

Efficiency of motors

New efficiency classes for the low-voltage three-phase motors (IE = International Efficiency).

Along with the international discussion on energy efficiency a worldwide harmonized energy efficiency standard classification system has been established for low-voltage three-phase asynchronous motors. For many years low-voltage three-phase motors in the European Union have been sold in three efficiency classes EFF3, EFF2 and EFF1. Aside from this, many different efficiency classification systems have been introduced and well-proven in many countries all over the world.

This was the reason for the International Electrotechnical Commission IEC to develop and publish an energy efficiency standard which replaces all previous national issues. In parallel IEC developed and issued a new standard for determining motor efficiency. The new standard IEC 60034-30-1 defines and harmonizes worldwide the efficiency classes IE1, IE2, IE3 and IE4 for low-voltage three-phase motors in the power range from 0,12 kW to 1000 kW (2p=2, 4, 6, 8).

IE1 = Standard Efficiency

IE2 = High Efficiency

IE3 = Premium Efficiency

IE4 = Super Premium Efficiency

Complying with IEC 60034-30-1 standard the efficiency has to be determined in accordance with the new requirements given in the IEC 60034-2-1 standard.

New EU Commission Regulation 2019/1781 & 2021/341 regarding minimum efficiency of electric motors.

Motors covered by new Regulation

Type	general purpose, geared, with brake, Ex
Voltage	>50V ÷ 1000V
Frequency	50 Hz, 60 Hz or 50/60 Hz
Number of poles	2, 4, 6, 8
Rated power	0,12kW ÷ 1000kW
Duty	continuous (S1, S3≥80 % or S6≥80%)

Motors excluded from new Regulation

Type	<ul style="list-style-type: none"> • multi-speed, slip-ring and with mechanical commutators • motors completely integrated into a product whose efficiency cannot be tested independently from the product • motors with an integrated variable speed drive (compact drives) whose efficiency cannot be tested independently from the variable speed drive • motors with an integrated brake which forms an integral part of the inner motor construction and can neither be removed nor powered by a separate power source during the testing of the motor efficiency • motors specifically designed and specified to operate wholly immersed in a liquid • motors specifically qualified for the safety of nuclear installations, as defined in Article 3 of Council Directive 2009/71/EURATOM • explosion-protected motors specifically designed and certified for mining, as defined in Annex I, point 1 of Directive 2014/34/EU • motors in cordless or battery-operated equipment and motors in hand-held equipment whose weight is supported by hand during operation • motors in hand-guided mobile equipment moved while in operation • Totally Enclosed Non-Ventilated (TENV) motors • motors placed on the market before 1 July 2029 as substitutes for identical motors integrated in products placed on the market before 1 July 2021, and specifically marketed as such • motors designed specifically for the traction of electric vehicles
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Designed for altitudes > 4000 m a.s.l.

Designed for ambient temperatures < -30°C or > 60°C

With maximum operating temperatures > 400°C

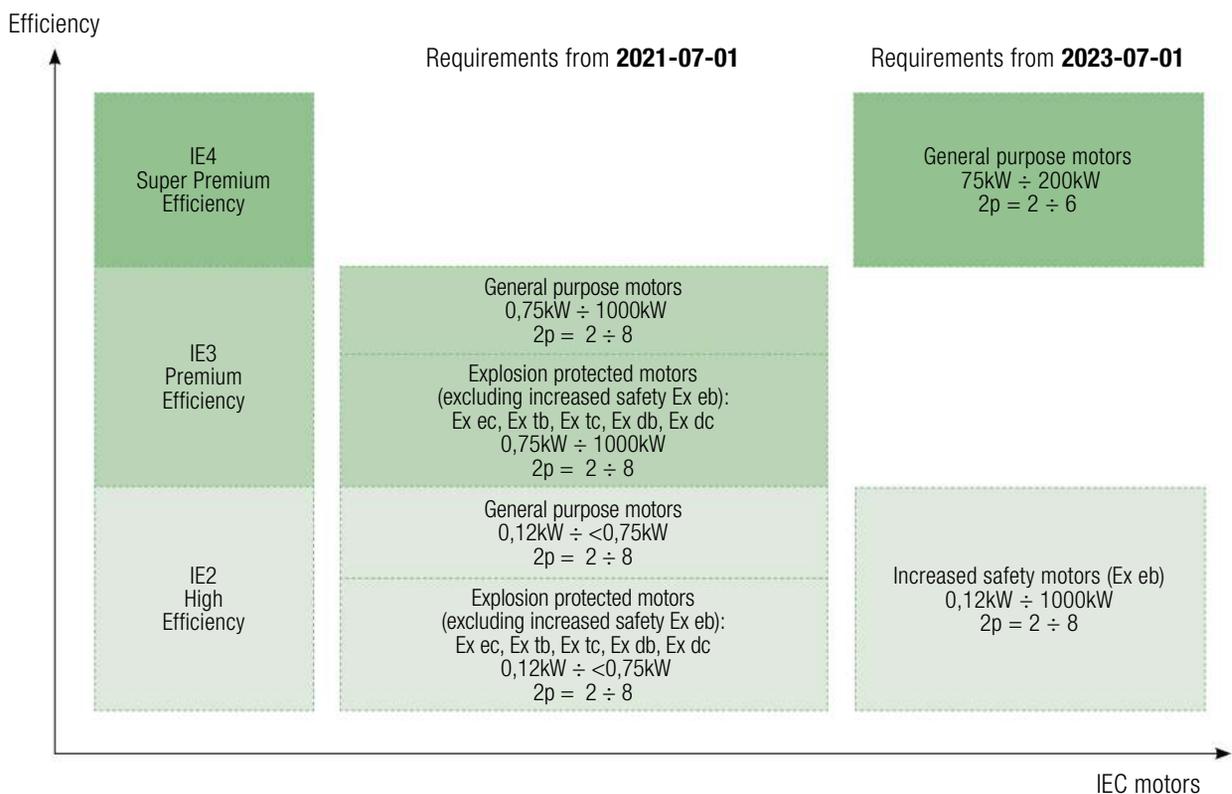
The Commission Regulation (EC) No 2019/1781 & 2021/341 describes efficiency requirements coming into force on **2021-07-01** and **2023-07-01**. The required efficiency class of three phase induction motors has to be as follows:

Required efficiency class of three phase induction motors	General purpose motors	Explosion protected motors except motors dedicated for underground mining	
		Increased safety (Ex eb)	Others (Ex ec, Ex tb, Ex tc, Ex db, Ex dc)
IE2	0,12kW ÷ <0,75kW 2p = 2 ÷ 8 from 2021-07-01	0,12kW ÷ 1000kW 2p = 2 ÷ 8 from 2023-07-01	0,12kW ÷ <0,75kW 2p = 2 ÷ 8 from 2021-07-01
IE3	0,75kW ÷ 1000kW 2p = 2 ÷ 8 from 2021-07-01	–	0,75kW ÷ 1000kW 2p = 2 ÷ 8 from 2021-07-01
IE4	75kW ÷ 200kW 2p = 2 ÷ 6 from 2023-07-01	–	–

Cantoni Group pursuing a policy of continuous development of its products, back in the past already took actions to extend offer of high efficiency motors including also explosion-proof motors – we are ready for the new requirements.

Moreover, at this point, **we can deliver to our Customers motors with higher efficiencies or in wider range than defined in Regulation 2019/1781 & 2021/341.**

A graph representation of the above table:



IE4 efficiency motors available upon request.

Ratings – Tolerances

Tolerances of motor parameters

Permissible deviations between catalogue values and real values are according to the IEC 60034-1:

Power factor $\cos \varphi$	$\Delta \cos \varphi = -1/6 (1 - \cos \varphi_N)$
Efficiency η	$\Delta \eta = -15\% (100 - \eta_N)$ for $P_N \leq 150 \text{ kW}$ $\Delta \eta = -10\% (100 - \eta_N)$ for $P_N > 150 \text{ kW}$
Speed n	$\Delta n = \pm 20\% (n_s - n_N)$ for $P_N > 1 \text{ kW}$ $\Delta n = \pm 30\% (n_s - n_N)$ for $P_N \leq 1 \text{ kW}$
Locked rotor current ratio I_L/I_N	$\Delta(I_L/I_N) = +20\% (I_L/I_N)$
Locked rotor torque ratio T_L/T_N	$\min (T_L/T_N) = -15\% (T_L/T_N)$ $\max (T_L/T_N) = +25\% (T_L/T_N)$
Breakdown torque ratio T_B/T_N	$\Delta(T_B/T_N) = -10\% (T_B/T_N)$
Moment of inertia J [kgm^2]	$\Delta J = \pm 10\% J$
Sound pressure level L_{pA} [dB]	$\Delta L_{pA} = +3 \text{ dB / A}$

Tolerances of supply voltage value and frequency

Motors comply in standard with voltage value and voltage frequency variations within zone A according to the IEC 60034-1:

Voltage value U	$\Delta U = \pm 5\%$
Voltage frequency f	$\Delta f = \pm 2\%$

Other extended tolerances of supply voltage and their frequency are available on request.

Standards

The electric motors are manufactured according to the international standards:

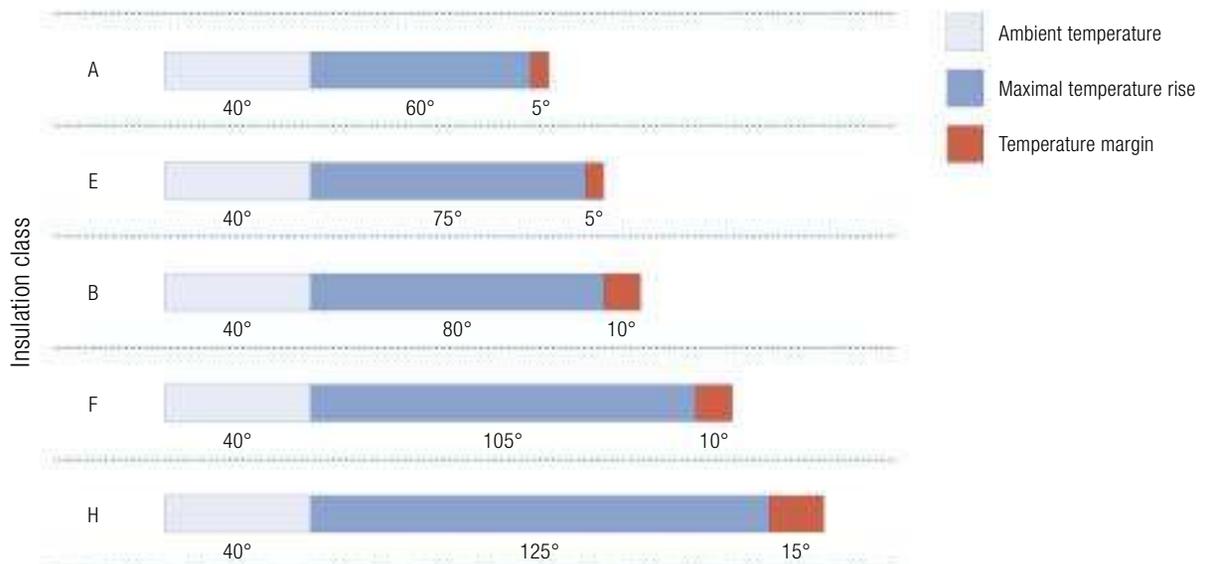
Rating and performance	IEC 60034-1
Methods for determining losses and efficiency	IEC 60034-2-1
Classification of degrees of protection	IEC 60034-5
Methods of cooling	IEC 60034-6
Symbols of construction and mounting arrangements	IEC 60034-7
Terminal markings and direction of rotation	IEC 60034-8
Noise limits	IEC 60034-9
Dimensions and output of electric machines	IEC 60072-1
Vibration limits	IEC 60034-14

Insulation classification

The insulation system of an electric motor is determined by a given insulation class on the basis of its thermal resistance. This thermal resistance should be guaranteed by the entire set of electric insulating materials used in the motor insulating system.

Thermal resistance classification is related to the temperature of the hotspot in the insulation occurring during rated operating conditions of the electric motor, allowing for the highest permissible rise in average temperature.

This rise should be selected so that at the highest permissible ambient temperature, the temperature of the hotspot in insulation will not exceed the value assigned to a given thermal resistance class.



Insulation class F in an electric motor means that at ambient temperature of 40°C the temperature rise of the winding may be max. 105°C with the additional temperature margin of 10°C (under specified measuring conditions in accordance with the IEC 60034-1 standard).

Symbols of thermal resistance classes (permissible insulation temperatures at 40°C ambient temperature)

Symbol	Temperature [°C]
A	105
E	120
B	130
F	155
H	180

3SIE series Class F/B

The standard motors made by Cantoni Motor in their basic version have the insulation class F while the temperature rise is for class B. This means longer life for motors.

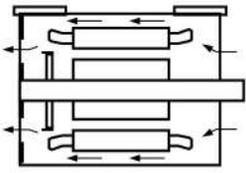
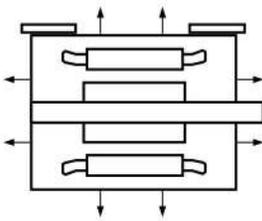
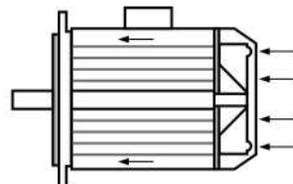
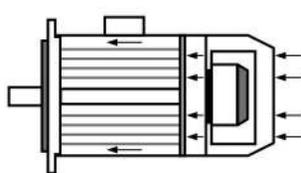
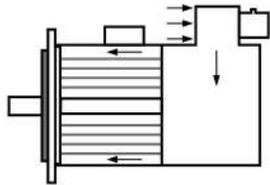
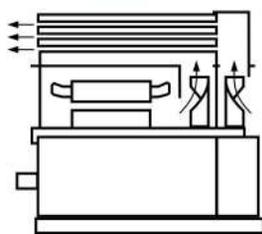
For special request we can deliver motors equipped with insulation class H.

Strengthened insulation system gives possibility to safe operation with frequency converters.

GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Cooling

General purpose motors from Cantoni Group are equipped with standard IC411 cooling according to IEC 60034-6. Other cooling methods (for example motors with external/separate cooling) are available on request.

IC code according to IEC 60034-6	Description	Drawing
IC01	<ul style="list-style-type: none"> – Open machine – Fan mounted on shaft – Often called "drip-proof" motor 	
IC410	<ul style="list-style-type: none"> – Enclosed machine – Surface cooled by natural convection and radiation – Without internal or external fan 	
IC411	<ul style="list-style-type: none"> – Enclosed machine – Smooth or finned casing – External shaft-mounted fan – Often called TEFC motor 	
IC416A	<ul style="list-style-type: none"> – Enclosed machine – Smooth or finned casing – External motorized axial fan integrated with the motor 	
IC416R	<ul style="list-style-type: none"> – Enclosed machine – Smooth or finned casing – External motorized radial fan integrated with the motor 	
IC611	<ul style="list-style-type: none"> – Enclosed machine – Heat Exchanger fitted – Two separate air circuits – Shaft-mounted Fans – Often called CacA motor 	

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Standard terminal box equipment

Motor frame size	Number of terminals	Number of cable glands	Size of cable glands	Permissible cable diameter for cable gland	Optional rotation of terminal box	Temperature sensors in the winding	Thermal protection of bearings
56	6	1	M20	7÷13	180°	on request	no
63	6	1	M20	7÷13	180°	on request	no
71	6	1	M20	7÷13	180°	on request	no
80	6	1	M20	7÷13	180°	on request	no
90	6	1	M20	7÷13	180°	on request	no
100	6	1	M20	7÷13	180°	on request	no
112	6	1	M25	9÷17	180°	on request	no
132	6	1	M25	9÷17	180°	on request	no
160	6	1	M40	19÷28	180°	on request	on request
180	6	1	M40	19÷28	180°	on request	on request
200L8	6	1	M40	19÷28	180°	on request	on request
200L2÷6	6	3	2xM50/1xM16	24÷32/4÷8	4x90°	3xPTC	on request
225	6	3	2xM50/1xM16	24÷32/4÷8	4x90°	3xPTC	on request
250	6	3	2xM63/1xM16	32÷40/4÷8	4x90°	3xPTC	on request
280	6	3	2xM63/1xM16	32÷40/4÷8	4x90°	3xPTC	on request
315	6	3	2xM63/1xM16	44÷55/4÷8	4x90°	3xPTC	on request
355ML	6	4	2xM63/2xM20	51÷56/7÷13	4x90°	3xPTC	on request
355H	6	2	2xM63	51÷56	4x90°	3xPt100	Pt100
400	6 (bars)	3	3xM63	44÷55	180°	3xPt100	Pt100
450	3 (bars)	3	3xM80	58÷64	180°	3xPt100	Pt100
500	3 (bars)	on request	on request	on request	180°	3xPt100	Pt100

Vibration level

The rotor balancing method guarantees that a standard vibration level A is maintained in accordance with the IEC 60034-14. On customer's demand the motors can be produced with reduced vibration (level B).

Limits of maximum vibration velocity (r.m.s.) for shaft height H according to IEC 60034-14

Vibration level	Shaft height	
	56 ≤ H ≤ 132	H > 132
	Fitting type	mm/s
A	Free suspension	2.8
	Rigid setting	–
B	Free suspension	1.1
	Rigid setting	–

Remark:

Limits stated in the table mentioned above are applicable for uncoupled (disconnected from the driven machine) and operating at no load motors.

Noise level

Motors in standard comply with a permissible sound power level according to IEC 60034-9.

On customer's demand the motors can be delivered with reduced noise level by using special cooling systems or additional external sound-absorbing covers.

GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Terminal box

The terminal boxes of low voltage motors have threaded inlet holes designed for mounting cable glands.

The box contains a terminal board with marked terminals making possible connection of supply cables.

In addition, terminal boxes may be provided with additional terminals connected to the ends of thermal protection or anticondensation heater circuits and extra glands to connect these circuits.

Starting from frame size 355 motors contain terminal boxes with cable gland seals.

The circuits of thermal protection and anticondensation heaters are connected to separate terminal boxes.

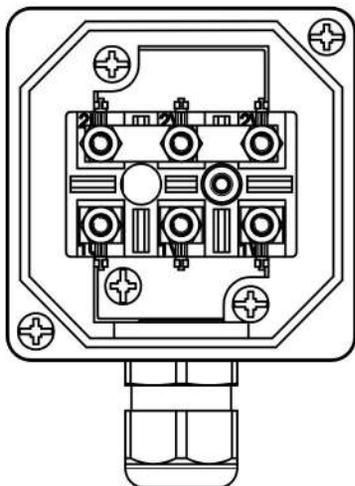
Inside the boxes there are special clamps used to ground the supply cable armouring.



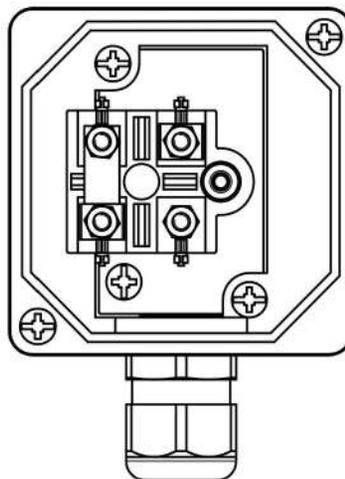
In standard all motors except series 2Sg are equipped with terminal box mounted on top (in case of 2Sg series terminal box can be on right or left side).

Standard terminal box view:

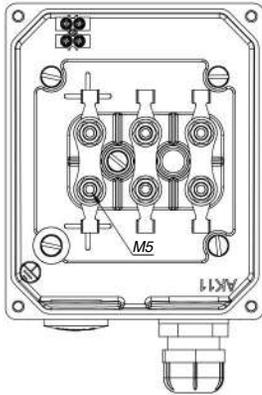
Frame size
3SIE, 2SIE, Sh56÷80 3-phase



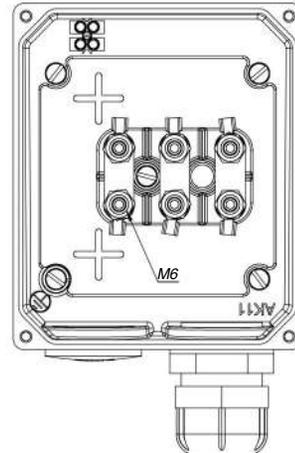
Frame size
SE(M)h56÷90 1-phase



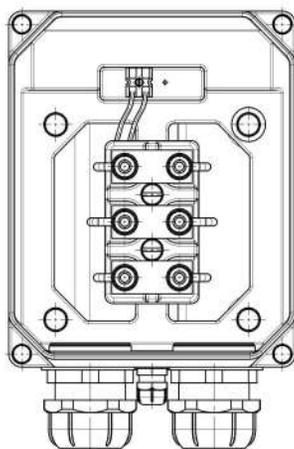
Frame size
3SIE90÷112



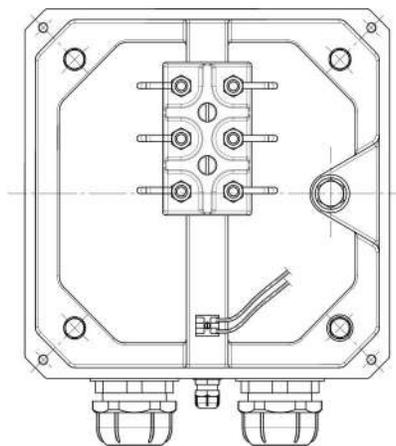
Frame size
3SIE132÷180 and 200L8



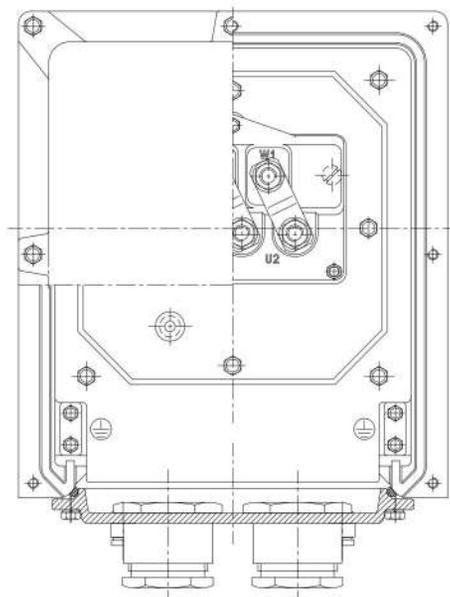
Frame size
3SIE200÷280 (except 200L8)
and 2Sg200 ÷ 315



Frame size
(3)SIE315



Frame size
2(3)SIE355ML
2(3)SIE355H

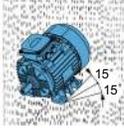
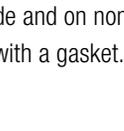


GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Degree of protection IP

IP 55

Degree of protection IP55 is the standard of our production according to the standard IEC 60034-5

Protection against penetration of solid matter			Protection against penetration of fluids		
1st digit	Description		2nd digit	Description	
0	 Not protected		0	 Not protected	
1	 Protected against solid bodies larger than 50 mm		1	 Protected against vertically falling drops of water	
2	 Protected against solid bodies larger than 12 mm		2	 Protected against vertically falling drops of water up to 15°	
3	 Protected against solid bodies larger than 2,5 mm		3	 Protected against rain up to 60°	
4	 Protected against solid bodies larger than 1 mm		4	 Protected against rain falling from any direction	
5	 Protected against deposition of dust		5	 Protected against sprayed water from any direction	
6	 Totally protected against deposition of dust		6	 Protected against temporary immersion	
			7	 Protected against immersion between 0,15 and 1 m	
			8	 Protected against immersion at preset pressure and time	

Each size 56 to 180 motor is equipped with seal rings (Simmerring or V-ring) on drive side and on non drive side. Labyrinth seals protect the motors from size 200 and above. The terminal box is sealed with a gasket.

Higher degree of protection is available on request.

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Painting and corrosivity classes

Standard painting system with RAL5010 color used in all our motors comply with C3 corrosion class according to ISO 12944.

For special request motors can be painted with other colors and with alternative painting systems (up to C5M corrosion class).

RAL 5010/C3

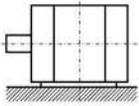
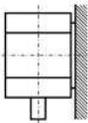
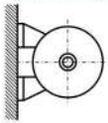
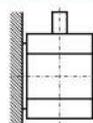
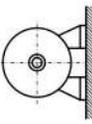
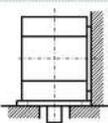
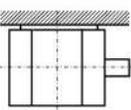
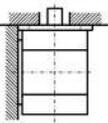
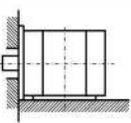
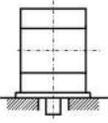
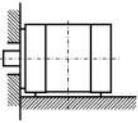
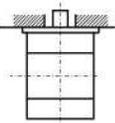
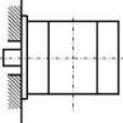
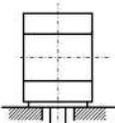
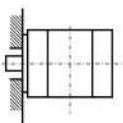
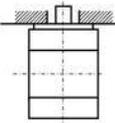


Corrosion class	Environment	
	Interior	Exterior
C1 (very low)	Heated buildings with a clean atmosphere such as hotels, offices, shops, schools.	N/A
C2 (low)	Unheated buildings, where condensation may occur e.g. storehouses, sports halls.	Atmosphere contaminated to a small extent, mostly rural regions.
C3 (medium)	Production space of high humidity and certain air contamination e.g. foodstuff plants, laundries, breweries, dairies.	Industrial and urban atmosphere with an average Sulphur oxide (IV) contamination level. Inshore areas of low salinity.
C4 (high)	Chemical plants, swimming pools, ship repair yards.	Industrial areas and inshore areas of medium salinity.
C5I (very high – industrial)	Buildings and areas of almost constant condensation and high contamination.	Industrial areas of high humidity and aggressive atmosphere.
C5M (very high – marine)	Buildings and areas of almost constant condensation and high contamination.	Coast and offshore areas with high salt content.

GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Mounting arrangements

According to the IEC 60034-7 standard

Horizontal shaft				Vertical shaft			
Designation				Designation			
Code II	Code I	Frame size		Code II	Code I	Frame size	
	IM 1001	IM B3	56 ÷ 500		IM 1011	IM V5	56 ÷ 315
	IM 1051	IM B6	56 ÷ 280		IM 1031	IM V6	56 ÷ 315
	IM 1061	IM B7	56 ÷ 280		IM 2011 or IM 2111	IM V15	56 ÷ 355
	IM 1071	IM B8	56 ÷ 280		IM 2031 or IM 2131	IM V36	56 ÷ 355
	IM 2001	IM B35	56 ÷ 500		IM 3011	IM V1	56 ÷ 500
	IM 2101	IM B34	56 ÷ 132		IM 3031	IM V3	56 ÷ 280
	IM 3001	IM B5	56 ÷ 315		IM 3611	IM V18	56 ÷ 180
	IM 3601	IM B14	56 ÷ 132		IM 3631	IM V19	56 ÷ 180

*Other mounting arrangements available on special request

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Definitions

Relation between rated output power and rated torque on motor shaft:

$$T = \frac{9,55 \times P}{n}$$

where:

- T [Nm] is rated output torque on motor shaft
- P [W] is rated output power on motor shaft
- n [rpm] is rated speed of motor shaft

Relation between rated output power on shaft and rated consumed power from mains:

$$P_1 = \frac{P}{\eta} \times 100$$

where:

- P_1 [kW] is rated consumed power from mains by motor
- P [kW] is rated output power on motor shaft
- η [%] is rated efficiency of motor

Relation between rated consumed power from mains and rated voltage, current, power factor:

$$P_1 = \sqrt{3} \times U \times I \times \cos\varphi$$

where:

- P_1 [W] is rated consumed power from mains by motor
- U [V] is rated supply voltage of motor
- I [A] is rated current consumed from mains by motor
- $\cos\varphi$ is rated power factor of motor

Units of measurement

Parameter name	Symbol	Unit name	Symbol
Frequency	f	Hertz	Hz
Active power	P	Watt	W
Voltage	U	Volt	V
Electric Current	I	Amper	A
Power factor	cosφ	N/A	N/A
Resistance	R	Ohm	Ω
Sound power level	L _w	decibel	dB
Sound pressure level	L _p	decibel	dB

GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Permissible shaft end loads

Frame size	Number of poles	Horizontal operation		Vertical operation			Frame size	Number of poles	Horizontal operation		Vertical operation		
		$F_R(x=0)$	$F_R(x=\max)$	F_P	F_{a1}	F_{a2}			$F_R(x=0)$	$F_R(x=\max)$	F_P	F_{a1}	F_{a2}
		[kN]		[kN]					[kN]		[kN]		
2SIE (Sh) 56	2	0,20	0,16	0,04	0,03	0,05	3SIE 225 S	4	4,18	3,40	3,19	2,42	4,16
	4	0,25	0,20	0,05	0,04	0,06		8	5,55	4,40	4,55	3,80	5,52
	6	0,25	0,20	0,06	0,05	0,07		2	3,31	2,81	2,53	1,93	3,29
2SIE (Sh) 63	2	0,20	0,16	0,04	0,04	0,06	3SIE 225 M	4	3,97	3,23	3,13	2,26	4,24
	4	0,25	0,20	0,06	0,05	0,07		6	4,57	3,72	3,98	2,95	5,33
	6	0,27	0,22	0,06	0,05	0,07		8	5,35	4,24	4,48	3,62	5,62
	8	0,27	0,22	0,07	0,06	0,08		2	4,09	3,39	3,11	2,33	4,13
3,2SIE (Sh) 71	2	0,29	0,24	0,07	0,05	0,09	3SIE 250 M	4	4,90	4,06	3,85	2,68	5,36
	4	0,36	0,30	0,09	0,07	0,11		6	5,92	4,90	4,99	3,81	6,55
	6	0,40	0,35	0,10	0,08	0,12		8	6,52	5,28	5,49	4,26	7,10
3,2SIE 80	2	0,33	0,27	0,09	0,06	0,12	3SIE 280 S	2	3,94	3,34	3,07	2,01	4,43
	4	0,44	0,37	0,12	0,09	0,15		4	6,69	5,67	5,01	3,65	6,77
	6	0,51	0,42	0,14	0,11	0,17		6	7,86	6,67	5,79	4,32	7,70
	8	0,51	0,42	0,17	0,15	0,20		8	8,78	7,27	7,09	5,78	8,84
3SIE 90	2	0,79	0,66	0,64	0,44	0,84	3SIE 280 M	2	3,80	3,22	3,03	1,89	4,49
	4	1,00	0,83	0,80	0,65	1,05		4	6,15	5,22	4,86	3,16	7,04
	6, 8	1,15	0,95	0,90	0,77	1,17		6	7,69	6,52	5,75	4,19	7,75
3SIE 100	2	1,11	0,89	0,90	0,61	1,17	3SIE 315 S	8	8,47	7,01	6,99	5,45	9,03
	4	1,39	1,12	1,12	0,90	1,46		2	3,56	3,08	2,96	1,63	4,69
	6, 8	1,60	1,29	1,26	1,08	1,64		4	5,75	4,82	4,74	2,71	7,37
3SIE 112	2	1,56	1,22	1,23	0,84	1,60	3SIE 315 MA	6	7,21	6,04	5,61	3,84	8,14
	4	1,92	1,58	1,50	1,19	1,96		8	8,51	7,05	7,03	5,32	9,30
	6, 8	2,20	1,80	1,69	1,26	2,20		2	3,07	2,65	2,82	1,23	4,89
3SIE 132	2	2,11	1,65	1,82	0,98	2,37	3SIE 315 MB	4	5,40	4,52	4,64	2,41	7,53
	4	2,67	2,08	2,31	1,36	3,00		6	6,75	5,66	5,48	3,22	8,40
	6, 8	3,06	2,39	2,51	1,40	3,26		8	7,88	6,52	6,83	4,72	9,62
3SIE 160	2	2,43	1,88	1,97	1,00	2,56	3SIE 315 MC	2	2,67	2,31	2,71	0,91	5,05
	4	3,06	2,38	2,54	1,43	3,31		4	5,16	4,33	4,58	2,20	7,64
	6, 8	3,54	2,81	2,83	1,80	3,68		6	6,27	5,33	5,34	2,68	8,78
3SIE 180	2	2,61	2,13	2,20	1,00	2,87	3SIE 315 MD	8	7,22	5,98	6,63	4,08	10,00
	4	3,30	2,68	2,83	1,37	3,68		2	2,84	2,48	2,71	0,63	5,37
	6, 8	3,78	3,07	3,17	1,93	4,12		4	6,27	5,33	4,34	1,46	8,06
3SIE 200 LA	2	2,91	2,44	2,24	1,72	2,92		6	7,57	6,44	5,08	1,87	9,23
3SIE 200 LB	2	2,85	2,39	2,23	1,67	2,93		8	8,76	7,45	6,76	3,48	11,12
3SIE 200 L	4	3,61	3,03	2,81	2,12	3,70		6	7,47	6,36	5,05	1,82	9,22
3SIE 200 LA	6	4,31	3,62	3,62	2,92	4,56		8	8,62	7,33	6,71	3,34	11,20
3SIE 200 LB	6	4,06	3,40	3,54	2,71	4,65							
3SIE 200 L	8	4,84	3,97	4,02	3,35	4,89							
2Sg (2p = 10÷12)													
		$F_R(x=0)$	$F_R(x=\max)$	F_P	F_{a1}	F_{a2}			$F_R(x=0)$	$F_R(x=\max)$	F_P	F_{a1}	F_{a2}
		[kN]		[kN]					[kN]		[kN]		
2Sg 200LA	10	5,50	4,60	4,20	3,50	5,10	2Sg 280S	10	9,30	7,70	6,70	5,40	8,40
2Sg 200LB	10	5,50	4,50	4,10	3,40	5,10		12	9,80	8,10	7,00	5,70	8,70
2Sg 200L	12	5,90	4,90	4,40	3,70	5,40	2Sg 280M	10	8,80	7,30	6,50	5,20	8,20
2Sg 225S	10	6,50	5,10	4,70	4,00	5,60		12	9,20	7,60	6,80	5,00	9,30
	12	6,70	5,30	4,80	4,20	6,00	2Sg 315S	10	9,30	7,70	7,60	5,50	10,20
2Sg 225M	10	6,30	4,90	5,70	4,40	7,40		12	9,80	8,10	8,00	5,90	10,80
	12	6,70	5,30	4,90	3,90	6,20	2Sg 315M	10	8,40	7,00	7,30	4,80	10,70
2Sg 250M	10	7,50	6,20	5,70	4,40	7,40	2Sg 315MA	12	9,30	7,70	7,90	5,50	11,10
	12	8,10	6,70	6,10	4,80	7,80	2Sg 315MB	12	9,10	7,60	7,80	5,30	11,20

DRIVING YOUR BUSINESS

Permissible shaft end loads

Value of radial force FR acting on the shaft end for a given belt pulley diameter is calculated according to the following formula:

$$F_R = \frac{19\,600 \times P \times k}{D_k \times n} \text{ [N]}$$

where: P – motor output [kW]
D_k – belt pulley diameter [m]
n – speed [rpm]
k – belt tension factor:
for V-belts k=2,2
for flat belts k=3

Value of force FR acting on any point of the shaft end (between points X=max and X=0) may be calculated according to the following formula:

$$F_R = F_{X0} - \frac{X}{E} \times (F_{X0} - F_{XMAX}) \text{ [N]}$$

where: F_{X0} – value of F_R force acting on the beginning of the shaft end
F_{XMAX} – value of F_R force acting on the end of the shaft end
E – length of the shaft end

VERSION WITH ROLLER BEARINGS for motors 355

Mechanical Size	Type of construction	No. of poles, 2p	D.E. bearing	N.D.E. bearing
3SIE 355 ML	IM1001 (B3)	4÷8	NU222EM1C3	6222 C3
3SIE 355 ML	IM1001 (B3)	4÷8	NU322 EM1C3 ¹⁾	6322 C3 ¹⁾
3SIE 355 H	IM1001 (B3)	4÷8	NU322 EM1C3	6322 C3

Motor type	Number of poles	Length of shaft extension E (mm)	Horizontal mounting		
			Permissible radial forces		Permissible axial forces
			F _{X0} kN	F _{Xmax} kN	F _A kN
3SIE 355 ML	4	210	22	18	5
	6	210	23	15	5,5
	8 ²⁾	210	24	14	6
3SIE 355 ML	4	210	34,0 ¹⁾	21,0 ¹⁾	7,0 ¹⁾
	6	210	36,0 ¹⁾	21,0 ¹⁾	8,0 ¹⁾
	8 ²⁾	210	38 ¹⁾	21 ¹⁾	9 ¹⁾
3SIE 355 H	4	210	27	17	6
	6	210	29	15	7
	8 ²⁾	210	30	15	8

VERSION WITH ROLLER BEARINGS for motors 3SIE/Sh 400-500

Mechanical Size	Type of construction	No. of poles, 2p	D.E. bearing	N.D.E. bearing
3SIE/Sh 400..s	IM1001 (B3)	4÷10	on request	on request
3SIE/Sh 450..s	IM1001 (B3)	4÷12	on request	on request
3SIE/Sh 500..s	IM1001 (B3)	4÷10	on request	on request

¹⁾ oversized bearings.

²⁾ vertical operation possible upon request.

For motors series Sh size ≥ 400 information about permissible loads on request.

GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Bearing types and bearing nodes

Frame size	Number of poles	Bearings
2SIE (Sh) 56	2÷6	6201 2Z C3
2SIE (Sh) 63	2÷8	6202 2Z C3
3,2SIE (Sh) 71	2÷8	6203 2Z C3
3,2 SIE 80	2÷8	6204 2Z C3
3SIE 90	2÷8	6205 2Z C3
3SIE 100	2÷8	6206 2Z C3
3SIE 112	2÷8	6306 2Z C3
3SIE 132	2÷8	6308 2Z C3
3SIE 160	2÷8	6309 2Z C3
3SIE 180	2÷8	6311 2Z C3
3SIE 200L8	8	6312 2Z C3/6311 2Z C3
3SIE 200	2÷6	6312 C3
3SIE 225	2÷8	6313 C3
3SIE 250	2÷8	6315 C3
3SIE 280	2	6315 C3
3SIE 280	4÷8	6318 C3
3SIE 315S,MA,MB	2	6315 C3
3SIE 315MC	2	6316 C3
3SIE 315S,MA,MB	4÷8	6318 C3
3SIE 315MC,MD	4÷8	6320 C3 / 6318 C3

The bearings in basic version of motors for horizontal and vertical duty, excluding 3SIE 315 with 2p=2.

BEARINGS for 2Sg (2p = 10 ÷ 12)		
Frame size	Number of poles	Bearings
2Sg 200	10÷12	6312 C3
2Sg 225	10÷12	6313 C3
2Sg 250	10÷12	6315 C3
2Sg 280	10÷12	6317 C3
2Sg 315	10÷12	6318 C3

Frame size	Type of construction	No. of poles, 2p	D.E. Bearing	N.D.E. Bearing
3SIE 355ML	IM1001 (B3)	2	6217 C3	6217 C3
3SIEL 355ML	IM2001 (B35)	4÷8	6222 C3	6222 C3
3SIEK 355ML	IM3011 (V1)	4÷8	6322 C3	6322 C3
3SIE 355H	IM1001 (B3)	2	6217 C3	6217 C3
3SIEL 355H	IM2001 (B35)	4÷8	6322 C3	6322 C3
3SIEK 355H	IM3011 (V1)	4÷8	6322 C3	6322 C3
3SIE 355..s	IM1001 (B3)	2	6217 C3	6217 C3
3SIEL 355..s	IM2001 (B35)	4÷8	6322 C3	6322 C3
3SIEK 355..s	IM3001 (V1)	4÷8	6322 C3	6322 C3
3SIE 400..s	IM1001 (B3)	2		
3SIEL 400..s	IM2001 (B35)	4÷10		
3SIEK 400..s	IM3011 (V1)	4÷10		
3SIE 450..s	IM1001 (B3)	4÷12		
3SIEL 450..s	IM2001 (B35)	4÷12		
3SIEK 450..s	IM3011 (V1)	4÷12		
3SIE 500..s	IM1001 (B3)	4÷12		
3SIEL 500..s	IM2001 (B35)	4÷12		
3SIEK 500..s	IM3011 (V1)	4÷12		

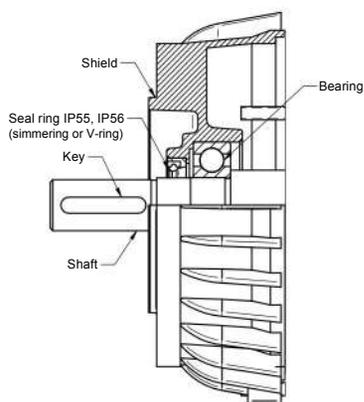
The bearings in basic version of motors for horizontal and vertical duty.

on request

DRIVING YOUR BUSINESS

Bearing types and bearing nodes

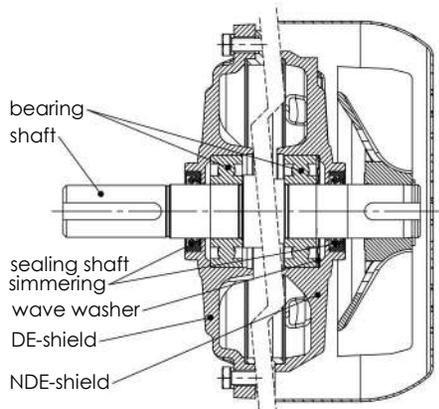
Frame size
3SIE, S(E)h56 ÷ 80



Motor frame size	Bearings lubrication on the run	Motor frame size	Bearings lubrication on the run
56	no	200L2÷6	yes
63	no	225	yes
71	no	250	yes
80	no	280	yes
90	no	315	yes
100	no	355ML	yes
112	no	355H	yes
132	on request	400	yes
160	on request	450	yes
180	on request	500	yes
200L8	on request		

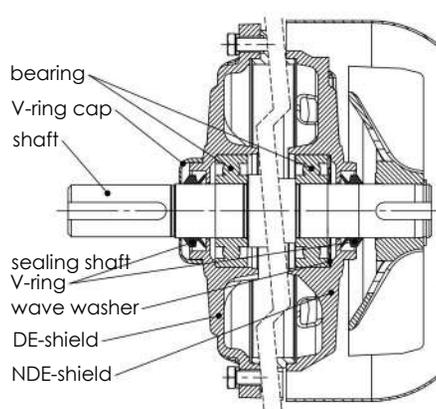
Frame size
3SIE90 ÷ 180 and 200L8 (with simmering)

D side ND side

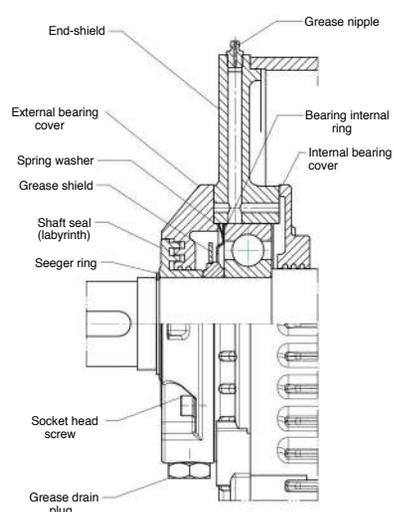


Frame size
3SIE90 ÷ 180 and 200L8 (with V-ring)

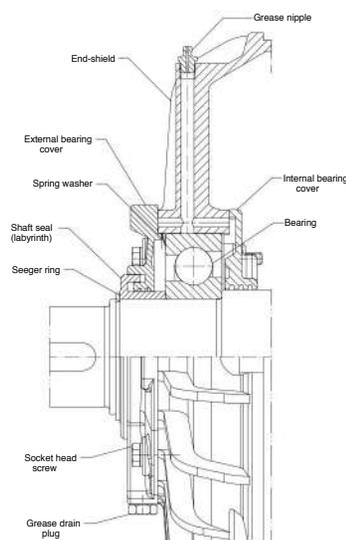
D side ND side



Frame size
(2,3)SIE200 ÷ (2,3)SIE315 (except 200L8) and 2Sg315



Frame size
2Sg200 ÷ 2Sg280



GENERAL PURPOSE 3-PHASE INDUCTION MOTORS

Material of housing, end shields and feet

Frame size [mm]	Motor housing	End shields	Feet
2SIE (Sh) 56	Aluminium	Aluminium	Aluminium – screwed
2SIE (Sh) 63	Aluminium	Aluminium	Aluminium – screwed
3,2SIE (Sh) 71	Aluminium	Aluminium	Aluminium – screwed
3,2SIE 80	Aluminium	Aluminium	Aluminium – screwed
3SIE 90	Aluminium	Aluminium	Aluminium – screwed
3SIE 100	Aluminium	Aluminium	Aluminium – screwed
3SIE 112	Aluminium	Cast iron	Aluminium – screwed
3SIE 132	Aluminium/Cast iron	Cast iron	Aluminium/Cast iron – screwed or integrated
3SIE 160	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 180	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 200	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 225	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 250	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 280	Cast iron	Cast iron	Cast iron – screwed or integrated
3SIE 315	Cast iron	Cast iron	Cast iron – screwed or integrated
355	Cast iron	Cast iron	Cast iron – integrated
400	Cast iron	Cast iron	Cast iron – integrated
450	Cast iron	Cast iron	Cast iron – integrated
500	Cast iron	Cast iron	Cast iron – integrated

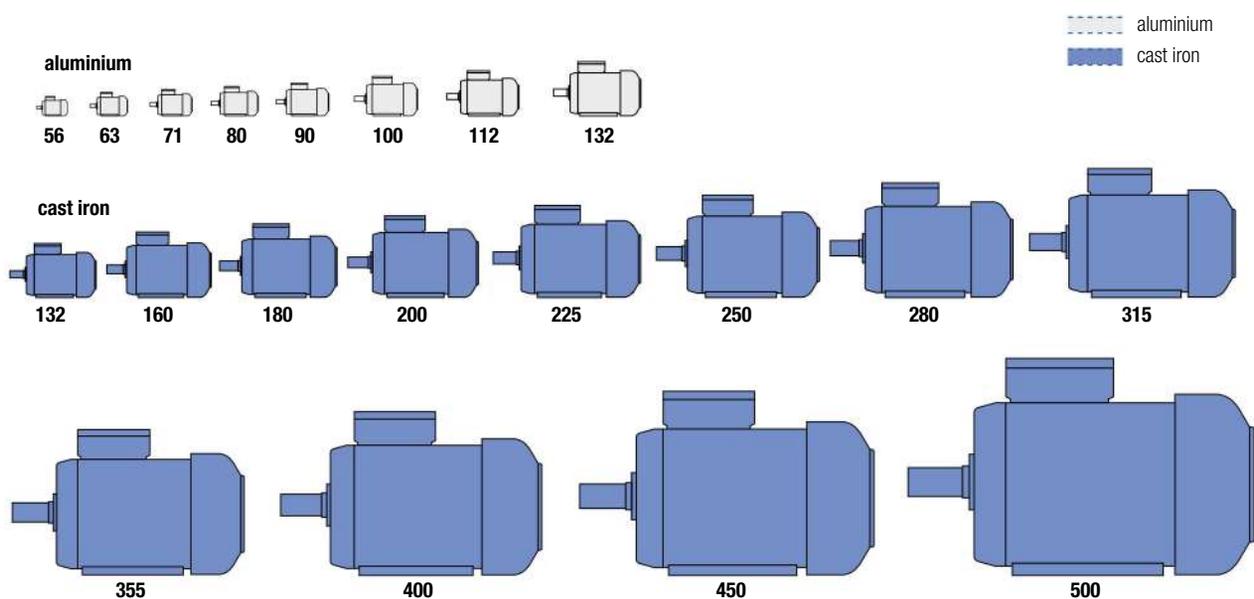
In motors series 3SIE, Sh, Sg of frame size 80, 90 and 100 mm: on request end shields may be made of cast iron.

In motors 3SIE of frame size 132, 160 and 180 mm – feet may be integrated with housing (motors with cast iron housing).

In motors 3SIE of frame size 90 and 100 flanges are made of cast iron.

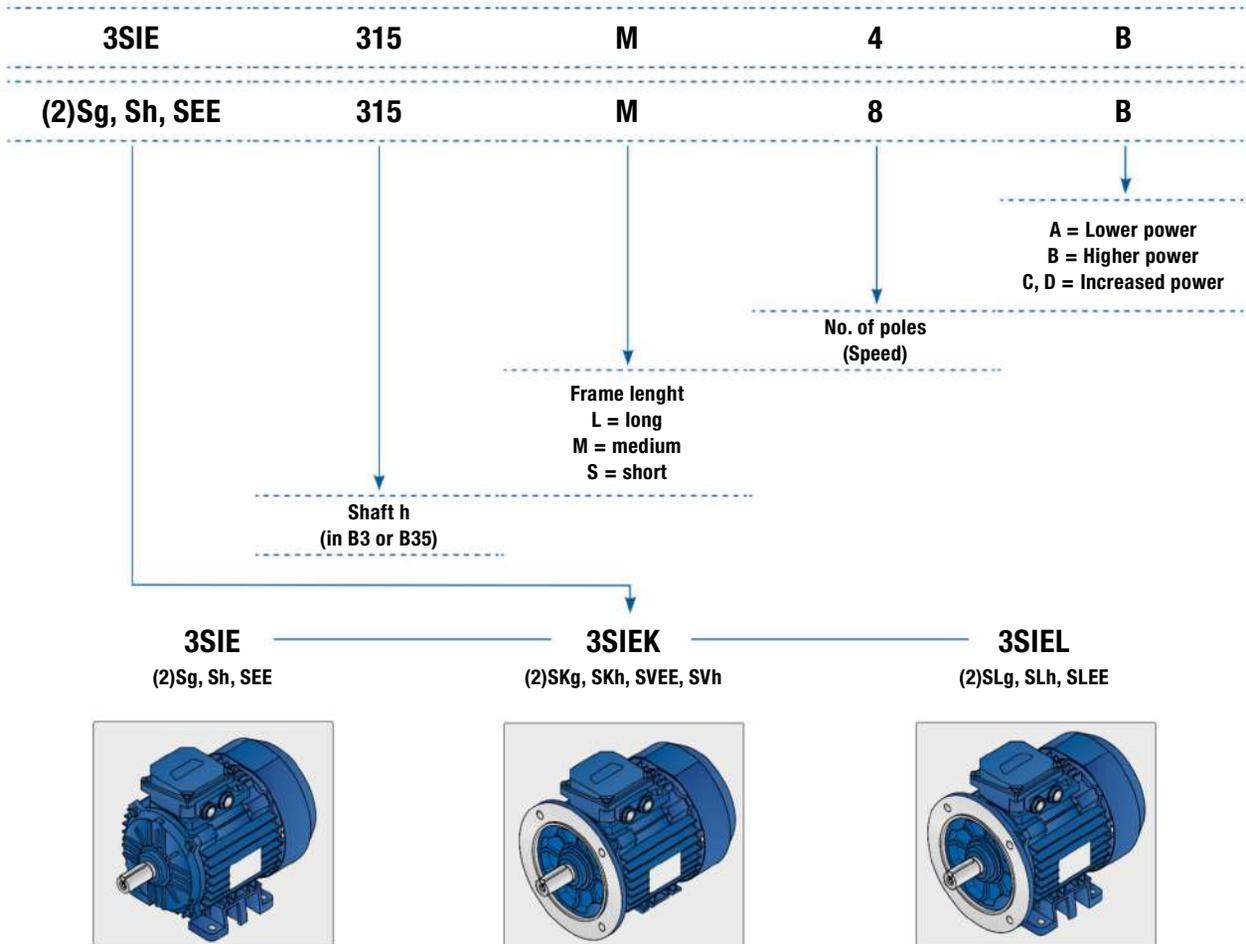
In motors 3SIE of frame size 90 to 112 cast iron motor housing and feet are possible.

In motors 2Sg series from frame 200 to 315 cast iron feet can be only integrated.



DRIVING YOUR BUSINESS

Nomenclature



Frequency converter operation (VSD)

Electronic speed control is carried out using a frequency converter (VSD) that adjusts the speed of the motor – and therefore the torque produced – based on the energy needed.

Motor size	Sh56-80 3SIE80	(Sg,Sh)90-180 3SIE90-180	2Sg200-280 3SIE200-280	2Sg315 (3)SIE315	(Sg,Sh)355-500 3SIE355
In standard designed for frequency converter supply	Yes	Yes	Yes	No (available on request)	No (available on request)
Permissible output parameters of the frequency converter (measured on motor terminals – including supply cable between motor and frequency converter):	$U_{peak} \leq 1,35kV$ $t_r \geq 0,8\mu s$				$U_{peak} < 1,5kV$ $t_r > 0,5\mu s$
Insulated bearing or bearing chamber on NDE-side	N/A	N/A	Available on request	Yes (in motors designed for frequency converter supply with rated power >100kW)	
Speed control range	Permissible speed control range will depend on the application (load curve) and parameters of the frequency converter thus it should be established individually.				

In case of higher voltage peaks and/or lower time rise it's necessary to use motors with special insulation systems (available on request) or to use proper output filters in the frequency converter (which can reduce voltage peaks and increase voltage time rise).