

Permanent magnet synchronous motors for inverter operation



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Type Approval Certificate

This is to certify that the undermentioned product(s) has/have been tested in accordance with the relevant requirements of the GL Type Approval System.

Certificate No. 89 739 - 24 HH

Company: VEM motors GmbH
Elektronenstrasse Warrigrode
Carl-Friedrich-Gauß-Strasse 1
38855 Warrigrode, GERMANY

Product Description: Induction motors for marine applications / environments

Type: K11R, K21R, WE1R, W21R 112 ... up to 315 ... K22R 305
Es-K11R, Es-K21R, Es-WE1R, Es-WE21R 112 ... up to 315 ... Es-K22R 305

Environmental Category: H

Technical Data / Range of Application:
 Size: 112, 132, 160, 180, 200, 225, 250, 280, 315, 355
 Rated voltage: up to 230 V
 Rated power: 0.5 kW up to 420 kW
 Synchronous speed: 250 1/min up to 3600 1/min
 Rated frequency: 50 Hz, 60 Hz
 Ambient temperature: 40 °C
 Duty type: S1-S9
 Thermal class: 180/200 optional 180/200
 Type of enclosure: IP 55, IP 56, IP 66
 No. of poles: 2, 4, 6, 8, 10, 12, 14 and combinations
 Spec. model: S3 (Seewasserschutz), resistant to seawater

Valid for all variants independent of voltage, power, speed and type of construction

Description of type: x = 1, 2 or 3

Test Standard: DIN EN 60034 - 1 / April 2005

Documents: Drawings ZA 144 (01.09.03), ZA 141 (10.08.03)
 Descriptions and technical data: ZA 144, B1, S-609.93; EW-N 1000, B1 13.01.2005
 Works acceptance certificate, test reports dated 1.4.12, 19.03.11, 08.2009
 Test report K209 305/04, Ser. No. 127200001 issue 20.01.04

Remarks: None

Valid until: 2014-01-25

Page: 1 of 1

File No. I.0.03

Hamburg, 2009-08-25

Germanischer Lloyd
Wolfgang Voß
Heinz Dieter Hespe

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Type Approval Certificate

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Certificate No. 98 733 - 95 HH

Company: VEM motors Thurm GmbH
Juliane-Drewecke-Strasse 35
68868 Zeilkau, GERMANY

Product Description: Induction motors, Ex-protected (increased safety)

Type: IE-KPER 80 ... up to IE-KPER 100 ...
 IE-KPER 95 ... up to IE-KPER 132 ... I KPER 95 ... up to I KPER 132 ...

Environmental Category: H

Technical Data / Range of Application:
 Size: 80, 90, 100, 112, 132
 K-G-L-M-NK-M2-S-S-X
 Rated voltage: up to 230 V
 Rated power: 0.12 kW up to 5.5 kW
 Synchronous speed: 750 1/min up to 3600 1/min
 Rated frequency: 50 Hz, 60 Hz
 Ambient temperature: 40 °C
 Duty type: S1
 Insulation class: F
 Degree of protection: IP 54, IP 55, IP 56, IP 65, IP 66
 No. of poles: 2, 4, 6, 8 and combinations
 Spec. model: Marine version
 Designation: Ex e II T1, T2, T3 or T4 (increased safety)
 Description of type: S3 = "1, 2 or 3"

Test Standard: EN 60034-1 / April 2005
 GL Guidelines for the Performance of Type Approval, V-7.4 part 4, ed. 1999

Documents: Drawing 05-001-93 dated 03.08.2010, DSRK-Approval No. 201 54 134
 Workstandard 07-011131.07a, 111131.07b, 111131.07c, 111131.07d, 111800.200
 Test reports 0312704003/01/01/01.03.09, 2.2.04, in DIN 50408 / EN 10304
 Modification list dated 27.07.00

Remarks: Conditions and remarks of the certificate of conformity issued by PTB and IBEAU
 Freiburg must be observed

Valid until: 2015-08-26

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File No. I.0.03

Hamburg, 2010-08-27

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Certificate No. 98 733 - 95 HH

Certificates of Conformity of Physikalisch-Technische Bundesanstalt PTB and IBEAU Freiburg

Type of motors: Certificates of Conformity

K, 55 ... K, 132	IEB01 02 ATEx 1108 U	Ex II 2 G Ex e II
K, 55	PTB 89 ATEx 3308 or IBEAU 02 ATEx 1108	Ex II 2 G Ex e II T1, T2 or T4
K, 63	PTB 89 ATEx 3309 or IBEAU 02 ATEx 1110	Ex II 2 G Ex e II T1, T2 or T4
K, 71	PTB 89 ATEx 3310 or IBEAU 02 ATEx 1111	Ex II 2 G Ex e II T1, T2 or T4
K, 80	PTB 89 ATEx 3311 or IBEAU 02 ATEx 1112	Ex II 2 G Ex e II T1, T2 or T4
K, 90	PTB 89 ATEx 3312 or IBEAU 02 ATEx 1113	Ex II 2 G Ex e II T1, T2 or T4
K, 100	PTB 89 ATEx 3313 or IBEAU 02 ATEx 1114	Ex II 2 G Ex e II T1, T2 or T4
K, 112	PTB 89 ATEx 3314 or IBEAU 02 ATEx 1115	Ex II 2 G Ex e II T1, T2 or T4
K, 132	PTB 89 ATEx 3315 or IBEAU 02 ATEx 1116	Ex II 2 G Ex e II T1, T2 or T4

Test Standard: EN 60034-1 / April 2005
 GL Guidelines for the Performance of Type Approval, V-7.4 part 4, ed. 1999

Documents: Drawing 05-001-94/1 dated 05.01.1995, DSRK-Approval No. 303 54 134
 Workstandard 07-011131.07a, 111131.07b, 111131.07c, 111131.07d, 111131.07e, 111131.07f
 Test reports 0312704003/01/01/01.03.09, 2.2.04, in DIN 50408 / EN 10304
 Modification list dated 27.07.00

Remarks: None

Valid until: 2015-08-26

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Type Approval Certificate

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Certificate No. 70 072 - 91 HH

Company: VEM motors Thurm GmbH
Juliane-Drewecke-Strasse 35
68868 Zeilkau, GERMANY

Product Description: Induction motors

Type: KPER 80 ... up to KPER 100 ... I KPER 95 ... up to I KPER 132 ...
 IE-KPER 95 ... up to IE-KPER 100 ... I IE-KPER 95 ... up to I IE-KPER 132 ...

Environmental Category: H

Technical Data / Range of Application:
 Size: 80, 90, 100, 112, 132
 K-A-U-V-G-V-G-L-L-V-L-M-L-Z-M-MV-MV-M2-S-S-X
 Rated voltage: up to 230 V
 Rated power: 0.12 kW up to 5.5 kW (max. 11 kW at short time duty)
 Synchronous speed: 750 1/min up to 3600 1/min
 Rated frequency: 50 Hz, 60 Hz
 Ambient temperature: 40 °C
 Duty type: S1
 Insulation class: F
 Degree of protection: IP 54, IP 55, IP 56, IP 65, IP 66
 No. of poles: 2, 4, 6, 8, 10, 12 and combinations
 Spec. model: Marine version
 Description of type: S3 = "1, 2 or 3"

Test Standard: EN 60034-1 / April 2005
 GL Guidelines for the Performance of Type Approval, V-7.4 part 4, ed. 1999

Documents: Drawing 05-001-94/1 dated 05.01.1995, DSRK-Approval No. 303 54 134
 Workstandard 07-011131.07a, 111131.07b, 111131.07c, 111131.07d, 111131.07e, 111131.07f
 Test reports 0312704003/01/01/01.03.09, 2.2.04, in DIN 50408 / EN 10304
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Hamburg, 2010-08-27

Germanischer Lloyd
Wolfgang Voß
Heinz Dieter Hespe

Innovative drives made in Germany

The reduction of CO₂-emission is the big challenge of our time. Thus the reduction of energy consumption is the main topic in many applications. Especially modern speed-controlled electric drives offer the chance to save maximum energy. A solution with remarkable energy efficiency is offered by using permanent magnet synchronous motors (PM motors). They are operated exclusively with frequency inverters and are characterised by a significantly higher efficiency (>IE3) and an improved part load behaviour than asynchronous motors.

In addition PM-motors can reach a higher output than asynchronous motors of the same size. Because of the rotor following exactly the rotating field, PM-motors can be used for example in conveyor belts with several drives that are operated synchronously. All types of constructions and a multitude of modifications of standard motor design are available.

With the three new design series
PM synchronous energy saving motors
PM synchronous high-power motors
PM synchronous torque motors

VEM has entered into technology of permanent magnet synchronous motors. These products combine the established design principles of the series K21R/WE1R with this new technology.

Technical characteristics Synchronous energy saving motors PE1R/PE0R

- Power range 0,09 to 75 kW
- 4-, 6- and 8-pole design
- 750 to 3.000 r.p.m.
- Torque 0,6 Nm to 860 Nm
- Sizes 56 to 315
- Degree of protection IP55
- Thermal class 155 [F/B]

Technical characteristics Synchronous high-power motors P21R/P20R

- Power range 0,25 to 75 kW
- 4-, 6-, 8- and 12-pole design
- 500 to 3.000 r.p.m.
- Torque 0,55 Nm to 700 Nm
- Sizes 56 to 280
- Degree of protection IP55
- Thermal class 155 [F/B]

The application range and usage of this new design series is comparable to asynchronous motors for pumps, ventilators, compressors and process technology.

Advantages

- Highest energy efficiency
- Approved robust and low-vibration grey cast iron design
- Compact design with minimised dimensions
- Low-noise operation
- Modern modular system complying with series K21R/K22R
- Colour systems for climate groups „moderate“ and „world wide“ according to IEC 721-2-1
- High operational reliability by modern production technologies

Technical characteristics Synchronous torque motors P2.F/P2.B

- Power range 12 to 471kW
- 12-pole design
- 200 to 600 r.p.m.
- Torque 573 Nm to 7.500 Nm
- Sizes 200 to 355
- Degree of protection IP55
- Thermal class 155 [F/B]

The motors comply with the relevant national and international regulations.

Design, construction, production and test are done according to the requirements of DIN ISO 9001 and are certified by German Lloyd Certification GmbH.

The products contained in this printed information are also listed in the interactive electronic catalogue of the VEM group, edition V 7.0 and newer.

More information about the company and the products of the VEM group can be found in the internet: www.vem-group.com

Technical explanations

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Standards and regulations

The motors comply with the relevant standards and regulations, particularly with the following:

Title	EN / DIN VDE	IEC
Rotating electrical machines, rating and performance	EN 60034-1	IEC 60034-1 IEC 60085
Efficiency classes of single-speed, three-phase, cage induction motors		IEC 60034-30
Rotating electrical machines, methods for determining losses and efficiency	DIN EN 60034-2-1	IEC 60034-2-1
Three-phase asynchronous motors for general use, with standardised dimensions and outputs, frame sizes 56 – 315	EN 50347	IEC 60072
Terminal markings and direction of rotation for rotating electrical machines	EN 60034-8	IEC 60034-8
Rotating electrical machines, symbols for types of construction and erection	EN 60034-7	IEC 60034-7
Built-in thermal protection	-	IEC 60034-11
Rotating electrical machines, methods of cooling	EN 60034-6	IEC 60034-6
Rotating electrical machines, degrees of protection	EN 60034-5	IEC 60034-5
Rotating electrical machines, mechanical vibrations	EN 60034-14	IEC 60034-14
Rotating electrical machines, noise limits	EN 60034-9	IEC 60034-9
Rotating electrical machines, starting performance of induction cage motors up to 660 V, 50 Hz	EN 60034-12	IEC 60034-12
IEC standard voltages	-	IEC 60038

VEM motors conform furthermore to various foreign regulations which are aligned to IEC 60034-1 or else have taken over the latter's stipulations as European standard EN 60034-1.

Rating plates

In standard design, the motor rating plate is normally marked in the German and English languages.

Other languages may be used with non-EU languages available against extra price.

The rating plate indicates the most important design data such as type designation and motor number, output, rated voltage and frequency, rated current, type of construction, degree of protection, power factor, speed, thermal class.

For PM motors this information is extended with data necessary for inverter parameterisation (e.g. rating plate for inverter parameterisation for FC302/Danfoss).

The data may vary according to type. In the case of motors with relubricating device, the quantity of grease per lubrication event and the relubricating intervals are also indicated on the rating plate or an additional plate. The rating plates are fastened on the housing with grooved drive studs and cannot be lost. They may be made of aluminium or stainless steel (extra price).

Dimensions and types of construction

The motors are available in types of construction IM B3, IM B35 and IM V1 and related types taking into account all constraints valid for the basic design.








Ambient temperature

The standard versions of all VEM motors are suitable for use under ambient temperatures from -20°C to +40°C. The motors can be used at ambient temperatures as low as -40°C, but they have to be ordered accordingly.

If frequent moisture condensation is to be expected at the place of installation of a motor, we recommend the use of anti-condensation heating devices or other appropriate precautions.

Rated output

The rated output applies to continuous operation as specified in DIN EN 60034-1, related to a coolant temperature of 40°C and an altitude of ≤ 1000 m above sea level.

	VEM motors GmbH D 38855 Wemigerode Made in Germany			Th.cl. 155(F/B)
				IP 55 1530 kg
	Synchronmotor mit Permanentmagnetläufer / Permanent magnet synchron motor			IEC/EN 60034-1
	PE1R 132M 4 KR NS TWS WE	3-Mot.N ^o		181449/0001 F
				IM B5
	U	f	n	M
	V	Hz	r.p.m.	Nm
	Nominal 347 Y 50 1500			42,8 7,5 13,3 0,99
	Max. 229 V L 8,46 mH R 120 0,482 Ω J 0,024 kgm ²			
	U P020 (1000 min ⁻¹)			
	Fett/Grease Staburags NBU 8EP			
	DE 3308 C3 DIN 625	26 cm ³	4000 h	
	NE 6308 C3 DIN 625	17 cm ³		04.10

Rated voltage and frequency

In the basic version, motors are supplied for mains power systems with 400 V and 50 Hz (complies with inverter input voltage). The motors can only be operated in connection with a frequency inverter.

Rated voltage and frequency will be adjusted to the technical requirements of the drive. The rated voltage (fundamental wave output voltage) of the PM synchronous motors is always smaller than the mains voltage. The rated frequency complies with the required rated speed.

Motor torque

The design torque in Nm given at the motor shaft will be

$$M = 9550 \cdot \frac{P}{n}$$

where P = design output in kW
n = speed in rpm

Type designation

P	E	1	R	160	M	X	4	KTY
1	2	3	4	5	6	7	8	9

1	Design version P ... Permanent magnet synchronous motor
2	Design condition 2 ... Series 2 E ... Energy saving motor
3	Standard characteristic number 0 ... IEC, progressive design series 1 ... DIN design 2 ... Transnorm design, IEC
4	Degree of cooling R ... Fin cooled, IC 411 F ... Forced-air cooled, IC 416 B ... Water cooled, IC 31W
5	Shaft height in mm 56, 63, 71, 80, 90, 100, 112, 132, 160, 180, 200, 250, 280, 315, 355
6	Foot length K ... small G ... large S ... short M ... medium L ... long
7	Symbols for different output X, Y, Z ...
8	Pole number 4, 6, 8, 12
9	Special designs KTY ... Temperature detector KTY ... for further symbols refer to Modifications summary Base catalogue 01-2010

Motor protection

The following variations of motor protection are possible, if ordered:

- motor protection with thermistor temperature sensors in the stator winding
- bimetal temperature sensor as opener or closer in the stator winding
- silicon diodes KTY
- resistance thermometer to monitor winding or bearing temperature
- bearing vibration diagnosis

Bearings/bearing lubrication

VEM motors are equipped with anti-friction bearings from respected manufacturers. The rated bearing lifetime is at least 20,000 h with the exploitation of the maximum permissible load. The rated bearing lifetime for motors installed in a horizontal position without additional axial loading is 40,000 h in the case of coupling service.

The versions fixed bearing at N-end, without fixed bearing (floating bearing arrangement), permanent lubrication, relubrication device, heavy bearing on D-end (for increased lateral forces), easy bearing arrangement and the bearing schedules disk spring or wave washer types, V-ring types and figures of bearing arrangement can be taken from the overviews of the bearing arrangements.

The respective flat grease nipples are contained in the tables of the design drawings. Motors in the normal versions with two deep groove ball bearings have preloaded bearings, where the preloading is implemented by a disk spring or a wave washer. Versions with cylindrical roller bearings on the D-end (heavy bearing arrangement VL) are excepted from the preloading. The "fixed bearing N-end" version is possible in the case of motors without a "fixed bearing". Fixed bearing at D-end possible on request.

The most important prerequisite for achieving the normal bearing lifetime is correct lubrication, i.e. the use of the right kind of grease according to the application, the filling with the correct amount of grease and the maintenance of the subsequent relubrication periods.

The frame sizes 56 to 160 are equipped with life-lubricated bearings. These bearings are to be changed promptly in accordance with the usable grease life.

In the case of motors from size 180, the bearings must be relubricated promptly in accordance with the usable grease life. Under normal operating conditions, the lubrication filling will allow 10,000 operating hours for the 2-pole version and 20,000 operating hours for the 4-pole version without relubrication.

Under normal service conditions, for version with relubrication device, 2,000 or 4,000 operational hours will apply. A grease of type KE2R-40 as specified in DIN 51825 will be used as standard grease. The used grease is to be removed from the lubrication chamber in the external bearing cover after five relubrications.

A change of bearings is only possible when using suitable equipment. The best solution is to ask an authorized service centre (see also installation, operation and maintenance manual). Information about bearing sizes, grease types and quantities and times for relubrication are to be taken from an additional plate attached to the motor.

Bearing monitoring

The motors can be prepared for equipment of or equipped with temperature detectors, shock pulse and vibration detectors for bearing monitoring. PT100 can be fitted on the bearings as temperature sensors.

They can be designed in 2-, 3- or 4-wire circuit. The connection is either done in the main terminal box or in a separate auxiliary terminal box that is fixed at the main terminal box or on the motor housing depending on the design. For wear monitoring of the anti-friction bearings it is possible for size 132 and bigger to install shock pulse sensors (SPM) at the end shields. Thus a monitoring with mobile recorders is possible. For remote monitoring it is also possible to use permanently wired shock pulse or vibration sensors.

Use of insulated bearings

Magnetic unbalances induce a voltage in the shaft of the motors. This shaft voltage results in equalising currents between rotor and stator leading through the bearings. If the voltage rises above a limit value of 500 mV, bearings can be damaged. Because of the design this value will not be exceeded in any case for VEM standard motors at mains operation. However these effects can be amplified by frequency inverter operation, whereas the design of the inverter is one of the most important influences. Pulse inverters generate especially high frequency voltages and currents depending on the pulse frequency and the pulse modulation. Output filters in the inverter minimise these effects.

To avoid bearing damages motors in size 315 and above are fitted with insulated bearings on N-end as standard.

Winding and insulation

VEM motors of design series P2../PE... are produced in thermal class 155 [F] as standard. High quality enamelled copper wires and insulation materials combined with an impregnation treatment based on low-solvent varnish are used. These materials offer a high mechanical and electrical strength and guarantee a long life time of the motors. A design in thermal class 180 [H/F] is available (additional charge).

Inverter supply means higher voltage loads for the motor winding than sinusoidal mains supply. Therefore the winding insulation of the motor must be selected according to the following information:

Series	Size	Max. permitted values	
		U	du/dt
		[V]	[kV/μs]
PE../P2..	56-132T	≤ 1,000	≤ 0.5
	56-132T acc. to Sp.2945	≤ 1,350	≤ 1.0
	132[P20. 112] to 355	≤ 1,350	≤ 1.5
PU1./PU0.	56-132T acc. to Sp.9382	≤ 1,560	≤ 3.0
	132 [PU0. 112] to 355	≤ 1,850	≤ 5.0
PV1./PV0.	132[PV0. 112] to 355	≤ 2,500	≤ 5.0

Motors for inverter operation in VIK design (VIK 04.2005)

Output voltages at the inverter ≤ 690 V

According to VIK recommendation 04.2005, no. 6.7 / NAMUR recommendation NE38, motors are permitted to be operated with a maximum peak voltage of 1,350 V complying with DIN IEC 60034-17 and a voltage rise time du/dt of 1.5 kV/μs at the motor terminals. Higher peak voltages must be agreed separately. This means VIK motors for inverter operation are produced in design PE.../P2.. if no other voltage peak values are agreed. It is not allowed to use permanent magnet motors in zone 2.

Wiring, grounding and EMC

All motors must be connected with shielded, symmetric cables and EMC cable glands (glands with 360°-shield contacting) to assure a proper grounding and design complying with the EMC regulation. The 360° grounding has to be done for all cable entries according to the product related information for the cable glands. It must be assured to have the best available potential equalisation between motor housing and inverter. Thus it is prevented to induce a grounding current through the motor shaft in the working machine.

Types of construction

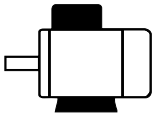
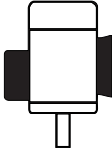
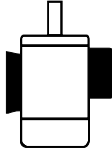
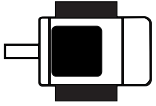
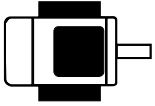
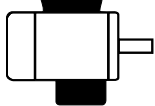
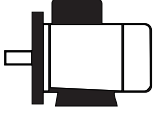
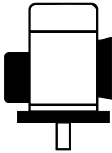
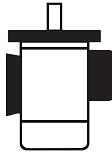


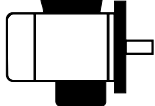
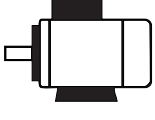
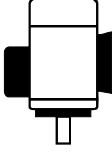
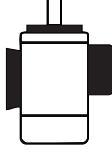
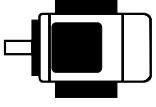
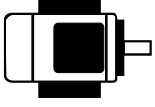
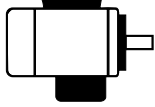
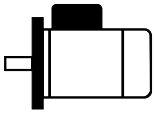
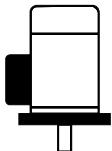
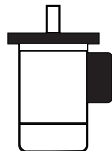
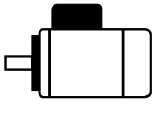
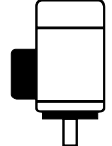
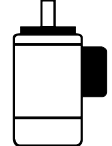
The most frequently used types of construction are shown in the following table. Other types of construction on request. The type of construction is designated on the nameplate according to Code I, DIN EN 60034-7. Standard motors in sizes 56 – 200 that are ordered in the basic types of construction can also be used in the following other types of construction:

- IM B3 in IM B5, IM B7, IM B8 und IM V6
- IM B35 in IM 2051, IM 2061, IM 2071 und IM V36
- IM B34 in IM 2151, IM 2161, IM 2171 und IM2131
- IM B5 in IM V3
- IM B14 in IM V19

Motors of types IM V5, IM V1 or IM V18 may optionally be fitted with a protective roof to prevent smaller parts from falling into their interior. For types with the shaft end pointing upward the user must provide a suitable covering to prevent smaller parts from falling into the fan cover.

The cooling air flow must not be obstructed by the covering. As from frame size 225, consultation with the manufacturer will be necessary for the types IM V5, IM V6, IM B6, IM B7 and IM B8. In the frame size range as of 315L, the types IM B5 and IM V3 are not available.

Overview of types of construction

Basic types of construction	Derived types of construction				
IM B3 IM 1001	IM V5 IM 1011	IM V6 IM 1031	IM B6 IM 1051	IM B7 IM 1061	IM B8 IM 1071
					
IM B35 IM 2001	IM V15 IM 2011	IM V36 IM 2031	- IM 2051	- IM 2061	- IM 2071
					
IM B34 IM 2101	- IM 2111	- IM 2131	- IM 2151	- IM 2161	- IM 2171
					
IM B5 IM 3001	IM V1 IM 3011	IM V3 IM 3031			
					
IM B14 IM 3601	IM V18 IM 3611	IM V19 IM 3631			
					

Design version

Shaft height	Series	Material for Housing End shields Feet	Foot mounting
63 to 132T	P.1R	Grey cast iron	bolted on
100 LX	P.1R		cast on
132 to 280	P.1R		bolted on
315, 355	P2.R		cast on
56 to 100	P20R		cast on
112 to 250	P20R		bolted on
280 to 315	P20R		cast on

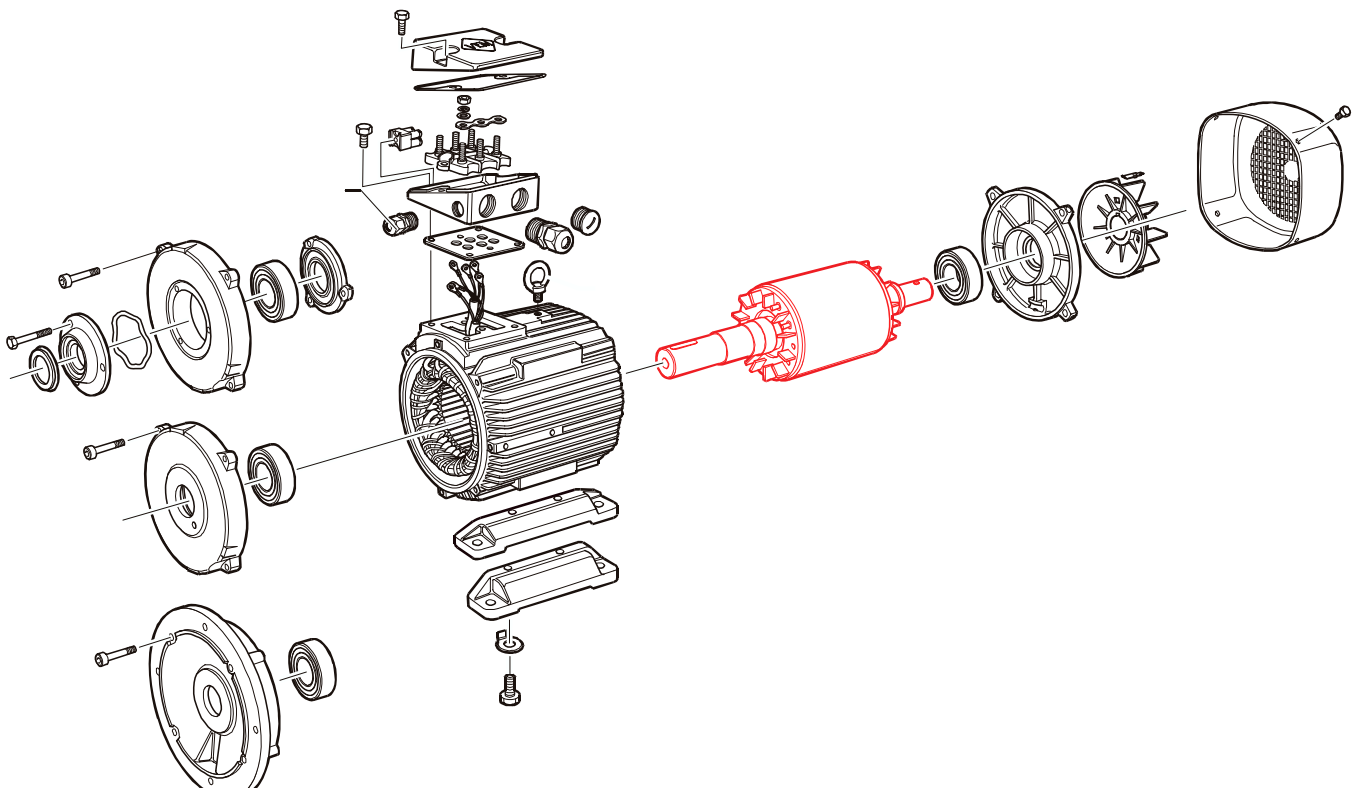


Figure 1: principle design of PM motor



Figure 2: principle design of PM motor

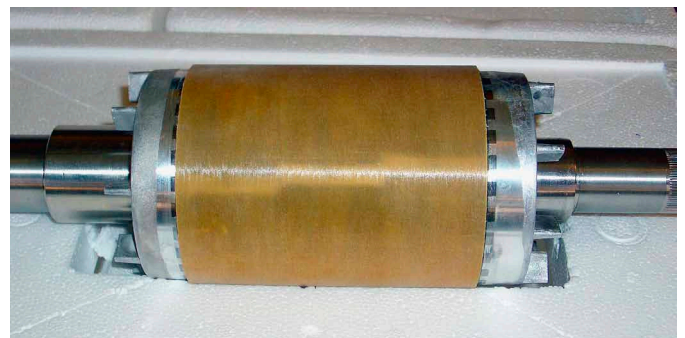


Figure 3: PM rotor complete, with bandage

From the outside PM motors don't differ from asynchronous motors (ASM). The design is based on the robust and reliable VEM standard motors in grey cast iron housing. The stator complies with the basic series K2.R. In addition the squirrel

cage of the ASM is used as basis for the magnet wheel (rotor). The rotor body of the squirrel cage motor is turned after die casting, then the neodymium magnets are fixed by gluing and afterwards they will be bandaged (see figure 2 and 3).

Cooling and ventilation

The motors are equipped with radial plastic or aluminium alloy fans, which cool independently of the direction of rotation of the motor (IC 411 as specified in DIN EN 60034-6).

Attention is to be paid that a minimum distance of the fan cover from the wall is maintained (dimension B1) when the motor is being installed.

Hints for calculation of drive design and for operation of motors in connection with frequency inverters

Motors are only one part of a complex electric drive system. However a poor design of the drive system will mainly show in motor operation, whereas a faulty parameterisation will be noticed at the mechanical transmission elements like couplings and belt drives. Modern inverters mostly protect themselves and the motor against thermal overload. But unacceptable high voltage peaks at the motor terminals will not be recognized. The drive can have problems if the output circuit is missing at the inverter and/or the cables are too long. In addition this often results in serious damage of the motor insulation.

There are several options to optimise the drive system:

- Output filter circuits at the inverter (choke, du/dt filters or sine filters)
- Motor with reinforced insulation system
- Combination of both options

The planning of whole drive systems is bound to the knowledge of the interaction of all used components.

The planning engineer has to select the different components very carefully. It is mainly his responsible decision that, at the motor terminals, the permissible voltages are not exceeded. This includes also the decision about the motor insulation system, always taking the effects of the other components into account.

Examples for drive components having decisive influences on the motor insulation system:

Motor cable

(Length, type, wiring, shielding, etc.)

Long motor cables can induce unacceptable pulse voltages at the motor terminals. The impact of long motor cables can be reduced by the following components that are directly attached to the output of the inverter, so that the values can be reduced:

Output chokes

reduce the capacitive recharging currents for long cables. Due to the shape of the output voltage of the inverter, capacitance components have particularly for long lines a negative effect. The cable capacitances result in recharging currents that the inverter has to produce additionally. The total current (motor current and recharging current) can become very high, for long motor lines (an for the operation of several motors), that the peak output current is exceeded. In such a case, the inverter shuts off with the message "over-current".

When using the shielded cable, required for the observance of the electromagnetic compatibility (EMC), the critical cable length is further reduced due to the fact that the shield forms, together with the power cables, additional capacitances. The chokes reduce the recharging current it must be located directly at the inverter output, to lower the switching loss in the inverter. The output choke reduces, with the cable capacitances, the rise speed at the motor terminals, the voltage spikes are minimised.

du/dt-Filter

By the high switching frequencies, resulting from the very short switching periods, voltage spikes of up to 5 kV/μs are produced. These spikes are shortening the lifetime of the motor insulation system. Using a du/dt filter, the rise speed of the voltage can be limited below 500 V/μs, and the voltage peaks decrease to values below 1.000 V. If the voltage strength of the motor insulation system is unknown or the motor cables are very short, a du/dt filter should be used. For very long lines it could be required to implement additionally to the du/dt filter one or two chokes.

Sine filter

modulate the non-sinusoidal output voltage of the inverter into a sinusoidal motor voltage. The advantages of sine filters base on a significant improve of the harmonic distortion factor of the voltage (near to sine shape). A specific insulation system is not necessary. The true running is improved, the motor loss and the magnetic noise is reduced.

Sine filters have the general disadvantage that there is a voltage drop that could not be neglected. The output voltage at the filter could be reduced as much as 15%, i.e. the edge frequency of the inverter has to be decreased by about 15% resulting possibly in a larger motor, or the motor winding has to be adapted to the reduced feeding voltage.

Motor limits for continuous operation

The planning of variable speed drives prerequisites both the knowledge about the torque or the output along the speed of the driven machine, and also for the motor itself. Within the speed range below the nominal motor speed, the torque for the continuous operation (limit torque) must be observed, and for speed above the nominal motor speed, the reduced break-down torque must be taken into account.

The provided torque depends both on the motor (design, cooling method, etc.) and the inverter (parameters, pulse frequency, modulation procedure, output circuitry).

Adjustable drive systems with permanent magnet synchronous motors

Permanent magnet synchronous motors can be use in every application where machines are driven with variable speed. As for separately excited synchronous motors a direct start from the mains is not possible for permanent magnet synchronous motors. PM synchronous motors must only be operated in connection with a frequency inverter.

As a PM synchronous motor with field-oriented control has the same characteristics as a DC motor, the PM motor was almost exclusively used in demanding applications for controlled drives because of the missing brushes (lower maintenance costs). Today PM synchronous motors are use also in application ranges where efficiency is very important. As the efficiency is very high in full load and part load operational range, this kind of drive is economically advantageous for working machines with a quadratically declining torque characteristic (e.g. pump drives)

PM synchronous motors fulfil the requirements for efficiency class IE3 without additional expenses for motor mass. Because of this effect of double savings

- High efficiency in operation (reduction of energy consumption) and
- Reduction of material (copper, grey cast iron, aluminium, etc.) at the production (compared to asynchronous motors)

is a drive with PM synchronous motor a sustainable investment for the future.

Special features of the calculation of a controlled drive system with PM synchronous motor:

PM synchronous motors are excited by permanent magnets. That means the strength of the exciting field is determined when calculating the design of the motor. It remains constant. A PM synchronous motor has therefore no field weakening operation as is known for asynchronous motors. In the whole speed control range (condition: rated speed = maximum speed) the induced voltage is proportional to the speed. If a suitable inverter is used, a limited field weakening range can be realised by changing one component of the current.

In PM synchronous motors the standard correlation of rated speed to motor pole number and rated frequency (mainly 50 Hz or 60 Hz) is not necessary anymore. The optimum adjustment of the motor to the working machine or the process requirements and the output voltage of the inverter is possible without any problems.

As example the rated speed of 3,000 r.p.m. is realised by a 4-pole PM synchronous motor with a winding of 100 Hz. 2-pole PM synchronous motors are not available in our production range. On the other hand lower rated speeds (e.g. 1,200 r.p.m or 900 r.p.m.) can be realised with smaller rated frequencies. PM synchronous motors can transfer very high overload torques. They must only be designed accordingly and the inverter must be able to transfer the necessary peak currents for the required amount of time.

As option PM synchronous motors can also be supplied with resolver. Thus we are able to detect exactly the speed of the magnet wheel and its position in the stator. By means of a field-oriented control we are than able to realise drives that require for example very high accuracy of synchronised speed and constant torque. It might be necessary to use a brake resistance to protect the inverter at high moments of inertia and fast speed changes.

The motors are also available as drive unit with frequency inverter. There are some benefits for the customer:

- Pre-parameterised unit
- Radio interference suppression grade complying with EN 55011 class A1 up to 150 m shielded cable length
- Radio interference suppression grade complying with EN 55011 class B1 up to 50 m shielded cable length
- Integrated braking chopper
- Mains input voltage 380 ... 500 V +/- 10%, 50/60 HZ

What information must be contained in a motor inquiry?

If a controlled asynchronous motor is exchange with a comparable PM synchronous motor the information remain the same (e.g. for drives with quadratically decreasing torque characteristic). A 2-pole design is not available. Instead a 4-pole motor with 100 Hz winding is used.

For the best possible design and optimum quotation of a PM synchronous motor the manufacturer will need the following information:

- Mains voltage, mains frequency

For determination of pole number and torque/output:

- Required torque of the working machine in the adjusting speed range

Because of the limited field-weakening range a value for maximum speed shall be selected that is equal to the rated speed. Alternatively the adjusting speed range must be stated, in which the motor is operated with constant output.

Motors with forced ventilation:

- Information about the time period of loading in the lower speed range (below 50% of the rated speed) for drives with constant torque
- Required thermal reserve
- (F/B, F/90K or H/F)
- Maximum cooling air temperature, if deviating from +40°C
- Maximum height of installation if it is above 1,000 m
- Overload requirements and – periods

For determination of winding insulation

- Maximum pulse voltages at the motor terminals of the installed motor (if necessary information about the use of output chokes or filters)

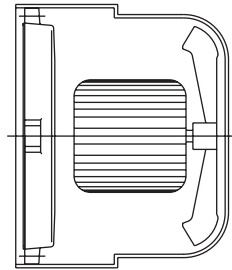
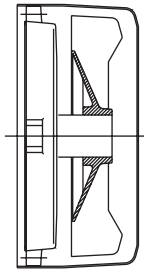
Start of operation and parameterisation of the inverter

The start of operation and the parameterisation of the inverter must be done according to the installation manual and the manual for parameterisation of the inverter manufacturer.

Modular design of motor series and modifications

The design concept of the series permits the option of adding components to solve modern control tasks, such as a pulse

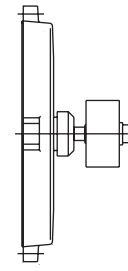
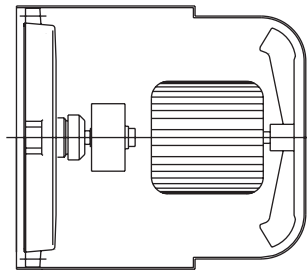
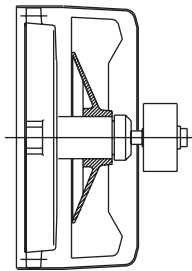
generator, a tacho generator, brakes, a speed monitor and forced-ventilation units according to the customer's need.



Standard version
Cooling method IC 411, Self-ventilation

Special version
Cooling method IC 416, Forced-ventilation

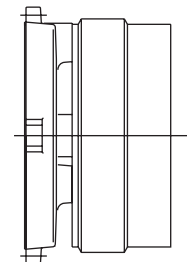
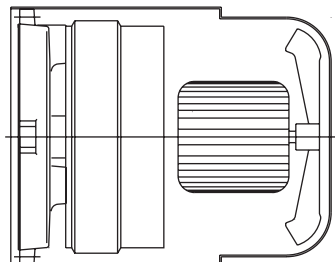
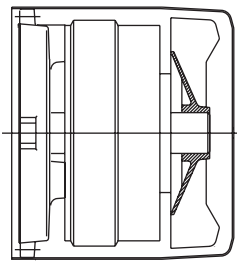
Special version
Cooling method IC 410, Non-ventilated



Special version
Cooling method IC 411, Self-ventilation,
With built-on incremental sensor

Special version
Cooling method IC 416, Forced-ventilation,
With built-on incremental sensor

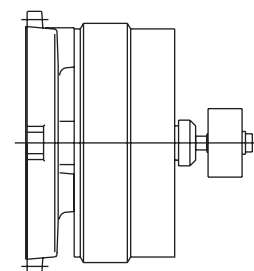
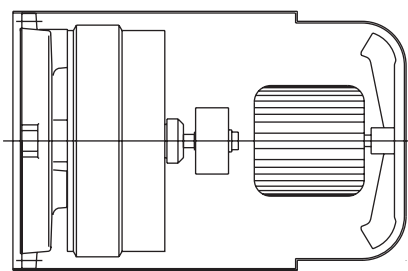
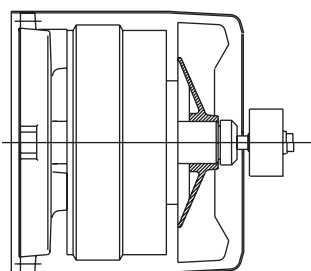
Special version
Cooling method IC 410, Non-ventilated,
With built-in incremental sensor



Special version
Cooling method IC 411, Self-ventilation,
With built-on brake

Special version
Cooling method IC 416, Forced-ventilation,
With built-on brake

Special version
Cooling method IC 410, Non-ventilated,
With built-on brake



Special version
Cooling method IC 411, Self-ventilated,
With built-on brake and incremental
sensor

Special version
Cooling method IC 416, Forced-ventilation,
With built-on brake and incremental
sensor

Special version
Cooling method IC 410, Non-ventilated,
With built-on brake and incremental
sensor

Fits

Shaft ends

Shaft ends	up to Ø 48 starting from Ø 55	k6 m6
Matching part		H7

Tolerances

Electrical parameters

The following tolerances are permitted as specified in DIN EN 60034-1:

Efficiency (when determined indirectly)	- 0.15 (1- η) for ≤ 150 kW - 0.1 (1- η) for $P_N > 150$ kW
Power factor	$\frac{1-\cos \varphi}{6}$ min. absolute value 0.02 max. absolute value 0.07
Total losses (used for machines with rated output ≥ 150 kW)	+ 10%
Slip (at standard load in warmed-up state)	± 20 % for $P_N \geq 1$ kW ± 30 % for $P_N < 1$ kW
Starting current (in the planned starting connection)	+ 20 % without lower limit
Starting torque	- 15 % and + 25 %
Pull-up torque	- 15 %
Pull-out torque	- 10 % (after application of this tolerance M_K/M still at least 1,6)
Moment of inertia	± 10 %
Noise level (measurement area – sound intensity level)	+ 3 dB (A)

Tolerances – Mechanical parameters

Letter codes	Meaning of the dimension	Fit or tolerance
acc. to DIN EN 50347		
B [a]	Spacing of feet fixing holes in axial direction	± 1 mm
P [a ₁]	Diameter or width across corners of flange	- 1 mm
A [b]	Spacing of feet fixing holes across axial direction	± 1 mm
N [b ₁]	Diameter of centring flange	h6
D, DA [d, d ₁]	Diameter of the cylindrical shaft end	m6
M [e ₁]	Pitch circle diameter of the mounting flange	$\pm 0,8$ mm
AB [f], AC [g]	Largest width of the motor (without terminal boxes)	+ 2 %
H [h]	Shaft height (lowest edge of foot to centre of shaft end)	- 1 mm
L, LC [k, k ₁]	Total length of the motor	+ 1 %
HD [p]	Total height of the motor (lowest edge of foot)	+ 2 %
K, K' [s, s ₁]	Diameter of the mounting holes of the foot or flange	+ 3%
GA, GC [t, t ₁]	Lowest edge of shaft end to the upper edge of the key	+ 0,2 mm
F, FA [u, u ₁]	Width of the key	h9
C, CA [w ₁ , w ₂]	Distance from the centre of the first foot mounting hole to the shaft shoulder or flange face	$\pm 3,0$ mm
	Distance from the shaft shoulder to the flange face in the case of fixed bearing on D-end	$\pm 0,5$ mm
	Distance from the shaft shoulder to the flange face	$\pm 3,0$ mm
m	Motor mass	- 5 to +10 %

Taking necessary manufacturing tolerances and deviations in materials in the case of the raw materials used into account, these tolerances are permitted for three-phase asynchronous motors. The following remarks are given in the standard:

1. A guarantee of all or any of the values as specified in the table is not mandatory. Guaranteed values to which the permissible deviations should apply must be specified expressly in tenders. The permissible deviations must comply with the table.
2. Attention is drawn to the differences in the interpretation of the concept of a "guarantee". In some countries, there is a differentiation between typical and declared values.
3. If a permissible deviation only applies in one direction, the value will not be limited in the other direction

Bearings

Permanent magnet synchronous motors for inverter operation
Basic design (light bearing arrangement LL)

Type	Bearing D-end	V-Ring	Y-Ring	Felt ring	Wave washer	Disk spring	Bearing N-end	V-Ring	Wave washer	Felt ring	Figure	
											DS	NS
P.1R 63	6201 2Z C3	-	-	11.5x19	-	-	6201 2Z C3	-	32	12x22	1	2
P.1R 71	6202 2Z C3	-	-	14.5x21	-	-	6202 2Z C3	-	35	15x24	1	2
P.1R 80	6204 2Z C3	-	-	19.5x26	-	-	6204 2Z C3	-	47	20x32	1	2
P.1R 90	6205 2Z C3	-	-	24.5x35	-	-	6205 2Z C3	-	52	25x40	1	2
P.1R 100	6206 2Z C3	-	-	29.2x40	-	-	6205 2Z C3	-	52	25x40	1	2
P.1R 100 LX	6206 2Z C3	-	-	29.2x40	-	-	6206 2Z C3	-	62	30x50	1	2
P.1R 112	6206 2Z C3	-	-	29.2x40	-	-	6206 2Z C3	-	62	30x50	1	2
P.1R 132 S4T	6208 2Z C3	-	-	39x60	-	-	6206 2Z C3	-	62	30x50	1	2
P.1R 132 S, M6, 8	6208 2Z C3	-	-	-	80	-	6207 2Z C3	-	-	-	6	8
P.1R 132 M4, MX6	6308 2Z C3	-	-	-	90	-	6308 2Z C3	-	-	-	6	8
P.1R 160 M, MX8	6309 2Z C3	-	-	-	100	-	6308 2Z C3	-	-	-	6	8
P.1R 160 L	6310 2Z C3	-	-	-	110	-	6309 2Z C3	-	-	-	6	8
P.1R 180 M4, L6, 8	6310 2Z C3	-	-	-	110	-	6309 2Z C3	-	-	-	6	8
P.1R 180 L4	6310 C3	50A	-	-	-	-	6310 C3	50A	-	-	6	8
P.1R 200 L, LX6	6312 C3	60A	-	-	-	130	6310 C3	50A	-	-	6	8
P.1. 225 S, M	6313 C3	65A	-	-	-	140	6312 C3	60A	-	-	6	8
P.1. 250 S, M	6314 C3	70A	-	-	-	150	6313 C3	65A	-	-	6	8
P.1. 280 S, M	6316 C3	80A	-	-	-	170	6314 C3	70A	-	-	6	8
P21. 315 S, M	6317 C3	80A	-	-	-	180	6316 M C3 VL 0241	80A	-	-	6	8
P21. 315 MX	6220 C3	-	RB100	-	-	180	6316 M C3 VL 0241	80A	-	-	13	16
P21. 315 MY, L, LX	6320 C3	-	RB100	-	-	180	6317 M C3 VL 0241	85A	-	-	18	19
P22. 355	6324 C3	-	RB120	-	-	260	6317 M C3 VL 0241	85A	-	-	18	19

missing values in preparation

Special design (heavy bearing arrangement VL)

Type	Bearing D-end	V-Ring	Y-Ring	Bearing N-end	V-Ring	Figure	
						DS	NS
P.1R 132 S, M6, 8	NU 208 E	40A	-	6207 2Z C3	-	4	10
P.1R 132 M4, MX6	NU 308 E	40A	-	6308 2Z C3	-	4	10
P.1R 160 M, MX8	NU 309 E	45A	-	6308 2Z C3	-	4	10
P.1R 160 L	NU 310 E	50A	-	6309 2Z C3	-	7	10
P.1R 180 M4, L6, 8	NU 310 E	50A	-	6309 2Z C3	-	7	10
P.1R 180 L4	NU 310 E	50A	-	6310 C3	50A	7	9
P.1R 200 L, LX6	NU 312 E	60A	-	6310 C3	50A	7	9
P.1. 225 S, M	NU 313 E	-	RB65	6312 C3	60A	7	9
P.1. 250 S, M	NU 314 E	-	RB70	6313 C3	65A	7	9
P.1. 280 S, M	NU 316 E	-	RB80	6314 C3	70A	7	9
P21. 315 S, M	NU 317 E	-	RB85	6316 M C3 VL 0241	80A	7	9
P21. 315 MX	NU 2220 E	-	RB100	6316 M C3 VL 0241	80A	15	16
P21. 315 MY, L, LX	NU 320 C3	-	RB100	6317 M C3 VL 0241	85A	20	19
P21. 355	NU 324 C3	-	RB120	6317 M C3 VL 0241	85A	20	19

Notes:

≤ 132T without fixed bearing, from size 132 fixed bearing on N-end as standard

For vertical types of construction ≥ 315MY: Q317 C3, figure 20, 21

≥ 315 insulated bearing as standard on N-end (vertical types of construction with Q-bearing, insulated bearing D-end)

≥ 315MX relubrication device as standard

Bearing arrangement

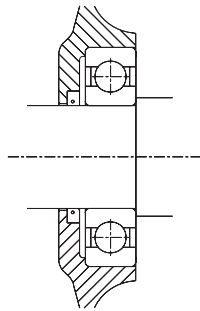


Figure 1

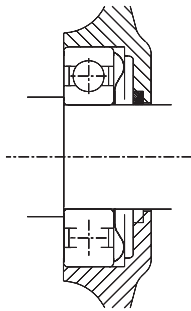


Figure 2

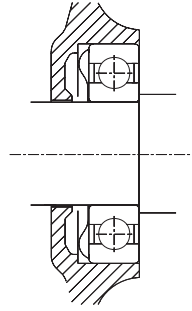


Figure 3

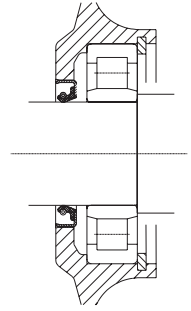


Figure 4

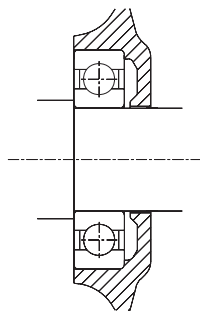


Figure 5

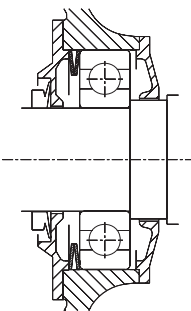


Figure 6

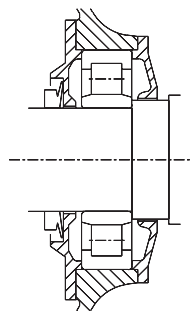


Figure 7

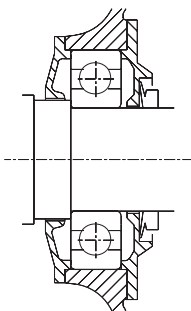


Figure 8

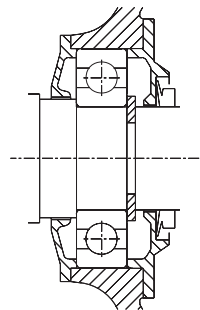


Figure 9

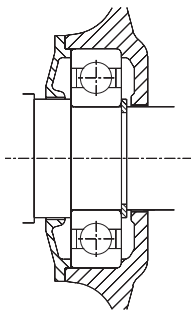


Figure 10

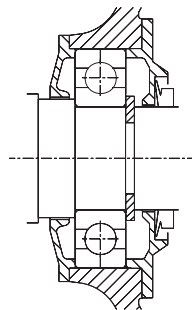


Figure 11

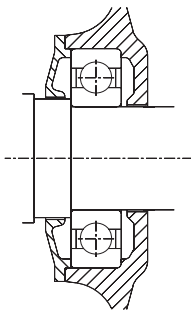


Figure 12

Bearing arrangement

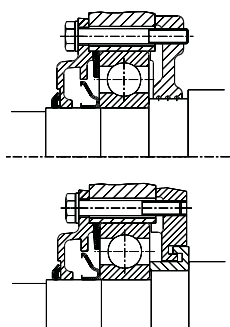


Figure 13

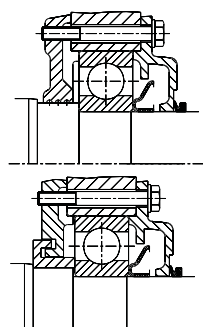


Figure 14

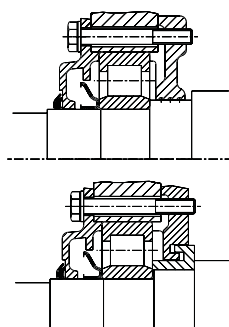


Figure 15

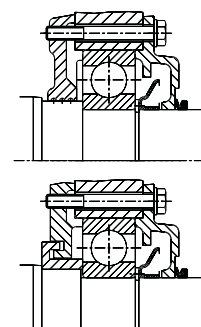


Figure 16

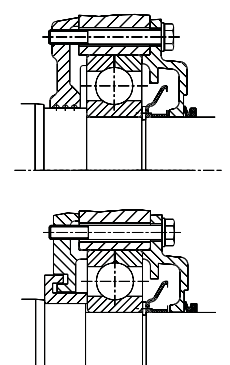


Figure 17

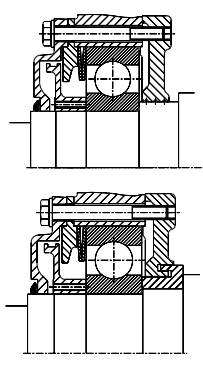


Figure 18

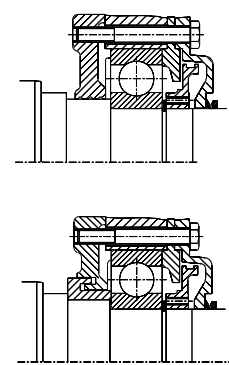


Figure 19

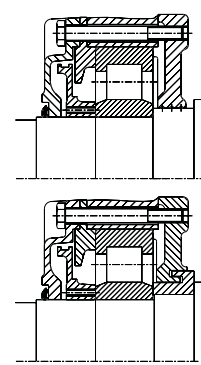


Figure 20

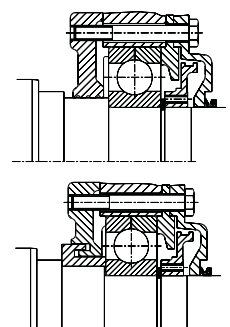


Figure 21

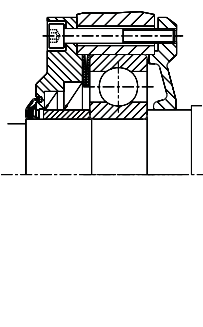


Figure 22

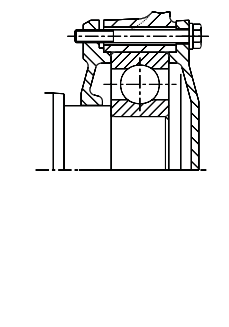


Figure 23

Permanent magnet synchronous energy saving motors for inverter operation

with surface cooling, type of cooling IC 411
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

		Rated speed	Rated frequency	Rated output	Torque	max. torque (2 min)	Voltage	Efficiency η	Power factor	Rated current	Phase resistance at 20°C	No load voltage at speed 1000 r.p.m.	Magnetising inductance	Leakage inductance	Magnetising reactance	Leakage reactance	Motor moment of inertia	Motor mass		
				[kW]	[Nm]		[V]	[%]	[-]	[A]	R_{120}	U_{P020}	L_{1H}	$L_{1\sigma}$	X_{1H}	$X_{1\sigma}$	J	m		
											[Ω]	V/1000 r.p.m.	[mH]	[mH]	[Ω]	[Ω]	kgm ²	kg		
PE1R 63 K4	PE0R 56 K4	3,000 r.p.m.	100 Hz	0.18	0.6	2.5	335	80	0.99	0.35	32	100	60	28	37.7	17.59	0.00019	4.8		
PE1R 63 G4	PE0R 56 G4			0.25	0.8	3.5	320	81.5	0.99	0.5	18	105	105	42	18	26.39	11.31	0.00024	5.2	
PE1R 71 K4	PE0R 63 K4			0.37	1.2	4	300	81	0.99	0.8	13.5	95	95	37	15	23.25	9.42	0.0004	6.8	
PE1R 71 G4	PE0R 63 G4			0.55	1.8	7	320	83	0.99	1.1	8.5	105	105	31	10	19.48	6.28	0.0005	7.8	
PE1R 80 K4	PE0R 71 K4			0.75	2.4	10	335	81.6	0.99	1.6	4.6	110	110	25	8	15.7	5	0.00087	10.6	
PE1R 80 G4	PE0R 71 G4			1.1	3.5	14	330	86.4	0.99	2.25	2.8	105	105	18	5	11.3	3.1	0.00107	11.7	
PE1R 90 S4	PE0R 80 K4			1.5	4.8	19	315	88	0.99	3	14	105	105	12	3	7.54	1.88	0.00207	15.5	
PE1R 90 L4	PE0R 80 G4			2.2	7	28	280	88.1	0.99	5.2	0.8	90	90	5	1	3.142	0.63	0.0026	18	
PE1R 100 L4	PE0R 90 L4			3	9.5	45	320	92.7	0.99	5.9	0.6	100	100	4.7	1.3	3	0.8	0.004	23.5	
PE1R 112 MY4	PE0R 100 S4			4	12.7	50	330	91.2	0.99	7.75	0.4	110	110	3.2	0.8	2.011	0.5	0.00725	30	
PE1R 132 SY4T	PE0R 100 L4			5.5	17.5	85	320	92.5	0.99	10.5	0.25	110	110	2.4	0.6	1.508	0.38	0.009	37	
PE1R 132 S4T	-			7.5	23.9	100	314	93	1.00	14.6	0.2	105	105	1.6	0.4	1.005	0.25	0.011	45	
PE1R 132 M4	PE0R 132 S4			11	35	44	370	92	0.99	18.8	0.11	121	121	1.8	0.79	1.13	0.5	0.028	70	
PE1R 160 M4	PE0R 132 M4			15	48	60	366	92.1	0.99	24.5	0.063	120	120	1.2	0.48	0.76	0.31	0.035	92	
PE1R 160 L4	PE0R 160 S4			18.5	59	74	374	92.2	0.99	32	0.039	123	123	1.07	0.38	0.67	0.24	0.078	120	
PE1R 180 M4	PE0R 160 M4			22	70	88	368	92.3	0.99	36.5	0.032	121	121	0.86	0.29	0.54	0.18	0.09	136	
PE1R 180 L4	PE0R 180 S4			30	95							R							0.138	170
PE1R 200 L4	PE0R 180 M4			37	118							R							0.168	200
PE1R 225 S4	PE0R 200 M4			45	143							R							0.275	270
PE1R 225 M4	PE0R 200 L4			55	175							R							0.313	300
PE1R 250 M4	PE0R 225 M4	75	239							R							0.525	375		
PE1R 63 K4	PE0R 56 K4	1,500 r.p.m.	50 Hz	0.12	0.8	2.5	310	77	0.98	0.3	95	170	160	80	50.3	25.13	0.00019	4.8		
PE1R 63 G4	PE0R 56 G4			0.18	1.1	3.5	310	80.5	0.98	0.4	57	180	180	130	60	40.8	18.85	0.00024	5.2	
PE1R 71 K4	PE0R 63 K4			0.25	1.6	4	300	69.5	0.98	0.65	44	165	165	110	50	34.6	15.71	0.0004	6.8	
PE1R 71 G4	PE0R 63 G4			0.37	2.4	7	310	74	0.98	0.95	26	175	175	85	35	26.7	11	0.0005	7.8	
PE1R 80 K4	PE0R 71 K4			0.55	3.5	10	320	81	0.98	1.25	14.5	190	190	76	24	23.9	7.5	0.00087	10.6	
PE1R 80 G4	PE0R 71 G4			0.75	4.8	14	325	82.4	0.98	1.65	9.5	195	195	61	19	19.2	6	0.00107	11.7	
PE1R 90 S4	PE0R 80 K4			1.1	7	19	315	84.9	0.99	2.4	6	195	195	36	9	11.3	2.8	0.00207	15.5	
PE1R 90 L4	PE0R 80 G4			1.5	9.5	28	305	86.9	0.99	3.3	3.4	190	190	24.5	5.5	7.7	1.7	0.0026	18	
PE1R 100 L4	PE0R 90 L4			2.2	14	45	315	90.5	0.99	4.5	2.1	195	195	1.5	4.5	4.9	1.4	0.004	23.5	
PE1R 100 LX4	PE0R 100 S4			3	19.1	50	335	91.6	0.99	5.7	1.5	215	215	16	4	5	1.3	0.00725	30	
PE1R 112 M4	PE0R 100 L4			4	25.5	70	320	92.3	0.99	7.9	0.9	205	205	10.5	2.5	3.3	0.8	0.009	37	
PE1R 112 MX4	PE0R 132 S4			5.5	35	100	325	93.1	0.99	10.6	0.65	210	210	8.2	1.8	2.6	0.6	0.011	45	
PE1R 132 M4	PE0R 132 M4			7.5	42.8	60	347	94	0.99	13.3	0.482	229	229	6.09	2.37	1.91	0.74	0.024	70	
PE1R 160 M4	PE0R 160 S4			11	70	88	352	94.1	0.99	19.5	0.29	228	228	4.12	1.48	1.3	0.46	0.033	92	
PE1R 160 L4	PE0R 160 M4			15	95.5	119	356	94.8	0.98	26	0.128	228	228	3.69	1.31	1.16	0.41	0.068	120	
PE1R 180 M4	PE0R 180 S4			18.5	118	147	355	95	0.98	32.3	0.107	227	227	3.04	1.03	0.96	0.32	0.079	136	
PE1R 180 L4	PE0R 180 M4			22	140	175	355	95.4	0.98	38.5	0.08	227	227	2.84	0.94	0.89	0.3	0.126	170	
PE1R 200 L4	PE0R 200 M4			30	191	239	352	95.6	0.98	52.5	0.052	225	225	2.11	0.65	0.66	0.2	0.162	220	
PE1R 225 S4	PE0R 200 L4			37	236	294	366	95.6	0.97	62	0.039	235	235	1.91	0.56	0.6	0.18	0.269	270	
PE1R 225 M4	PE0R 225 M4			45	286	358	365	95.7	0.98	76.6	0.026	233	233	1.6	0.45	0.5	0.14	0.308	300	
PE1R 250 M4	PE0R 225 M4	55	350	420	367	95.8	0.97	93	0.019	236	236	1.31	0.37	0.41	0.12	0.517	375			

R = on request

The maximum speed depends on the DC link voltage of the inverter, on the load and on the type of inverter.

Parameters with index 1: phase values

Parameters with index 20: valid for 20°C, e.g.: R_{120} : phase resistance at 20°C

Changes reserved due to technical progress.

missing values in preparation

Permanent magnet synchronous energy saving motors for inverter operation

with surface cooling, type of cooling IC 411
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

		Rated speed	Rated frequency	Rated output	Torque	max. torque (2 min)	Voltage	Efficiency η	Power factor	Rated current	Phase resistance at 20°C	No load voltage at speed 1000 r.p.m.	Magnetising inductance	Leakage inductance	Magnetising reactance	Leakage reactance	Motor moment of inertia	Motor mass
				[kW]	[Nm]		[V]	[%]	[-]	[A]	R_{120}	U_{P020}	L_{1H}	$L_{1\sigma}$	X_{1H}	$X_{1\sigma}$	J	m
											[Ω]	V/1000 r.p.m.	[mH]	[mH]	[Ω]	[Ω]	kgm ²	kg
PE1R 63 K6	PE0R 56 K6			0.09	0.8	3.5	280	76.5	0.99	0.25	86	240	110	110	34.6	34.56	0.00024	4.9
PE1R 63 G6	PE0R 56 G6			0.12	1.3	4.8	285	79	0.99	0.3	63	260	90	90	28.3	28.27	0.00027	5.7
PE1R 71 K6	PE0R 63 K6			0.18	1.7	7	275	81.5	0.99	0.45	36	250	70	60	22	18.85	0.00045	7.4
PE1R 71 G6	PE0R 63 G6			0.25	2.4	10	285	83	0.99	0.6	25	270	55	45	17.3	14.14	0.0006	8.3
PE1R 80 K6	PE0R 71 K6			0.37	3.5	14	310	84	0.99	0.75	19	280	37	23	11.6	7.23	0.0013	11
PE1R 80 G6	PE0R 71 G6			0.55	5.3	21	310	86	0.99	1.15	10.7	295	25	15	7.9	4.71	0.00175	12.5
PE1R 90 S6	PE0R 80 K6			0.75	7.2	28	305	86.5	0.99	1.6	7.5	290	25	13	7.9	4.08	0.00325	16
PE1R 90 L6	PE0R 80 G6			1.1	10.5	42	300	87.5	0.99	2.4	4.7	290	19	9	6	2.83	0.00425	19
PE1R 100 L6	PE0R 90 L6			1.5	14.3	60	310	89	0.99	3	2.7	305	14	6	4.4	1.88	0.00625	24
PE1R 112 M6	PE0R 100 L6			2.2	21	75	305	91	0.99	4.4	1.6	300	10	3	3.1	0.94	0.01225	33.5
PE1R 132 S6T	-			3	29	100	310	91.5	0.99	6	1.3	305	9	3	2.8	0.94	0.0139	39
PE1R 132 S6	PE0R 112 MX6			3	28.6	57	369	91	0.99	5.2	1.71	348	10.9	5.9	3.43	1.85	0.016	46
PE1R 132 M6	PE0R 112 MX6			4	38.2	76	361	92	0.99	7	1.06	342	7.72	4.02	2.42	1.26	0.021	53
PE1R 132 MX6	PE0R 132 S6			5.5	52.5	105	369	93	0.99	9.3	0.547	355	6.91	3.2	2.17	1.01	0.04	70
PE1R 160 M6	PE0R 132 M6			7.5	71.5	143	365	93.2	0.99	13	0.38	351	5.16	2.3	1.62	0.72	0.052	86
PE1R 160 L6	PE0R 160 S6			11	105	210	354	93.5	0.99	19.5	0.244	338	4.36	1.67	1.37	0.53	0.103	114
PE1R 180 L6	PE0R 160 M6			15	143	286	360	94	0.98	26	0.168	345	3.38	1.22	1.06	0.38	0.135	136
PE1R 200 L6	PE0R 180 S6			18.5	177	353	368	93.5	0.98	31.6	0.111	354	2.95	1.03	0.93	0.32	0.224	175
PE1R 200 LX6	PE0R 180 M6			22	210	420	374	93.6	0.99	37	0.087	361	2.49	0.84	0.78	0.26	0.269	200
PE1R 225 M6	PE0R 200 M6			30	286	707	377	94.2	0.98	50	0.057	364	2.05	0.66	0.65	0.21	0.437	265
PE1R 250 M6	PE0R 225 M6			37	353	442	362	94	0.98	64	0.038	351	1.45	0.49	0.46	0.15	0.825	360
PE1R 280 S6	PE0R 250 S6			55	525	657	354	94.3	0.98	97.5	0.025	341	1.12	0.37	0.35	0.12	1.2	465
PE1R 280 M6	PE0R 250 M6			75	716	895	358	94.6	0.97	132	0.018	343	0.88	0.28	0.28	0.09	1.49	520
PE1R 315 S6	PE0R 280 S6			90	860	1074	361	93.8	0.97	158	0.012	347	0.79	0.24	0.25	0.08	2.42	690
PE1R 71 K8	PE0R 63 K8			0.09	1.1	5	300	80	0.99	0.2	88	375	90	110	28.3	34.56	0.0005	6.6
PE1R 71 G8	PE0R 63 G8			0.12	1.5	7	290	82.5	0.99	0.3	51	365	60	75	18.9	23.56	0.0006	8.1
PE1R 80 K8	PE0R 71 K8			0.18	2.3	9	300	80.5	0.99	0.4	40	365	65	55	20.4	17.28	0.0013	10.5
PE1R 80 G8	PE0R 71 G8			0.25	3.2	14	310	83.5	0.99	0.6	26	390	50	40	15.7	12.57	0.00175	12
PE1R 90 S8	PE0R 80 K8			0.37	4.7	20	300	85.6	0.99	0.8	12	400	22	21	6.9	6.6	0.003	15
PE1R 90 L8	PE0R 80 G8			0.55	7	28	310	86.8	0.99	1.1	7.3	410	18	16	5.6	5.03	0.00378	18
PE1R 100 L8	PE0R 90 L8			0.75	9.6	38	275	87.3	0.99	1.7	4.8	370	14	11	4.4	3.46	0.00625	23
PE1R 100 LX8	PE0R 100 S8			1.1	14	55	310	88.2	0.99	2.3	3.6	410	14	9	4.4	2.83	0.009	28
PE1R 112 M8	PE0R 100 L8			1.5	19.1	75	320	89.4	0.99	2.9	2.4	430	11	7	3.5	2.2	0.01225	33.5
PE1R 132 S8T	-			2.2	28	100	300	89.9	0.99	4.6	1.5	400	8	4	2.5	1.26	0.0139	39

The maximum speed depends on the DC link voltage of the inverter, on the load and on the type of inverter.

Parameters with index 1: phase values

Parameters with index 20: valid for 20°C, e.g.: R_{120} : phase resistance at 20°C

Changes reserved due to technical progress.

Permanent magnet synchronous high-power motors for inverter operation

with surface cooling, type of cooling IC 411
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

		Rated speed	Rated frequency	Rated output	Torque	max. torque (2 min)	Voltage	Efficiency η	Power factor	Rated current	Phase resistance at 20°C	No load voltage at speed 1000 r.p.m.	Magnetising inductance	Leakage inductance	Magnetising reactance	Leakage reactance	Motor moment of inertia	Motor mass	
				[kW]	[Nm]		[V]	[%]	[-]	[A]	R_{120}	U_{R020}	L_{1H}	$L_{1\sigma}$	X_{1H}	$X_{1\sigma}$	J	m	
											[Ω]	V/1000 r.p.m.	[mH]	[mH]	[Ω]	[Ω]	kgm ²	kg	
P21R 63 K4	P20R 56 K4	3,000 r.p.m. 100 Hz		0.37	1.2	2.5	95	77.5	0.98	0.8	32	100	60	28	37.7	17.6	0.00019	4.8	
P21R 63 G4	P20R 56 G4			0.55	1.8	3.5	100	78	0.98	1.2	18	18	105	42	18	26.4	11.3	0.00024	5.2
P21R 71 K4	P20R 63 K4			0.75	2.4	4	95	75	0.98	1.7	13.5	95	95	37	15	23.2	9.4	0.0004	6.8
P21R 71 G4	P20R 63 G4			1.1	3.5	7	93	78	0.98	2.5	8.5	105	105	31	10	19.5	6.3	0.0005	7.8
P21R 80 K4	P20R 71 K4			1.5	4.8	10	100	81	0.98	3.2	4.6	110	110	25	8	15.7	5	0.00087	10.6
P21R 80 G4	P20R 71 G4			2.2	7	14	100	85.5	0.98	4.6	2.8	105	105	18	5	11.3	3.1	0.00107	11.7
P21R 90 S4	P20R 80 K4			3	9.5	19	90	86	0.98	6.8	14	105	105	12	3	7.5	1.9	0.00207	15.5
P21R 90 L4	P20R 80 G4			4	12.7	28	90	87.4	0.98	9.3	0.8	90	90	5	1	3.14	0.63	0.0026	18
P21R 100 L4	P20R 90 L4			5.5	17.5	45	100	92.9	0.98	10.9	0.6	100	100	4.7	1.3	3	0.8	0.004	23.5
P21R 112 MY4	P20R 100 S4			7.5	23.9	50	110	93.3	0.99	14.2	0.4	110	110	3.2	0.8	2	0.5	0.00725	30
P21R 63 K4	P20R 56 K4	1,500 r.p.m. 50 Hz		0.19	1.2	2.5	340	73	0.98	0.45	95	170	160	80	50.3	25.1	0.00019	4.8	
P21R 63 G4	P20R 56 G4			0.25	1.6	3.5	330	77.5	0.98	0.57	57	180	180	130	60	40.8	18.8	0.00024	5.2
P21R 71 K4	P20R 63 K4			0.3	1.9	4	315	66.5	0.98	0.75	44	165	165	110	50	34.6	15.7	0.0004	6.8
P21R 71 G4	P20R 63 G4			0.45	2.9	7	340	75	0.98	1.4	26	175	175	85	35	26.7	11	0.0005	7.8
P21R 80 K4	P20R 71 K4			0.8	5.1	10	330	79	0.98	1.75	14.5	190	190	76	24	23.9	7.5	0.00087	10.6
P21R 80 G4	P20R 71 G4			1.2	7.6	14	340	80	0.98	2.5	9.5	195	195	61	19	19.2	6	0.00107	11.7
P21R 90 S4	P20R 80 K4			1.5	9.6	19	330	81	0.98	3.3	6	195	195	36	9	11.3	2.8	0.00207	15.5
P21R 90 L4	P20R 80 G4			2.2	14	28	320	85	0.97	4.8	3.4	190	190	24.5	5.5	7.7	1.7	0.0026	18
P21R 100 L4	P20R 90 L4			3.5	22	45	325	88	0.98	6.2	2.1	195	195	15.5	4.5	4.9	1.4	0.004	23.5
P21R 100 LX4	P20R 100 S4			4	25.5	50	335	90	0.98	8	1.5	215	215	16	4	5	1.3	0.00725	30
P21R 112 M4	P20R 100 L4	5.5	35	70	325	92	0.98	10.9	0.9	205	205	10.5	2.5	3.3	0.8	0.009	37		
P21R 112 MX4		7.5	48	100	330	92	0.98	14.6	0.65	210	210	8.2	1.8	2.6	0.6	0.011	45		
P21R 132 M4	P20R 132 S4	7.5	48							R						0.024	70		
P21R 160 M4	P20R 132 M4	11	70							R						0.033	92		
P21R 160 L4	P20R 160 S4	22	140							R						0.068	120		
P21R 180 M4	P20R 160 M4	30	191							R						0.079	136		
P21R 180 L4	P20R 180 S4	33	207							R						0.126	170		
P21R 200 L4	P20R 180 M4	43	271							R						0.162	200		
P21R 225 S4	P20R 200 M4	49	309							R						0.269	270		
P21R 225 M4	P20R 200 L4	60	382							R						0.308	300		
P21R 250 M4	P20R 225 M4	75	478							R						0.517	375		

R = on request

The maximum speed depends on the DC link voltage of the inverter, on the load and on the type of inverter.

Parameters with index 1: phase values

Parameters with index 20: valid for 20°C, e.g.: R_{120} : phase resistance at 20°C

Changes reserved due to technical progress.

missing values in preparation

Permanent magnet synchronous high-power motors for inverter operation

with surface cooling, type of cooling IC 411
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

		Rated speed	Rated frequency	Rated output	Torque	max. torque (2 min)	Voltage	Efficiency η	Power factor	Rated current	Phase resistance at 20°C	No load voltage at speed 1000 r.p.m.	Magnetising inductance	Leakage inductance	Magnetising reactance	Leakage reactance	Motor moment of inertia	Motor mass		
				[kW]	[Nm]		[V]	[%]	[-]	[A]	R_{120}	U_{P020}	L_{1H}	$L_{1\sigma}$	X_{1H}	$X_{1\sigma}$	J	m		
											[Ω]	V/1000 r.p.m.	[mH]	[mH]	[Ω]	[Ω]	kgm ²	kg		
P21R 63 K6	P20R 56 K6	1,000 r.p.m.	50 Hz	0.18	1.72	3.5	330	67	0.99	0.45	86	240	110	110	34.6	34.6	0.00024	4.9		
P21R 63 G6	P20R 56 G6			0.25	2.4	4.8	330	69.5	0.99	0.6	63	260	90	90	28.3	28.3	0.00027	5.7		
P21R 71 K6	P20R 63 K6			0.4	3.8	7	310	73.5	0.99	0.9	36	250	70	60	22	18.8	0.00045	7.4		
P21R 71 G6	P20R 63 G6			0.5	4.8	10	330	74	0.99	1.3	25	270	55	45	17.3	14.1	0.0006	8.3		
P21R 80 K6	P20R 71 K6			0.6	5.7	14	335	75.5	0.99	1.7	19	280	37	23	11.6	7.2	0.0013	11		
P21R 80 G6	P20R 71 G6			0.9	8.6	21	335	80.5	0.99	2.3	10.7	295	25	15	7.9	4.7	0.00175	12.5		
P21R 90 S6	P20R 80 K6			1.4	13.4	28	335	81	0.99	3.2	7.5	290	25	13	7.9	4.1	0.00325	16		
P21R 90 L6	P20R 80 G6			1.9	18.1	42	330	82	0.99	4.7	4.7	290	19	9	6	2.8	0.00425	19		
P21R 100 L6	P20R 90 L6			3	29	60	335	85.5	0.99	6	2.7	305	14	6	4.4	1.9	0.00625	24		
P21R 112 M6	P20R 100 L6			3.5	33	75	325	89	0.99	8.8	1.6	300	10	3	3.1	0.9	0.01225	33.5		
P21R 132 S6 T				5	48	100	330	89	0.99	11	1.3	305	9	3	2.8	0.9	0.0139	39		
P21R 132 MX6	P20R 132 S6			8.5	81							R						0.04	70	
P21R 160 L6	P20R 160 S6			11	105							R						0.103	114	
P21R 180 L6	P20R 160 M6			15	143							R						0.134	136	
P21R 200 L6	P20R 180 S6			19	177							R						0.224	175	
P21R 200 LX6	P20R 180 M6			22	210							R						0.269	200	
P21R 225 M6	P20R 200 M6			30	286							R						0.437	265	
P21R 250 M6	P20R 225 M6			37	353							R						0.825	360	
P21R 280 S6	P20R 250 S6			55	525	657	354	94	0.98	97.5	0.025	341	1.12	0.37	0.35	0.12	1.2	465		
P21R 280 M6	P20R 250 M6			75	716	895	358	94.6	0.97	132	0.018	343	0.88	0.28	0.28	0.09	1.49	520		
P21R 71 K8	P20R 63 K8	750 r.p.m.	50 Hz	0.18	2.3	5	340	74	0.98	0.4	88	375	90	110	28.3	34.6	0.0005	6.6		
P21R 71 G8	P20R 63 G8			0.25	3.2	6.5	320	76.5	0.98	0.6	51	365	60	75	18.8	23.6	0.0006	8.1		
P21R 80 K8	P20R 71 K8			0.37	4.7	9	345	71.7	0.98	0.85	40	365	65	55	20.4	17.3	0.0013	10.5		
P21R 80 G8	P20R 71 G8			0.55	7	14	350	75.5	0.98	1.2	26	390	50	40	15.7	12.6	0.00175	12		
P21R 90 S8	P20R 80 K8			0.75	9.6	20	325	82.5	0.98	1.6	12	400	22	21	6.9	6.6	0.003	15		
P21R 90 L8	P20R 80 G8			1.1	14	28	330	84.4	0.98	2.2	7.3	410	18	16	5.6	5	0.00375	18		
P21R 100 L8	P20R 90 L8			1.5	19.1	38	300	83.9	0.98	3.4	4.8	370	14	11	4.4	3.5	0.00625	23		
P21R 100 LX8	P20R 100 S8			2.2	28	55	330	85	0.98	4.5	3.6	410	14	9	4.4	2.8	0.009	28		
P21R 112 M8	P20R 100 L8			3	38.2	75	340	87	0.98	5.5	2.4	430	11	7	3.5	2.2	0.01225	33.5		
P21R 132 S8T				4	50.9	100	310	87.7	0.98	8.3	1.5	400	8	4	2.5	1.3	0.0139	39		
P21R 90 S12	P20R 80 K12			500 r.p.m.	50 Hz	0.55	10.5	21	330	74.8	0.99	1.3	23	530	40	60	12.6	18.8	0.00325	16
P21R 90 L12	P20R 80 G12					0.75	14.3	28	315	77	0.99	1.8	15	530	25	35	7.9	11	0.00425	19
P21R 100 LX12	P20R 100 S12	1.5	29			60	340	75.5	0.99	3.4	8.5	560	20	22	6.3	6.9	0.009	28		

R = on request

The maximum speed depends on the DC link voltage of the inverter, on the load and on the type of inverter.

Parameters with index 1: phase values

Parameters with index 20: valid for 20°C, e.g.: R_{120} : phase resistance at 20°C

Changes reserved due to technical progress.

missing values in preparation

Permanent magnet synchronous torque motors for inverter operation

with forced ventilation, cooling type IC 416
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

Rated values at operating voltage										Values at max. voltage						
U _A ¹⁾	f	P _n	M _n	I _n	η _n	cos φ _n	U _{A max}	M _{max}	M _{max} /M _n	I _{max}	η _{max}	cos φ _{max}	J	m		
(S1)										corresponds to M _{max}					J	m
[V]	[Hz]	[kW]	Nm	A	%	-	[V]	Nm		A	%	-	kgm ²	kg		
Rated speed 220 r.p.m. – 22 Hz cut-off-frequency																
P21F 225 M12	P20F 200 M12	339	22	13	573	27.5	86.7	0.95	395	1,031	1.8	50	78.7	0.88	0.44	265
P21F 250 M12	P20F 225 M12	338	22	17	750	35	88.5	0.95	390	1,35	1.8	63.5	82.4	0.88	0.825	360
P21F 280 S12	P20F 250 S12	335	22	22	950	44	90	0.95	387	1,62	1.7	76	84	0.87	1.35	465
P21F 280 M12	P20F 250 M12	343	22	28	1200	54.5	90	0.95	397	2,2	1.8	100	84.5	0.87	1.55	520
P21F 315 S12	P20F 280 S12	338	22	37	1600	74	91.5	0.93	392	2,88	1.8	134	86.5	0.84	2.63	690
P21F 315 M12	P20F 280 M12	341	22	47	2050	93	91.5	0.94	394	3,69	1.8	170	87	0.84	3.33	800
P21F 315 MX12	P20F 280 MX12	337	22	51	2200	101	91.5	0.94	389	3,96	1.8	183	87	0.85	3.6	880
P21F 315 L12	P20F 315 L12	345	22	78	3400	152	92.5	0.93	397	6,12	1.8	284	88	0.82	6.76	1250
P22F 355 MY12			22	97	4200					7,56	1.8				9.3	1500
P22F 355 M12		313	22	120	5200	261	94	0.9	372	9,36	1.8	483	90	0.77	9.3	1500
P22F 355 MX12			22	143	6200					11,16	1.8				9.5	1600
P22F 355 LY12			22	150	6500					11,7	1.8				15.8	2400
P22F 355 L12			22	173	7500					13,5	1.8				15.8	2400
Rated speed 300 r.p.m. – 30 Hz cut-off-frequency																
P21F 225 M12	P20F 200 M12	350	30	18	573	35	89.5	0.95	400	1031	1.8	65.5	83.2	0.86	0.44	265
P21F 250 M12	P20F 225 M12	330	30	24	750	47.5	91	0.95	377	1350	1.8	86.5	86.1	0.87	0.825	360
P21F 280 S12	P20F 250 S12	335	30	30	950	59.5	92	0.94	384	1620	1.7	102	87.5	0.86	1.35	465
P21F 280 M12	P20F 250 M12	334	30	38	1200	75.5	92	0.94	383	2200	1.8	138	88	0.86	1.55	520
P21F 315 S12	P20F 280 S12	333	30	50	1600	101	93	0.93	383	2880	1.8	182	89	0.84	2.63	690
P21F 315 M12	P20F 280 M12	343	30	64	2050	125	93.5	0.93	394	3690	1.8	226	89.5	0.84	3.33	800
P21F 315 MX12	P20F 280 MX12	329	30	69	2200	140	93	0.93	377	3960	1.8	252	90	0.84	3.6	880
P21F 315 L12	P20F 315 L12	336	30	107	3400	210	94	0.93	384	6120	1.8	392	90	0.82	6.76	1,250
P22F 355 MY12			30	132	4200					7560	1.8				9.3	1,500
P22F 355 M12		326	30	163	5200	338	95	0.9	385	9360	1.8	631	92	0.76	9.3	1,500
P22F 355 MX12			30	195	6200					11160	1.8				9.5	1,600
P22F 355 LY12			30	204	6500					11700	1.8				15.8	2,400
P22F 355 L12			30	236	7500					13500	1.8				15.8	2,400
Rated speed 430 r.p.m. – 43 Hz cut-off-frequency																
P21F 225 M12	P20F 200 M12	350	43	26	573	49.5	91.7	0.94	397	1031	1.8	91.5	87	0.85	0.44	265
P21F 250 M12	P20F 225 M12	337	43	34	750	65.5	93.1	0.95	381	1350	1.8	120	89.5	0.86	0.825	360
P21F 280 S12	P20F 250 S12	346	43	43	950	81	93.5	0.94	393	1620	1.7	148	90.5	0.8	1.35	465
P21F 280 M12	P20F 250 M12	333	43	54	1200	106	94	0.94	380	2200	1.8	195	91	0.85	1.55	520
P21F 315 S12	P20F 280 S12	342	43	72	1600	138	94.5	0.93	392	2880	1.8	252	91.5	0.83	2.63	690
P21F 315 M12	P20F 280 M12	324	43	92	2050	187	94.5	0.93	370	3690	1.8	340	92	0.83	3.33	800
P21F 315 MX12	P20F 280 MX12	349	43	99	2200	185	95	0.93	397	3960	1.8	340	92	0.83	3.6	880
P21F 315 L12	P20F 315 L12	337	43	153	3400	297	95	0.93	383	6120	1.8	554	92.5	0.81	6.76	1250
P22F 355 MY12			43	189	4200					7560	1.8				9.3	1500
P22F 355 M12		324	43	234	5200	483	96	0.9	383	9360	1.8	901	94	0.75	9.3	1500
P22F 355 MX12			43	279	6200					11160	1.8				9.5	1600
P22F 355 LY12			43	293	6500					11700	1.8				15.8	2400
P22F 355 L12			43	338	7500					13500	1.8				15.8	2400

¹⁾ inverter output voltage realised as operating voltage for active current

missing values in preparation

Permanent magnet synchronous torque motors for inverter operation

with forced ventilation, cooling type IC 416
thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

Rated values at operating voltage										Values at max. voltage						
U _A ¹⁾	f	P _n	M _n	I _n	η _n	cos φ _n	U _{A max}	M _{max}	M _{max} /M _n	I _{max}	η _{max}	cos φ _{max}	J	m		
(S1)										corresponds to M _{max}						
[V]	[Hz]	[kW]	Nm	A	%	-	[V]	Nm		A	%	-	kgm ²	kg		
Rated speed 500 r.p.m. – 50 Hz cut-off-frequency																
P21F 225 M12	P20F 200 M12	336	50	30	573	59	92.6	0.94	379	1031	1.8	109	88.6	0.85	0.44	265
P21F 250 M12	P20F 225 M12	341	50	39	750	75.5	93.5	0.94	384	1350	1.8	136	90.7	0.86	0.825	360
P21F 280 S12	P20F 250 S12	341	50	50	950	96	93.5	0.94	392	1620	1.7	161	91.5	0.85	1.35	465
P21F 280 M12	P20F 250 M12	340	50	63	1200	120	94.5	0.94	387	2200	1.8	220	91.8	0.85	1.55	520
P21F 315 S12	P20F 280 S12	346	50	84	1600	158	95	0.93	396	2880	1.8	290	92.5	0.82	2.63	690
P21F 315 M12	P20F 280 M12	344	50	94	2050	179	95	0.93	392	3690	1.8	369	93	0.83	3.33	800
P21F 315 MX12	P20F 280 MX12	336	50	115	2200	223	95.5	0.93	382	3960	1.8	406	93	0.83	3.6	880
P21F 315 L12	P20F 315 L12	339	50	178	3400	341	95.5	0.93	385	6120	1.8	638	93	0.81	6.76	1250
P22F 355 MY12			50	220	4200					7560	1.8				9.3	1500
P22F 355 M12		322	50	272	5200	562	96	0.9	380	9360	1.8	1045	95	0.75	9.3	1500
P22F 355 MX12			50	325	6200					11160	1.8				9.5	1600
P22F 355 LY12			50	340	6500					11700	1.8				15.8	2400
P22F 355 L12			50	393	7500					13500	1.8				15.8	2400
Rated speed 600 r.p.m. – 60 Hz cut-off-frequency																
P21F 225 M12	P20F 200 M12	336	60	36	573	70.5	93.1	0.94	379	1031	1.8	129	89.7	0.85	0.44	265
P21F 250 M12	P20F 225 M12	329	60	47	750	93.5	94.3	0.94	370	1350	1.8	168	91.8	0.86	0.825	360
P21F 280 S12	P20F 250 S12	347	60	60	950	112	94.5	0.94	393	1620	1.7	190	92.5	0.85	1.35	465
P21F 280 M12	P20F 250 M12	325	60	75	1200	150	95	0.94	368	2200	1.8	279	92.5	0.84	1.55	520
P21F 315 S12	P20F 280 S12	325	60	101	1600	201	95.5	0.93	370	2880	1.8	364	93.5	0.83	2.63	690
P21F 315 M12	P20F 280 M12	336	60	129	2050	249	95.5	0.93	382	3690	1.8	455	94	0.82	3.33	800
P21F 315 MX12	P20F 280 MX12	321	60	138	2200	281	95	0.93	365	3960	1.8	504	94	0.83	3.6	880
P21F 315 L12	P20F 315 L12	334	60	214	3400	418	96	0.92		6120	1.8				6.76	1250
P22F 355 MY12			60	264	4200					7560	1.8				9.3	1500
P22F 355 M12		321	60	327	5200	677	96.5	0.9	379	9360	1.8	1257	95	0.75	9.3	1500
P22F 355 MX12			60	390	6200					11160	1.8				9.5	1600
P22F 355 LY12			60	408	6500					11700	1.8				15.8	2400
P22F 355 L12			60	471	7500					13500	1.8				15.8	2400

¹⁾ inverter output voltage realised as operating voltage for active current

missing values in preparation

Permanent magnet synchronous torque motors for inverter operation

water-cooled, type of cooling IC 31W

thermal class 155 [F/B], type of protection IP 55

Motor selection data

Inverter input voltage 400 V, 50 Hz

	Rated values at operating voltage										Values at max. voltage				
	U _A ¹⁾	f	P _n	M _n	I _n	η _n	cos φ _n	U _{A max}	M _{max}	M _{max} /M _n	I _{max}	η _{max}	cos φ _{max}	J	m
	[V]	[Hz]	[kW]	Nm	A	%	-	[V]	Nm		A	%	-	kgm ²	kg
Rated speed 220 r.p.m. – 22 Hz cut-off-frequency															
P21B 225 M12	373	22	19.8	860	41.5	81.5	0.91	395	1031	1.2	50	78.7	0.88	0.44	265
P21B 250 M12	369	22	25.9	1125	52.5	84.5	0.91	390	1350	1.2	63.5	82.4	0.88	0.825	360
P21B 280 S12	366	22	32.8	1425	67	86	0.9	387	1620	1.1	76	84	0.87	1.35	465
P21B 280 M12	374	22	41.5	1800	82	87	0.9	397	2200	1.2	100	84.5	0.87	1.55	520
P21B 315 S12	371	22	55.3	2400	110	88.5	0.88	392	2880	1.2	134	86.5	0.84	2.63	690
P21B 315 M12	373	22	70.8	3075	140	89	0.88	394	3690	1.2	170	87	0.84	3.33	800
P21B 315 MX12	371	22	78.3	3400	157	88.5	0.88	389	3960	1.2	183	87	0.85	3.6	880
Rated speed 300 r.p.m. – 30 Hz cut-off-frequency															
P21B 225 M12	380	30	27	860	53.5	85.5	0.9	400	1031	1.2	65.5	83.2	0.86	0.44	265
P21B 250 M12	358	30	35.3	1125	72	88	0.9	377	1350	1.2	86.5	86.1	0.87	0.825	360
P21B 280 S12	364	30	44.8	1425	89.5	89	0.89	384	1620	1.1	102	87.5	0.86	1.35	465
P21B 280 M12	362	30	56.5	1800	113	89.5	0.89	383	2200	1.2	138	88	0.86	1.55	520
P21B 315 S12	363	30	75.4	2400	151	90.5	0.88	383	2880	1.2	182	89	0.84	2.63	690
P21B 315 M12	374	30	96.6	3075	188	91	0.87	394	3690	1.2	226	89.5	0.84	3.33	800
P21B 315 MX12	360	30	106.8	3400	216	91	0.87	377	3960	1.2	252	90	0.84	3.6	880
Rated speed 430 r.p.m. – 43 Hz cut-off-frequency															
P21B 225 M12	378	43	38.7	860	75	88.5	0.89	397	1031	1.2	91.5	87	0.85	0.44	265
P21B 250 M12	363	43	50.7	1125	98.5	91	0.90	381	1350	1.2	120	89.5	0.86	0.825	360
P21B 280 S12	374	43	64.2	1425	122	91.5	0.89	393	1620	1.1	148	90.5	0.8	1.35	465
P21B 280 M12	359	43	81.1	1800	159	92	0.89	380	2200	1.2	195	91	0.85	1.55	520
P21B 315 S12	371	43	108.1	2400	208	93	0.87	392	2880	1.2	252	91.5	0.83	2.63	690
P21B 315 M12	351	43	138.5	3075	281	93	0.87	370	3690	1.2	340	92	0.83	3.33	800
P21B 315 MX12	380	43	153.1	3400	287	93	0.87	397	3960	1.2	340	92	0.83	3.6	880
Rated speed 500 r.p.m. – 50 Hz cut-off-frequency															
P21B 225 M12	361	50	45.0	860	90	90	0.89	379	1031	1.2	109	88.6	0.85	0.44	265
P21B 250 M12	366	50	58.9	1125	114	91.9	0.89	384	1350	1.2	136	90.7	0.86	0.825	360
P21B 280 S12	373	50	74.6	1425	140	92.5	0.89	392	1620	1.1	161	91.5	0.85	1.35	465
P21B 280 M12	366	50	94.2	1800	180	93	0.89	387	2200	1.2	220	91.8	0.85	1.55	520
P21B 315 S12	376	50	125.7	2400	237	93.5	0.87	396	2880	1.2	290	92.5	0.82	2.63	690
P21B 315 M12	372	50	161.0	3075	306	94	0.87	392	3690	1.2	369	93	0.83	3.33	800
P21B 315 MX12	366	50	178.0	3400	347	94	0.86	382	3960	1.2	406	93	0.83	3.6	880
Rated speed 600 r.p.m. – 60 Hz cut-off-frequency															
P21B 225 M12	361	60	54.0	860	107	91	0.89	379	1031	1.2	129	89.7	0.85	0.44	265
P21B 250 M12	353	60	70.7	1125	140	92.8	0.89	370	1350	1.2	168	91.8	0.86	0.825	360
P21B 280 S12	374	60	89.5	1425	168	93.5	0.88	393	1620	1.1	190	92.5	0.85	1.35	465
P21B 280 M12	349	60	113.1	1800	225	93.5	0.89	368	2200	1.2	279	92.5	0.84	1.55	520
P21B 315 S12	351	60	150.8	2400	302	94.5	0.87	370	2880	1.2	364	93.5	0.83	2.63	690
P21B 315 M12	363	60	193.2	3075	374	94.5	0.87	382	3690	1.2	455	94	0.82	3.33	800
P21B 315 MX12	350	60	213.6	3400	434	94.5	0.86	365	3960	1.2	504	94	0.83	3.6	880

¹⁾ inverter output voltage realised as operating voltage for active current

Notes to dimensions

Dimensional designations according to EN 50 347 and IEC 60 072.

Flange sizes in the dimensional tables are given in accordance to DIN 42948.

All dimensional data in mm VEM motors GmbH reserves the right to change technical data without preceding information. Dimensional data in catalogues can lose their validity. Binding dimensional data can be requested from the VEM sales organisations.

Flange dimensions

Flanges with threadholes

Flange type acc. to EN 50 347	Flange type acc. to DIN 42948	LA c_1	M e_1	N b_1	P a_1	S s_1	T f_1
FT 65	C 80	6.5	65	50	80	M5	2.5
FT 75	C 90	8	75	60	90	M5	2.5
FT 85	C 105	8.5	85	70	105	M6	2.5
FT 100	C 120	8	100	80	120	M6	3
FT 115	C 140	10	115	95	140	M8	3
FT 130	C 160	10	130	110	160	M8	3.5
FT 165	C 200	12	165	130	200	M10	3.5
FT 215	C 250	12	215	180	250	M12	4

Flanges with through holes

Flange type acc. to EN 50 347	Flange type acc. to DIN 42948	LA c_1	M e_1	N b_1	P a_1	S s_1	T f_1
FF 100	A 120	9	100	80	120	7	3
FF 115	A 140	9	115	95	140	9	3
FF 130	A 160	9	130	110	160	9	3.5
FF 165	A 200	10	165	130	200	11	3.5
FF 215	A 250	11	215	180	250	14	4
FF 265	A 300	12	265	230	300	14	4
FF 300	A 350	13	300	250	350	18	5
FF 350	A 400	15	350	300	400	18	5
FF 400	A 450	16	400	350	450	18	5
FF 500	A 550	18	500	450	550	18	5
FF 600	A 660	22	600	550	660	22	6
FF 740	A 800	25	740	680	800	22	6

According to EN 50 347 the flanges FF have through holes and the flanges FT have threadholes.
The standard DIN 42948 for flanges A and C are still valid yet.

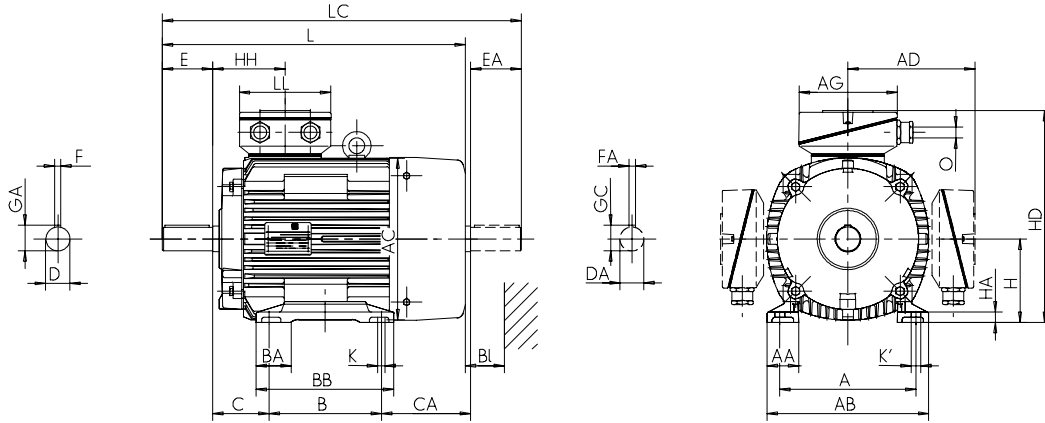
Tolerances for dimension N (b_1) see respective dimensional tables
LA (c_1) length of engagement

Permanent magnet synchronous motors for inverter operation

Size 56 to 280

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B3 [IM 1001]



Type designation	Flange size	A	AA	AB	AC	AD**)	B	BA	BB	C	CA	D	DA	DB *)	E	EA	F	FA
PE1R, P21R		b	n	f	g	g1	a	m	e	w1	w2	d	d1		l	l1	u	u1
P.1O 56 K4 U	FF100	90	18	110	-	98	71	-	86	36	28	9	9	M3	20	20	3	3
P.1R 56 G2,4	FF100	90	18	110	109	98	71	-	86	36	52	9	9	M3	20	20	3	3
P.1R 63 K4,6	FF115	100	28	128	109	98	80	-	100	40	39	11	11	M4	23	23	4	4
P.1R 63 G2,4,6	FF115	100	28	128	109	98	80	-	100	40	39	11	11	M4	23	23	4	4
P.1R 71 K4,6,8	FF130	112	32	138	124	104	90	-	116	45	43,5	14	14	M5	30	30	5	5
P.1R 71 G4,6,8	FF130	112	32	138	124	104	90	-	116	45	43,5	14	14	M5	30	30	5	5
P.1R 80 K4,6,8	FF 165	125	38	168	139	111	100	-	125	50	63	19	19	M6	40	40	6	6
P.1R 80 G4,6,8	FF 165	125	38	168	139	111	100	-	125	50	63	19	19	M6	40	40	6	6
P.1R 90 S4,6,8	FF 165	140	40	178	157	119	100	-	130	56	74	24	22	M8	50	50	8	6
P.1R 90 L4,6,8	FF 165	140	40	178	157	119	125	-	155	56	71	24	22	M8	50	50	8	6
P.1R 100 L4,6,8	FF 215	160	45	192	177	126	140	-	175	63	73	28	24	M10	60	50	8	8
P.1R 100 LX4,8	FF 215	160	32	188	196	136	140	-	171	63	102	28	28	M10	60	60	8	8
P.1R 112 M6,8	FF 215	190	50	224	196	136	140	-	180	70	95	28	28	M10	60	60	8	8
P.1R 112 MY4	FF 215	190	50	224	196	136	140	-	180	70	95	28	28	M10	60	60	8	8
P.1R 112 M4	FF 215	190	50	224	196	136	140	-	180	70	129	28	28	M10	60	60	8	8
P.1R 132 S4,6,8T	FF265	216	50	256	196	155	140	-	180	89	129	38	28	M12	80	60	10	8
P.1R 132 S4,6,8	FF265	216	50	256	217	178	140	55	180	89	153	38	32	M12	80	80	10	10
P.1R 132 M4	FF265	216	50	256	258	199	178	55	218	89	138	38	38	M12	80	80	10	10
P.1R 132 MX6	FF265	216	50	256	258	199	178	55	218	89	138	38	38	M12	80	80	10	10
P.1R 132 M6,8	FF265	216	50	256	217	178	178	55	218	89	135	38	32	M12	80	80	10	10
P.1R 160 M4,6,8	FF300	254	55	296	258	214	210	60	257	108	135	42	38	M16	110	80	12	10
P.1R 160 MX8	FF300	254	55	296	258	199	210	60	257	108	135	42	38	M16	110	80	12	10
P.1R 160 L4,6,8	FF300	254	55	296	313	242	254	60	301	108	142	42	42	M16	110	110	12	12
P.1R 180 M4	FF300	279	62	328	313	242	241	65	288	121	142	48	42	M16	110	110	14	12
P.1R 180 L4	FF300	279	62	328	351	261	279	65	326	121	176	48	48	M16	110	110	14	14
P.1R 180 L6,8	FF300	279	62	328	313	242	279	65	326	121	104	48	42	M16	110	110	14	12
P.1R 200 L4,6,8	FF 350	318	70	372	351	261	305	70	360	133	138	55	48	M20	140	110	16	14
P.1R 200 LX6	FF 350	318	70	372	351	261	305	70	360	133	138	55	48	M20	140	110	16	14
P.1R 225 S4,8	FF 400	356	75	413	390	300	286	75	343	149	196	60	55	M20	140	110	18	16
P.1R 225 M4	FF 400	356	75	413	390	300	311	75	368	149	211	60	55	M20	140	110	18	16
P.1R 225 M6,8,12	FF 400	356	75	413	390	300	311	75	368	149	171	60	55	M20	140	110	18	16
P.1R 250 M4,6,8,12	FF 500	406	84	471	440	358	349	84	412	168	210	65	55	M20	140	110	18	16
P.1R 280 S4,6,8,12	FF 500	457	94	522	490	386	368	96	431	190	234	75	65	M20	140	140	20	18
P.1R 280 M4,6,8,12	FF 500	457	94	522	490	386	419	96	482	190	229	75	65	M20	140	140	20	18

*) Centre holes acc. to DIN 332-DS

**) Terminal box left/right

Permanent magnet synchronous motors for inverter operation

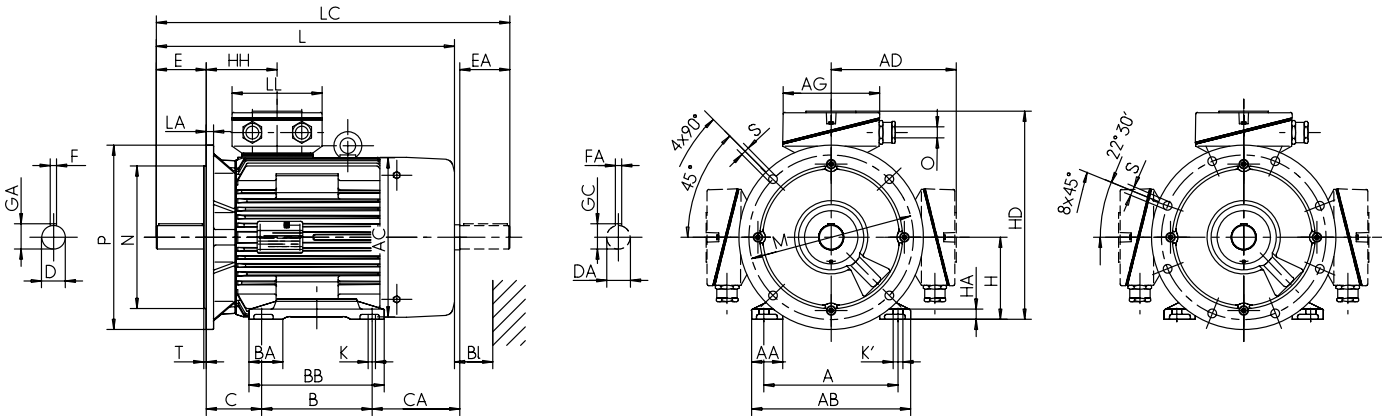
Size 56 to 280

with surface ventilator, cooling method IC 411, thermal class 155 [F/B],

degree of protection IP 55

Type of construction IM B35 [IM 2001]

Flange dimensions see table „flange dimensions“



Type designation	GA	GC	H	HA	HD	HD **)	HH	K	K'	L	LC	Terminal box type	AG	LL	O	Hole pattern	Bl.
PE1R, P21R	t	t1	h	c	p	p	A	s	s'	k	k1		x	z	r		Bl
P.1O 56 K4 U	10.2	10.2	56	7	154	R	58	6	6	150	175	KA 05	92	92	M20x1.5	4L	14
P.1R 56 G2,4	10.2	10.2	56	7	154	R	58	6	6	176	199	KA 05	92	92	M20x1.5	4L	14
P.1R 63 K4,6	12.5	12.5	63	10	161	R	58	8	8	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 63 G2,4,6	12.5	12.5	63	10	161	R	58	8	8	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 71 K4,6,8	16	16	71	11	175	R	61	8	8	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 71 G4,6,8	16	16	71	11	175	R	61	8	8	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 80 K4,6,8	21.5	21.5	80	12	191	R	67	10	10	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 80 G4,6,8	21.5	21.5	80	12	191	R	67	10	10	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 90 S4,6,8	27	24.5	90	14	210	R	70	10	10	275	330	KA 05	92	92	M25x1.5	4L	16
P.1R 90 L4,6,8	27	24.5	90	14	210	R	70	10	10	297	352	KA 05	92	92	M25x1.5	4L	16
P.1R 100 L4,6,8	31	27	100	15	227	R	75	12	12	331	386	KA 05	92	92	M25x1.5	4L	18
P.1R 100 LX4,8	31	31	100	11	237	R	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M6,8	31	31	112	18	249	R	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M6,8	31	31	112	18	249	R	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M4	31	31	112	18	249	R	77	12	12	391	459	KA 05	92	92	M25x1.5	4L	20
P.1R 132 S6,8T	41	31	132	18	287	R	105	12	12	430	498	KA 05-13	104	112	M32x1.5	4L	20
P.1R 132 S4,6,8	41	35	132	16	310	257	108	12	12	459	542	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M4	41	41	132	16	331	279	114	12	12	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 MX6	41	41	132	16	331	279	114	12	12	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M6,8	41	35	132	16	310	257	108	12	12	479	562	KK 25 A	156	145	M32x1.5	4L	35
P.1R 160 M4,6,8	45	41	160	18	374	307	114	15	15	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 MX8	45	41	160	18	374	307	114	15	15	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 L4,6,8	45	45	160	18	402	336	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 M4	51.5	45	180	20	422	356	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 L4	51.5	51.5	180	20	441	369	147	15	20	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 L6,8	51.5	45	180	20	422	369	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 200 L4,6,8	59	51.5	200	22	461	389	147	19	25	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 200 LX6	59	51.5	200	22	461	389	147	19	25	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 225 S4,8	64	59	225	25	525	442	168	19	25	757	881	KK 100 A	213	207	M50x1.5	8L	40
P.1R 225 M4	64	59	225	25	525	442	168	19	25	797	921	KK 100 A	213	207	M50x1.5	8L	40
P.1R 225 M6,8,12	64	59	225	25	525	442	168	19	25	757	881	KK 100 A	213	207	M50x1.5	8L	40
P.1R 250 M4,6,8,12	69	59	250	28	608	484	177	24	30	862	977	KK 200 A	282	242	M63x1.5	8L	45
P.1R 280 S4,6,8,12	79.5	69	280	32	666	546	206	24	30	924	1072	KK 200 A	282	242	M63x1.5	8L	50
P.1R 280 M4,6,8,12	79.5	69	280	32	666	546	206	24	30	970	1118	KK 200 A	282	242	M63x1.5	8L	50

**) Terminal box left/right
R = on request

Permanent magnet synchronous motors for inverter operation

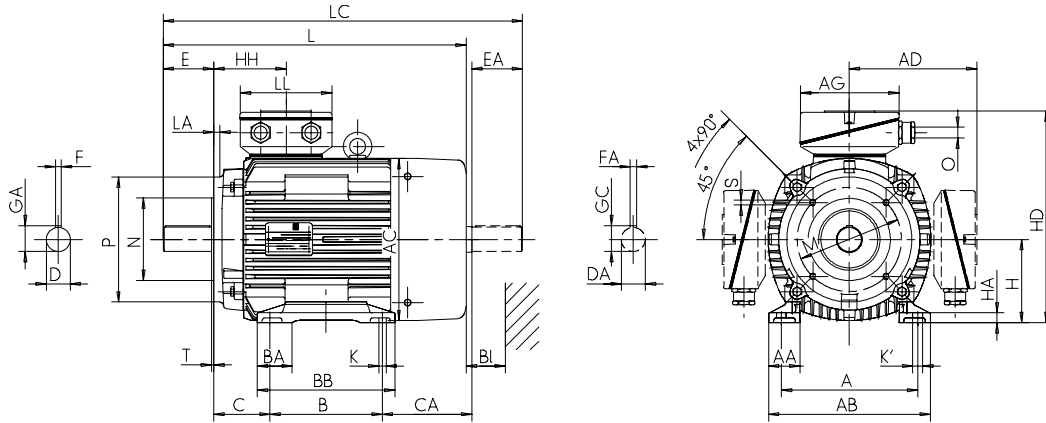
Size 56 to 180

with surface ventilator, cooling method IC 411, thermal class 155 [F/B],

degree of protection IP 55

Type of construction IM B34 [IM 2101]

Flange dimensions see table „flange dimensions“



Type designation	Flange size		A	AA	AB	AC	AD**)	B	BA	BB	C	CA	D	DA	DB*)	E	EA	F	FA
	small	big	b	n	f	g	g1	a	m	e	w1	w2	d	d1		l	l1	u	u1
K21O 56 K4 U	FT 65	FT 85	90	18	110	-	98	71	-	86	36	28	9	9	M3	20	20	3	3
P.1R 56 G4	FT 65	FT 85	90	18	110	109	98	71	-	86	36	52	9	9	M3	20	20	3	3
P.1R 63 K2,4,6	FT 75	FT 100	100	28	128	109	98	80	-	100	40	39	11	11	M4	23	23	4	4
P.1R 63 G2,4,6	FT 75	FT 100	100	28	128	109	98	80	-	100	40	39	11	11	M4	23	23	4	4
P.1R 71 K4,6,8	FT 85	FT 115	112	32	138	124	104	90	-	116	45	43,5	14	14	M5	30	30	5	5
P.1R 71 G4,6,8	FT 85	FT 115	112	32	138	124	104	90	-	116	45	43,5	14	14	M5	30	30	5	5
P.1R 80 K4,6,8	FT 100	FT 130	125	38	168	139	111	100	-	125	50	63	19	19	M6	40	40	6	6
P.1R 80 G4,6,8	FT 100	FT 130	125	38	168	139	111	100	-	125	50	63	19	19	M6	40	40	6	6
P.1R 90 S4,6,8	FT 115	FT 130	140	40	178	157	119	100	-	130	56	74	24	22	M8	50	50	8	6
P.1R 90 L4,6,8	FT 115	FT 130	140	40	178	157	119	125	-	155	56	71	24	22	M8	50	50	8	6
P.1R 100 L4,6,8	FT 130	FT 165	160	45	192	177	126	140	-	175	63	73	28	24	M10	60	50	8	8
P.1R 100 LX4,8	FT 130	FT 165	160	32	188	196	136	140	-	171	63	102	28	28	M10	60	60	8	8
P.1R 112 M6,8	FT 130	FT 165	190	50	224	196	136	140	-	180	70	95	28	28	M10	60	60	8	8
P.1R 112 M6,8	FT 130	FT 165	190	50	224	196	136	140	-	180	70	95	28	28	M10	60	60	8	8
P.1R 112 M4	FT 130	FT 165	190	50	224	196	136	140	-	180	70	129	28	28	M10	60	60	8	8
P.1R 132 S6,8T	FT 130	FT 165	216	50	256	196	155	140	-	180	89	129	38	28	M12	80	60	10	8
P.1R 132 S4,6,8	FT 130	FT 165	216	50	256	217	178	140	55	180	89	153	38	32	M12	80	80	10	10
P.1R 132 M4	FT 165	FT 215	216	50	256	258	199	178	55	218	89	138	38	38	M12	80	80	10	10
P.1R 132 MX6	FT 165	FT 215	216	50	256	258	199	178	55	218	89	138	38	38	M12	80	80	10	10
P.1R 132 M6,8	FT 130	FT 165	216	50	256	217	178	178	55	218	89	135	38	32	M12	80	80	10	10
P.1R 160 M4,6,8	FT 165	FT 215	254	55	296	258	214	210	60	257	108	135	42	38	M16	110	80	12	10
P.1R 160 MX8	FT 165	FT 215	254	55	296	258	199	210	60	257	108	135	42	38	M16	110	80	12	10
P.1R 160 L4,6,8	FT 215	FT 265	254	55	296	313	242	254	60	301	108	142	42	42	M16	110	110	12	12
P.1R 180 M4	FT 265	-	279	62	328	313	242	241	65	288	121	142	48	42	M16	110	110	14	12
P.1R 180 L6,8	FT 265	-	279	62	328	313	242	279	65	326	121	104	48	42	M16	110	110	14	12

*) Centre holes acc. to DIN 332-DS

**) Terminal box left/right

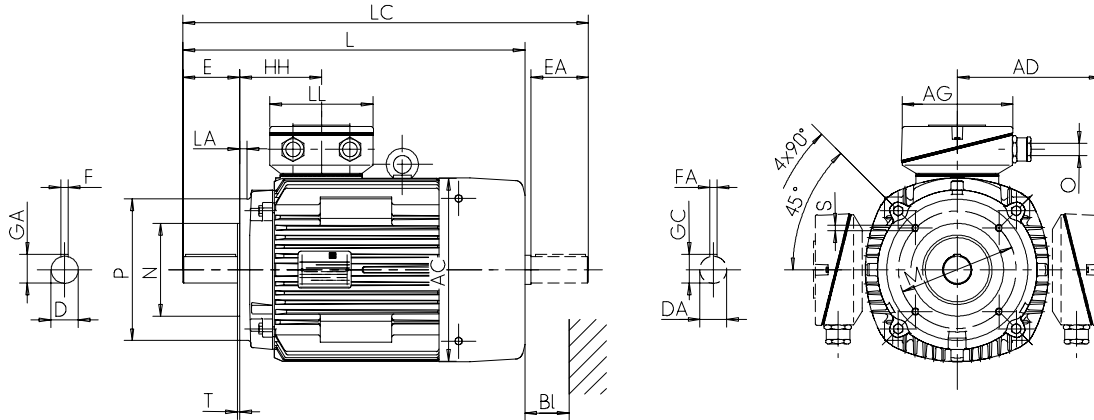
Permanent magnet synchronous energy efficient motors for inverter operation

Size 56 to 180

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B14 [IM 3601]

Flange dimensions see table „flange dimensions“



Type designation	GA t	GC t1	H h	HA c	HD p	HD**) p	HH A	K s	K' s'	L k	LC k1	Terminal box type	AG x	LL z	O r	Hole pattern	Bl. Bl.
K210 56 K2,4 U	10.2	10.2	56	7	154	A	58	6	6	150	175	KA 05	92	92	M20x1.5	4L	-
P.1R 56 G2,4	10.2	10.2	56	7	154	A	58	6	6	176	199	KA 05	92	92	M20x1.5	4L	14
P.1R 63 K2,4,6	12.5	12.5	63	10	161	A	58	8	8	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 63 G2,4,6	12.5	12.5	63	10	161	A	58	8	8	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 71 K2,4,6,8	16	16	71	11	175	A	61	8	8	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 71 G2,4,6,8	16	16	71	11	175	A	61	8	8	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 80 K2,4,6,8	21.5	21.5	80	12	191	A	67	10	10	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 80 G2,4,6,8	21.5	21.5	80	12	191	A	67	10	10	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 90 S2,4,6,8	27	24.5	90	14	210	A	70	10	10	275	330	KA 05	92	92	M25x1.5	4L	16
P.1R 90 L2,4,6,8	27	24.5	90	14	210	A	70	10	10	297	352	KA 05	92	92	M25x1.5	4L	16
P.1R 100 L2,4,6,8	31	27	100	15	227	A	75	12	12	331	386	KA 05	92	92	M25x1.5	4L	18
P.1R 100 LX4,8	31	31	100	11	237	A	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M6,8	31	31	112	18	249	A	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 MY4	31	31	112	18	249	A	77	12	12	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M4	31	31	112	18	249	A	77	12	12	391	459	KA 05	92	92	M25x1.5	4L	20
P.1R 132 S4,2,6,8T	41	31	132	18	287	A	105	12	12	430	498	KA 05-13	104	112	M32x1.5	4L	20
P.1R 132 S4,6,8	41	35	132	16	328	275	108	12	12	459	542	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M4	41	41	132	16	349	297	114	12	12	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 MX6	41	41	132	16	349	297	114	12	12	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M6,8	41	35	132	16	328	275	108	12	12	479	562	KK 25 A	156	145	M32x1.5	4L	35
P.1R 160 M4,6,8	45	41	160	18	389	322	114	15	15	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 MX8	45	41	160	18	389	322	114	15	15	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 L2,4,6,8	45	45	160	18	417	351	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 M4	51.5	45	180	20	417	351	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 L6,8	51.5	45	180	20	417	364	138	15	20	609	724	KK 63 A	193	167	M40x1.5	4L	35

** Terminal box left/right

Permanent magnet synchronous motors for inverter operation

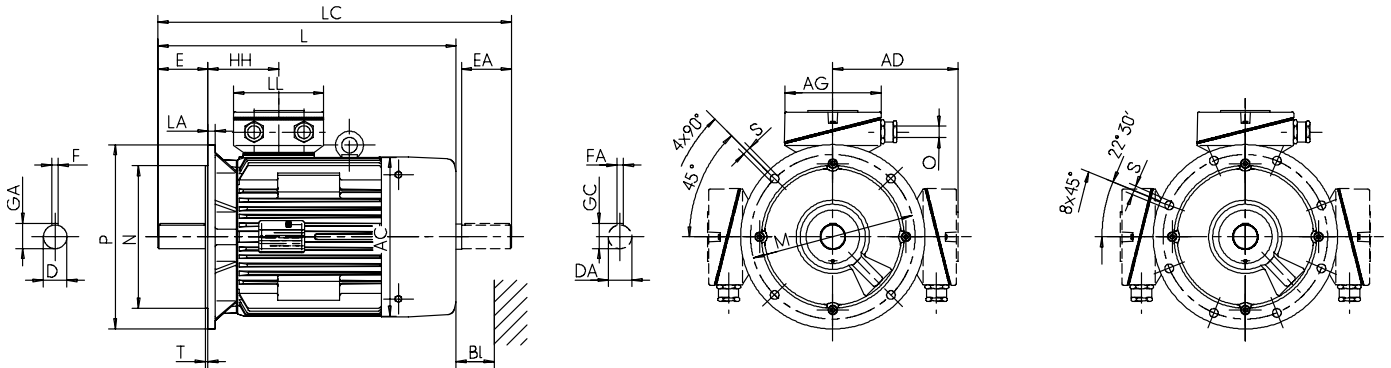
Size 56 to 280

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B5 [IM 3001]

Type of construction IM V1 [IM 3011]

Flange dimensions see table „flange dimensions“



Type designation	Flange size	AC g	AD**) g1	D d	DA d1	DB *)	E l	EA l1	F u	FA u1	GA t	GC t1	H h	HH A	L k	LC k1	Terminal box type	AG x	LL z	O r	Hole pattern	Bl Bl
P.10 56 K4 U	FF100	-	98	9	9	M3	20	20	3	3	10.2	10.2	56	81	173	197	KA 05	92	92	M20x1.5	4L	14
P.1R 56 G4	FF100	109	98	9	9	M3	20	20	3	3	10.2	10.2	56	81	199	223	KA 05	92	92	M20x1.5	4L	14
P.1R 63 K4,6	FF115	109	98	11	11	M4	23	23	4	4	12.5	12.5	63	58	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 63 G4,6	FF115	109	98	11	11	M4	23	23	4	4	12.5	12.5	63	58	179	205	KA 05	92	92	M20x1.5	4L	14
P.1R 71 K4,6,8	FF130	124	104	14	14	M5	30	30	5	5	16	16	71	61	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 71 G4,6,8	FF130	124	104	14	14	M5	30	30	5	5	16	16	71	61	206	239	KA 05	92	92	M20x1.5	4L	14
P.1R 80 K4,6,8	FF 165	139	111	19	19	M6	40	40	6	6	21.5	21.5	80	67	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 80 G4,6,8	FF 165	139	111	19	19	M6	40	40	6	6	21.5	21.5	80	67	249	293	KA 05	92	92	M20x1.5	4L	16
P.1R 90 S4,6,8	FF 165	157	119	24	22	M8	50	50	8	6	27	24.5	90	70	275	330	KA 05	92	92	M25x1.5	4L	16
P.1R 90 L4,6,8	FF 165	157	119	24	22	M8	50	50	8	6	27	24.5	90	70	297	352	KA 05	92	92	M25x1.5	4L	16
P.1R 100 L4,6,8	FF 215	177	126	28	24	M10	60	50	8	8	31	27	100	75	331	386	KA 05	92	92	M25x1.5	4L	18
P.1R 100 LX4,8	FF 215	196	136	28	28	M10	60	60	8	8	31	31	100	77	357	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M6,8	FF 215	196	136	28	28	M10	60	60	8	8	31	31	112	77	391	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 MY4	FF 215	196	136	28	28	M10	60	60	8	8	31	31	112	77	391	425	KA 05	92	92	M25x1.5	4L	20
P.1R 112 M4	FF 215	196	136	28	28	M10	60	60	8	8	31	31	112	77	391	459	KA 05	92	92	M25x1.5	4L	20
P.1R 132 S4,6,8T	FF265	196	155	38	28	M12	80	60	10	8	41	31	132	105	430	498	KA 05-13	104	112	M32x1.5	4L	20
P.1R 132 S4,6,8	FF265	217	178	38	32	M12	80	80	10	10	41	35	132	108	459	542	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M4	FF265	258	199	38	38	M12	80	80	10	10	41	41	132	114	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 MX6	FF265	258	199	38	38	M12	80	80	10	10	41	41	132	114	481	565	KK 25 A	156	145	M32x1.5	4L	35
P.1R 132 M6,8	FF265	217	178	38	32	M12	80	80	10	10	41	35	132	108	479	562	KK 25 A	156	145	M32x1.5	4L	35
P.1R 160 M4,6,8	FF300	258	214	42	38	M16	110	80	12	10	45	41	160	114	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 MX8	FF300	258	199	42	38	M16	110	80	12	10	45	41	160	114	559	643	KK 63 A	193	167	M40x1.5	4L	35
P.1R 160 L4,6,8	FF300	313	242	42	42	M16	110	110	12	12	45	45	160	138	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 M4	FF300	313	242	48	42	M16	110	110	14	12	51.5	45	180	138	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 L4	FF300	351	261	48	48	M16	110	110	14	14	51.5	51.5	180	147	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 180 L6,8	FF300	313	242	48	42	M16	110	110	14	12	51.5	45	180	138	609	724	KK 63 A	193	167	M40x1.5	4L	35
P.1R 200 L4,6,8	FF 350	351	261	55	48	M20	110	110	16	14	59	51.5	200	147	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 200 LX6	FF 350	351	261	55	48	M20	110	110	16	14	59	51.5	200	147	680	796	KK 63 A	193	167	M40x1.5	4L	35
P.1R 225 S4,8	FF 400	390	300	60	55	M20	140	110	18	16	64	59	225	168	757	881	KK 100 A	213	207	M50x1.5	8L	40
P.1R 225 M4	FF 400	390	300	60	55	M20	140	110	18	16	64	59	225	168	797	921	KK 100 A	213	207	M50x1.5	8L	40
P.1R 225 M6,8,12	FF 400	390	300	60	55	M20	140	110	18	16	64	59	225	168	757	881	KK 100 A	213	207	M50x1.5	8L	40
P.1R 250 M4,6,8,12	FF 500	440	358	65	55	M20	140	110	18	16	69	59	250	177	862	977	KK 200 A	282	242	M63x1.5	8L	45
P.1R 280 S4,6,8,12	FF 500	490	386	75	65	M20	140	140	20	18	79.5	69	280	206	924	1,072	KK 200 A	282	242	M63x1.5	8L	50
P.1R 280 M4,6,8,12	FF 500	490	386	75	65	M20	140	140	20	18	79.5	69	280	206	970	1,118	KK 200 A	282	242	M63x1.5	8L	50

*) Centre holes acc. to DIN 332-DS

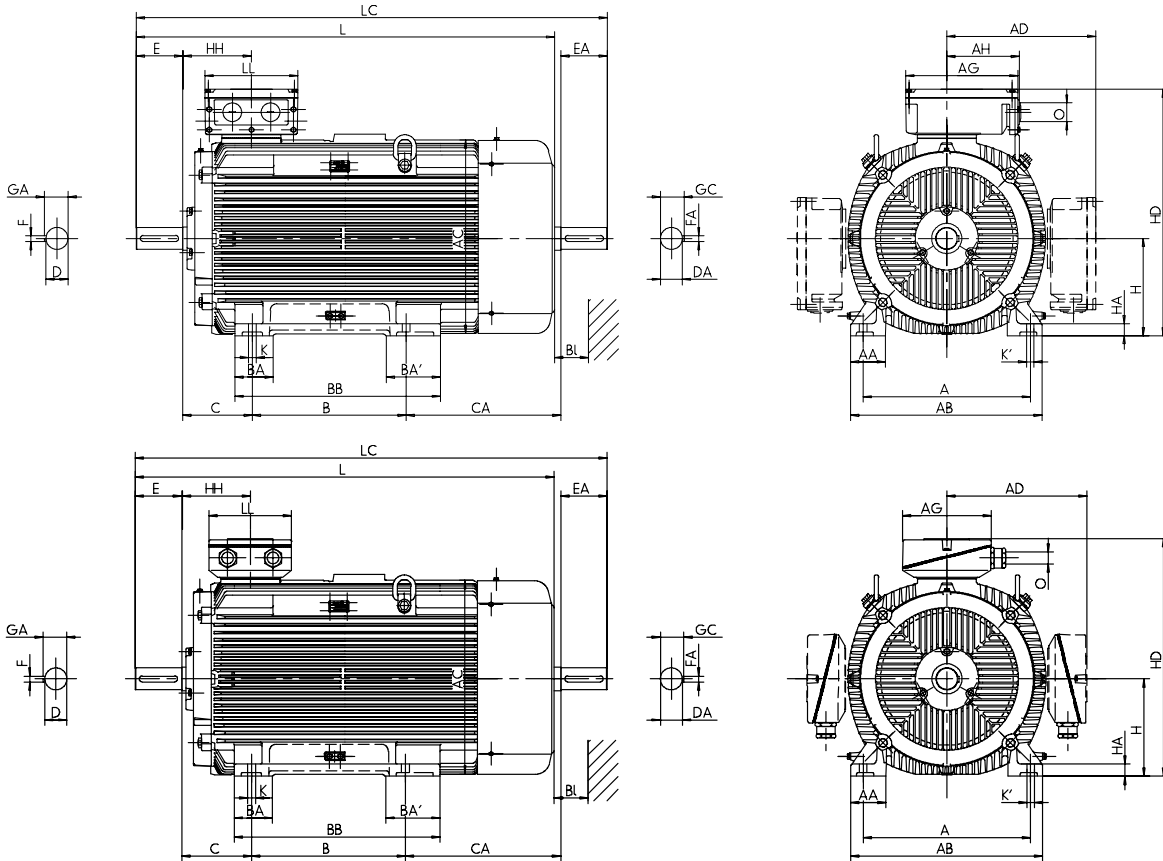
**) Terminal box left/right

Permanent magnet synchronous motors for inverter operation

Size 315

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B3 [IM 1001]



Type designation	Flange size	A	AA	AB	AC	AD**)	B	BA	BA'	BB	C	CA	D	DA	DB *)	E	EA	F	FA
PE1R, P21R		b	n	f	g	g1	a	m	m1	e	w1	w2	d	d1		l	l1	u	u1
P21R 315 S4,6,8,12	FF 600	508	126	590	550	416	406	120	-	503	216	316	80	70	M20	170	140	22	20
P21R 315 M4,6,8,12	FF 600	508	126	590	550	416	457	120	-	554	216	320	80	70	M20	170	140	22	20
P21R 315 MX4	FF 600	508	126	590	550	416	457	120	150	554	216	400	80	70	M20	170	140	22	20
P21R 315 MX6,8	FF 600	508	126	590	550	416	457	120	150	554	216	320	80	70	M20	170	140	22	20
P21R 315 MX12	FF 600	508	126	590	550	416	457	120	150	554	216	320	80	70	M20	170	140	22	20
P21R 315 MY4,6,8,12	FF 600	508	110	590	610	498	457	120	-	573	216	495	80	70	M20	170	140	22	20
P21R 315 L4,6,8,12	FF 600	508	110	590	610	498	508	120	-	624	216	564	80	70	M20	170	140	22	20
P21R 315 LX4	FF 600	508	110	590	610	481	508	120	-	624	216	689	80	70	M20	170	140	22	20
P21R 315 LX6,8,12	FF 600	508	110	590	610	498	508	120	-	624	216	564	80	70	M20	170	140	22	20

*) Centre holes acc. to DIN 332-DS

**) Terminal box left/right

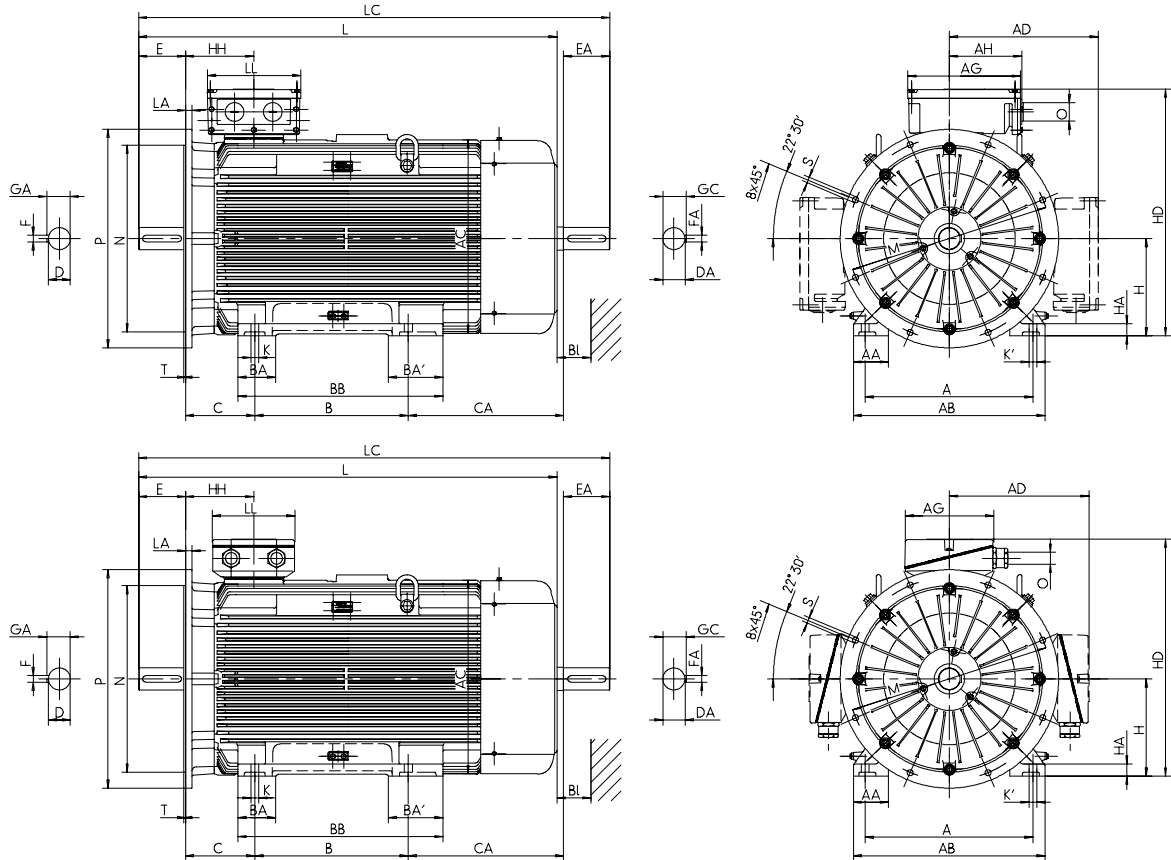
Permanenterregte Synchronmotoren für Umrichterbetrieb

Size 315

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B35 [IM 2001]

Flange dimensions see table „flange dimensions“



Type designation	GA	GC	H	HA	HD	HD**)	HH	K	K'	L	LC	Terminal box type	AG	LL	AH	O	BI
PE1R, P21R	t	t1	h	c	p	p	A	s	s'	k	k1		x	z	-	r	Bl
P21R 315 S4,6,8,12	85	74.5	315	44	731	595	211	28	35	1080	1248	KK 200 A	282	242	-	M63x1.5	55
P21R 315 M4,6,8,12	85	74.5	315	44	731	595	211	28	35	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX4	85	74.5	315	44	731	595	211	28	35	1210	1383	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX6,8	85	74.5	315	44	731	595	211	28	35	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX12	85	74.5	315	44	731	595	211	28	35	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MY4,6,8,12	85	74.5	315	44	774	628	230	28	35	1300	1478	KK 400 B	315	294	265	M63x1.5	55
P21R 315 L4,6,8,12	85	74.5	315	44	774	628	230	28	35	1420	1598	KK 400 B	315	294	265	M63x1.5	55
P21R 315 LX4	85	74.5	315	44	796	628	230	28	35	1540	1723	KK 400 B	315	294	265	M63x1.5	55
P21R 315 LX6,8,12	85	74.5	315	44	796	628	230	28	35	1420	1598	KK 400 B	315	294	265	M63x1.5	55

***) Terminal box left/right

Permanent magnet synchronous motors for inverter operation

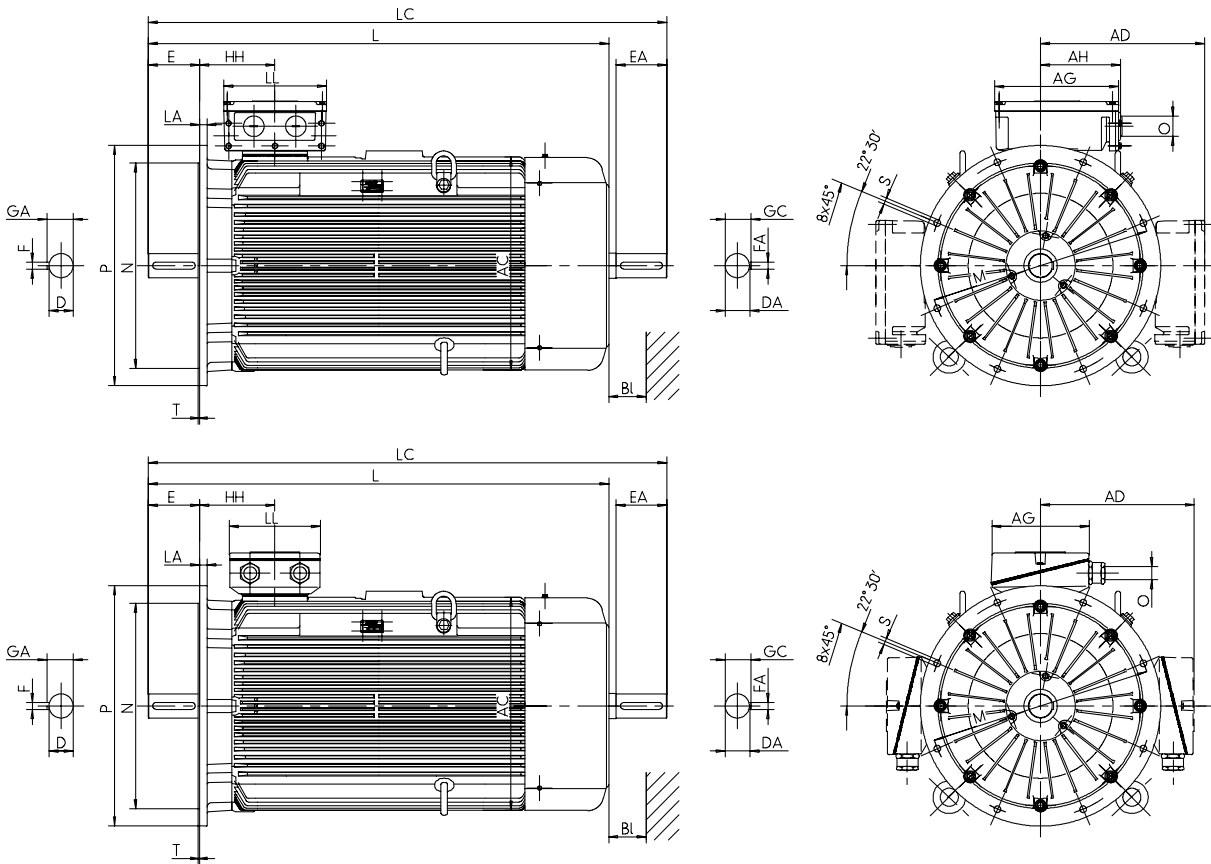
Size 315

with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B5 [IM 3001] up to size 315 MY,

Type of construction IM V1 [IM 3011]

Flange dimensions see table „flange dimensions“



Type designation	Flange size	AC g	AD**) g1	D d	DA d1	DB *)	E l	EA l1	F u	FA u1	GA t	GC t1	H h	HH A	L k	LC k1	Terminal box type	AG x	LL z	AH -	O r	BI Bl
P21R 315 S4,6,8,12	FF 600	550	416	80	70	M20	170	140	22	20	85	74.5	315	211	1080	1248	KK 200 A	282	242	-	M63x1.5	55
P21R 315 M4,6,8,12	FF 600	550	416	80	70	M20	170	140	22	20	85	74.5	315	211	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX4	FF 600	550	416	80	70	M20	170	140	22	20	85	74.5	315	211	1215	1383	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX6,8	FF 600	550	416	80	70	M20	170	140	22	20	85	74.5	315	211	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MX12	FF 600	550	416	80	70	M20	170	140	22	20	85	74.5	315	211	1135	1303	KK 200 A	282	242	-	M63x1.5	55
P21R 315 MY4,6,8,12	FF 600	610	498	80	70	M20	170	140	22	20	85	74.5	315	230	1300	1478	KK 400 B	315	294	265	M63x1.5	55
P21R 315 L4,6,8,12	FF 600	610	498	80	70	M20	170	140	22	20	85	74.5	315	230	1420	1598	KK 400 B	315	294	265	M63x1.5	55
P21R 315 LX4	FF 600	610	481	80	70	M20	170	140	22	20	85	74.5	315	230	1540	1723	KK 400 B	315	294	265	M63x1.5	55
P21R 315 LX6,8,12	FF 600	610	498	80	70	M20	170	140	22	20	85	74.5	315	230	1420	1598	KK 400 B	315	294	265	M63x1.5	55

*) Centre holes acc. to DIN 332-DS

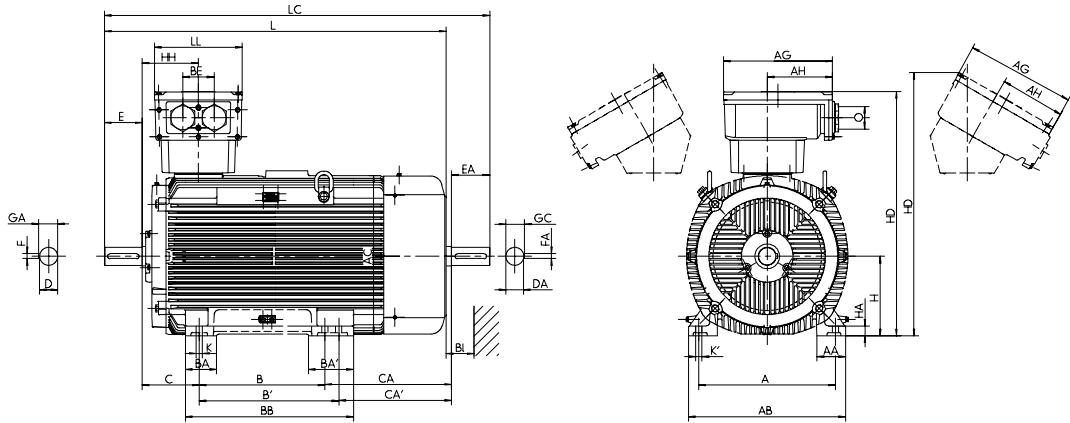
**) Terminal box left/right

Permanent magnet synchronous motors for inverter operation

Size 355

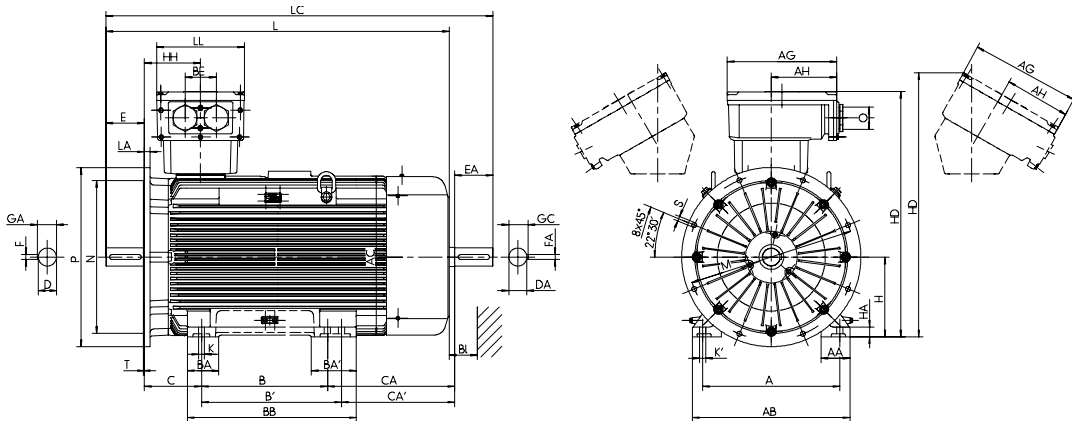
with surface ventilator, cooling method IC 411, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM B3 [IM 1001],



Type of construction IM B35 [IM 2001]

Flange dimensions see table „flange dimensions“



Type designation	Flange size	A b	AA n	AB f	AC g	B a	BA m	BA' m1	BB e	C w1	CA w2	D d	DA d1	DB *)	E l	EA l1	F u	FA u1
P22R 355 MY4,6,8,12	FF 740	610	130	700	715	560	140	200	750	254	561	100	80	M24	210	170	28	22
P22R 355 M4	FF 740	610	130	700	715	560	140	200	750	254	561	100	80	M24	210	170	28	22
P22R 355 M6,8,10	FF 740	610	130	700	715	560	140	200	750	254	561	100	80	M24	210	170	28	22
P22R 355 MX6,8,12	FF 740	610	130	700	715	560	140	200	750	254	681	100	80	M24	210	170	28	22
P22R 355 MX4	FF 740	610	130	700	715	560	140	200	750	254	681	100	80	M24	210	170	28	22
P22R 355 LY4,L4	FF 740	610	130	700	715	630	140	200	750	254	611	100	80	M24	210	170	28	22
P22R 355 L, LY6,8,12	FF 740	610	130	700	715	630	140	200	750	254	611	100	80	M24	210	170	28	22

Type designation	GA t	GC t1	H h	HA c	HD p	HD **)	HH A	K s	K' s'	L k	LC k1	Terminal box type	AG x	LL z	AH	BE	O r	BI Bl
P22R 355 MY4,6,8,12	106	85	355	44	1091	1172	250	28	35	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 M4	106	85	355	44	1091	1172	250	28	35	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 M6,8,10	106	85	355	44	1091	1172	250	28	35	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 MX6,8,12	106	85	355	44	1091	1172	327	28	35	1690	1875	KK 630 A	496	390	301	140	M72x2	60
P22R 355 MX4	106	85	355	44	1083	1174	327	28	35	1690	1875	KK 1000 A	615	474	385	200	M72x2	60
P22R 355 LY4,L4	106	85	355	44	1083	1174	327	28	35	1690	1875	KK 1000 A	615	474	385	200	M72x2	60
P22R 355 L, LY6,8,12	106	85	355	44	1083	1174	327	28	35	1690	1875	KK 1000 A	615	474	385	200	M72x2	60

*) Centre holes acc. to DIN 332-DS

**) Terminal box left/right

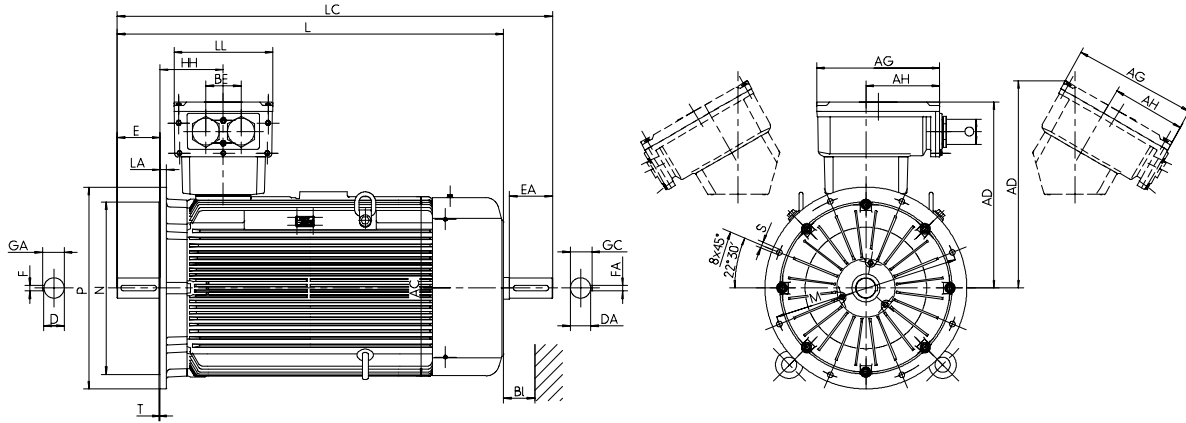
Permanent magnet synchronous motors for inverter operation

Size 355

with surface ventilator, cooling method IC 403, thermal class 155 [F/B], degree of protection IP 55

Type of construction IM V1 [IM 3011]

Flange dimensions see table „flange dimensions“



Type designation	Flange size	AC g	AD g1	AD **)	D d	DA d1	DB *)	E l	EA l1	F u	FA u1	GA t	GC t1	H h	HH A	L K	LC K1	Terminal box type	AG x	LL z	AH -	BE -	O r	Bl. Bl
P22R 355 MY4,6,8,12	FF 740	715	736	817	100	80	M24	210	170	28	22	106	85	355	250	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 M4	FF 740	715	736	817	100	80	M24	210	170	28	22	106	85	355	250	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 M6,8,12	FF 740	715	736	817	100	80	M24	210	170	28	22	106	85	355	250	1570	1755	KK 630 A	496	390	301	140	M72x2	60
P22R 355 MX6,8,12	FF 740	715	736	817	100	80	M24	210	170	28	22	106	85	355	327	1690	1875	KK 630 A	496	390	301	140	M72x2	60
P22R 355 MX4	FF 740	715	728	819	100	80	M24	210	170	28	22	106	85	355	327	1690	1875	KK 1000 A	615	474	385	200	M72x2	60
P22R 355 LY,L4	FF 740	715	728	819	100	80	M24	210	170	28	22	106	85	355	327	1690	1875	KK 1000 A	615	474	385	200	M72x2	60
P22R 355 L, LY6,8,12	FF 740	715	728	819	100	80	M24	210	170	28	22	106	85	355	327	1690	1875	KK 1000 A	615	474	385	200	M72x2	60

*) Centre holes acc. to DIN 332-DS

***) Terminal box left/right

Permanent magnet synchronous motors for inverter operation

Size 225 to 355

Design with forced ventilation, type of cooling IC 416

changes in dimensions for design with forced ventilation and water cooling

Type designation	L
	K
P21F 225 M12	950.5
P21F 250 M12	1016.5
P21F 280 S12	1119
P21F 280 M12	1165
P21F 315 S12	1223.5
P21F 315 M12	1278.5
P21F 315 MX12	1278.5
P21F 315 L12	1568.5
P22F 355 MY12	1890.5
P22F 355 M12	1890.5
P22F 355 MX12	1890.5
P22F 355 LY12	1890.5
P22F 355 L12	1890.5

Design with water cooling, type of cooling 31W

Type designation	L	LC
	K	K1
P21B 225 M12	710	830
P21B 250 M12	737	857
P21B 280 S12	875	1028
P21B 280 M12	875	1028
P21B 315 S12	909	1056
P21B 315 M12	964	1111
P21B 315 MX12	964	1111
P21B 315 L12	1266	1410
P22B 355 MY12	1405	1592
P22B 355 M12	1405	1592
P22B 355 MX12	1525	1712
P22B 355 LY12	1485	1672
P22B 355 L12	1525	1712



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