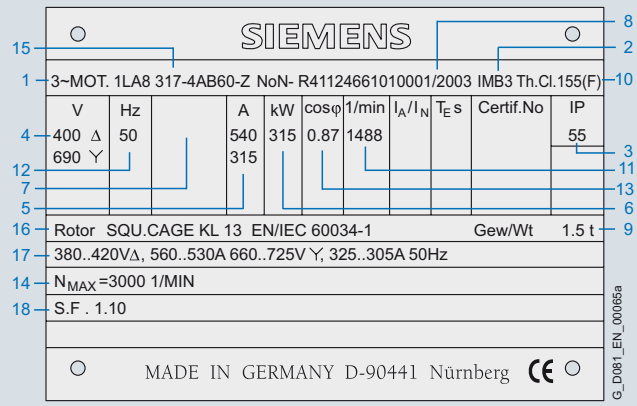
The following table lists the most important technical specifications. For further information and details, see Catalog D 81.1 part 0 “Introduction”.

Technical specifications at a glance

Type of motor	Squirrel-cage induction motor
Connection types	Star/delta connection You can establish the connection type used from the Order No. supplements in the selection and ordering data for the required motor.
Number of poles	2, 4, 6, 8
Rated output	160 ... 1250 kW (at 50 Hz)
Rated speed (synchronous speed)	750 ... 3600 rpm
Rated torques	800 ... 10,300 Nm
Insulation of the stator winding according to EN 60034-1 (IEC 60034-1)	Temperature class 155 (F) Used in mains-fed operation (at rated output) as: temperature class 130 (B) Used in converter-fed operation (at rated output): temperature class 155 (F) For coolant temperatures of up to 40 °C as standard DURIGNIT IR 2000 insulation system with impregnation by VPI or current-UV technique
Degree of protection according to EN 60034-5 (IEC 60034-5)	Motor series 1LA8 and 1PQ8: IP55 Motor series 1LL8: IP23
Cooling according to EN 60034-6 (IEC 60034-6)	Self-ventilated (motor series 1LA8) Motor frame sizes 315 to 450 (IC 411) Forced-air cooled (motor series 1PQ8) Motor frame sizes 315 to 450 (IC 416) Self-ventilated (motor series 1LL8) Motor frame sizes 315 to 450 (IC 01)
Admissible coolant temperature	See “Coolant temperature and site altitude” in Catalog D 81.1 part 0 “Introduction”
Standard voltages according to EN 60038 (IEC 60038)	50 Hz: 400 V, 500 V, 690 V The voltage used can be found in the selection and ordering data for the required motor.
Type of construction according to EN 60034-7 (IEC 60034-7)	Without flange: IM B3 With flange: IM V1 without protective cover, IM V1 with protective cover, IM B35
Frame design	Cast-iron with cast frame feet for IM B3 and IM B35 types of construction
Paint finish Suitability of paint finish for climate group in accordance with IEC 60721, Part 2-1	Standard: Standard paint finish (moderate = expanded) RAL 7030 stone gray
Vibration quantity level according to EN 60034-14 (IEC 60034-14)	Level A (standard- without special vibration requirements) optional: Level B (with special vibration requirements)
Shaft extension according to DIN 748 (IEC 60072)	With featherkey, half-key balancing
Shaft and flange accuracy according to DIN 42955 (IEC 60072-1)	Tolerance N (normal) Optional: Tolerance R (reduced)
Sound pressure level to DIN EN ISO 1680 (tolerance +3 dB)	The sound pressure level is listed in the selection and ordering data for the required motor.
Weights	The weight is listed in the selection and ordering data for the required motor.
Mechanical limit speeds	The limit speed is listed in the selection and ordering data for the required motor.
Packing weights and dimensions	See “Packing weights and packing dimensions” in Catalog D 81.1 part 0 “Introduction”.
Rating plates	Fixed to the motor (optionally: 1 additional set of rating plates, loose), labeled as standard in English/German, can be supplied in French/Spanish, Italian or Portuguese without additional charge See “Rating plate” in Catalog D 81.1 part 0 “Introduction”.
Connection and connection boxes	See “Connection, circuit and connection box” in Catalog D 81.1 part 0 “Introduction”.
Bearing design	See “Bearings” in Catalog D 81.1 part 0 “Introduction”.
Cantilever forces	See “Admissible cantilever forces” in Catalog D 81.1 part 0 “Introduction”
Pulse encoder	See “Special technology” in Catalog D 81.1 part 0 “Introduction”
Options	See the “Options” for “Special versions”

Rating plate

According to DIN EN 60034-1, the approximate overall weight is specified on the rating plate for all motors of frame size 90 and above (from approx. 30 kg).
For all motors, an additional rating plate can be supplied loose, order code **K31**. An extra rating plate for identification codes is also possible, order code **Y82**. In the standard version, the rating plate is available in English and German.



1 Motor type: 3-phase LV motor
2 Type of construction
3 Degree of protection
4 Rated voltage [V] and circuit
5 Rated current [A]
6 Rated output [kW]
7 Standards and regulations
e.g. explosion-proof motors
8 Serial number
9 Motor weight [kg]
10 Temperature class
11 Rated speed [rpm]
12 Rated frequency [Hz]
13 Power factor [cos φ]
14 Maximum speed [rpm]
15 Motor type
16 Rotor class
17 Additional details (optional)
18 Service factor

Example of rating plate for 1LA8

Converter-fed operation

The motors are equipped with standard rotors and are suitable for mains-fed or converter-fed operation.
All motors can therefore be operated with a converter, in principle. Special measures are necessary in the case of some motors, especially when separately driven fans are used.
All data are applicable for a 50 Hz sinusoidal supply.

Rated voltage

The tolerance for the rated voltage is in accordance with DIN EN 60034-1 in all cases, a rated voltage range is not specified.

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, PT 100 resistance thermometers 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.
If PT 100 resistance thermometers are ordered for cooling temperature monitoring (order code **A61**) or KTY84 temperature sensors (order code **A23**), the standard thermistors are omitted. A combination of **A12** and **A61** or **A12** and **A23** is possible; additional charge on request.

Insulation

The standard insulation of the motors is designed such that converter-fed operation is possible without limitation at voltages ≤500 V. 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 4, 5 and 8 must be operated under these preconditions on a converter.
This does not apply to motors with voltages >500 up to 690 V, which must have special insulation for operation on a pulse-controlled AC converter (SINAMICS, SIMOVERT MASTERDRIVES) without a converter circuit (d*u*/d*t* filter or sinusoidal filter), i.e. when 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 conductor cross-sections permitted for the converter.

Ventilation/noise generation

The fan noise can increase at speeds that are higher than the rated speed of self-ventilated motors (this is not the case for forced ventilated motors 1PQ8). To increase motor utilization at low speeds it is recommended that forced ventilated motors are used, e.g. those of series 1PQ8.

In general, for converter-fed operation, the noise level is higher than that specified in the catalog (exception: 1PQ8). The increase depends on the converter type and can lie between 5 and 10 dB(A) depending on the frame size and number of poles for the motor.

Mechanical stress and grease lifetime

When motors are operated at speeds above the rated speed, the running smoothness and the bearings are subjected to greater mechanical stress. This reduces the grease lifetime and the bearing lifetime. More detailed information on request.

Bearings

To prevent damage being caused as a result of bearing currents, insulated bearings are used at the non-drive-end of 1LA8, 1LL8 and 1PQ8 motors for converter-fed operation in the standard version (this can be recognized when 9th position of Order No. = "**P**").

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 that is inherent in the control method for a converter: the sum of the three-phase voltages is – in contrast to straightforward mains-fed operation – not equal to zero at every point in time. 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 level of the currents due to the internal capacitances is proportional to the gradients, i.e. the voltage variation of the DC voltage ($i_{(t)} = C \cdot$ d*u*/d*t*).

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.

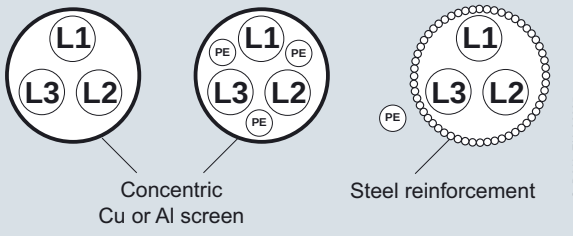
The voltage that is injected capacitively across the bearing can result, in the worst case, in stochastic arcing through the lubrication film of the bearing and prematurely age or damage the bearing. *(The current pulses caused by arcing in the lubrication film are known as EDM currents (Electrostatic Discharge Machining) in the technical literature.)*

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 as a result of bearing currents.

The most important measures for reducing bearing currents:

- Insulated motor bearings at the non-drive-end NDE (BS) (standard for 1LA8, 1LL8 and 1PQ8 for converter-fed operation)
- Use of cables with a symmetrical cable cross-section:



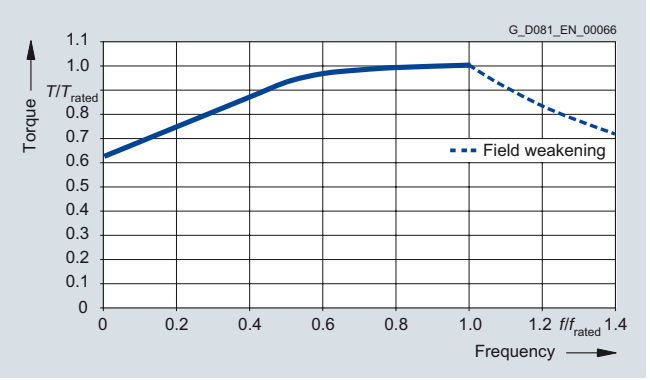
- Preference given to a supply with insulated neutral point (IT system)
- Use of earthing cables with low impedance in a large frequency range (DC up to approximately 70 MHz):
  for example, plaited copper ribbon cables, HF litz wires
- Separate HF equipotential-bonding cable between motor frame and driven machine
- Separate HF equipotential-bonding cable between motor housing and converter PE busbar
- 360° HF contacting of the cable shield on the motor frame 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.
- Using motor reactors at the converter
- Common-mode filters at the converter output

Thermal torque limits

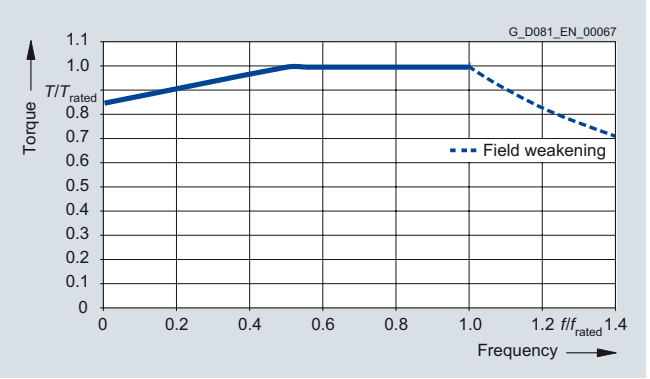
Guide values for the maximum load torques at various speeds can be obtained from the diagrams below.

In the case of self-ventilated motors, such as series 1LA8 and 1LL8, the thermally permissible load torques are reduced for continuous operation for speeds below the rated speed. This must be taken into account in those applications in particular that are not subjected to a load torque that is dependent on the square of the speed. Also in the case of forced-air cooled motors of series 1PQ8, the maximum load torques are reduced slightly for high speed ranges.

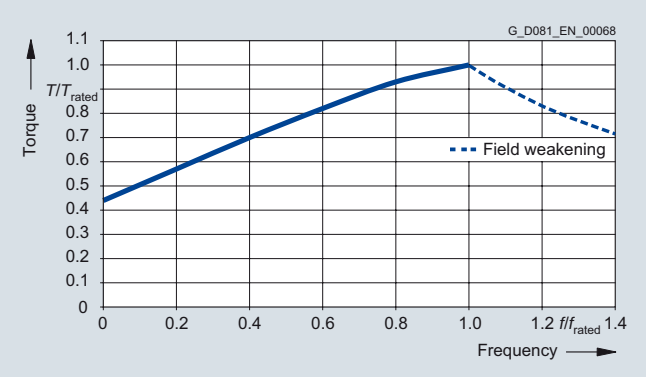
When motors are operated at speeds above their rated speed (operation in the field-weakening range), the maximum load torque is also reduced.



Thermal torque limit characteristic 1LA8



Thermal torque limit characteristic 1PQ8



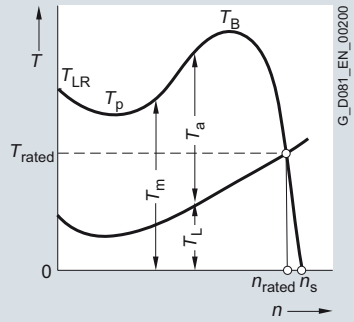
Thermal torque limit characteristic 1LL8

Technical explanations regarding torque and determination of the start-up time for mains-fed operation

Torque characteristics – Torque characteristics for special drives

Torque characteristics

The torque generated on the shaft of a three-phase motor in the torque range of $n = 0$ to $n = n_s$ has a very varying magnintude. The characteristic curve of the torque as a function of the speed of a three-phase motor with torque class (CL) of a squirrel-cage rotor shows the following diagram.



T_{rated}	Rated torque	T_{LR}	Locked-rotor torque
T_m	Motor torque	T_B	Breakdown torque
T_L	Load torque	T_p	Pull-up torque
T_a	Acceleration torque	n_{rated}	Rated speed
		n_s	Synchronous speed

The values for locked-rotor torque and breakdown torque as well as for locked-rotor current of a specific motor can be taken from the selection and ordering data.

The limit for the mechanical overload capability is the break-down torque. According to IEC/EN 60034-1, asynchronous motors at rated voltage and rated frequency must withstand up to 1.6 times the rated torque for 15 s. The pull-up torque of asynchronous motors at rated voltage must - if not specified otherwise - have at least the values stated in the following rated torque.

For three-phase motors without pole-change with a rated output equal to or greater than 100 kW:
0.3 times rated torque and at least 0.5 times locked-rotor torque

According to IEC/EN 60034-1, the following tolerances are permitted:

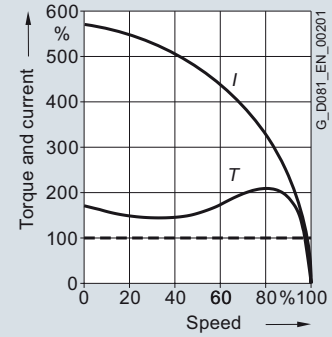
- for the locked-rotor torque of –15 to 25 % of the total locked-rotor torque
- for the locked-rotor current up to 20 % of the stated locked-rotor current without lower limit
- for the breakdown torque up to –10 % of the stated breakdown torque
- for the pull-up torque –15 % of the guaranteed value.

Under observance of these tolerances, the locked-rotor torque must be sufficiently higher than the the break loose torque of the driven machine and the motor torque during start-up up to reaching the operating speed must always be higher than the load torque.

In the case of squirrel-cage motors, the locked-rotor torque and breakdown torque are listed in the selection and ordering data as multiples of the rated torque. The normal practice is to start squirrel-cage motors directly online. The torque class indicates that with direct online starting, even if there is a 5 % undervoltage, it is possible to start up the motor against a load torque of:

- 130 % (for CL 13),
- 100 % (for CL 10),
- 70 % (for CL 7),
- 50 % (for CL 5)

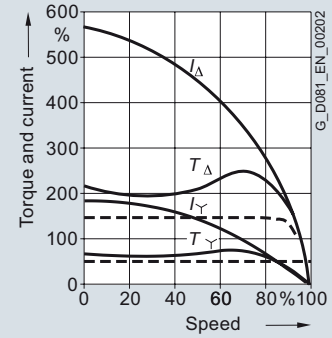
of the rated torque.



Torque curves for direct starting

Motors with CL 10 torque class

– – – – – maximum load torque during the starting



Motors with CL 13 torque class

– – – – – maximum load torque during starting

The rated torque can be calculated as follows:

$$T_{rated} = 9.55 \cdot P_{rated} \cdot \frac{1000}{n_{rated}}$$

T_{rated} Rated torque in Nm
n_{rated} Rated speed in rpm
P_{rated} Rated output in kW

The rated speed of the motor differentiates itself from the synchronous speed by the slip s_{rated}.

It is:

$$s_{rated} = \frac{n_s - n_{rated}}{n_s} \cdot 100$$

s_{rated} Slip in %
n_s Synchronous speed in rpm
n_{rated} Rated speed in rpm

Determination of the start-up time

Calculation of the start-up time for direct online starting

The start-up time from $n = 0$ to $n = n_{op}$ can be approximately determined using the average acceleration torque.

$$t_{st} = \frac{\sum J \cdot n_{op}}{9.55 \cdot T_{aav}}$$

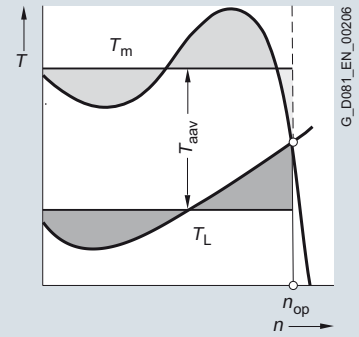
t_{st} Start-up time in s
J Total moment of inertia in kgm^2
n_{op} Operating speed in rpm
T_{aav} Average acceleration torque in Nm

The total moment of inertia is made up of the motor moment of inertia plus the moment of inertia of the driven machine and the coupling or pulleys and is converted to the speed of the motor shaft.

Limit values for the start-up curve of three-phase motors with squirrel-cage rotor for voltages up to and including 690 V are defined in EC/EN 60034.

If no sound start-up is possible due to a high moment of inertia and/or a high load torque, a larger motor or a three-phase motor with SINAMICS frequency converter can be selected for N-compact motors.

A mechanical solution for coping with the heavy starting is the employment of a starting coupling, whose application is limited by its capability to absorb heat.



T_m Motor torque
T_L Load torque
T_{aav} average acceleration torque
n_{op} Operating speed

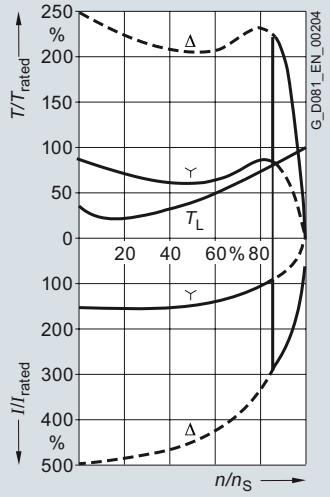
Determination of the average acceleration torque

Start-up for three-phase motors with squirrel-cage rotor

The normal practice is to start squirrel-cage motors directly online.

- It must be observed that the torque and speed characteristics for a specific motor are predetermined - independently of the heaviness of the start-up.
  Star delta start-up must be realized for motors with squirrel-cage rotor if small locked-rotor currents (e.g. in the supply conditions of the electric power company) or a particularly low start-up torque (soft starting) are required. Locked-rotor torque, breakdown torque and all other torque values as well as the locked-rotor current are 25 to 30 % of the values at direct online starting.
- The motor torque must be sufficiently higher than the load torque during the start-up in the Y-stage. The change from star to delta must not occur before approximating the operating speed.

The adjoining diagram shows a case in which the star delta start-up is not appropriate because the too elevated load torque causes the early change which in turn causes a high torque and current surge that renders the star-delta starting ineffective.



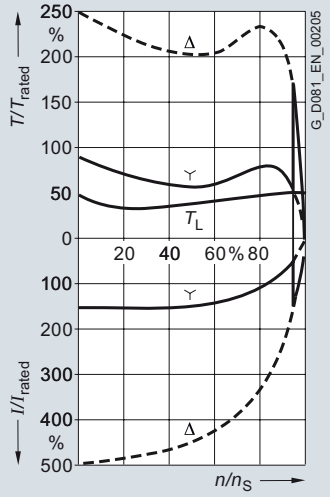
Unfavorable
star-delta starting

The torque characteristics can be approximately reduced by the square of the voltage and the current characteristics linearly with the voltage by reducing the voltage at the motor terminals with the help of a starting transformer or starting resistors.

A starting with rated current is possible on the converter.

Soft starting for motors with squirrel-cage rotor can also be realized using the stator-resistance starting circuit (a resistor is engaged in one phase during the start-up). The locked-rotor torque can be arbitrarily reduced with the help of this circuit. The locked-rotor current without a resistor or reactor is a bit higher in both phases than for direct online starting.

The starting can be facilitated using the electronical motor starter "SIKOSTART", that limits the torque and the current during starting.



Correct
star-delta starting

The following has to be provided in case of requests regarding start-ups:

1st Required output and rated speed of the driven machine

2nd Planned motor speed

3rd Load torque of the driven machine, depending on the speed of the driven machine or the motor speed

4th Total external moments of inertia and rated speed of the driven machine or with regard to the motor speed

5th Number of starts within a particular time frame and duty cyle or

6th Characteristics and number of operating cycles within a particular time frame (method of braking)

Start-up times and moments of inertia for 1LA8 motors for mains-fed operation

Default values

The values in the following table are only valid for 1LA8 motors for mains-fed operation and apply for a continuous heating of 90 % of the rated output at 50 Hz (0.9 x P_{rated}).
The admissible moments of inertia must be reduced again by 20 % at 60 Hz. The moment of inertia J_{adm} in the tables is the moment of inertia which the driven machine is allowed to have as a maximum in order to start the motor. For this purpose has the moment of inertia already been considered in the selection and ordering data.

Frame size	Order No.	Locking of brake		Admissible moment of inertia and start-up times when starting the motor			
		cold	warm	1x cold		1x warm	
		Braking time	Braking time	Moment of inertia	Start-up time	Moment of inertia	Start-up time
		t_{Br}	t_{Br}	J_{adm}	t_{st}	J_{adm}	t_{st}
FS		s	s	kgm^2	s	kgm^2	s
Self-ventilated motors for mains-fed operation cast-iron series 1LA8 – 2-pole, 3000 rpm at 50 Hz							
315	**1LA8 315-2AC❑❑**	18	10	125	33.9	48	13.0
315	**1LA8 317-2AC❑❑**	17.5	10	140	33.2	58	13.4
355	**1LA8 353-2AC❑❑**	18	9	175	41.4	33	7.8
355	**1LA8 355-2AC❑❑**	20	10	190	45.8	40	9.7
355	**1LA8 357-2AC❑❑**	15	7.5	180	30.0	40	6.7
400	**1LA8 403-2AC❑❑**	22	13	245	40.2	95	15.7
400	**1LA8 405-2AC❑❑**	19	11	255	37.2	90	13.1
400	**1LA8 407-2AC❑❑**	17	9.5	300	34.9	85	9.9
450	**1LA8 453-2AE❑❑**	21.5	15	178	31.3	83	14.6
450	**1LA8 455-2AE❑❑**	20.5	14	190	30.2	90	14.3
450	**1LA8 457-2AE❑❑**	19	13	200	28.2	95	13.4
Self-ventilated motors for mains-fed operation cast-iron series 1LA8 – 4-pole, 1500 rpm at 50 Hz							
315	**1LA8 315-4AB❑❑**	22	13	590	36.9	350	21.9
315	**1LA8 317-4AB❑❑**	19	11	730	32.3	425	18.8
355	**1LA8 353-4AB❑❑**	20	11	1000	45.7	270	12.4
355	**1LA8 355-4AB❑❑**	18	10	1020	39.6	280	10.9
355	**1LA8 357-4AB❑❑**	19	10.5	1370	41.9	370	11.3
400	**1LA8 403-4AB❑❑**	20.5	11.5	1420	46.2	430	14.0
400	**1LA8 405-4AB❑❑**	20	11	1600	44.5	480	13.3
400	**1LA8 407-4AB❑❑**	19	10.5	1750	43.6	525	13.1
450	**1LA8 453-4CE❑❑**	17.5	10	950	23.7	300	7.5
450	**1LA8 455-4AC❑❑**	18.5	10.5	1200	26.8	370	8.3
450	**1LA8 457-4AC❑❑**	17	9	1160	22.3	380	7.3

Frame size	Order No.	Locking of brake		Admissible moment of inertia and start-up times when starting the motor			
		cold	warm	1x cold		1x warm	
		Braking time	Braking time	Moment of inertia	Start-up time	Moment of inertia	Start-up time
		t_{Br}	t_{Br}	J_{adm}	t_{st}	J_{adm}	t_{st}
FS		s	s	kgm^2	s	kgm^2	s
Self-ventilated motors for mains-fed operation cast-iron series 1LA8 – 6-pole, 1000 rpm at 50 Hz							
315	**1LA8 315-6AB❑❑**	33	18	1900	57.4	830	25.1
315	**1LA8 317-6AB❑❑**	31	15.5	2300	55.6	1000	24.2
355	**1LA8 355-6AB❑❑**	40	22	2950	62.2	1350	28.5
355	**1LA8 357-6AB❑❑**	40	22	3950	62.5	1800	28.5
400	**1LA8 403-6AB❑❑**	34	18.4	3450	51.1	850	12.6
400	**1LA8 405-6AB❑❑**	32	17.5	3500	43.3	900	11.1
400	**1LA8 407-6AB❑❑**	24	12	2200	25.6	740	8.6
450	**1LA8 453-6AB❑❑**	16	7	1400	15.5	560	6.2
450	**1LA8 455-6AB❑❑**	19	8.5	1700	18.1	670	7.1
450	**1LA8 457-6AB❑❑**	16	7	1800	15.9	720	6.4
Self-ventilated motors for mains-fed operation cast-iron series 1LA8 – 8-pole, 750 rpm at 50 Hz							
315	**1LA8 315-8AB❑❑**	40	22	4800	109.5	1950	44.5
315	**1LA8 317-8AB❑❑**	42	23	6800	125.9	2500	46.3
355	**1LA8 355-8AB❑❑**	41	22.5	6200	89.6	3100	44.8
355	**1LA8 357-8AB❑❑**	40	22	7600	88.7	3800	44.3
400	**1LA8 403-8AB❑❑**	55	30	9700	107.5	4400	48.8
400	**1LA8 405-8AB❑❑**	54	29.5	11000	102.9	5400	50.5
400	**1LA8 407-8AB❑❑**	52	28.5	11200	95.4	5400	46.0
450	**1LA8 453-8AB❑❑**	44	25	9800	78.8	2900	23.3
450	**1LA8 455-8AB❑❑**	42	23	10500	71.4	3000	20.4
450	**1LA8 457-8AB❑❑**	44	25	12400	78.1	3700	23.3