot}} \cdot 9550}{n_1 / (i \cdot \eta)} = \frac{P_{\text{mot}} \cdot 9550}{n_2} \cdot \eta$$

Maximum motor torque

The maximum output torque T_{2N} of the gearbox must not be exceeded. For this purpose, it must be checked that the maximum motor torque $T_{1\text{max}}$ is below the resulting output torque of the gearbox:

$$T_{1\text{max}} \leq \frac{T_{2N}}{i \cdot \eta}$$

This test is particularly important for small service factors $f_B < 1$, gearboxes with high transmission ratios and tandem gearboxes.

Code	Description	Unit
η	Gearbox efficiency	%
i	Transmission ratio	–
n_1	Input speed of the gearbox	rpm
n_2	Output speed of the gearbox	rpm
P_{mot}	Motor power	kW
$T_{1\text{max}}$	Maximum permissible motor torque	Nm
T_2	Required output torque of the driven machine	Nm
T_{2N}	Maximum output torque of the gearbox	Nm

Input speed

For an identical power and output speed, in the selection tables 4-pole geared motors have priority over 6-pole motors.

As result of the very wide range of transmission ratios of SIMOGEAR gearboxes, it is hardly necessary to use motors with other pole numbers. In addition to good availability worldwide, 4-pole motors generally offer the optimum solution regarding price, length, noise level and service life.

Further, from the modular system, motors with other pole numbers can be mounted. As a consequence, the following special combinations can be implemented:

- Extremely high output speeds (2-pole motors)
- Extremely low output speeds (8-pole motors)
- Lower noise solutions (6-pole or 8-pole motors)

For converter operation, the gearboxes are driven at variable speeds.

When configuring the system, we recommend that the maximum input speed in continuous operation is maintained, wherever possible, at 1500 rpm.

At higher motor speeds above 1500 rpm you will generally experience higher noise levels and a lower bearing service life. This depends to a large extent on the transmission ratio and gearbox size in question. Furthermore, higher speeds additionally influence the thermal properties, the service life of the shaft sealing rings and the service intervals of the gearbox.

Tandem gearboxes

An additional helical gearbox is mounted in front of the main gearbox on tandem gearboxes, allowing the gear to generate very low output speeds.

The SIMOGEAR product portfolio includes four-stage, five-stage and six-stage gearboxes.

When a gearbox version with low output speeds is selected, additional checks may need to be carried out when the gearbox is configured.

Checking the maximum motor power

The maximum motor power P_N connected to the gearbox must be reduced according to the maximum output torque at the gearbox T_{2N} . For this purpose, the maximum permissible motor torque $T_{1\text{max}}$ must be calculated and the relevant motor current value then determined.

Protective measures

The following precautions must be taken in order to ensure that the continuous current consumption of the motor never exceeds the calculated maximum motor torque $T_{1\text{max}}$:

- Line operation:
Set the tripping current of the motor circuit breaker to this current value.
- Converter operation:
Limit the output current of the converter according to the calculated motor current.

Brake motors

The braking torque T_{br} must be limited according to the maximum permissible motor torque $T_{1\text{max}}$ for tandem geared motors with a brake.

In this case, the maximum permissible braking torque corresponds to twice the value of the motor torque. Please contact Siemens for advice about higher switching frequencies.

$$T_{br\text{max}} = 2 \times T_{1\text{max}}$$

Preventing gearbox blockage

Tandem gearboxes must be protected against blockage at the output end. Blockage can result in indeterminable torques and shaft loads and cause irreparable damage to the gearbox. If the risk of blockage cannot be eliminated, you can install friction clutches, for example.

Code	Description	Unit
P_N	Rated motor power	kW
$T_{1\text{max}}$	Maximum permissible motor torque	Nm
T_{2N}	Maximum output torque of the gearbox	Nm
$T_{br\text{max}}$	Maximum braking torque	Nm

Configuring guide

Configuring a gearbox

2

Gearbox fastening

Gearboxes and geared motors are normally secured by bolts of property 8.8.

When the largest possible motor frame size is attached to the gearbox and with a higher load classification, elevated levels of vibration and/or smaller service factors, further measures need to be taken for flange-mounted designs of gearboxes and geared motors.

Recommended bolt property class for DZ/ZZ and DF/ZF:

Helical gearboxes DZ/ZZ and DF/ZF with the smallest available output flanges must be bolted to the mounting surface with bolts of grade 10.9 (see table).

Gearbox type		Flange	Property class of bolt/nut
DZ/ZZ29	DF/ZF29	A120	10.9 ¹⁾
DZ/ZZ39	DF/ZF39	A120	10.9 ¹⁾
DZ/ZZ49	DF/ZF49	A140	10.9
DZ/ZZ59	DF/ZF59	A160	10.9
DZ/ZZ69	DF/ZF69	A200	10.9
DZ/ZZ79	DF/ZF79	A250	10.9
DZ/ZZ89	DF/ZF89	A300	10.9
DZ/ZZ109	DF/ZF109	A350	10.9
DZ/ZZ129	DF/ZF129	A350	10.9
DZ/ZZ149	DF/ZF149	A450	10.9
DZ/ZZ169	DF/ZF169	A450	10.9
DZ/ZZ189	DF/ZF189	A550	10.9

¹⁾ Use suitable washers underneath the bolt head

We recommend that you consider the following possibilities:

- Selection of a larger output flange
- Use of bolts of property class 10.9
- Use of an anaerobic adhesive to improve the friction lock between the gearbox and the mounting surface

Recommended bolt quality for FF/FAF and KF/KAF:

Parallel shaft gearboxes FF/FAF and bevel gearboxes KF/KAF in combination with larger motors must be bolted to the mounting surface with bolts of grade 10.9 (see table).

Gearbox type		Flange	Motor frame size											
			63	71	80	90	100	112	132	160	180	200	225	250
FF/FAF39	KF/KAF39	A160	8.8	8.8	8.8	10.9	10.9							
FF/FAF49	KF/KAF49	A200	8.8	8.8	8.8	8.8	10.9	10.9						
FF/FAF69	KF/KAF69	A250	8.8	8.8	8.8	8.8	8.8	8.8	10.9					
FF/FAF79	KF/KAF79	A250	8.8	8.8	8.8	8.8	8.8	8.8	10.9					
FF/FAF89	KF/KAF89	A300		8.8	8.8	8.8	8.8	10.9	10.9	10.9				
FF/FAF109	KF/KAF109	A350			8.8	8.8	8.8	8.8	8.8	10.9	10.9			
FF/FAF129	KF/KAF129	A450				8.8	8.8	8.8	8.8	8.8	8.8	8.8		
FF/FAF149	KF/KAF149	A450				8.8	8.8	8.8	8.8	8.8	8.8	10.9	10.9	10.9
FF/FAF169	KF/KAF169	A550					8.8	8.8	8.8	8.8	10.9	10.9	10.9	10.9
FF/FAF189	KF/KAF189	A660						8.8	8.8	8.8	8.8	8.8	8.8	10.9

Shaft load and bearing service life

Available radial force

The radial forces either come from the driven machine (mixer, hoisting gear) or they are caused by the transmission elements.

The available radial force F_{Ravail} at the output shaft is obtained as follows:

- The required geared motor output torque T_2
- Average diameter of the mounted transmission elements d_0
- Transmission element type, e.g. sprocket wheel
- Ambient temperature

The transmission element type determines the additional factor C (see table).

The ambient temperature determines the additional factor T .

$$F_{Ravail} = 2000 \cdot \frac{T_2}{d_0} \cdot C \cdot T$$

Additional factor C for the transmission element type

Transmission element	Explanation	Additional factor C
Gear wheel	> 17 teeth	1.00
	≤ 17 teeth	1.15
Sprocket wheel	≥ 20 teeth	1.00
	14 ... 19 teeth	1.25
	≤ 13 teeth	1.40
Toothed belts	Preloading force	1.50
V-belts	Preloading force	2.00
Flat belts	Preloading force	2.50
Agitator/mixer	Rotating radial force	2.50

Additional factor T for ambient temperature

Temperature range	Low-temperature factor T
–20 °C ... +60 °C	1.0
–21 °C ... –40 °C	1.5

Permissible radial force

The permissible radial force F_{R2} is determined by the required bearing service life, among other things. The nominal service life L_{h10} is determined in accordance with ISO 281. Normally, calculating the nominal bearing service life is completely adequate.

The bearing service life can be calculated for special operating conditions and in special cases on request, based on the modified service life L_{na} .

The selection tables specify the permissible radial force F_{R2} for the output shafts of the foot-mounted design with solid shaft "1" (see shaft designs from [page 10/46](#)). These table values refer to the force application point at the center of the shaft extension and are minimum values, which apply under the most unfavorable conditions (force application angle, mounting position, direction of rotation).

If the values in the table are not sufficient, or if other gearbox designs are being used, then please contact Siemens.

Permissible axial force

If no radial force is present, then max. 50 % of the permissible radial force can be applied as a permissible axial force F_{ax} (tension or compression).

Higher permissible radial and axial forces

The permissible radial force load can be increased, taking the force application angle α and the direction of rotation into account. Installing reinforced bearings also means that higher loads are permitted on the output shaft.

If higher radial or axial forces or combined loads comprising radial and axial forces occur, then please contact Siemens.

Note:

Bevel gearboxes B and K and helical worm gearboxes C in type of construction M1 with foot mounting on the face side: A maximum of 50 % of the radial force F_{R2} specified in the tables is permissible.

Helical geared motors ZB and DB in foot/flange-mounted designs:

When transmitting torque through the flange surface, a maximum of 50 % of the radial force F_{R2} specified in the tables is permissible.

Variables for defining shaft load and bearing service life

Code	Description	Unit
α	Force application angle	°
a	Gearbox constant	kNmm
b, d, l, y, z	Gearbox constants	mm
C	Additional factor to calculate the radial force	–
d_0	Average diameter of the mounted transmission element	mm
F_{ax}	Permissible axial force	N
F_x	Permissible radial force from out of center force application point	N
F_{xperm1}	Permissible radial force, limited by the bearing service life, at a distance of x from the shaft shoulder	N
F_{xperm2}	Permissible radial force, limited by the shaft strength, at a distance of x from the shaft shoulder	N
F_{Ravail}	Available radial force from the mounted transmission element	N
F_{R2}	Permissible radial force at the center of shaft extension ($l/2$)	N
L_{h10}	Nominal bearing service life	h
L_{na}	Modified bearing service life	h
T	Additional factor for ambient temperature	–
T_2	Geared motor output torque	Nm
x	Distance from the shaft shoulder up to the point where force is applied	mm

Configuring guide

Configuring a gearbox

Shaft load and bearing service life

Definition of the point of application of radial and axial forces

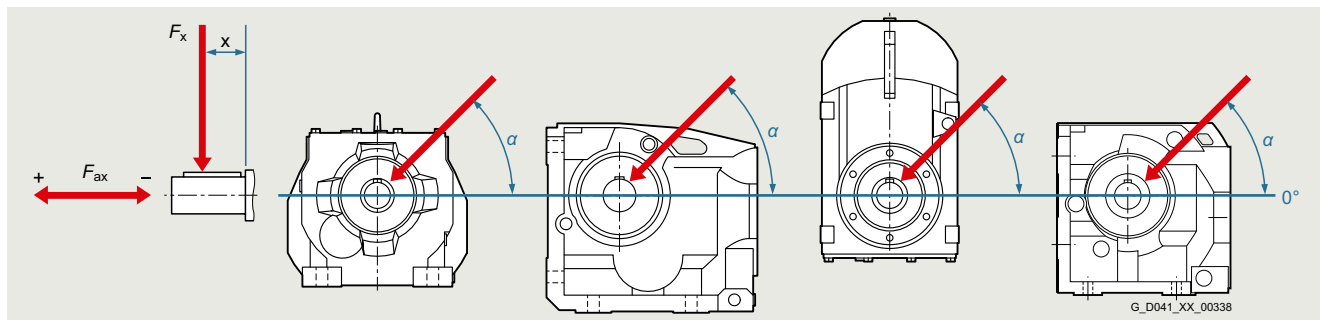


Fig. 2/5 Diagram showing force application point

Radial force conversion for out-of-center force application point

If the force is not applied at the center of the shaft extension, the permissible radial force must be calculated using the following formula.

The lower value of F_{xperm1} (bearing service life) and F_{xperm2} (strength) is the permissible radial force. The calculation is applicable without axial force.

Permissible radial force according to the bearing service life

$$F_{xperm1} = F_{R2} \cdot \frac{y}{(z + x)}$$

Permissible radial force according to the shaft strength

$$F_{xperm2} = \frac{a}{(b + x)}$$

Gearbox constants for calculating the radial force

Gearbox size	Constants y mm	z mm	a kNmm	b mm	d mm	l mm
Helical gearboxes Z and D						
19	91	71	52.8	12	20	40
29	104	79	137	12	25	50
39	116	91	109	0	25	50
49	138	108	260	15	30	60
59	143.5	108.5	414	19	35	70
69	169	134	385	0	35	70
79	172.5	132.5	536	0	40	80
89	212.5	162.5	929	0	50	100
109	250	190	1212	0	60	120
129	297	227	2051	0	70	140
149	319	234	4930	0	90	170
169	398	293	7350	0	110	210
189	469	364	11235	0	120	210
Helical gearboxes E						
39	99.5	79.5	60	0	20	40
49	119.0	94.0	100	0	25	50
69	139.6	109.6	183	0	30	60
89	154.4	114.4	320	0	40	80
109	183.4	133.4	525	0	50	100
129	189.4	129.4	810	0	60	120
149	213.6	143.6	1120	0	70	140
Parallel shaft gearboxes F						
29	108.5	83.5	159	0	25	50
39	123.5	98.5	146	0	25	50
49	154.5	124.5	239	0	30	60
69	175	140	378	0	35	70
79	191	151	544	0	40	80
89	226	176	884	0	50	100
109	256	196	1500	0	60	120
129	324	254	2625	0	70	140
149	385	300	5525	0	90	170
169	460	355	7728	0	110	210
189	538	433	11655	0	120	210

Shaft load and bearing service life

Gearbox constants for calculating the radial force

Gearbox size	Constants					
	y mm	z mm	a kNmm	b mm	d mm	l mm
Bevel gearboxes B						
19	97.5	77.5	38	0	20	40
29	117	97	83	0	20	40
39	143.5	113.5	209	0	30	60
49	175	140	392	0	35	70
Bevel gearboxes K						
39	123.5	98.5	152	0	25	50
49	154.5	124.5	235	0	30	60
69	175	140	378	0	35	70
79	191	151	556	0	40	80
89	226	176	916	0	50	100
109	256	196	1470	0	60	120
129	324	254	2800	0	70	140
149	385	300	5525	0	90	170
169	459.5	354.5	7350	0	110	210
189	538	433	10920	0	120	210
Helical worm gearboxes C						
29	117.5	97.5	84	0	20	40
39	123.5	98.5	157	0	25	50
49	154.5	124.5	236	0	30	60
69	171.5	136.5	410	0	35	70
89	220.0	175.0	736	0	45	90
Worm gearboxes S						
09	83.5	63.5	36	0	16	40
19	98.0	78.0	76	0	20	40
29	120.5	100.5	72	0	20	40

Configuring guide

Configuring a gearbox

2

Shaft load and bearing service life for electric-monorail gearboxes EHB

Available radial force EHB

The total available radial force comprises the force due to weight on the running wheel and the tangential force exerted by the torque. The weight distribution depends on the relevant trolley type and on the number of drives and running wheels. Forces are also exerted as a result of weight transfer during startup, braking and ascending travel. These forces must be taken into account in the available radial force calculation.

Your Siemens contact person will be pleased to provide configuring advice. In order to dimension the drive, we will need the completed [checklist on page 2/5](#).

Variables for defining shaft load and bearing service life

Code	Description	Unit
H	Vertical distance between running axis and center of gravity	mm
L1	Distance between running wheels	mm
L2	Horizontal distance between running wheel and center of gravity	mm
L3	Distance between swivel joints	mm
S	Center of gravity	mm

Trolley type 1

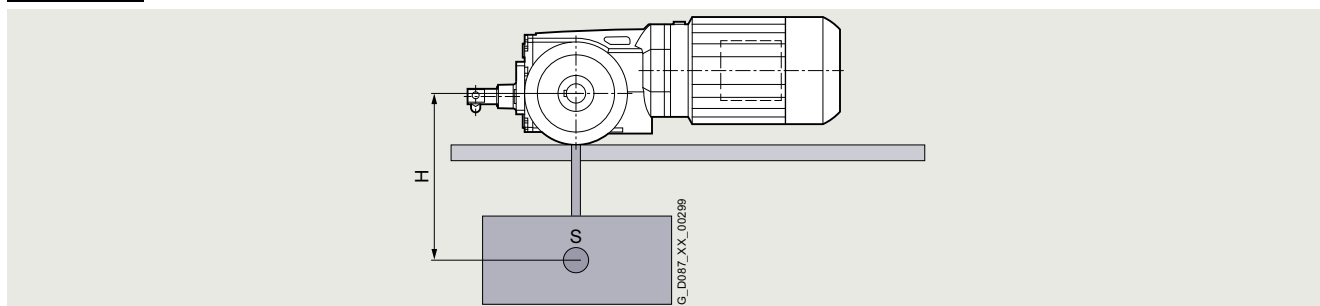


Fig. 2/6 Trolley type 1: 1 running wheel, one wheel is driven

Trolley type 2

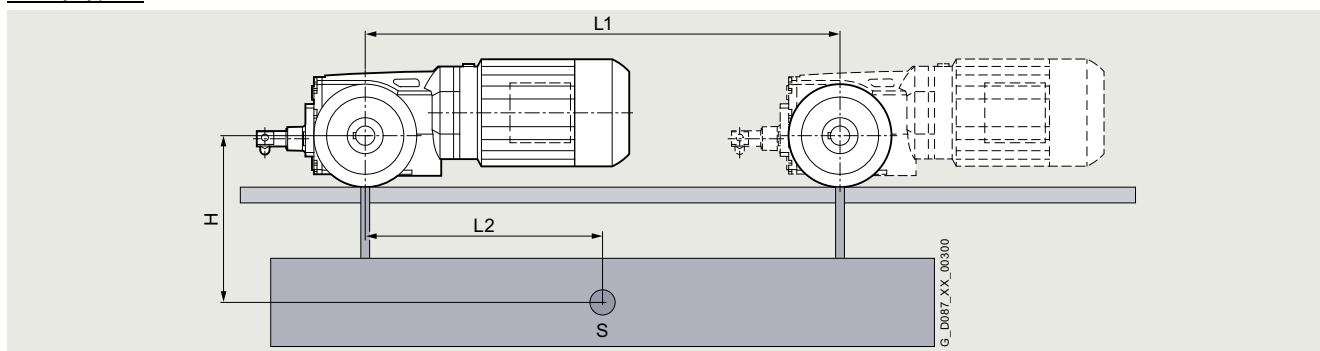


Fig. 2/7 Trolley type 2: 2 running wheels, one wheel at the front or rear is driven

Trolley type 3

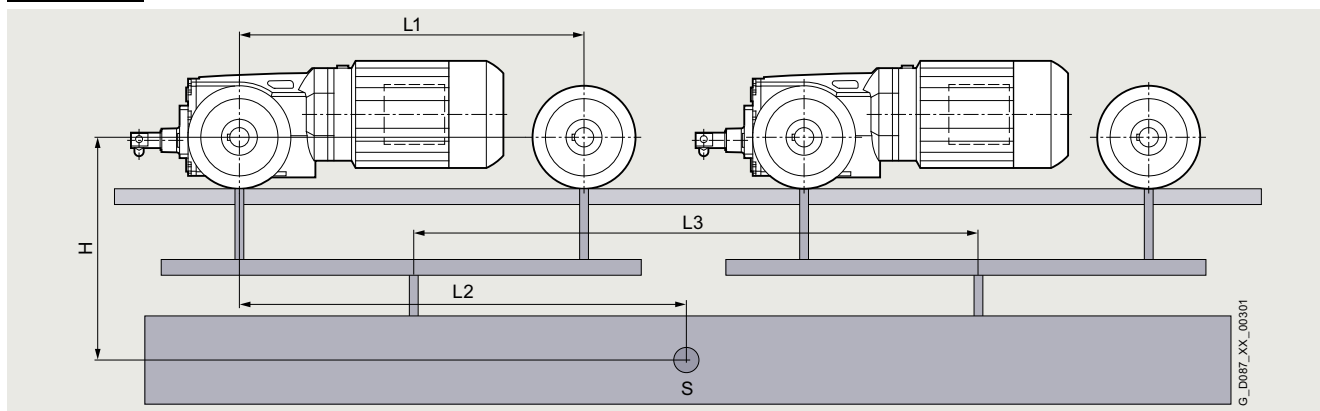


Fig. 2/8 Trolley type 3: 4 running wheels, 2 wheels are driven

Shaft load and bearing service life for electric-monorail gearboxes EHB

Permissible radial force EHB

The selection tables specify the permissible radial force F_{R2} . The table values refer to the force application point x, [see table "Gearbox constants for calculating the radial force" from page 2/12](#).

Note:

For BH.39 with 25 x 35 solid shaft, the permissible radial force F_x must always be calculated using the conversion below (even when $x = 18$ mm), because the table values apply to a 30 x 50 solid shaft.

Radial force conversion for force application at distance other than x

When the distance x to the shaft shoulder is other than the value stated in the table, use the following formulas to convert the permissible radial force.

The lowest value of F_{xperm1} (bearing service life), F_{xperm2} (strength) and F_{Rmax} is the permissible radial force F_x . The calculation is applicable without axial force.

Permissible radial force according to the bearing service life

$$F_{xperm1} = F_{R2} \cdot \frac{y}{(z + x1)}$$

Permissible radial force according to the shaft strength

$$F_{xperm2} = \frac{a}{(b + x1)}$$

Permissible radial force for force application at distance other than x

$$F_x \leq F_{xperm1}; F_{xperm2}; F_{R2max}$$

Condition: Available radial force ≤ permissible radial force

Variables for defining shaft load and bearing service life

Code	Description	Unit
α	Force application angle	°
a, b, d, l, y, z	Gearbox constants	Nmm / mm
d_0	Average diameter of the mounted transmission element	mm
F_G	Force due to weight	N
F_{R2}	Permissible radial force (from power table)	N
F_{R2max}	Maximum permissible radial force according to table "Gearbox constants for calculating the radial force" from page 2/12	N
F_{Ravail}	Available radial force	N
F_x	Permissible radial force from out of center force application point	N
F_{xperm1}	Permissible radial force, limited by the bearing service life, at a distance of x from the shaft shoulder	N
F_{xperm2}	Permissible radial force, limited by the shaft strength, at a distance of x from the shaft shoulder	N
RWC	Running wheel center	—
x	Distance from the shaft shoulder up to the force application point at running wheel center for F_{R2} according to table "Gearbox constants for calculating the radial force" from page 2/12	mm
x1	Distance from the shaft shoulder up to the force application point at running wheel center for F_x	mm

Definition of the force application point EHB

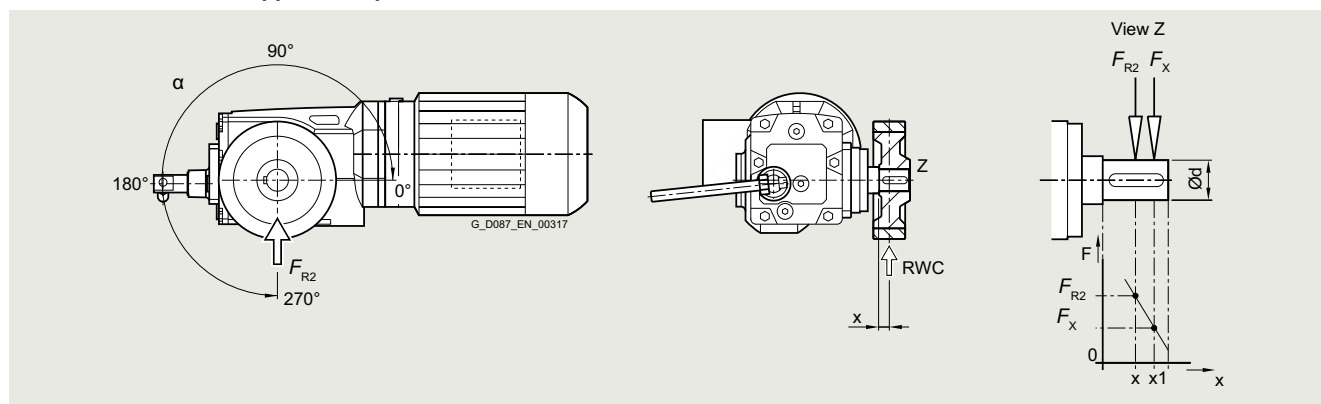


Fig. 2/9 Force application point

Gearbox constants for calculating the radial force

Gearbox size	Constants		a	b	d	l	T_2	F_{R2max}	Force application x
	y	z							
	mm	mm	Nmm	mm	mm	mm	Nm	N	mm
Light-load applications									
BH.29	158	145	97500	0	25	35	90	7500	13
BH.39	170	162	216000	0	25	35	200	12000	18
BH.39	170	152	270000	0	30	50	200	15000	18
Heavy-load applications									
KH.49	199	171	333000	0	30	60	420	18500	18
KH.49	199	171	518000	0	35	70	420	18500	28
KH.69	239	211	700000	0	45	90	600	25000	28
KH.79	257	225	1280000	0	55	110	820	40000	32

Configuring guide

Configuring a gearbox

2

Permissible torque for the SIMOLOC assembly system

It is important to note that the maximum permissible torque is dependent on the selected machine shaft diameter.

Diameter of customer's shaft	Max. permissible torque T2					
	Nm					
	29	39	49	69	79	89
Metric shafts						
20	115					
25	150	205				
30		290	375			
35			480	460	840	
40				600	1000	1110
50						1750
Imperial shafts						
0.75"	100					
1"	150	205				
1.1875"		290	375			
1.25"		290	415			
1.375"			480	460	840	
1.4375"			480	500	915	
1.5"				545	1000	
1.625"				600	1000	1180
1.75"						1375
1.9375"						1680
2"						1750

Determining the duty type

The power ratings for continuous duty with constant load (duty type S1) are listed in the power tables. The motor power ratings listed in the catalog can be converted to the lower duty cycle using the corresponding k_{DC} factors for S1, S2, and S3 duty types.

$$P_{DC} = P_N \cdot k_{DC}$$

Code	Description	Unit
P_{DC}	Power for the new duty cycle	kW
P_N	Rated motor power	kW
k_{DC}	Factor for increased power	–

For increased power, you should note that the breakdown torque ratio must not fall below 1.6. This same regulation applies when differentiating between the following groups of duty types.

Duty types according to EN 60034-1 (IEC 60034-1)

Duty type	Description	Information required	Factor for increased power k_{DC}
S1	Continuous duty Cyclic duration factor = 100 %	–	–
S2	Constant load for a brief time, e.g. S2 – 30 min	Load duration	60 min 1.10 30 min 1.20 10 min 1.40
S3	Intermittent periodic duty, where starting has no significant influence (cyclic operation), e.g. S3 – 40 %	Cyclic duration factor in % (referred to 10 min)	60 % 1.10 40 % 1.15 25 % 1.30 15 % 1.40
S4 ... S10	Intermittent periodic duty with the influence of starting	Cyclic duration factor in % (referred to 10 min), starts per hour, load torque and moment of inertia The duty type and motor power can be determined if the number of starting operations per hour, starting time, load duration, type of braking, braking time, idle time, cycle time, standstill time and required power are specified.	On request –

Duty types

S1

Continuous duty with constant load

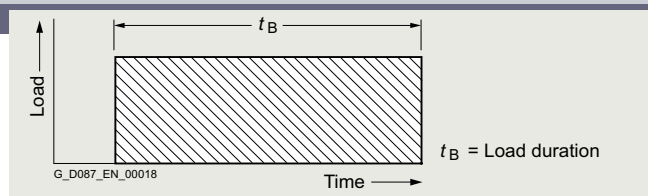


Fig. 2/10 Duty type S1

Where starting and electrical braking do not affect the motor stator winding temperature rise:

S2

Short-time duty

Recommendation: Operating times 10, 30, 60 and 90 minutes

After each period of duty the motor remains at zero current until the winding has cooled down to the coolant temperature.

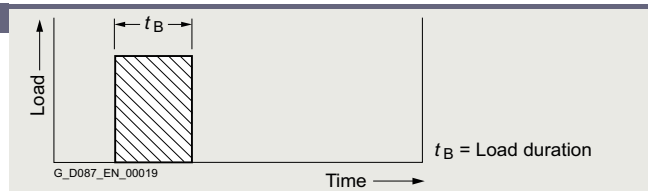


Fig. 2/11 Duty type S2

Configuring guide

Configuring a three-phase motor

Determining the duty type

Duty types

Where starting and electrical braking do not affect the motor stator winding temperature rise:

S3

Intermittent duty

Where starting does not affect the temperature. Unless specified otherwise, the cycle duration is 10 minutes. Values of 15 %, 25 %, 40 % and 60 % are recommended for the cyclic duration factor.

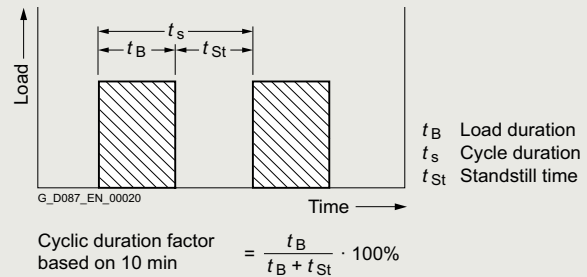


Fig. 2/12 Duty type S3

S6

Continuous duty with intermittent load

The cycle duration, if nothing else has been agreed, is 10 minutes. Values of 15 %, 25 %, 40 % and 60 % are recommended for the load duration factor.

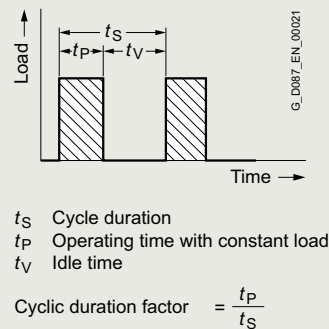


Fig. 2/13 Duty type S6

S10

Operation with discrete constant loads

In this case, a maximum of four discrete loads are available, where each load results in the thermal steady state. For this duty type, a load of the same value as the one used for the S1 duty type should be selected.

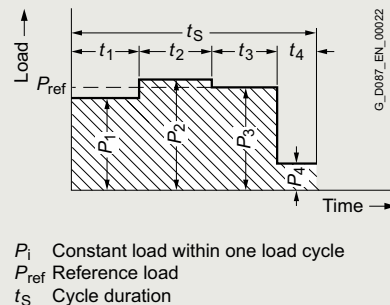


Fig. 2/14 Duty type S10

Starting and braking influence the temperature rise of the stator winding and the rotor cage:

S4

Intermittent duty where starting influences the temperature

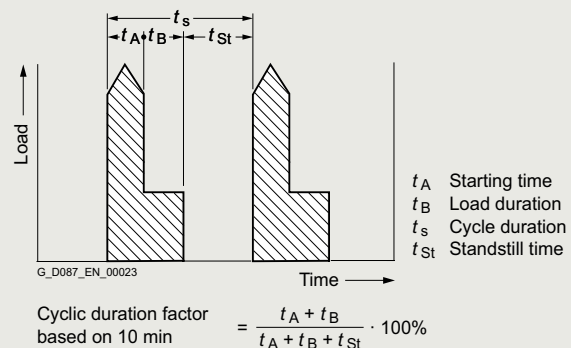


Fig. 2/15 Duty type S4

Determining the duty type

Duty types

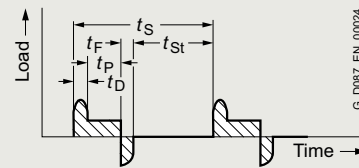
Starting and braking influence the temperature rise of the stator winding and the rotor cage:

S5

Intermittent duty where starting and braking influence the temperature

For the **S4** and **S5 duty types**, this code should be followed by the cyclic duration factor, the moment of inertia of the motor (J_{mot}), and the moment of inertia of the load (J_L), both referred to the motor shaft.

The cycle duration, if nothing else has been agreed, is 10 minutes. Values of 15 %, 25 %, 40 %, and 60 % are recommended for the cyclic duration factor.



t_S Cycle duration
 t_D Starting time
 t_P Operating time with constant load
 t_F Time with electrical braking
 t_{St} Standstill time with windings at zero current

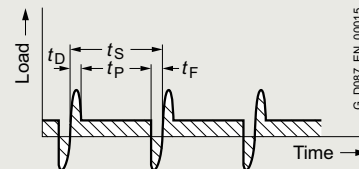
$$\text{Cyclic duration factor} = \frac{t_D + t_P + t_F}{t_S}$$

Fig. 2/16 Duty type S5

S7

Continuous duty with starting and braking

For S7 and S8 duty types, the moment of inertia of the load (J_L) referred to the motor shaft must be known.



t_S Cycle duration
 t_D Starting time
 t_P Operating time with constant load
 t_F Time with electrical braking

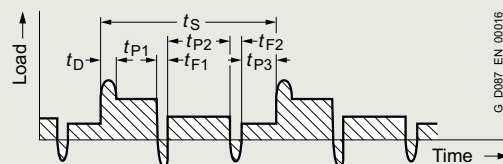
$$\text{Cyclic duration factor} = 1$$

Fig. 2/17 Duty type S7

S8

Continuous duty with non-periodic load and speed changes (converter operation)

Most of the intermittent operating conditions occurring in practice are a combination of the above mentioned duty types. All of the operating conditions must be known in order to precisely determine a suitable motor.



t_S Cycle duration
 t_D Starting time
 t_P Operating time with constant load (P1, P2, P3)
 t_F Time with electrical braking (F1, F2)

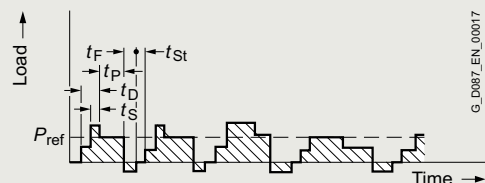
$$\text{Cyclic duration factor} = \frac{t_D + t_{P1}}{t_S} \cdot \frac{t_{F1} + t_{P2}}{t_S} \cdot \frac{t_{F2} + t_{P3}}{t_S}$$

Fig. 2/18 Duty type S8

S9

Continuous duty with non-periodic load and speed changes (converter operation)

Most of the intermittent operating conditions occurring in practice are a combination of the above mentioned duty types. All of the operating conditions must be known in order to precisely determine a suitable motor.



t_D Starting time
 t_P Operating time with constant load
 t_F Time with electrical braking
 t_{St} Standstill time with windings at zero current
 t_S Time with overload

Fig. 2/19 Duty type S9

Configuring guide

Configuring a three-phase motor

Switching frequency

A higher switching frequency means that there is a higher number of starting operations per hour. This leads to a higher thermal load on the motor winding.

The permissible switching frequency Z_{perm} has to be determined for different operating cases.

This value is influenced by the corresponding load torque, the additional moment of inertia, the power requirement, and the cyclic duration factor. These can be evaluated using the factors k_M , k_{FI} and k_P .

For 60 Hz operation, the calculated permissible switching frequency Z_{perm} must be reduced by 25 %. See the technical specifications for brakes in [chapter 11](#) for the permissible switching frequency for operation with function rectifiers.

The permissible no-load switching frequency Z_A for motors with brake L must be obtained from table "No-load switching frequency for brakes L/LS" on page 11/46.

$$Z_{\text{perm}} = Z_A \cdot k_M \cdot k_{FI} \cdot k_P$$

The permissible no-load switching frequency Z_0 for motors without brakes must be obtained from the [Selection and ordering data](#) in [chapter 9](#).

$$Z_{\text{perm}} = Z_0 \cdot k_M \cdot k_{FI} \cdot k_P$$

Code	Description	Unit
DC	Cyclic duration factor	%
J_{mot}	Moment of inertia of motor and brake	kgm ²
J_Z	Additional moment of inertia of a high inertia fan	kgm ²
J_X	Reduced moment of inertia on motor shaft	kgm ²
J_{add}	Additional moment of inertia	kgm ²
k_{FI}	Factor for taking into account the additional moment of inertia	–
k_M	Factor for taking into account the load torque while accelerating	–
k_P	Factor for taking into account the required power and duty cycle	–
P_S	Actual steady-state power of the motor	kW
P_N	Rated motor power	kW
T_A	Acceleration torque of the motor	Nm
T_N	Rated motor torque	Nm
T_X	Reduced load torque on motor shaft	Nm
t_R	Cyclic duration factor (decimal)	
Z_0	No-load switching frequency, motor without brake	1/h
Z_A	No-load switching frequency, motor with brake	1/h
Z_{perm}	Permissible switching frequency	1/h

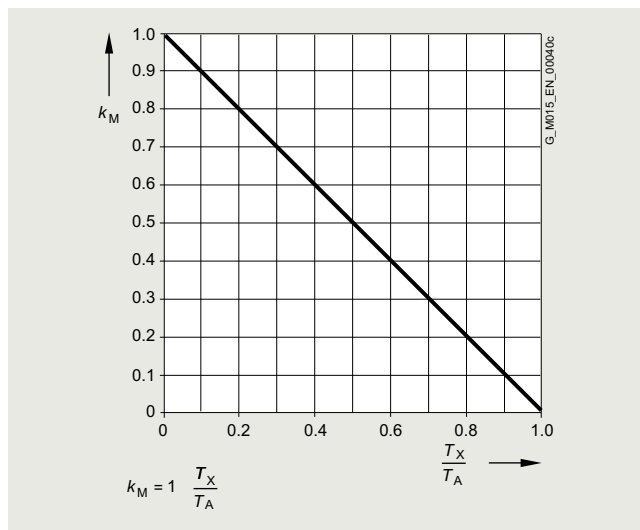


Fig. 2/20 Torque when accelerating

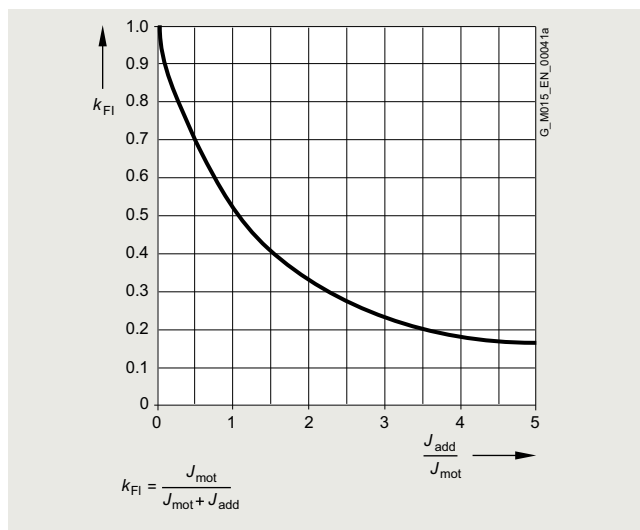


Fig. 2/21 Additional moment of inertia

$$J_{\text{add}} = J_X + J_Z$$

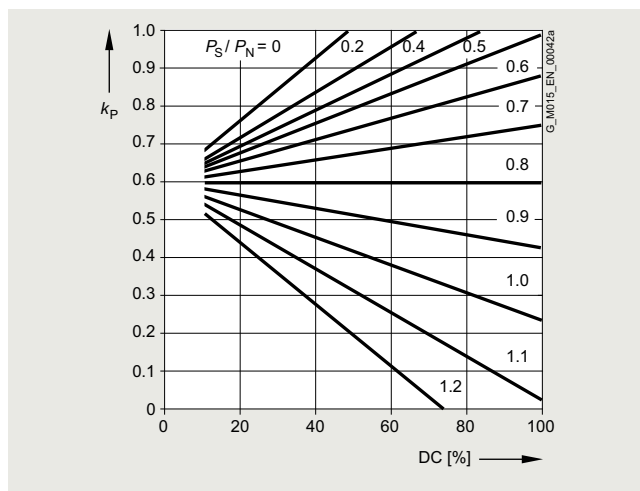


Fig. 2/22 Power requirement and duty cycle

$$k_P = t_R \cdot (1 - (P_S / P_N)^2) + 0.6 \cdot (1 - t_R) + 0.24 \cdot t_R$$

Additional moments of inertia

The motor moment of inertia with standard fan is specified in the motor selection lists. The higher moment of inertia should be used for metal or high-inertia fans. This is also valid for mounted brakes, backstops and encoder systems.

Line feeder cables

Line feeder cables must be adequately dimensioned. The number of required parallel (if applicable) feeder cables is determined by the maximum connectable conductor cross-section, the type of cable, the cable installation, the ambient temperature and the permissible current. In Germany, DIN VDE 0298 must be applied when dimensioning cables.

Undervoltage

For an undervoltage condition as a result of weak line supplies, catalog values such as motor power, torque and speed are not reached. This is especially important when considering motor starting.

Motor protection

A distinction is made between current-dependent and temperature-dependent protective devices for motors.

Current-dependent protective devices

Fuses are only used to protect line cables in the event of a short-circuit. They are not suitable for overload protection of the motor. The motors are usually protected by thermally delayed overload protection devices (circuit breakers for motor protection or overload relays).

This protection is current-dependent and is particularly effective in the case of a locked rotor. For normal operation with short starting operations, starting currents that are not excessive and for a low switching frequency, motor circuit breakers provide adequate protection. Motor circuit breakers are not suitable for heavy starting duty or high switching frequencies. Differences in the thermal time constants for the protective devices and the motor result in unnecessary early tripping when the circuit breaker is set to the rated current.

Temperature-dependent protective devices

Temperature-dependent protective devices are integrated in the motor winding and can be implemented as **temperature sensors** and **temperature switches**.

The number of temperature-dependent protective devices depends on the number of windings and their function.

The alarm is normally set to 10 K below the switch-off temperature. The rated response temperatures (NAT) of the protective devices depend on the thermal class of the motors.

In order to achieve full thermal protection, it is necessary to combine a thermally delayed overcurrent release and a PTC thermistor.

Coolant temperature and installation altitude

The rated power specified in the [selection and ordering data in chapter 9](#) is valid for a coolant temperature of +40 °C and an installation altitude of 1000 m above sea level.

Please contact Siemens for higher coolant temperatures.

The table with correction factors provides a rough idea of the derating required if conditions are different.

This results in a permissible motor power of:

$$P_{\text{perm}} = P_N \cdot k_{\text{HT}}$$

Code	Description	Unit
P_{perm}	Permissible motor power	kW
P_N	Rated motor power	kW
k_{HT}	Factor for abnormal coolant temperature and installation altitude	–

Factor k_{HT} for different installation altitude and coolant temperature

Installation altitude SA	Coolant temperature CT					
	< +30 °C	+30 ... +40 °C	+45 °C	+50 °C	+55 °C	+60 °C
m						
1000	1.07	1.00	1.00	0.92	0.87	0.82
1500	1.04	0.97	0.93	0.89	0.84	0.79
2000	1.00	0.94	0.90	0.86	0.82	0.77
2500	0.96	0.90	0.86	0.83	0.78	0.74
3000	0.92	0.86	0.82	0.79	0.75	0.70
3500	0.88	0.82	0.79	0.75	0.71	0.67
4000	0.82	0.77	0.74	0.71	0.67	0.63

Configuring guide

Configuring a three-phase motor

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Degrees of protection

The motors are supplied in IP55 to standard IEC 60034-5. They can be installed in dusty or humid environments. The motors are suitable for operation in tropical climates. Guide value below 60 % relative atmospheric humidity for a coolant temperature +40 °C.

Other requirements on request.

First code number	Brief description	Second code number	Brief description
4	The motor is protected against solid objects greater than 1 mm.	4	The motor is protected against water splashed from all sides.
5	The motor is protected against dust.	5	The motor is protected against jets of water.
6	The machine is dust-tight.	6	The motor is protected against "heavy seas" or powerful jets of water.
		7	The motor is protected against immersion.
		8	The motor is protected against long periods of immersion under pressure.

The first code number of the degree of protection indicates the degree to which an enclosure provides protection against contact and the ingress of foreign bodies.

The second code number indicates the protection that an enclosure offers regarding the ingress of water.

Increased corrosion protection as well as additional protective measures for the winding (protection against moisture and acid, corrosion protection in the motor) can support the selected degree of protection.

The degree of protection only refers to the motor. When selecting higher degrees of protection, the equipment on the gearbox side should be taken into account (seals, vents).

Cooling and ventilation

When the geared motor is mounted and the air intake is restricted, you must ensure that a minimum clearance is maintained between the fan cover and the wall and that the cooling air is not immediately drawn in again.

Further, it must be guaranteed that the cooling air flow to the gearbox is not obstructed. As a consequence, the gearbox operating temperature can be further reduced.

Forced ventilation

The use of a separately driven fan is recommended to increase motor utilization at low speeds and to limit noise generation at speeds significantly higher than the synchronous speed. Both are mainly used in conjunction with converter operation.

Typical areas of application for forced ventilation:

- High switching frequency
- Converter drives with a control range > 1:20
- Converter drives with rated torque at low speeds
- Noise reduction
- At high speeds

Bearing system

The bearing service life of motors with horizontal mounting is 40000 hours if there is no additional axial loading at the coupling output and 20000 hours when utilized according to the maximum admissible load. This assumes that the motor is operated at 50 Hz. The nominal bearing service life is reduced for converter operation at higher frequencies.

In order to achieve the calculated lifetime in continuous operation, the admissible vibration values (measured at the end shield) must be determined according to evaluation zones A and B stipulated in ISO 10816. If higher vibration velocities occur in operation, special measures must be taken.

Please contact Siemens in this regard.

Overview

The brakes can be used as working brakes or holding brakes. A holding brake is suitable for holding masses and loads at a fixed position. A working brake is also capable of decelerating masses and loads.

The brakes are designed as spring-loaded brakes. When the brake is mounted, it increases the length of the motor. The dimensions are shown in the dimensional drawings.

The spring-loaded brakes are suitable for a standard ambient temperature range of -20 to $+45$ °C.

Variables

Code	Description	Unit
f_{br}	Braking torque correction factor	–
J_{AD}	Moment of inertia of the adapter	kgm ²
J_B	Moment of inertia of the brake	kgm ²
J_G	Moment of inertia of the gearbox	kgm ²
J_{mot}	Moment of inertia of the motor	kgm ²
J_X	Moment of inertia of the load referred to the motor shaft	kgm ²
J_Z	Additional moment of inertia of a high inertia fan	kgm ²
k	Factor for taking into account operating conditions	–
L_N	Service life of the brake lining until readjustment	h
L_{nmax}	Service life of the brake lining until replacement	h
M_2	Rated braking torque of the brake, characteristic value at a relative speed of 100 rpm	Nm
M_4	Minimum holding torque of the brake without slippage (DIN VDE 0580)	Nm
n_{br}	Braking speed	rpm
η	Efficiency (drive)	%
Q_{perm}	Maximum permissible friction energy during cyclic switching, as a function of the switching frequency	J
s_{br}	Braking distance	m
t_1	Application time of the brake	ms
t_{br}	Braking time	s
T_{br}	Rated braking torque (rated torque M_2)	Nm
T_x	Reduced load torque on the motor shaft	Nm
v	Travel velocity	m/s
W_1	Friction energy per braking operation	J
W_{1max}	Maximum permissible friction energy with a single switching, thermal characteristic value of the brake	J
W_{tot}	Friction energy until the brake lining is replaced	MJ
W_V	Friction energy until the brake is readjusted	MJ
Z	Switching frequency	1/h

Determining the braking torque

The braking torque must be selected in accordance with the particular drive application.

The following criteria are decisive when it comes to making the selection:

- Intended use: Working brake or holding brake
- Static safety
- Required braking time
- Permissible brake delay
- Possible braking distance
- Brake wear

The braking torque is determined using the safety factor k , which can be selected in the range from 1.0 to 2.5. As a general rule of thumb, the factor for horizontal motion is approx. 1.0 to 1.5 and for vertical motion approx. 2.0 to 2.5. However, the precise braking torque depends to a large extent on the particular operating conditions.

The rated braking torque M_2 is based on a speed of $n = 100$ rpm and decreases with increasing motor speed. When calculating the braking torque, this is taken into account using the correction factor f_{br} . This means that the rated braking torque is applicable for most braking operations for converter operation.

For line operation, braking is directly from the motor speed.

In addition, for vertical conveyors, the increased speed when moving downwards must be taken into account.

$$T_{br} > T_x \cdot k \cdot f_{br}$$

Braking torques as a function of the speed and permissible speed limits

The braking torque available decreases with increasing motor speed.

The maximum permissible speeds from which emergency stops can be made are listed in the [table on page 11/42](#). These speeds should be considered as guide values and must be checked for the specific operating conditions.

The maximum permissible friction energy depends on the switching frequency and is shown for individual brakes in the [diagram "Permissible operating energy" on page 11/41](#). Increased wear can be expected when the brakes are used for emergency stops.

Several braking torques are available for the L-brakes. These are set in the factory. In the case of holding brakes with set braking torques of ≤ 50 % of the nominal braking torque, permissible operating energy (Q_{perm}) of up to 140 % of the rated data can be achieved under certain conditions.

Configuring guide

Configuring a brake

2

Braking energy per braking operation

The braking energy W per braking operation comprises the energy of the moments of inertia to be braked and the energy which must be applied in order to brake against a load torque.

T_x is positive if the load torque is directed against the direction of motion, and thus has a decelerating effect (horizontal motion, upward vertical motion).

T_x is negative if the load torque is directed in the same direction as the motion, and thus has an accelerating effect (downward vertical motion).

The permissible operating energy Q_{perm} must be checked against the relevant switching frequency using the [diagram "Permissible operating energy" on page 11/41](#). This is of particular importance for emergency stop circuits.

$$W_1 = \frac{T_{\text{br}}}{T_{\text{br}} \pm T_x \cdot \eta} \cdot \frac{(J_G + J_{AD} + J_{\text{mot}} + J_z + J_x + J_B \cdot \eta) \cdot n_{\text{br}}^2}{182.5}$$

$$W_1 < Q_{\text{perm}}$$

In applications with holding brakes, which require low braking torques but release very high braking energies in the event of an emergency stop due to high flywheel masses, higher permissible friction work ($W_{1\text{max}}$) of up to 140 % compared to the values in the [table "Working capacity for L/LS brakes" on page 11/45](#) can also be released under certain conditions.

Permissible friction work ($W_{1\text{max}}$) of up to 140 % applies to:

- Brakes with order codes **B31, B32, B34, B43, B44 B45, B46** ((for a selection of brakes, see [page 11/29](#))
- Max. speed of brakes:
Order codes **B31, B32, B34, B43, B44** = 3000 rpm
Order codes **B45, B46** = 2500 rpm
- Individual Emergency Stops with intervals >10 min between braking operations
- Brakes with standard friction lining

Note:

Not suitable for applications with potential energy and vertical loads, as well as the options Functional Safe Brake (order code **C09**) and low-wear friction lining (order code **C06**).

The increased friction energy results in increased brake wear. This means that the brake has to be inspected and maintained more frequently. This must also be considered when calculating the wear and planning maintenance activities.

Service life of the brake lining

The service life of the brake lining L_N until the air gap has to be readjusted depends on various factors. The main influencing factors include the masses to be braked, the motor speed, the switching frequency, and, therefore, the temperature at the friction surfaces.

This means it is not possible to specify a value for the friction energy until readjustment that is valid for all operating conditions.

However, a wear calculation can be made according to the friction energy, so that the service life can be defined in normal operation.

Brake service life

The brake lining is subject to wear as a result of friction. As a consequence, the air gap increases and the brake application time lengthens. The air gap can be readjusted. The friction lining should be replaced after a certain number of readjustments.

Service life of the brake lining until readjustment

$$L_N = \frac{W_V}{W_1 \cdot Z}$$

Service life of the brake lining until replacement

$$L_{\text{nmax}} = \frac{W_{\text{tot}}}{W_1 \cdot Z}$$

Brake control

Definition of switching times (VDI 2241)

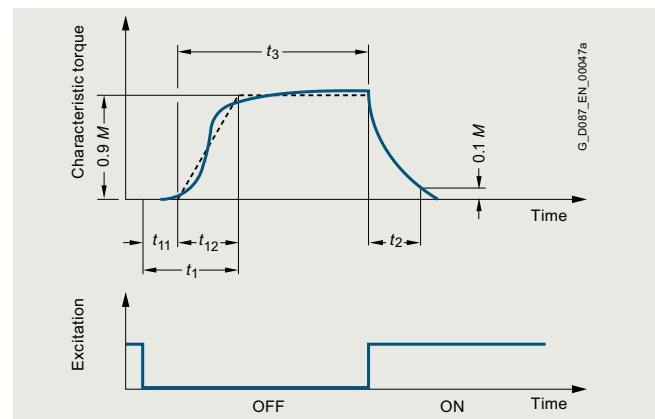


Fig. 2/23 Brake switching times

Switching times:

- t_1 Application time of the brake
- t_2 Disconnection time
- t_3 Slipping time
- t_{11} Response time
- t_{12} Rise time

Fast brake application

Disconnection on the AC side

If the brake is disconnected from the power supply, the magnetic field that keeps the brake open against the force of the springs is dissipated. The springs push the armature plate in the direction of the counter-friction surface, clamping the rotor. The resulting friction slows down the drive.

If only the AC power supply is disconnected prior to the rectifier, this results in a time delay in the braking operation. The reason for this is a slow reduction of the magnetic field in the brake solenoid. This can be particularly problematic for vertical applications. In order to accelerate the closing of the brake, the power supply of the brake must (also) be disconnected on the DC side.

Rectifier for disconnection on the DC side

Electromagnetically released spring-loaded brakes can be disconnected on the AC side and the DC side. Disconnection on the DC side means that the inductance and thus the magnetic field in the brake solenoid are reduced very quickly.

For disconnection on the DC side, a wire jumper can be removed from the rectifier and replaced by the contacts of an external switch. This enables significantly shorter application times to be achieved than those achieved for disconnection on the AC side.

Brake control

Function rectifiers for fast brake application

If function rectifiers are used for fast brake application, then there is no need for an external switch and therefore less wiring is required.

Disconnection on the DC side using current sensing

One option of disconnecting on the DC side is to sense the motor current. If the motor current falls below the rectifier's sensor current when disconnected from the three-phase line supply, the brake solenoid is disconnected from the DC voltage electronically without any contacts.

Used in conjunction with disconnection on the DC side by means of current sensing, rectifiers are generally suitable for being connected in parallel with the motor connection, even in applications involving moving loads or large moments of inertia. Brakes controlled in this way are completely wired to the motor terminal board. Converter operation is not permissible.

Disconnection on the DC side using voltage sensing

Another option of disconnecting on the DC side is by sensing the rectifier supply voltage.

An integrated switching transistor switches off the load if the input voltage falls below a specified switching threshold. Used in conjunction with disconnection on the DC side using voltage sensing, rectifiers are generally suitable for operation with separate AC-side brake control using an additional switching contact.

Connection in parallel with the motor connection is also possible, but it is not recommended, as the rectifier disconnection response will be impaired by the influence of the motor winding. In addition, many applications involve driving loads or large moments of inertia. This can cause the no-load voltage generated when the motor coasts down to considerably delay brake application if the switching threshold for voltage sensing is not fallen below.

If connection in parallel with the motor connection is nevertheless desired or required, disconnection on the DC side using current sensing is recommended.

Fast brake release

Function rectifiers for fast brake release

Rectifiers with overexcitation (high-speed excitation)

Rectifiers with overexcitation operate for approximately 300 ms ± 15 % with bridge rectification, i.e. when being released, the brakes are supplied with twice the rated solenoid voltage.

After this time the rectifiers automatically switch from bridge to half-wave rectification and the brakes are operated with the rated solenoid voltage. This results in shorter release times and higher brake switching frequencies. The friction lining wear is also reduced, the permissible friction energy until the air gap is readjusted increases, and starting losses are reduced.

Rectifiers with overexcitation are generally suitable for being connected in parallel to the motor connection or for a separate circuit in the case of converter operation (note connection information for disconnection on the DC side).

Brake switching time

The total time it takes the motor to come to a standstill comprises the following times:

- Brake application time t_1
- Braking time t_{br}

The first is the time it takes the brake to reach 90 % of its braking torque. This time may be circuit- and control-dependent. The braking time is determined as follows:

$$t_{br} = \frac{(J_G + J_{AD} + J_{mot} + J_B + J_Z + J_X \cdot \eta) \cdot n_{br}}{9.55 \cdot (T_{br} \pm T_x \cdot \eta)}$$

If T_x supports the braking operation, T_x is positive; otherwise it is negative.

Braking distance and positioning accuracy

Braking distance s_{br} is the distance traveled by the driven machine during braking time t_{br} and application time t_1 .

With linear motion, a positioning accuracy of between ± 12 % and ± 15 % can be assumed. However, this can be heavily influenced by the condition of the brake.

The formula below applies to horizontal motion and upward vertical motion.

$$s_{br} = v \cdot \left(\frac{t_1}{1000} + 0.5 \cdot t_{br} \right)$$

Cyclic duration factor

The cyclic duration factor DC is the ratio between the load duration and the cyclic duration. The cyclic duration is the sum of the ON times (operational periods) and the no-voltage periods.

$$DC = \frac{t_s}{t_s + t_o} \cdot 100$$

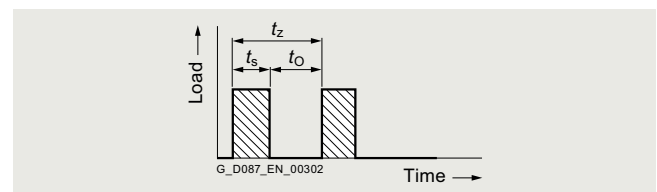


Fig. 2/24 Cyclic duration factor

Code	Description	Unit
DC	Cyclic duration factor	%
t_s	Close time (on-load factor)	s
t_o	Open time (off-load factor)	s
t_z	Cycle time (duty cycle time)	s

Rated torque and holding torque

Rated torque

The rated torque M_2 is the switching torque assigned by the manufacturer of the brake for identification. This is indicated on the rating plate when selecting a working brake.

Holding torque

The holding torque M_4 is the highest torque with which the closed brake can be loaded without causing a slip. With the functionally safe holding brake, the holding torque M_4 is indicated on the rating plate.

In the case of functionally safe attachments (Functionally Safe Brake and Functionally Safe Rotary Encoder), the M_4 torque is specified on the rating plate, as the brake may only be used as a holding brake with an Emergency Stop function.

Configuring guide

Configuring an encoder

Incremental encoders

Incremental encoders are used to determine the position of rotor shafts and are used to approach a precisely defined angular position. This is achieved by photoelectrically scanning the graduation on an indexing disk. With incremental measuring methods, the graduation consists of a regular grid structure. The position information is obtained by counting the individual increments (measuring steps) from a set zero point. Since an absolute reference is required to determine positions, the indexing disks are provided with an additional track that has a reference mark. The absolute position determined by the reference mark is assigned exactly one measuring step. The reference mark must, therefore, be scanned before an absolute reference can be established or the last selected reference point found.

The incremental signals are transmitted as square-wave pulse train sequences U_{a1} (A) and U_{a2} (B), phase-shifted through 90° elec. The reference mark signal consists of a reference pulse U_{a0} (N), which is gated with the incremental signals. In addition, the integrated electronics generate inverse signals $\overline{U_{a1}}$ (A), $\overline{U_{a2}}$ (B) and $\overline{U_{a0}}$ (N) for noise-proof transmission. The illustrated sequence of output signals – with U_{a2} lagging behind U_{a1} – applies for clockwise rotation of the motor.

The fault-detection signal $\overline{U_{aS}}$ indicates fault conditions such as breakage of the supply cables or failure of the light source, etc. It can be used to shut down machines in automated production environments.

The distance between two successive edges of the incremental signals U_{a1} and U_{a2} using 1-fold, 2-fold, or 4-fold evaluation is one measuring step.

The maximum permissible speed or travel velocity must never be exceeded, not even for a short time.

Incremental encoders are used with applications which require a precisely defined position to be approached/found again. In the case of incremental encoders, the machine must travel to a reference point after each power-off state, as the position is not usually stored in the controller, and movements of the machine while the power is off are not recorded.

For the technical specifications of the incremental encoder, please refer to chapter "Motor options" on [page 11/52](#).

Principle of operation: Photoelectric scanning

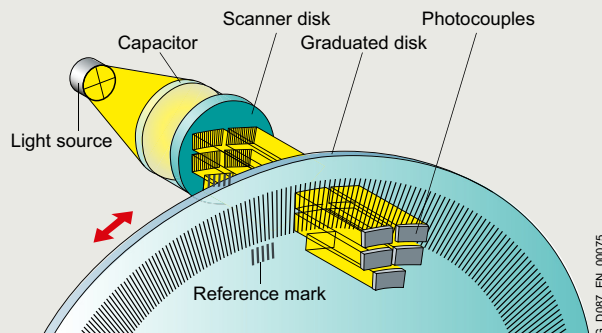


Fig. 2/25 Principle of operation, photoelectric scanning

Output signals

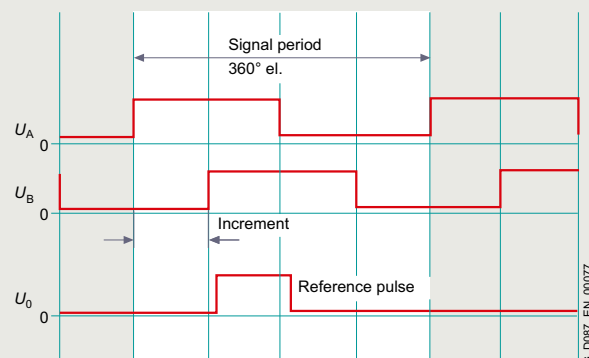


Fig. 2/26 Output signals

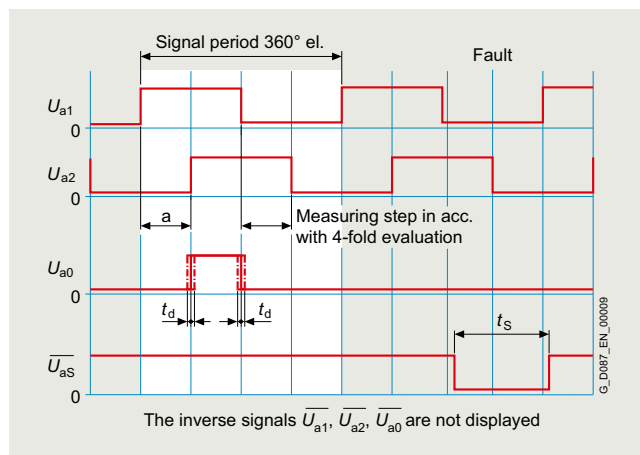


Fig. 2/27 Inverse output signals

Absolute encoders

Absolute encoders are used to determine the position of rotor shafts and to approach a precisely defined angular position.

With the absolute measuring method, the position value is available from the encoder immediately after switch-on and can be called at any time by the subsequent electronics. There is no need to move the axes to find the reference position. The absolute position information is read from the graduation on the indexing disk, which consists of several parallel indexing tracks. The track with the finest scale division is interpolated for the position value and is used to generate an optional incremental signal at the same time. The indexing disks are photoelectrically scanned.

With singleturn rotary encoders, the absolute position information is repeated at each revolution. Multiturn rotary encoders can also differentiate between revolutions.

Absolute encoders are used with applications which require a precisely defined position to be approached/found again.

For the technical specifications of the absolute encoder, please refer to chapter "Motor options" on [page 11/53](#).

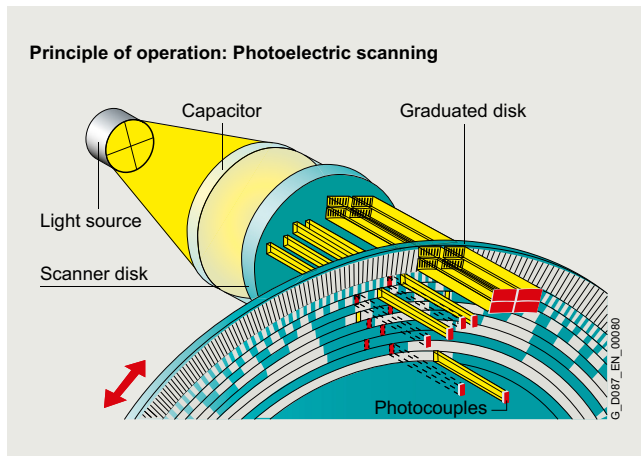


Fig. 2/28 Principle of operation, photoelectric scanning

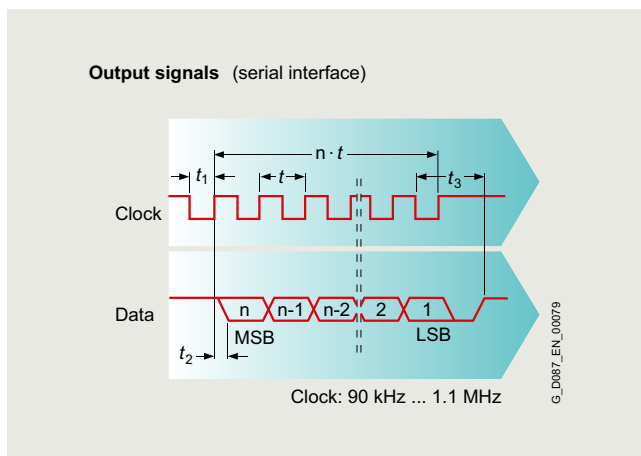


Fig. 2/29 Output signals

Encoder systems with DRIVE-CLiQ interface

Motors with DRIVE-CLiQ encoder interface are provided for the SINAMICS S120 converter system. The signal transmission to the converter is digital. The DRIVE-CLiQ rotary encoder has an electronic nameplate that simplifies commissioning and diagnostics. Motor and encoder system are automatically identified and all motor parameters are set automatically, see SINAMICS Equipment Manual.

DRIVE-CLiQ rotary encoders for the SINAMICS drive system are equipped with an internal module that includes an electronic nameplate. The DRIVE-CLiQ rotary encoder is equipped with a cable with a length of 1 m with flange socket. The flange socket has a SPEED-CONNECT-READY M17 male thread with O-ring. This is called the DRIVE-CLiQ interface.

The technical data for the DRIVE-CLiQ rotary encoder can be found in the chapter "Motor options" on [page 11/49](#).

The signal connection between motor and Motor Module takes place via a pre-assembled MOTION-CONNECT DRIVE-CLiQ cable.

More information on the signal cables can be found in the chapter "Motor options" on [page 11/49](#).

Configuring guide

Configuring the functionally safe mounted components

Safety
Integrated

2

Overview

Legal framework

The purpose of the Machinery Directive 2006/42/EC and "Supply of Machinery (Safety) Regulations 2008" is to ensure that all machines placed on the market within the European Economic Area meet common minimum safety requirements.

Functional safety – electric drives

The standards listed under the machinery directive define appropriate safety functions that must be implemented for electric, variable-speed drive systems. When viewed in this context, a drive train essentially comprises the elements "sensor – controller – actuator" which interact with one another to ensure functional safety.

The distributor or operator of the machine/installation bears responsibility for the required safety functions and their properties.

In cases where Siemens provides support with the definition of safety-relevant components at the project planning stage, Siemens shall not accept any responsibility for the selection of components or the implementation of safety functions.

Trend toward integrated safety systems

The trend toward greater complexity and higher modularity of machines has seen a shift in safety functions away from the classical central safety functions (for example, shutdown of the complete machine using a main disconnecting means) and into the machine control system and the drives. Frequently, this also significantly increases the productivity. This is because, for instance, equipping times can be reduced and during these setup times, depending on the machine type, other parts can still continue to produce.

Installation of SIMOGEAR geared motors

Geared motors must be installed such that the drive fastening elements in the machine are aligned uniformly and precisely. Vibration and resonance with rotational frequency and with multiples of the line frequency must be prevented. Care must be taken to ensure unobstructed ventilation (flow of cooling air and exhaust air must not be hindered).

Electrical connection of motors

The electrical connection of the motors must conform to the tolerance limits defined by EN 60034-1 for zone A (voltage $\pm 5\%$, frequency $\pm 2\%$).

Environmental conditions

The functionally safe components are suitable for typical industrial environments, not for harsh industrial environments such as offshore or chemical industry.

When operating on a frequency converter and comparable power control devices, resonances must be avoided.

With respect to mechanical environmental conditions, the motors are approved for vibration and shock in accordance with EN 60721-3-3:1995 Class 3M3.

Functionally safe brake

The following must be observed for the use of the functionally safe brake:

- The functionally safe brake can only be used as a holding brake with emergency stop function (max. 2000 emergency stops over the entire service life). The switching operations in normal operation must take place when the drive is at a standstill. A brake design must be carried out, the permissible limit values must be observed.
- For the design of the brakes, the holding torque of the brake (M_4 torque) must be used.
- The safety characteristic values of the safe brake apply to system designs in which 80 % of the characteristic torque of the brake are sufficient for the safety function. This must be ensured when designing the brake.
- The use of the geared motor with functionally safe brake is approved for an ambient temperature of -20 °C to $+40\text{ °C}$.
- The motors must be designed in temperature class 155 (F) and equipped with thermal motor protection and a corresponding evaluation unit as standard.
- The maximum input speed can be found in the technical specifications, see [table "Braking torques as a function of speed and permissible speed limits with operating brake" on page 11/41](#).
- The functionally safe brakes must be operated with appropriate safe brake relays. Therefore, only DC voltage variants can be selected for the safe brakes.
- The function rectifiers (order codes **C59** and **C60**) are not possible in combination with the functionally safe brake.
- In safety-relevant applications, the rotors must always be replaced after 10 years at the latest.
- When configuring the brake, the wear of the friction lining (e.g. due to emergency stops) must be taken into account.
- All specified restrictions apply to friction linings (permissible switching frequency, permissible friction energy, reactivation during operation as a holding brake, break loose torque after a prolonged idle time, temperature range, etc.).
- Increased corrosion protection (order code **C10**) must not be used in conjunction with the functionally safe brake.
- Not all torque variants of the standard version are also suitable for the safe brake.

Note:

Before you commission SIMOGEAR geared motors with the functionally safe brake, please read the information in the operating instructions BA 2332.



Functionally safe rotary encoders



Fig. 2/30 Functionally safe rotary encoder IN 8.5834FS2

Function

Safe actual value sensing with encoder

A drive monitor with encoder is necessary for operation of a series of safety functions.

Further information about safety functions can be found in the Safety Integrated Function Manual.

<https://support.industry.siemens.com/cs/document/109781722>

Safe actual value sensing with functionally safe rotary encoder

A functionally safe rotary encoder (sensor) must be used in conjunction with a suitable encoder evaluation system (controller) and a frequency converter (actuator) in order to implement certain safety functions.

Safety functions

For detailed descriptions of individual functions, please refer to Catalog D 31.2.

For the technical specifications of the functionally safe rotary encoder, please refer to chapter "Motor options" on page 11/61.

Note:

Before you commission SIMOGEAR geared motors with a functionally safe rotary encoder, please read the information in the operating instructions BA 2730 and BA 2331.

Please note the following with respect to functionally safe rotary encoders:

- Functional safety can be ensured only if the functionally safe rotary encoder is evaluated by a suitable control and evaluation unit.
- The motors must be designed with temperature class 155 (F) and equipped as standard with thermal motor protection and a suitable evaluation unit.
- The maximum permissible air gaps for brake motors with functionally safe rotary encoder are different, see table "Technical specifications of brake with functionally safe rotary encoder" on page 11/61.
- The motors are supplied as standard with the option "Encoder under cover" (order code **Q95**) as mechanical protection.
- The option "Manual brake release lever with locking mechanism" (order code **C03**) cannot be selected for the brake motors with the functionally safe rotary encoder IN 8.5834 (order codes **Q42** and **Q43**) and IA 8.5883 (order codes **Q77** and **Q78**).
- The function rectifiers (order codes **C59** and **C60**) cannot be combined with the functionally safe rotary encoder.
- The use of the geared motor with the functionally safe rotary encoder is approved for an ambient temperature of $-30\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$.

Environmental conditions

With respect to mechanical environmental conditions, the motors are approved for vibration and shock in accordance with EN 60721-3-3:1995 Class 3M3.

Encoder connections

When connecting the encoders, care must be taken to ensure that suitable connecting cables are used:

- Incremental encoder IN 8.5834 (order codes **Q42** and **Q43**) and absolute encoder IA 8.5883 (order codes **Q77** and **Q78**), max. cable length of 50 m
- DRIVE-CLiQ encoder, max. cable length of 100 m

The shield of the connecting cables must be bonded over a large area/grounded at both ends (at the encoder and at the controller).

Further information on the signal cables can be found in the chapter "Motor options" on page 11/64.

Configuring guide

Configuring the motor for converter operation

2

Operation of geared motors on a converter

It is possible in principle to operate the geared motors on a frequency converter. The Converter World Motor is optimized and designed for operation on the frequency converter.

Please note the following supplementary conditions:

- Converter motors are not subject to the Regulation (EU) 2019/1781 or "Ecodesign for Energy-Related Products and Energy Information Regulations 2021 (UK)" because they are not intended for direct operation on the three-phase network.
- Maximum speed of the geared motor in the field-weakening range
- Maximum speed of the brake, see [page 11/41](#)
- Speed limits of the backstop, see [page 11/69](#)

Motor characteristic

During the acceleration process, converters shift the speed-torque characteristic of the three-phase asynchronous motor over the traversing range to enable jerk-free acceleration. This enables the motor to be operated at different speeds (e.g. rapid traverse/creep speed), but also protects the mechanical components of the plant and gearbox.

Two main motor operating ranges are applicable for converter operation:

Constant flux (constant torque)

For converters with an unregulated DC link (e.g. SINAMICS G115D) the output voltage can be as high as the line-side input voltage minus any voltage drops in the converter (for example, for SINAMICS G115D: $U_{\text{Output}} = 0.87 \times U_{\text{Input}}$).

If the maximum output voltage has not yet been reached, the converter output voltage can be increased as the motor speed increases until **$V/f = \text{constant}$** applies. As a consequence, the magnetic flux, the motor current and therefore the transferred **continuous torque are constant** (provided that the motor is adequately cooled → in the case of self-cooling, the torque must be reduced in accordance with the motor characteristic at low speeds due to the reduced cooling). Alternatively, if a separately driven fan is used, the full motor torque can be utilized.

Field-weakening range

If the speed increases further when the maximum output voltage has been reached, then V/f does not remain constant.

The magnetic flux reduces with increasing motor speed, the motor current and therefore the transferred continuous torque reduces with respect to $1/n$, and the breakdown torque reduces according to $1/n^2$ (see motor characteristic). The motor can be operated in the field-weakening range at constant power as far as the limit of stability (see point "Mechanical load, grease service life").

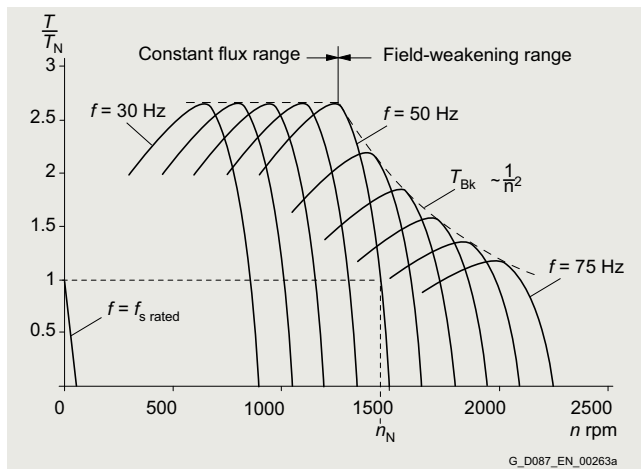


Fig. 2/31 Example for a 4-pole, three-phase asynchronous motor

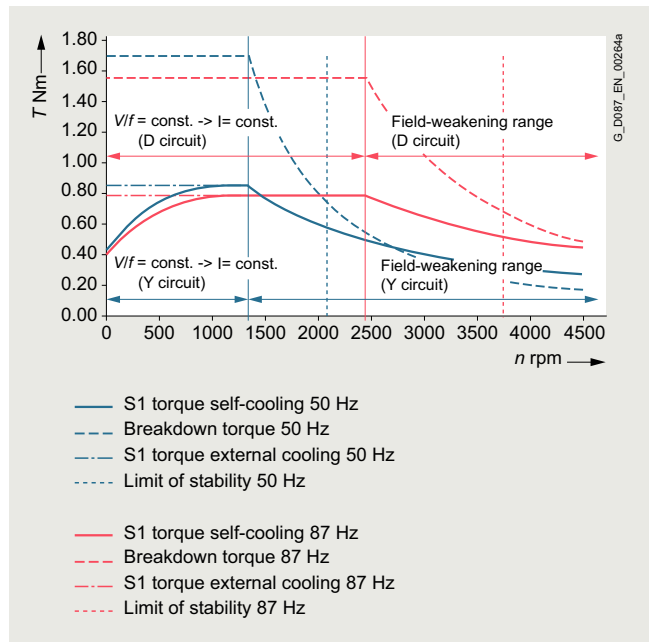


Fig. 2/32 Example of torque-speed characteristic of a 4-pole asynchronous motor

Utilization in accordance with temperature class F

For rated power and line operation, the motor is utilized in accordance with temperature class B (130 °C maximum permissible constant temperature referred to a maximum cooling air temperature of 40 °C).

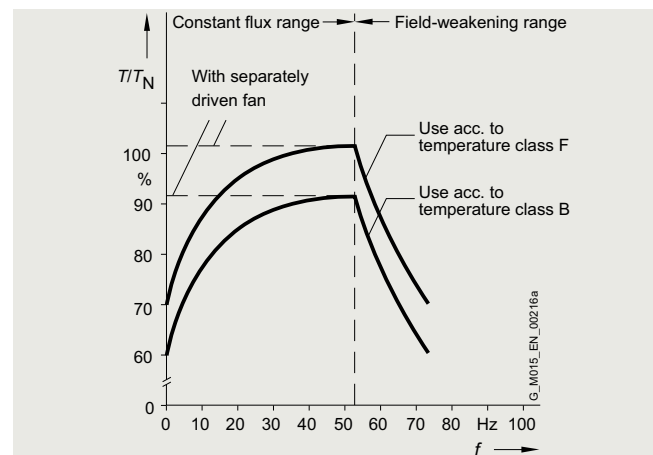
Siemens motors are designed as standard to temperature class F (155 °C maximum permissible constant temperature referred to a maximum cooling air temperature of 40 °C).

For converter operation at reduced output voltage, the power reserve of the motor can be used to achieve the rated power.

In this case, the rated torque is applied to the motor and the converter outputs a frequency at which the motor achieves rated speed.

At this operating point the slip and current consumption are higher than under line operation, so that the constant motor temperature increases accordingly. Prerequisite for utilizing the motor in accordance with temperature class F is that the converter is capable of providing a sufficiently high current:

$$I_{\text{FOutRated}} \geq I_{\text{Motor Rated inc}}$$



Peak load / acceleration torque

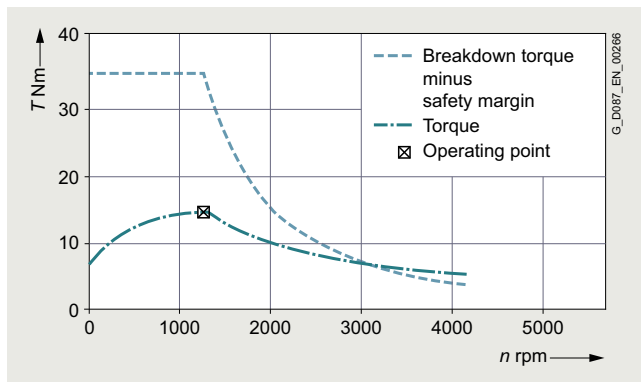
Based on experience, a safety margin of 30 % must be maintained from the breakdown torque:

$$T_{\max.} = 0.7 \times T_{Bk}$$

The engineering software "Sizer for Siemens Drives" incorporates a safety margin for the actual breakdown torque when the breakdown torque characteristic is displayed.

At a sufficiently high level of converter output current, the motor can therefore be accelerated with approximately 0.7 times its breakdown torque.

When operating with a high switching frequency, the motor's acceleration torque may have to be limited to its rated torque. As a general rule, the rms current must not exceed the rated motor current. It is recommended that the respective traversing cycle is entered in the engineering software "Sizer for Siemens Drives", because the rms values will then be calculated automatically and represented in combination with the respective motor characteristic.



Permissible voltage stress

More stress is placed on the insulation of the motor winding with converter operation than with line operation. The voltage stress also depends on the type of converter used. The converter subjects the motor winding to stress specially as voltage pulses are quickly switched.

The maximum voltage is influenced by the rise time of the pulses, the cable length and the type of cable used between motor and converter.

Output filters at the converter can reduce the maximum motor voltage to uncritical values. When using output filters, the control type, pulse frequency, output frequency, and limit torque that can be realized need to be observed, among other factors.

With converters without output filters, impermissible voltage peaks can occur even with a relatively short motor cable. Regenerative operation, in particular, can stress the motor insulation. This stress occurs predominantly during vertical motion and is dependent on the line voltage, converter type, cable length, and cable type.

For further details, see [chapter "Motor options" on page 11/9](#).

Bearing currents

Additional bearing currents can flow when motors are operated from converters. They are mainly caused by the steep voltage rises which occur during switching. Without output filters, significant voltage variations can occur at the winding terminals. This phenomenon mainly occurs for larger machines.

EMC-compliant installation of the drive system is a basic prerequisite for preventing premature bearing damage as a result of bearing currents.

Important measures for reducing bearing currents are:

- Using cables with a symmetrical cable cross-section.
- Using grounding cables with low impedance over a wide frequency range (0 Hz up to approximately 70 MHz), e.g. braided copper straps, HF finely-stranded conductors.
- Separate HF equipotential-bonding cable between motor housing and driven machine.
- Separate HF equipotential-bonding cable between motor housing and converter PE busbar.
- 360° HF contact of the cable shield at the motor housing and the converter PE busbar. This can be achieved using EMC glands at the motor and EMC shield clips at the converter, for example.
- Use of motor reactors.
- Common-mode filters at the converter output.
- Insulated motor bearing at the non-drive end (NDE).

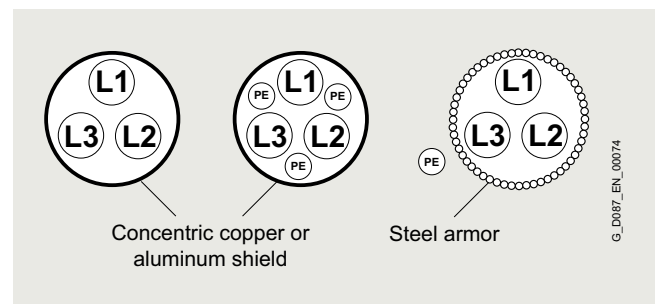


Fig. 2/33 Motors connected to a converter

Mechanical load and grease service life

High speeds that exceed the rated speed and the resulting increased vibration alter the mechanical smooth running operation and the bearings are subject to increased mechanical stress. This reduces the grease service life and the bearing service life.

More detailed information on request.

Configuring guide

Configuring a motor in an ATEX version



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Explosion-protected motors

In many industrial and public sectors, explosion protection and risk of explosion are ever-present, e.g. in the chemical industry, in refineries, on drilling platforms, at gas stations, in the production of animal feed and in sewage treatment plants.

The risk of explosion is always present when gases, fumes, mist or dust are mixed with oxygen in the air in an explosive ratio close to sources of ignition that are able to release the minimum ignition energy.

In the chemical and petrochemical industries in particular, when crude oil and natural gas are transported, or in mining, milling (e.g. grain and solids), this can result in serious injury and material damage.

To ensure maximum safety in these areas, legislators in most countries have implemented appropriate stipulations in the form of laws and regulations based on national and international standards.

Explosion-protected equipment is designed such that an explosion can be prevented when it is used properly.

The explosion-protected equipment can be designed in accordance with various types of protection.

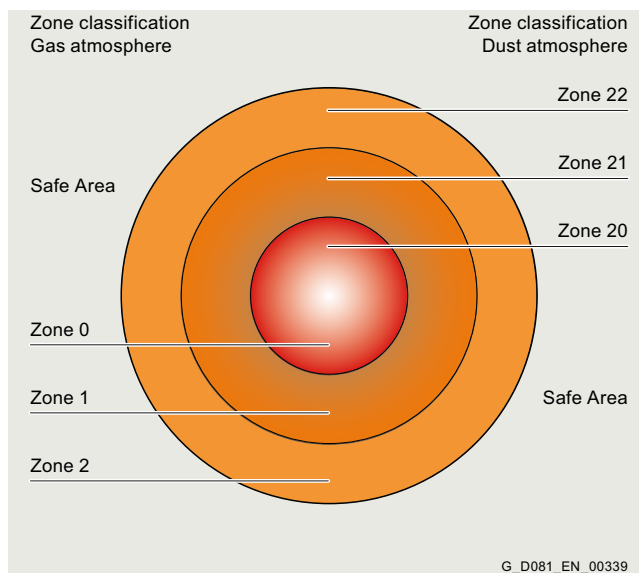
The local conditions must be subdivided into specified zones by the user with the assistance of the responsible authorities in accordance with the frequency of occurrence of an explosion hazard. Device (equipment) categories are assigned to these zones. The zones are then subdivided into possible types of protection and therefore into possible equipment (product) types.

Classification of zones

Explosive atmospheres are classified according to zones. Division into zones depends on the temporal and local probability of the presence of a hazardous, potentially explosive atmosphere. Information and specifications for classification of the zones are laid down in the following standards:

- IEC/EN 60079-10-1 for gas atmospheres
- IEC/EN 60079-10-2 for dust atmospheres

Further, a distinction is made between various explosion groups as well as temperature classes and these are included in the hazard assessment.



Depending on the particular zone and therefore the associated hazard, operating equipment must comply with defined minimum requirements regarding the type of protection. The different types of protection require corresponding measures to prevent ignition that should be implemented at the motor in order to prevent a surrounding explosive atmosphere from being ignited.

Zone	Gas 1) 2)	Dust 1) 2)	Zone definition according to IEC/EN 60079-10-1 for gas atmospheres IEC/EN 60079-10-2 for dust atmospheres	Assigned types of protection	Category acc. to 2014/34/EU	Equipment protection level acc. to IEC/EN 60079-0 of low-voltage motors
0	–	–	An area in which an explosive gas atmosphere is present continuously, over a long period or frequently .	Low-voltage motors and SIMOGEAR geared motors not permitted	1	Ga
1	–	–	An area in which it is expected that an explosive gas atmosphere will be present occasionally during normal operation.	Ex db eb, Ex db, h	2	Gb
2	–	–	An area in which it is expected that an explosive gas atmosphere will be present only rarely and then only for a short period during normal operation.	Ex ec, h	3	Gc
–	–	20	An area in which there is an explosive atmosphere comprising a dust-air mixture continuously, over long periods or frequently .	Low-voltage motors and SIMOGEAR geared motors not permitted	1	Da
–	–	21	An area in which it is expected that an explosive atmosphere comprising a dust-air mixture will be present occasionally during normal operation.	Ex tb, h	2	Db
–	–	22	An area in which it is expected that an explosive atmosphere in the form of a cloud of combustible dust in air will be present only rarely and then only for a short period during normal operation.	Ex tc ³⁾ , h	3	Dc

1) Motors of Zone 1 can also be used in Zone 2
Zone 21 can also be used in Zone 22

2) Motors that are certified for gas or dust protection must not be used in hybrid mixtures! Hybrid mixtures: Explosive gas and dust atmospheres are present simultaneously.

3) Ex tc motors are not approved for operation in environments containing conductive dust.



Explosion-protected motors

Types of protection

Type of protection "non-sparking" Ex ec acc. to IEC/EN 60079-7

Type of protection **Ex ec** ensures that a motor in normal operation as well as when operated under deviating conditions as specified in the standard is not able to ignite a surrounding explosive gas atmosphere.

MB motors are available in an **Ex ec** version.

Type of protection "dust explosion protection" Ex tc acc. to IEC/EN 60079-31

This type of protection applies for electrical equipment protected using a housing and with limited surface temperature for use in areas in which combustible dust can occur in concentration levels that could cause a fire or an explosion.

MB motors are available in an **Ex tc** version.

Explosion-protected motors for converter operation

In principle, explosion-protected motors (except for Ex eb) can be fed from converters. Particular attention must be paid to the interaction between the motor and converter in the overall system, especially with regard to the following aspects:

- The harmonic content of the supply voltage increases the motor temperature, so the motor power must be reduced.
- Less cooling of the motor at speeds below the rated speed
- Voltage stress on the motor winding
- Bearing currents

Device marking

The equipment group and category are specified in the device marking.

The device marking is defined as follows:

e.g. CE 0158 II 2G Ex eb IIC T3 Gb

- **CE** conformity marking
CE stands for "Communautés Européennes" (European Communities)
The manufacturer of the explosion-protected devices declares by means of CE marking that the relevant product has been manufactured in accordance with all applicable regulations and requirements of the EU and the requirements laid down in directive 2014/34/EU and the product has been subjected to the relevant conformity evaluation process.
- **0158** identification number of the inspecting authority (DEKRA)
- Marking for prevention of explosions in accordance with directive 2014/34/EU

Example "increased safety":

	CE	0158		II	3	G	Ex	ec	IIC	T3	Gc
CE marking											
Number of the certifying "notified" body (0158 = DEKRA)											
Explosion protection marking											
Equipment group: I = Underground II = All other areas											
Category: 2 (Zone 1/21) 3 (Zone 2/22)											
Ex atmosphere G = Gas D = Dust											
Explosion-protected equipment											
Type of protection Ex db, db eb, eb, ec, tb or tc (db eb = motor housing Ex db with terminal box Ex eb)											
Explosion group and explosion subgroup II = Gas (IIA, IIB or IIC) III = Dust (IIIA, IIIB or IIIC)											
Temperature class with max. surface temperature T1 = 450 °C T4 = 135 °C T2 = 300 °C T5 = 100 °C T3 = 200 °C T6 = 85 °C											
Equipment protection level (G = Gas; D = Dust): Ga = Very high protection, Da = Very high protection, Gb = High protection, Db = High protection, Gc = Increased protection, Dc = Increased protection											

Configuring guide

Configuring a motor in an ATEX version



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Explosion-protected motors

Technical specifications

General information on explosion-protected motors

Explosion-protected motors (MB motors) are suitable for operation in electrical power systems with a voltage tolerance of $\pm 10\%$. In a vertical type of construction where the shaft extension points downward, motors must be equipped with a canopy. Operating instructions are supplied as standard with explosion-protected geared motors in English and German.

Motor connection

Certified metric cable glands/sealing plugs are included in the scope of supply of MB motors.

Certified circuit breakers / tripping units must always be used for motor protection, see Catalog IC 10.

Type of protection Ex tc IIIB for use in Zone 22

- Ex tc IIIB according to IEC/EN 60079-31
- Version for Zone 22 for non-conductive dust (IP55) and line operation.

The surface temperature is $\leq 120^\circ\text{C}$ for rated operation. The motors are equipped with an external grounding terminal, a metal fan cover and a metal external fan.

Ambient temperature

Standard: -20 to $+40^\circ\text{C}$

Marking on the rating plate

Zone 22: II 3D Ex tc IIIB T120 °C Dc

Type of protection Ex ec for use in Zone 2

"Non-sparking" MB motors are suitable for use in hazardous areas of Zone 2 for temperature classes T1 to T3. The maximum surface temperature that can occur under normal operating conditions must lie below the temperature limit of the respective temperature class. The ventilation system must be in accordance with IEC/EN 60079-0. The motors are equipped with an external grounding terminal.

Ambient temperature

Standard: -20 to $+40^\circ\text{C}$

Marking on the rating plate

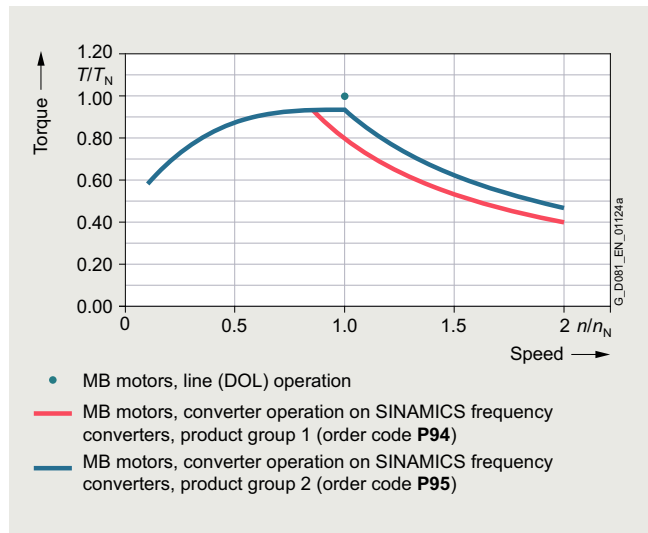
Zone 2: II 3G Ex ec IIC T3 Gc

Converter operation

General information

All the data listed in Catalog D 50.1 is applicable for a 50 Hz line supply. For converter operation, the reduced torques for constant torque and drives for fans, pumps and compressors must be observed due to the harmonic content of the supply.

This data is available in the Siemens Product Configurator: www.siemens.com/spc



Higher noise levels must be expected than for 50 Hz line operation for motors operating with converters due to the harmonic content of the supply. The frequency limit of MB motors, frame sizes 71 to 180, is $f_{\max}=100\text{ Hz}$.

Maximum voltage stress on the motor winding in converter operation

SIMOGear motor frame sizes 71 to 180:

- $\hat{U}_{\text{phase-phase}} \leq 1500\text{ V}$ (3000 V peak-peak values $V_{\text{pk/pk}}$)
- $\hat{U}_{\text{phase-ground}} \leq 1100\text{ V}$ (2200 V peak-peak values $V_{\text{pk/pk}}$)

The following generally applies to Siemens converters (SINAMICS):

- $U_{\text{line}} = 480\text{ V} \pm 10\%$ (BLM = Basic Line Module; DFE = Direct Front End)
- $U_{\text{line}} \leq 480\text{ V} \pm 10\%$ (ALM = Active Line Module; AFE = Active Front End); $U_{\text{dc}} < 720\text{ V}$

Additional configuration notes are documented in the declaration of compliance with the order 2.1 and in the EU type-examination certificates.



Explosion-protected motors

Order administration for explosion-protected motors (MB motors) for converter operation

PTC thermistor

For converter operation, MB motors must always be equipped with PTC thermistors (order code **M10**). Certified tripping units are required for this purpose. See Catalog IC 10.

Selection of the converters

SINAMICS converters are categorized into 3 product groups. Each product group is a data set with motor operating data each assigned to one converter. The converter type is stamped on the additional rating plate.

- **Product group 1** – Order code **P94**
Design for converter operation in the basic version with operating data
- **Product group 2** – Order code **P95**
Design for converter operation in the basic version with operating data SINAMICS S120 (ALM)
- **Product group 3** – Order code **P96**
Design for converter operation in the basic version with operating data SINAMICS G120D PM250
- **Product group 4** – Order code **P97**
Design for converter operation with performance data at the PWM converter

Note:

To comply with the admissible temperature class 130 (B), the power must be reduced (derating) for converter operation in Zones 2 and 22! The operating data for SINAMICS converters from Siemens are on the rating plate – the torque is reduced when compared to line operation. The motor operating data for converter operation is available in the Siemens Product Configurator (www.siemens.com/spc) selection and ordering tool. For converter operation, voltage codes/order codes are only admissible with one voltage only. When used in hazardous zones, a certified tripping unit is recommended for motors operated with converters, equipment Category 3 (Zones 2 and 22). Alternatively, an external, certified tripping unit can be used (see Catalog IC 10).

Rating plate

The operating data for line operation is specified on the rating plate – on an additional rating plate, according to the selected product, 4 rated operating points are possible in the following variants:

- 50 Hz field weakening range with rated operating points 5, 25, 50 and 100 Hz
- 60 Hz field weakening range with rated operating points 5, 30, 60 and 100 Hz
- 87 Hz characteristic with rated operating points 5, 25, 87 and 100 Hz; 87 Hz at 400 VΔ

Configuring guide

Notes

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