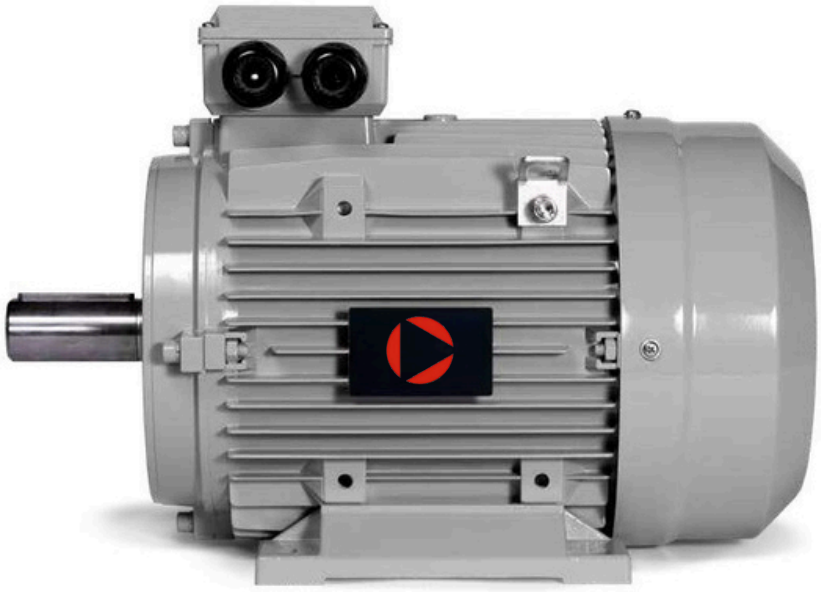
INFRANOR
MOTION EXCELLENCE

The MPM Series Manual

IE4 / IE5 Premium Synchronous Motors

Ultra Premium Efficiency



Legend

Version	Output Reason
V1	First Edition

We reserve the right to make technical changes for the purpose of improving the product.

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1.0 Product Description

The MPM motors (**MPM** = **M**ovinor **P**ermanent magnet **M**otors) combine the technology of a permanently excited synchronous motor with the classic asynchronous design.
The IE4 / IE5 Premium motors have buried permanent magnets (**IPM** = **I**ntegrated **P**ermanent **M**agnets) in the rotor providing superior performance and efficiency. The stator includes a three-phase winding that can be wired as Delta or Y configuration and run by a standard Inverter Drive (VFD). The motor is brushless and is electrically commutated by the drive/inverter through sensorless vector control.

1.1 Advantages compared to standard asynchronous motors

- Sustainable reduction of energy cost due to IE4 / IE5 efficiency (up to 98%).
- Further efficiency advantages in the partial load range
- Efficient use of materials and resources
- Reduced number of variants possible
- More compact design (1 to 2 sizes smaller)
- Lower motor weight
- Constant torque over the entire speed range
- Lower current consumption
- Better dynamic properties (3 times nominal torque)
- No slip due to innovative sensorless speed control
- Speeds up to 4,000 RPM are possible in the standard configuration

1.2 Advantages over PM (Permanent Magnet) servo motors

- Standard self-cooling TEFC (Totally Enclosed Fan-Cooled) design
- Higher Efficiency
- Lower purchase price due to the use of standardized components in production

1.3 Other advantages

- Increased protection against demagnetization due to buried magnets
- Innovative sensorless speed control enables operation similar to a servo motor
- Compatible with third-party frequency Inverters (VFD) manufacturers

1.4 Smaller shaft

Due to the size reduction, the shaft dimensions and installed bearings are smaller than in compatible asynchronous motors, and thus the axial and radial load capacities are lower. This can be partly compensated by using larger end shields.

2.0 Economic advantages due to efficiency improvements

MPM motors have the edge over comparable PM motors as they utilize standard components in their production process. The production of the IPM rotors creates a cost disadvantage when compared to pure asynchronous motors. This additional cost is typically amortized after a short time due to the higher efficiency.

2.1 Efficiency advantage in partial load range

Efficiency levels can differ depending on speed and workload. Notably, efficiency can be significantly lower when operating below rated values. In asynchronous motors it is necessary to first generate the opposing field in the rotor, resulting in higher losses at lower speeds compared to a PM motor. To accurately determine the benefits of the MPM range over an asynchronous motor, understanding the load cycle is crucial. If this information is unavailable, it is recommended to conduct a power measurement directly before the frequency inverter (VFD) and then compare the outcome.

2.2 Amortization calculation at nominal

To perform an amortization calculation the following values must be known:

- **η 1**: Efficiency of the machine being compared to.
- **η 2**: Efficiency of the MPM motor.
- **t**: Running time of the machine per year (hours).
- **P**: Nominal power of the machine (kW)
- **K**: Energy price from your electric supplier ($/kWhr)

It is necessary to include a frequency inverter which is required for the operation of the MPM motors. Two efficiency specifications are provided in the technical data of the MPM motors. The information for the Pure Sine refers to the hypothetical operating case where the MPM motor is powered directly off the mains (only for calculation purposes). The value with the inverter is slightly lower than the Pure Sine due to additional losses in the motor from PWM (Pulse Width Modulation). For this calculation, we will assume that the asynchronous motor being compared is also using a VFD with sensorless vector control.

Savings Per Year ($) = P * t * K * (η 2-η 1)

If no frequency inverter is used to operate the asynchronous motor, the purchase price of the frequency inverter and its efficiency must be included for the MPM motor. The efficiency advantage of the MPM motor is then reduced by approximately 2%.

3.0 Safety instructions for the operation of MPM motors

- All work for connection, commissioning, and installation may only be carried out by trained and qualified personnel. They must be familiar with and observe the following standards and guidelines: **DIN VDE 0105, IEC 364, Accident prevention regulations.** Improper behavior can cause serious personal injury and property damage.
- Before installation and commissioning, read the documentation as well as the commissioning and maintenance instructions. Observe the information on the nameplate, documentation) as well as technical data.

- Surface temperature greater than 100 C can occur on the motors. Make sure that no temperature-sensitive parts are in contact with or attached to the motor body. Protective measures against contact may have to be provided.
- Even if no voltage has been applied, voltages can occur at the motor terminals when the permanent magnet motor is rotating. Check and ensure that the motor is at a standstill before working on it.

- Strong magnetic fields can destroy or influence electronic devices. Strong magnetic fields in the rotor and their forces can attract magnetic parts and cause damage or injury.

4.0 General technical characteristics

- The motors are manufactured in accordance with standard **IEC/EN 60034-1: Rotating electrical machines Part 1: Design and operating characteristics**.
- The motors are self-cooling. Standard cooling is provided by a rear-mounted speed-dependent fan which increases surface convection.
- The motors have an aluminum housing. This includes both end shields for the B14 and B5 variants. The only exception: MPM 160L (B14 Flange), the drive side bearing shield is made of cast iron.
- The shafts are made of steel (material: 39NiCrMo3), with a cylindrical end and a threaded hole.
- Without a shaft seal, but this can be added in both end shields
- The winding has insulation class F.
- Color: RAL 7030

5.0 Order Code

Family	1	2	3	4	5	6	7	8	9	10 (optional)
MPM	80L	P	F	P	0	0-B01-UL	B5	TR	0	Customization Code

1. Frame Size

- 80L
- 90LL
- 112M
- 132M
- 160L

2. Thermal Sensor

0 = No Sensor
1 = PT100
2 = PT1000
S = x3 BI NC 130
T = x3 BI NO 130
P = PTC 130 (standard)
N = NTC 130

3. Fan Options

0 = No Fan
F = Fan Wheel (standard)
E = External Fan

4. Shaft Options

P = Feather key (standard)
G = Smooth
X = Custom

5. Ingress Protection

0 = IP-55 (standard)
IP56 = IP-56
IP65 = IP-65
IP66 = IP-66

6a. Feedback

0 = Sensorless (standard)
E01 = Resolver
XXX = Custom

6b. Additional Options

B01 = Bearing for Vertical Install
T05 = Drain for Water Condensation
T04 = Anti Condensation Heater
A02 = Insulation Class H Winding
A01 = Additional Winding Impregnation
UL = UL Version
P01 = Rain Cover
EX = Atex Zone 22/2
RAL#### = Other RAL Colors (RAL 7030 std.)
C# = Special Corrosion Paint (C1 - C5M)
F01 = 24Vdc Brake
F03 = Manual Brake Actuation Lever
F04 = IP55 Protection for Brake
R01 = Manual Rotation Level
IE5 = IE5 Efficiency
XX = Custom

7. Mounting Options (Section 13.0)

B3 = Foot Only
B5 = B5 Flange Only
B14 = B14 Flange Only
B35 = B5 Flange and Foot Mount
B34 = B14 Flange and Foot Mount

8. Terminal Box Options (Sections 13.1 - 13.2)

8a. - Choose One (Box Orientation)
T = Top (standard)
L = Left
R = Right

8b. - Choose One (Cable Exit)
R = Right (standard)
L = Left
A = Toward Shaft
B = Toward Fan

9. Winding Options

0 = 400 - 480 Vac (standard)
X = Custom

6.0 Electrical data Y-circuit

Characteristics	Symbol	Unit	80L	90LL	112M	132M	160L
Rated Power (S1)[1]	P	kW	3.0	6.5	10.9	18.4	31.2
Rated Speed	n	rpm	2,300				
Rated Frequency	f	Hz	115				
Rated Torque	Mn	Nm	12.5	27.0	45.3	76.4	129.5
Rated Voltage	Uac	Vac	363	356	345	398	397
Rated Current	In	Arms	5.8	11.6	20.0	32.7	58.6
Supply Voltage (VFD)	Uac	Vac	400				
Number of Poles	p	#	6				
Switching Frequency	fs	kHz	4				
Voltage Constant (effective value) ± 5%	Ke	V/krpm	147	142	132.5	157	147
Torque Constant ± 5%	Kt	Nm/Arms	2.44	2.35	2.19	2.6	2.43
Efficiency (pure sine)[2]	η	%	94.5	96.2	95.7	96.1	96.7
Efficiency (with VFD)	η	%	93.5	93.8	95.1	95.5	96.0
Max Speed	nmax	rpm	2,600	2,800	2,600	2,500	2,600
Max Torque	Tmax	Nm	25.0	54.0	90.6	152.8	259.0
Max Current	Imax	Arms	11.5	23.7	45.5	65.0	117.2
Winding Resistance (pp)	Rpp	Ohm	3.30	1.32	0.63	0.29	0.112
Winding Inductance (pp)	Lpp	mH	43.50	23.90	15.30	7.18	4.80
Winding Inductance Ld (pp)	Ld	mH	25.50	13.00	8.90	5.93	3.70
Winding Inductance Lq (pp)	Lq	mH	61.40	34.80	21.60	8.43	5.90

1: For continuous duty cycle

2: Pure sine efficiency is only used for comparing against a direct mains wired AC Vector Motor

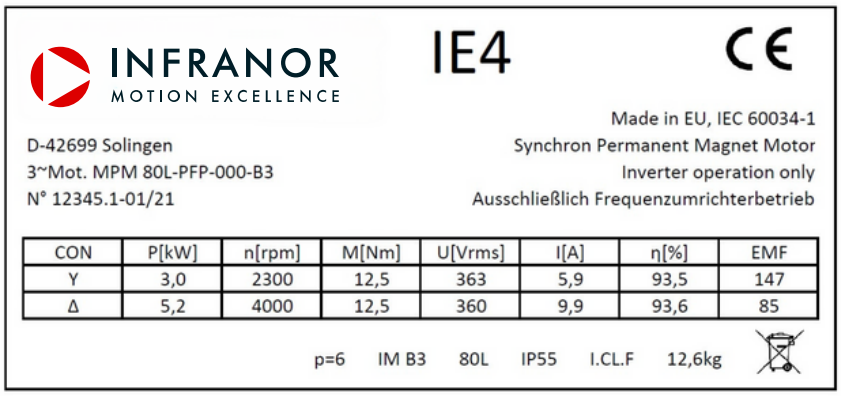
7.0 Electrical data Delta-circuit

Characteristics	Symbol	Unit	80L	90LL	112M	132M	160L
Rated Power (S1)[1]	P	kW	5.2	11.3	18.9	32.0	54.0
Rated Speed	n	rpm	4,000				
Rated Frequency	f	Hz	200				
Rated Torque	Mn	Nm	12.5	27.0	45.3	76.4	129.5
Rated Voltage	Uac	Vac	360	343	342	387	386
Rated Current	In	Arms	9.9	19.8	34.6	58.8	101.0
Supply Voltage (VFD)	Uac	Vac	400				
Number of Poles	p	#	6				
Switching Frequency	fs	kHz	4				
Voltage Constant (effective value) ± 5%	Ke	V/krpm	85	82.5	76.5	91	85
Torque Constant ± 5%	Kt	Nm/Arms	1.41	1.37	1.27	1.51	1.41
Efficiency (pure sine)[2]	η	%	97.2	97.3	98.2	98.1	95.1
Efficiency (with VFD)	η	%	93.6	94.0	95.2	95.1	94.4
Max Speed	nmax	rpm	4,500	4,800	5,000	4,300	4,500
Max Torque	Tmax	Nm	25.0	54.0	90.6	152.8	259.0
Max Current	Imax	Arms	19.5	41.0	78.5	111.3	203.0
Winding Resistance (pp)	Rpp	Ohm	1.10	0.46	0.19	0.12	0.038
Winding Inductance (pp)	Lpp	mH	15.00	7.90	5.00	2.21	1.50
Winding Inductance Ld (pp)	Ld	mH	8.00	4.07	2.90	1.72	1.10
Winding Inductance Lq (pp)	Lq	mH	21.90	11.90	7.00	2.71	1.80

1: For continuous duty cycle

2: Pure sine efficiency is only used for comparing against a direct mains wired AC Vector Motor

8.0 Nameplate



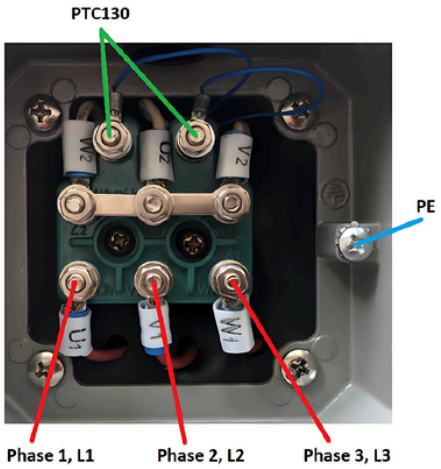
- **IE4 / IE5**: IE4 efficiency according to IEC/EN 60034-30-2, standard for variable speed motors fed by frequency inverters
  IE5 efficiency according to VDE 0530-30-2, Available upon customer request for motor size 80, 90, and 112.
- **CE:** Proof of conformity
- **IEC 60034-1:** Standard: Rotating electrical machines Part 1, Design and operational behavior.
- **3~Mot.:** Motor has three phases
- **MPM 80L-:** Motor designation
- **N 12345.1:** Serial number
- **-01/21**: Production week and year
- **CON:** Type of motor connection
- **Y:** This line contains the values for the motor wired as Star
- **Δ**: This line contains the values for the motor wired as Delta
- **P [kW]:** Output shaft power at rated speed in kW
- **n [RPM]:** Rated speed in revolutions per minute
- **M [Nm]:** Nominal torque in newton meters
- **U [Vrms]:** Rated voltage at rated speed in volts (rms = root mean squared, effective value)
- **I [A]:** Rated current in amps
- **η [%]**: Efficiency in percent with VFD
- **EMF:** EMF (electromagnetic force) in volts, effective value per 1,000 RPM
- **P=6:** Number of poles
- **IM B3:** Mounting design
- **80L:** Housing size (axis height and length)
- **IP55:** Ingress protection class
- **I.C.F:** Insulation class F
- **12.6 kg:** Motor weight

-  Disposal note, do not dispose of in household waste.

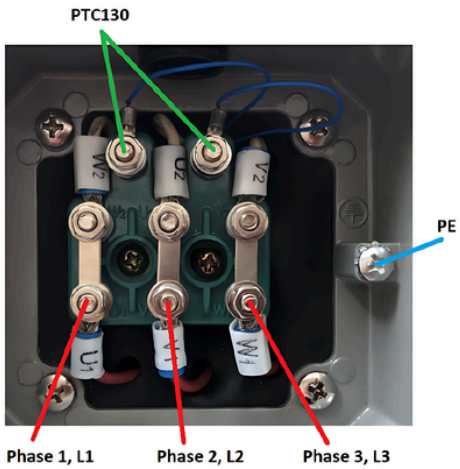
9.0 Electrical Connection

- Even if no voltage has been applied, voltage can occur at the motor terminals of a rotating motor with permanent magnets. Check and ensure that the motor is at a standstill before working on it.
- MPM motors are not intended for direct connection to a three-phase power supply system. They must be operated via a frequency inverter (VFD) with “sensorless vector control”. Failure to observe this may destroy the motor.
- Use the provided nameplate or manual data for proper parameters during commissioning.
- Check that the frequency inverter and motor are appropriate for each other (rated voltage and current) as well as the application type.
- The terminal box can be rotated 90 /180 / 270 degrees according to your requirements.
- The motor is grounded via the PE connection provided in the terminal box.
- The shielding of the motor must be carried out according to the frequency inverter operating instructions. If necessary use low- capacitance shielded cable and EMC cable glands.
- The cable must be intercepted via the strain relief of the cable gland.
- Make sure that no contamination (insulation, shielding, wire, etc.) remains in the terminal box.
- Connect the motor in Y or Delta connection according to your requirements.

Y - Connection



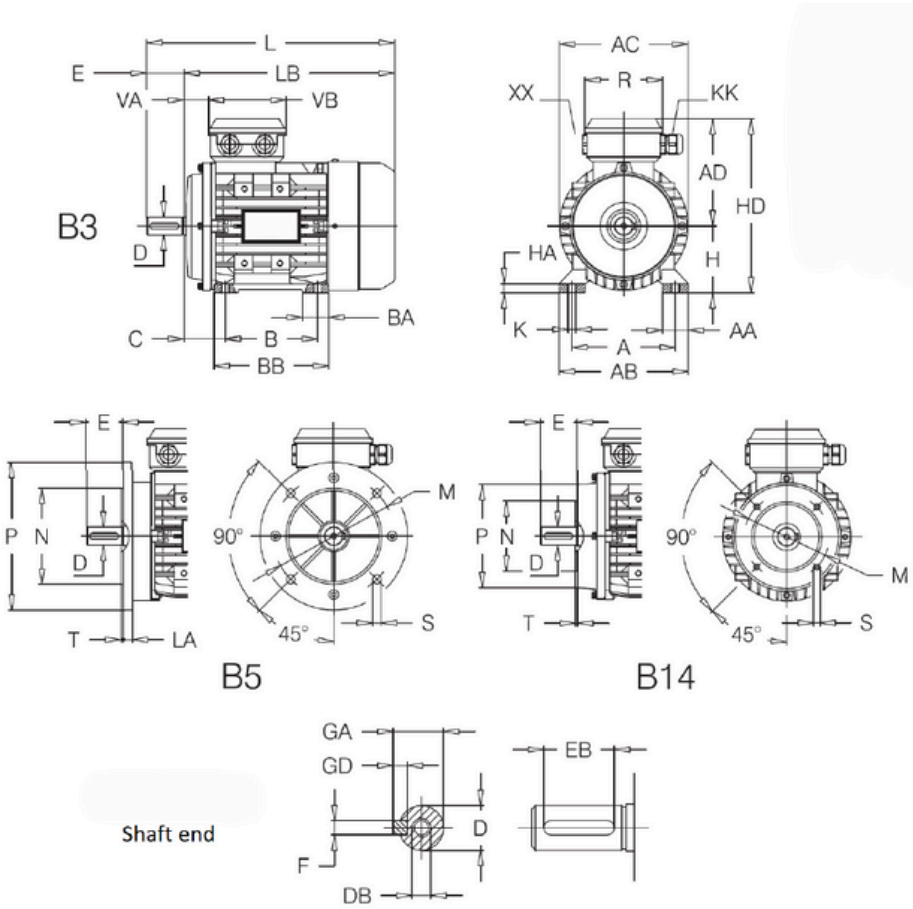
Delta Connection



10.0 Thermal protection

A PTC130 thermistor is provided as the standard option for the MPM motor thermal protection device. This can be connected to your VFD / drive using the terminals listed above. There is no polarity. Other temperature sensors are also available. In this case please observe the enclosed connection documents.

11.0 Mechanical dimensions



Motor Size (mm)	Dimensions						Feet								
	AC	AD	H	HD	LB	L	A	B	C	AB	BB	AA	BA	HA	K
80L	157	135	80	215	254	294	125	100	50	160	130	35	35	11	10x13
90LL	174	143	90	233	283	333	140	125	56	175	155	35	33	12	10x13
112M	221	174	112	286	334	394	190	140	70	220	180	55	42	15	12x15
132M	258	193	132	325	390	470	216	178	89	252	212	58	40	15	13x16
160L	314	235	160	395	530	640	254	254	108	291	293	54	90	17	16x20

Motor Size (mm)	Flange							Shaft						
	IM	M	N j6	p	LA	T	S	D	DB	E	GA	F	GD	EB
80L	B5 B14	165 100	130 80	200 120	10 -	3.5 3	12 M6	19 j6	M6	40	21.5	6	6	32
90LL	B5 B14	165 115	130 95	200 140	12 -	3.5 3	12 M8	24 j6	M8	50	27	8	7	40
112M	B5 B14	215 130	180 110	250 160	14 -	4 3.5	15 M8	28 j6	M10	60	31	8	7	50
132M	B5 B14	265 165	230 130	300 200	14 -	4 3.5	15 M10	38 k6	M12	80	41	10	8	70
160L	B5 B14	300 215	250 180	350 250	15 -	5 4	15 M12	42 k6	M16	100	45	12	8	90

11.1 Terminal box dimensions

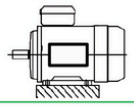
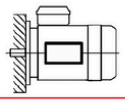
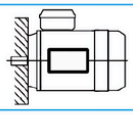
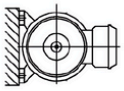
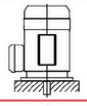
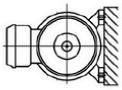
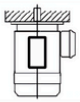
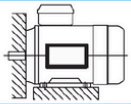
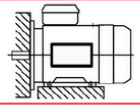
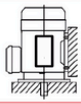
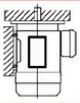
Motor Size (mm)	Terminal Box						
	VA	VB	R	XX	KK	Internal Screw	Max Cable Diam.
80L	27.5	105	105	M20 x 1.5	M20 x 1.5	x6 M4	12
90LL	32	105	105	M25 x 1.5	M25 x 1.5	x6 M4	15
112M	32	112	119	M25 x 1.5	M25 x 1.5	x6 M5	15
132M	37	112	119	M32 x 1.5	M32 x 1.5	x6 M5	21
160L	65	143	146	M40 x 1.5	M40 x 1.5 M16 x 1.5	x6 M6	30

12.0 Motor weight

Motor Size (kg)	Motor Weight				
	B3 Mount	B14 Mount	B5 Mount	B34 Mount	B35 Mount
80L	12.6	12.4	12.7	12.6	13
90LL	18.6	18.3	18.7	18.6	18.9
112M	34.7	34.5	35.1	35.1	35.5
132M	55	54.9	56	55	56.1
160L	98	102.6	99.5	102.8	99.6

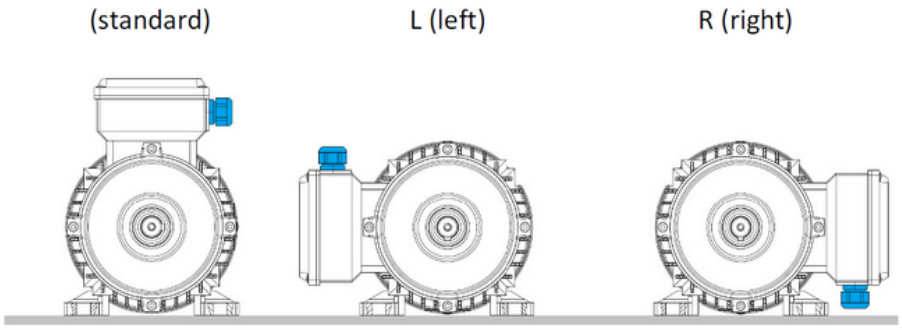
1: Motors have an aluminum housing.
2: Motor weight is shown with the following options: sensorless, no brake, and speed dependant fan wheel.

13.0 Mounting positions

IM B3 IM 1001		IM B5 IM 3001		IM B14 IM 3601	
IM B6 IM 1051		IM V1 IM 3011		IM V19 IM 3631	
IM B7 IM1061		IM V3 IM 3031		IM B34 IM 2101	
IM B8 IM 1071		IM B35 IM 2001		IM V18 IM 3611	
IM V5 IM 1011		IM V15 IM 2011			
IM V6 IM 1031		IM V36 IM 2031			

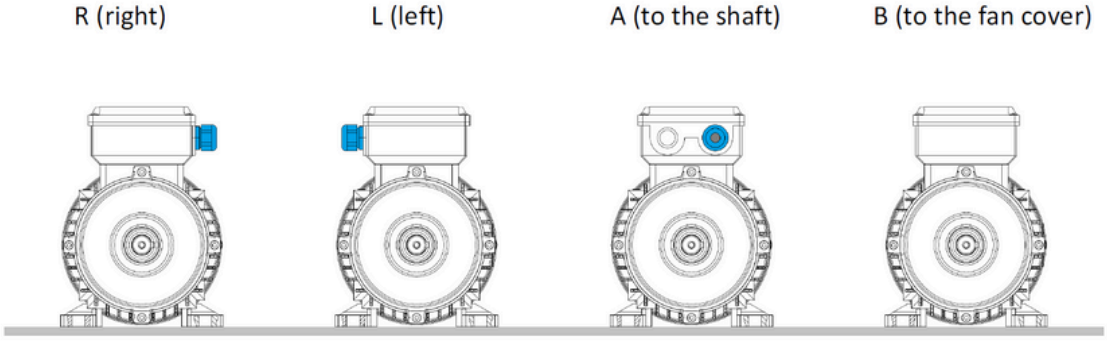
13.1 Position of terminal box

The positions shown are with the shaft facing you. If the terminal box position is not specified, the motor is supplied with the terminal box on top (standard).

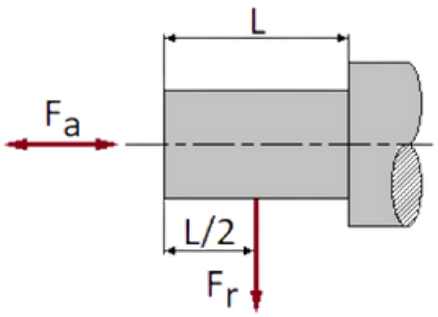


13.2 Cable outlet

The positions shown are with the shaft facing you. If the cable output is not specified, the motor is supplied with R (right) as standard.



14.0 Permissible bearing forces



Fr max force [N] at distance L/2

Motor Size	Fr max [N] at (L/2)			
	1,500 RPM	2,300 RPM	3,000 RPM	4,000 RPM
80L	1,120	970	880	800
90LL	1,210	1,040	960	870
112M	2,280	1,970	1,810	1,640
132M	2,600	2,220	2,060	1,870
160L	3,540	3,070	2,810	2,550

Fa max force [N] for horizontal installation

Motor Size	Fa max [N] Horizontal Install					
	750 RPM	1,000 RPM	1,500 RPM	3,000 RPM	4,000 RPM	5,000 RPM
80L	980	867	732	553	---	525
90LL	1,048	927	788	593	---	561
112M	1,780	1,547	1,265	880	975	N/A
132M	2,240	1,993	1,677	1,273	N/A	N/A
160L	2,450	2,090	2,100	1,910	N/A	N/A

Fa max force [N] for vertical installation

Motor Size	Fa max [N] Vertical Install					
	750 RPM	1,000 RPM	1,500 RPM	3,000 RPM	4,000 RPM	5,000 RPM
80L	985	878	743	562	---	532
90LL	1,060	943	800	605	---	571
112M	1,795	1,563	1,276	890	985	N/A
132M	2,274	2,022	1,720	1,293	N/A	N/A
160L	2,500	2,127	2,130	1,920	N/A	N/A

14.1 Built-in bearings

All bearings are lubricated for life. The bearings on the A (shaft) and B (rear) sides are identical. The service life is ~ 20,000 hours. For longer life, the maximum permissible bearing forces must be reduced.

By a factor of 0.87 for the service life of 30,000 hours.
By a factor of 0.79 for the service life of 40,000 hours.
By a factor of 0.74 for the service life of 50,000 hours.

The permissible operating temperature is -15 C to 110 C

Motor Size	Bearing "A" and "B" Side	Dimensions [mm]	Oil Seal (optional) [mm]
80L	6204-ZZ-C3	47 x 20 x14	35 x 20 x 7
90LL	6205-ZZ-C3	52 x 25 x 15	37 x 25 x 7
112M	6206-ZZ-C3	72 x 30 x 19	44 x 30 x 7
132M	6208-ZZ-C3	90 x 40 x 23	58 x 40 x 8
160L	6209-ZZ-C3	100 x 45 x 25	65 x 45 x 8

15.0 Balancing method

The MPM motors are dynamically balanced with a half key according to DIN EN 600034-14 (VDE 0530-14) and achieve vibration magnitude level B.

16.0 Mass inertia

The MPM motors are dynamically balanced with a half key according to DIN EN 600034-14 (VDE 0530-14) and achieve vibration magnitude level B.

Motor Size	J [kg cm^2]
80L	40.5
90LL	75
112M	248.6
132M	449
160L	1160

17.0 Efficiency Breakdown

The MPM series are metric motors regulated by the IEC (International Electrotechnical Commission) standards. According to the IEA electric-driven motors are responsible for 53% of global electricity use. In an effort to reduce consumption while also increasing performance and throughput, the IEC implemented energy efficiency test standards (IEC 600034-2-1 and IEC 60034-30-1). These standards have helped governments specify their minimum energy performance standards (MEPS) based on the five IE classes below. Please visit the IEC or NEMA websites for your specific country's MEPS requirements. IE2 and IE3 at the time this was written are the minimum for most countries.

IE Code	NEMA
IE1	Standard Efficiency
IE2	High Efficiency
IE3	Premium Efficiency
IE4	Super Premium Efficiency
IE5	Ultra Premium Efficiency

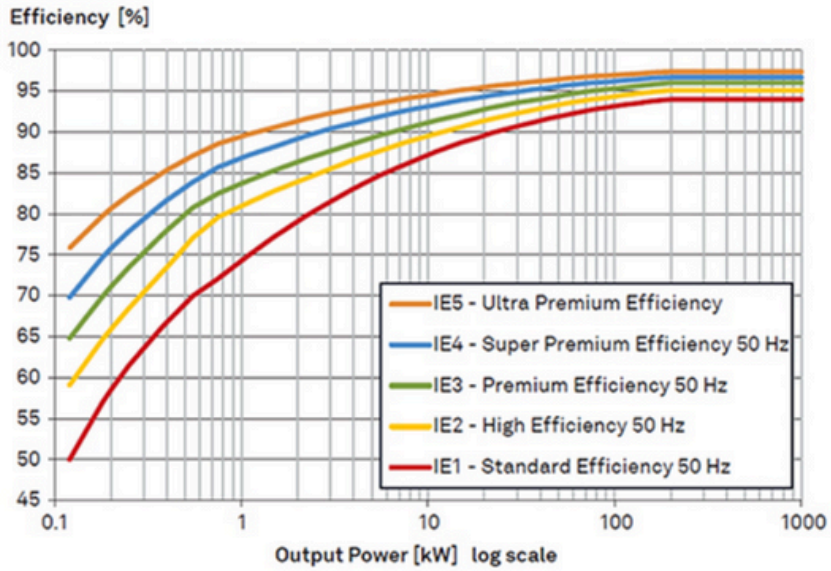
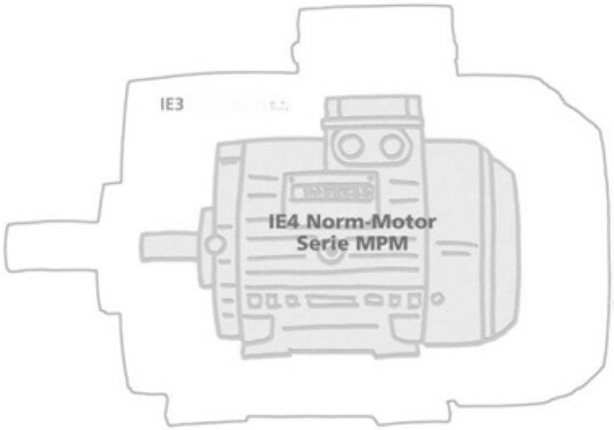


Figure 1: Motor efficiency classes according to IEC/EN 60034-30 (IE1 to IE5) and corresponding NEMA ratings (standard efficiency to ultra-premium efficiency). AC induction motors with FOC and electronic drives can meet IE3 and IE4 requirements. Permanent magnetic motors are needed to meet IE5 efficiency levels. (Image source: ECN)

Advanced Design

The advanced motor design allows for higher speeds and torque in combination with a smaller footprint and lower losses. For today's challenges efficiency according to IE5 can be achieved. The synchronous motor technology in a classic motor housing fulfills the economic requirements making it ideal for speed-controlled applications with high duty cycles and/or high partial loads.
Five frame sizes cover the power range of 1.1 to 54 kW.



[1] IEC Standards - https://www.iec.ch/government-regulators/electric-motors
[2] DigiKey - https://www.digikey.com/en/articles/how-to-simplify-motor-drive-and-inverter-designs-using-igbt-modules

MPM Series - Energy Calculation Worksheet

INFRANOR MOTION EXCELLENCE

Current Motor PN: _____ **MPM Motor PN:** _____

A. Motors Used

Enter the number of motors used in your current application (machine, factory, etc.) _____

B. Average Energy Used

Enter the average power [kW] of each motor used in your current application (machine, factory, etc.) _____

C. Current Efficiency

Enter the efficiency value [%] for your current motor. This can be averaged over multiple motors. _____

D. MPM Motor Efficiency

Enter the VFD MPM motor efficiency value [%] for the correct winding used. See section 6.0 and 7.0. _____

E. Difference in Efficiency

Subtract step C from step D. (D-C = E) _____

F. Running Time

Enter the average running time per year in hours. _____

G. Electricity Cost

Enter your electricity cost [$/kW hr]. If this is unknown you can use an estimate from the US Bureau of Labor Statistics for your location. (https://www.bls.gov/regions/midwest/data averageenergyprices_selectedareas_table.htm) _____

H. Energy Cost Savings Per Year

Multiply step A by step B, E, F and G to get your yearly savings of energy in dollars. (A*B*E*F*G). Positive value equals savings. If the value is negative you may not be saving money on energy but you still could be saving money on freight (smaller weight and size) compared to your current solution. This should be explored. _____

J. Cost to Run Over the Service Life (Optional)

If your current motor does not use a VFD you should include the cost of one for the MPM Series. Use an average service life of 20,000 hours. Results are per motor.

MPM Cost + VFD Cost + (B x D x G x 20,000) = _____

Current System Cost + (B x C x G x 20,000) = _____

Notes:

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