General note:

All the data listed in the catalog is applicable for a 50 Hz line supply. With converter-fed operation, the torque reduction factors for constant torque and drives for fans, pumps and compressors must be observed. Higher noise levels must be expected at frequencies other than 50 Hz for motors operating with converters due to the harmonic content of the supply.

Implementation of 1LA/1LG motors in areas subject to explosion hazards

Type of protection "n" (Zone 2)

II 3G Ex nA II T3
acc. to IEC/EN 60079-15

IEC/EN 60079-15 specifies that the motor and converter must be tested as a unit (individual test). Individual testing has been performed for motors of type of protection "n" operating with the MICROMASTER, SIMOVERT MASTERDRIVES, SINAMICS G110, SINAMICS S120 and SIMATIC ET 200S FC converters (partially for "Non-standard motors frame size 315" and above). For details, see factory certificate 2.1. Individual testing can be performed for non-Siemens converters on request; the customer may be required to supply the non-Siemens converter.

Design for Zone 2 for converter-fed operation, derating Ex nA II T3 acc. to IEC/EN 60079-15
⇒ **Order with order code M73**

Motors protected against dust explosions (Zone 21/22)

Zone 21: II 2D Ex tD A21 IP65 T 125 °C
Zone 22: II 3D Ex tD A22 IP55 T 125 °C
acc. to EN 50281/IEC 61241

The drive system comprising motors protected against dust explosions operating on MICROMASTER, SIMOVERT MASTERDRIVE, SINAMICS G110, SINAMICS S120 and SIMATIC ET 200S FC converters has been tested. For details, see factory certificate 2.1. Please inquire about operation with non-Siemens converters.

Design for Zone 21, as well as Zone 22 for conducting dust (IP65) for converter-fed operation, derating
⇒ **Order with order code M38**

Design for Zone 22 for non-conducting dust (IP55) for converter-fed operation, derating
⇒ **Order with order code M39**

Order codes M73, M38 and M39:

The rated operating points at 5, 25, 50 Hz and $f_{max.}$ are stamped on the rating plate; (alternative rated operating points at 6, 30, 60 Hz and $f_{max.}$ when ordered with 60 Hz voltage) for operation on MICROMASTER.

Alternatively, these rated operating points can be ordered for SIMOVERT MASTERDRIVES, SINAMICS G110, SINAMICS S120 or SIMATIC ET 200S FC with order code **Y68** and **"Plain text"**. The type of converter is specified on the rating plate.
The motors already have PTC thermistors for tripping in accordance with temperature class 130 (B). The thermistors must be operated by a tripping unit certified by the relevant testing authority.

With some motors it is necessary to reduce the limit speed or to use metal fans.

When 1LA8 motors are ordered, it must be specified in plain text whether "constant torque drive" or "fan/pump/compressor drive" is required.

Rated voltage

The tolerance of the motors specially developed for converter-fed operation with special insulation up to 690 V (the 9th and 10th position of the Order No. is marked with **"PM"**) is generally in accordance with DIN EN 60034-1 – A rated voltage range is not specified on the rating plate.

Mechanical limit speeds

When the motor is operated at its rated frequency, it is important to note that the maximum speeds are limited by the limits for the roller bearings, critical rotor speed and rigidity of the rotating parts.

Motor protection

A motor protection function can be implemented using the I^2t detection present in the converter software.

If required, more precise motor protection can be afforded by direct temperature measurement using KTY84 sensors or PTC thermistors in the motor winding. Some converters from Siemens determine the motor temperature using the resistance of the temperature sensor. They can be set to a required temperature for alarm and tripping.

Insulation

The standard insulation of 1LA and 1LG motors is designed such that converter-fed operation is possible up to 460 V +10 % (for motor serie 1LA8 up to 500 V +10 %). This also applies for operation with a pulse-controlled AC converter with voltage rise times t_s >0.1 µs at the motor terminals.

All motors with voltage codes 1, 3, 5, and 6 (400 V motors Δ connection) operating with a converter must be operated under these conditions. This does not apply to motors with voltages from 500 V to 690 V (+10 %), that must have special insulation for operation on a pulse-controlled AC converter (SIMOVERT MASTERDRIVES and MICROMASTER 440 for voltages between 500 and 600 V), (10th position of the Order No. = **"M"**). For converter-fed operation with the outputs specified in the catalog, the motors are used according to temperature class 155 (F), i.e. in this case neither a service factor >1 nor an increased coolant temperature is possible (order codes **C11**, **C12** and **C13** cannot be ordered).

Motor connection

When connecting the motors, it is important to consider the restrictions for mains-fed machines as well as the maximum admissible conductor cross-sections for the converter.

Ventilation and noise generation

The fan noise can increase at speeds that are higher than the rated speed of self-ventilated motors. To increase motor utilization at low speeds it is recommended that forced ventilated motors are used.

Mechanical stress and grease lifetime

Due to the increased speeds above the rated speed and the thereby increased vibrations, the mechanical smooth running is changed and the bearings are used stronger mechanically. Hereby, the grease lifetime and the bearing lifetime are reduced. Further information on request.

Utilization (non-standard motors)

When temperature class 155 (F) is used according to 130 (B), derating of 15 % is necessary.

Mechanical limit speeds $n_{max.}$ at maximum supply frequency $f_{max.}$

Default values

The values in the following table are valid for all areas of application with the exception of explosion-proof motors (see overleaf).

The values for motor series 1 LA8, 1PQ8 and 1LL8 are listed in the selection and ordering data in part “Non-standard motors frame size 315 and above”.

Motor frame size	Motor type		2-pole [1] $n_{max.}$ rpm	$f_{max.}$ Hz	4-pole $n_{max.}$ rpm	$f_{max.}$ Hz	6-pole $n_{max.}$ rpm	$f_{max.}$ Hz	8-pole $n_{max.}$ rpm	$f_{max.}$ Hz
1LA5, 1LA6, 1LA7, 1LA9, 1LP5, 1LP7, 1PP5, 1PP7										
56 M	**1LA7/1LA9**	**05.**	6000	100	4200	140	3600	180	3000	200
63 M	**1LA7/1LA9 1LP7/1PP7**	**06.**	6000	100	4200	140	3600	180	3000	200
71 M	**1LA7/1LA9 1LP7/1PP7**	**07.**	6000	100	4200	140	3600	180	3000	200
80 M	**1LA7/1LA9 1LP7/1PP7**	**08.**	6000	100	4200	140	3600	180	3000	200
90 L	**1LA7/1LA9 1LP7/1PP7**	**09.**	6000	100	4200	140	3600	180	3000	200
100 L	**1LA6/1LA7/1LA9 1LP7/1PP7/1PP6**	**10.**	6000	100	4200	140	3600	180	3000	200
112 M	**1LA6/1LA7/1LA9 1LP7/1PP7/1PP6**	**11.**	6000	100	4200	140	3600	180	3000	200
132 S/M	**1LA6/1LA7/1LA9 1LP7/1PP7/1PP6**	**13.**	5600	90	4200	140	3600	180	3000	200
160 M/L	**1LA6/1LA7/1LA9 1LP7/1PP7/1PP6**	**16.**	4800	80	4200	140	3600	180	3000	200
180 M/L	**1LA5/1LA9 1LP5/1PP5**	**18.**	5100	85	4200	140	3600	180	3000	200
200 L	**1LA5/1LA9 1LP5/1PP5**	**20.**	5100	85	4200	140	3600	180	3000	200
225 S/M	**1LA5**	**22.**	4500	75	4200	140	3600	180	3000	200
1LG4, 1LG6, 1LP4, 1PP4, 1PP6										
180 M/L	**1LG4/1LG6 1LP4/1PP4/1PP6**	**18.**	4600	76	4200	140	3600	180	3000	200
200 L	**1LG4/1LG6 1LP4/1PP4/1PP6**	**20.**	4500	75	4200	140	3600	180	3000	200
225 S/M	**1LG4/1LG6 1LP4/1PP4/1PP6**	**22.**	4500	75	4500	150	4400	220	4400	293
250 M	**1LG4/1LG6 1LP4/1PP4/1PP6**	**25.**	3900	65	3700	123	3700	185	3700	247
280 S/M	**1LG4/1LG6 1LP4/1PP4/1PP6**	**28.**	3600	60	3000	100	3000	150	3000	200
315 S	**1LG4/1LG6 1LP4/1PP4/1PP6**	**310**	3600	60	2600	87	2600	130	2600	176
315 M	**1LG4/1LG6 1LP4/1PP4/1PP6**	**313**	3600	60	2600	87	2600	130	2600	173
315 L	**1LG4/1LG6 1LP4/1PP4/1PP6**	**316 317 318**	3600 [2]	60 [2]	2600	87	2600	130	2600	173

[1] Request required for continuous duty in the $f_{max.}$ ($n_{max.}$) range.

[2] For vertical mounting $n_{max.}$ = 3000 rpm, $f_{max.}$ = 50 Hz.

Explosion-proof motors in Zone 1 with type of protection “de” (motor series 1MJ)

Motor frame size	Motor type	2-pole [1] $n_{max.}$ rpm	$f_{max.}$ Hz	4-pole $n_{max.}$ rpm	$f_{max.}$ Hz	6-pole $n_{max.}$ rpm	$f_{max.}$ Hz	8-pole $n_{max.}$ rpm	$f_{max.}$ Hz
1MJ6									
71 M	**1MJ6 07 .**	6000	100	3000	100	2000	100	1500	100
80 M	**1MJ6 08 .**	6000	100	3000	100	2000	100	1500	100
90 L	**1MJ6 09 .**	6000	100	3000	100	2000	100	1500	100
100 L	**1MJ6 10 .**	5400	90	3000	100	2000	100	1500	100
112 M	**1MJ6 11 .**	5400	90	3000	100	2000	100	1500	100
132 S/M	**1MJ6 13 .**	4800	80	3000	100	2000	100	1500	100
160 M/L	**1MJ6 16 .**	4500	75	3000	100	2000	100	1500	100
180 M/L	**1MJ6 18 .**	5100	85	3000	100	2000	100	1500	100
200 L	**1MJ6 20 .**	5100	85	3000	100	2000	100	1500	100
1MJ7									
225 S/M	**1MJ7 22 .**	4500	75	3000	100	2000	100	1500	100
250 M	**1MJ7 25 .**	3900	65	3700	100	2000	100	1500	100
280 S	**1MJ7 28 .**	3600	60	3000	100	2000	100	1500	100
315 S/M	**1MJ7 31 .**	3600 [2]	60 [2]	2600	87	2000	100	1500	100

Explosion-proof motors in Zone 1 with type of protection “e” (motor series 1MA)

1MA motors cannot be operated with a converter.

Explosion-proof motors in Zones 2, 21 and 22 with type of protection “n” or protection against dust explosions (motor series 1LA, 1LG and 1PQ8)

The values for motor series 1LA8 and 1PQ8 in Zones 2 and 22 are listed in the selection and ordering data in part “Non-standard motors frame size 315 and above”.

Motor frame size	Motor type		2-pole [1] $n_{max.}$ rpm	$f_{max.}$ Hz	4-pole $n_{max.}$ rpm	$f_{max.}$ Hz	6-pole $n_{max.}$ rpm	$f_{max.}$ Hz	8-pole $n_{max.}$ rpm	$f_{max.}$ Hz
1LA5, 1LA6, 1LA7, 1LA9										
56 M	**1LA7/1LA9**	**05.**	6000	100	3000	100	2000	100	1500	100
63 M	**1LA7/1LA9**	**06.**	6000	100	3000	100	2000	100	1500	100
71 M	**1LA7/1LA9**	**07.**	6000	100	3000	100	2000	100	1500	100
80 M	**1LA7/1LA9**	**08.**	6000	100	3000	100	2000	100	1500	100
90 L	**1LA7/1LA9**	**09.**	6000	100	3000	100	2000	100	1500	100
100 L	**1LA6/1LA7/1LA9**	**10.**	5400	90	3000	100	2000	100	1500	100
112 M	**1LA6/1LA7/1LA9**	**11.**	5400	90	3000	100	2000	100	1500	100
132 S/M	**1LA6/1LA7/1LA9**	**13.**	4800	80	3000	100	2000	100	1500	100
160 M/L	**1LA6/1LA7/1LA9**	**16.**	4500	75	3000	100	2000	100	1500	100
180 M/L	**1LA5/1LA9**	**18.**	5100 [3]	85 [3]	3000	100	2000	100	1500	100
200 L	**1LA5/1LA9**	**20.**	5100 [3]	85 [3]	3000	100	2000	100	1500	100
225 S/M	**1LA5**	**22.**	5100	85	3000	100	2000	100	1500	100
1LG4, 1LG6										
180 M/L	**1LG4/1LG6**	**18.**	4500	75	3000	100	2000	100	1500	100
200 L	**1LG4/1LG6**	**20.**	4500	75	3000	100	2000	100	1500	100
225 S/M	**1LG4/1LG6**	**22.**	4500	75	3000	100	2000	100	1500	100
250 M	**1LG4/1LG6**	**25.**	3900	65	3000	100	2000	100	1500	100
280 S/M	**1LG4/1LG6**	**28.**	3600	60	3000	100	2000	100	1500	100
315 S/M/L	**1LG4/1LG6**	**31.**	3600 [1]	60 [1]	2600	87	2000	100	1500	100

[1] Request required for continuous duty in the $f_{max.}$ ($n_{max.}$) range.

[2] For vertical mounting $n_{max.}$ = 3000 rpm, $f_{max.}$ = 50 Hz.

[3] For 1LA9 motors frame sizes 180 M/L and 200 L, $n_{max.}$ = 4500 rpm and $f_{max.}$ = 75 Hz.

Bearings and bearing currents

When operating multiphase induction machines on a converter, an electrical bearing stress results from a capacitive induced voltage via the bearing lubricating film, depending on the principle being used. The physical cause of this is the common-mode voltage at the converter output. The sum of the three phase-to-neutral voltages is not zero at all times, unlike with direct on-line operation. The high-frequency, pulse-shaped common-mode voltage brings about a residual current, which closes back to the converter's DC link via the machine's internal capacitances, the machine housing and the earthing circuit. The machine's internal capacitances include the main insulation winding capacitance, the geometric capacitance between the rotor and stator, the lubricating film capacitance and the capacitance of any bearing insulation that may be present. The current level via the internal capacitances is proportional to the common-mode voltage regulation ($i_{(t)} = C \cdot du/dt$).

In order to apply currents to the motor which are sinusoidal as far as possible (smooth running, oscillation torques, stray losses), a high clock frequency is required for the converter's output voltage. The related (very steep) switching edges of the converter output voltage (and also, therefore, of the common-mode voltage) cause correspondingly high capacitive currents and voltages on the machine's internal capacitances.

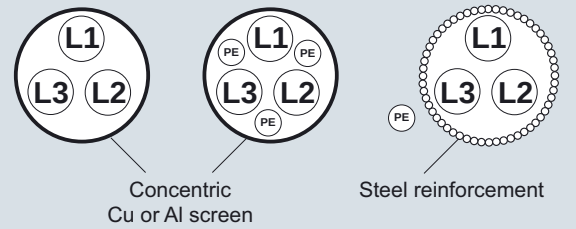
In the worst-case scenario, the capacitive voltage induced via the bearing can lead to random punctures of the bearing lubricating film, thus damaging the bearing/causing premature wear. The current pulses caused by the puncture in the lubricating film are referred to as EDM (Electrostatic Discharge Machining) currents, although this is not primarily a question of an electrostatic effect, but more of (partial) punctures of insulating material, i.e., of partial discharges.

This physical effect, which occurs in isolated cases, has mostly been observed in connection with larger motors.

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

The most important measures for reducing bearing currents:

- Insulated motor bearings at the non-drive end NDE
  The insulated bearing is standard for all non-standard 1LA8 motors designated for converter operation. Furthermore it is recommended that an insulated bearing is ordered for NDE for motor series 1LG, 1PP4, 1LP4 and 1MJ7 frame size 225 and above (order code **L27**).
- Hybrid bearings with ceramic bearing elements on drive end (DE) and non-drive end (NDE)
- Earthing brush for converter-fed operation for 1LG motors (order code **M44**)
- Use of cables with a symmetrical cable cross-section:



- Use of motor reactors
- Use of earthing cables with low impedance in a large frequency range (0 Hz up to approximately 70 MHz): for example, plaited copper ribbon cables, HF litz wires
- 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 contacting of the cable shield on the motor housing and the converter PE busbar. This can be achieved using EMC screwed glands on the motor end and EMC shield clips on the converter end, for example.
- Common-mode filters at the converter output (e.g. nanoperm rings).

The given measures can be required for motor series 1LA5 frame size 225 and 1LG frame size 225 and above depending on the application with converter-fed operation and are therefore recommend.