MOTOR

FM7/FM9

Installation manual

Ref.1707

FAGOR

FAGOR AUTOMATION

ORIGINAL INSTRUCTIONS

Original manual. Any translation of the original manual (spanish or english) will replace the phrase ORIGINAL INSTRUCTIONS with TRANSLATION OF THE ORIGINAL INSTRUCTIONS.

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FAGOR AUTOMATION

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The content of this manual and its validity for the product described here has been verified. Nevertheless, the information, technical or otherwise, in these manuals or in any other type of documentation is not guaranteed to be integral, sufficient or up to date.

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July 2017 / Ref.1707

Version history

Manual reference	Events
0209	FM7 family. E01 series
0306	FM7 family. E02 series
0604	FM7 family. E03 series
0702	FM7 family. HS3 series
0712	FM7 family. FM7-E600-□□□□-E01 model
1107	FM9 family. E01 series, models: FM9-B055-C5C□-E01, FM9-B071-C5C□-E01, FM9-A100-C5C□-E01, FM9-B113-C5C□-E01, FM9-A130-C5C□-E01
1306	MPC-4x70 power cable. The model FM9-B055-C5C□-E01-A replaces the FM9-B055-C5C□-E01
1707	Corrected ·mxl· dimension and ·dx· dimension of motor model FM7-D075-S1D1-HS3 FM9 family. E01 series, model: FM9-B037-C5C□-E01. FM7 family. E01/E02 series. The width of the terminal box has been changed, models: FM7-A110-□□□□-E0□, FM7-A150-□□□□-E0□, FM7-A185-□□□□-E0□, FM7-A220-□□□□-E0□, FM7-B120-□□□□-E0□, FM7-B170-□□□□-E0□. The graphs in S6-40% for larger sizes than B055 have been eliminated. FM7 family. HS3 series. The unnecessary inside detail of the motor has been eliminated from the dimensions diagram.

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GENERAL INDEX

ABOUT THE MANUAL

Title

MOTOR FM7/FM9.

Type of documentation

Description and installation of FM7/FM9 asynchronous spindle AC motors. Associated with FAGOR DDS drives.

Internal code

User manual. The manual code does not depend on the software version.

MAN MOTOR FM7/FM9 (IN) Code 04754031

Manual reference

Ref.1707

Web

The user must **always** use the latest reference (version) of this manual, available on FAGOR'S corporate website.
http://www.fagorautomation.com.

Email

info@fagorautomation.es

Startup

DANGER. In order to comply with the EC seal indicated on the component, verify that the machine that integrates this motor meets the 2006/42/EC Directive on machinery.

Before starting the motor up, read the indications of this chapter.

Warning

WARNING. The information described in this manual may be subject to changes due to technical modifications.

FAGOR AUTOMATION S. Coop. reserves the right to change the contents of this manual without prior notice.

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The contents of this manual have been verified and matched with the product described here. Even so, it may contain involuntary errors that make it impossible to ensure an absolute match. However, the contents of this document are regularly checked and updated implementing the pertinent corrections in a later edition.

EC DECLARATION OF CONFORMITY AND WARRANTY TERMS

The EC Declaration of Conformity is available in the downloads section of FAGOR'S corporate website at http://www.fagorautomation.com. · type of file: EC Declaration of Conformity ·

The warranty conditions are available in the downloads section of FAGOR's corporate website at http://www.fagorautomation.com. · type of file: General terms and conditions of purchase - warranty ·

To ensure a long life for the AC spindle motor, read carefully the procedures indicated in the CONTENTS section.

This manual contains detailed documentation of FM7/FM9 motors as well as their associated AC spindle drives.

GENERAL PRECAUTIONS

This manual may be modified due to improvements to the product, modifications or changes in their specifications.

For a copy of this manual, if its issue has been lost or damaged, contact your FAGOR dealer.

FAGOR shall not be held responsible for any modification made to the product by the user. This means the cancellation of the warranty.

CONTENTS

1 Operation safety

Symbols that may appear in this manual

Carefully read the following instructions before using the motor. In these instructions, the operating safety conditions are identified by the following labels.

Danger or prohibition symbol.

It warns about an immediate dangerous situation. Ignoring this warning may cause serious, even fatal, consequences.

Warning or caution symbol.

It warns about a potentially dangerous situation. Ignoring this warning may cause serious injuries (even fatal) or damages to the unit.

Mandatory symbol.

It warns about actions and operations that MUST BE carried out. In other words, they are not plain recommendations. Ignoring this warning may mean not complying with some safety regulation.

Information symbol.

Notes, warnings, advises and recommendations.

Symbols that the product may carry

Ground protection symbol.

It indicates that that point must be under voltage.

NOTE. After reading these instructions, have them always handy for those using the equipment.

2 Usage

DANGER.

Observe the following sections to avoid electrical discharges or any harm.

Take to ground the ground terminals of the motor and of the drive as specified by your international and/or local electrical regulation. Ignoring this warning may cause electrical discharges.

Use a ground connection according to the standard local and/or international regulation.

Do not damage the cables or apply excessive force on them. Do not load heavy items on them or crimp them with bolts or stapes. Ignoring this warning may cause electrical discharges.

WARNING.

Consider only the motor-drive combinations specified in the manual. Ignoring this warning may cause poor performance or not to work at all.

Use the shortest cables possible in the electrical installations. Separate the power cables from the signal cables. The noise on the signal cables may cause vibrations or poor performance of the unit.

Never install them in places exposed to water splashes, gasses and flammable or corrosive liquids or near flammable substances. Ignoring this warning may cause fire or poor performance.

Use it under the following ambient and work conditions:

- Interiors without corrosive or explosive gasses.
- Ventilated places without dust or metal particles.
- Ambient temperature and relative humidity indicated in this manual.
- Altitude 1000 meters above sea level.
- Locations that may be cleaned, maintained and tested.

3 Storage

DANGER.

Do not store the unit in places exposed to water splashes or corrosive liquids or gasses.

MANDATORY.

Store the motor horizontally and protected against any possible blow. Make sure that no strange elements get in through the openings of the cooling system.

Store the equipment avoiding direct exposure to the sun, keeping temperature and humidity within the specified ranges (temperature between 0 °C (32 °F) and 60 °C (140 °F) and relative humidity between 5 % and 95 %).

4 Shipping

WARNING.

Do not pull the cables or lift the motor up from its shaft in transit. Ignoring this warning may cause personal injury or poor motor performance due to damage to the motor.

Do not load the products too much. Ignoring this warning may cause the load to break or personal injury.

MANDATORY.

Use only the eyebolts of the motor to lift it up and transport it. Do not try to move it when it is connected to other equipment.

Before lifting it or moving it, make sure that they eyebolts are properly bolted in, the load is balanced and the cable and the sling used to move the motor is the right one.

5 Installation

WARNING.

Do not climb on top of the motor nor load it with heavy objects. Ignoring this warning may cause personal injury.

Do not block either the air intake or the air output in ventilated motors and prevent strange materials from getting in. Ignoring this warning may cause fire or damage to the unit.

When unpacking, use the proper tool to open the box. Ignoring this warning may cause personal injury.

Cover the rotary parts so they cannot be touched. Ignoring this warning may cause personal injury.

The motor shaft extension is covered with anti-corrosive paint. Before installing the motor, remove the paint with a cloth dampened in liquid detergent.

MANDATORY.

When connecting the motor to the machine load, special care must be taken with centering, the tension of the pulley and the parallelism of the pulley.

A flexible coupling must be used to couple the motor with the machine load.

The encoder attached to the motor shaft is a precision element. Do not apply excessive force on to the drive shaft. The machine must be designed so the axial and radial loads applied to the shaft extension while in operation must be within the range indicated in this manual for this model.

No additional machining must be carried out to the motor.

Flange-mount models may be installed with the load placed horizontally or vertically at the drive shaft with the motor shaft extension facing down (only on FM7 series). On FM9 series, the shaft extension may be facing up or down. If the motor shaft is horizontal, the terminal box must be facing up (on applicable models). Foot-mount models must be installed on the floor with the foot down or vertically with the shaft extension facing down (only on FM7 models). On FM9 series, the shaft extension may be facing up or down.

For further details, refer to this manual for the possible builts for each model.

6 Cabling

MANDATORY.

The installation must comply with Directive EMC 2014/30/EU.

The motor is component to be incorporated on machines. They must comply with Machine Safety Directive 2006/42/EC and cannot be started up until this directive is met.

Install the cables safely according to the connection diagrams. Ignoring this warning may cause the motor to run away and personal injury.

Make sure that the power input is off before doing the installation.

Foresee a protection circuit so the main machine is not connected when the motor-fan group is not running (when applicable).

Carry out the right ground connection and electrical noise control (disturbances).

Use the shortest cables possible in the installation. Run the power cables as far away from the signal cables as possible. Do not run the power cables and the signal cables through same cable hose or conduit. The noise in signal cables may cause vibration or poor performance.

Use the cables specified by FAGOR. When using other cables, check the rated current of the unit and bear in mind the work environment in order to properly select the cables.

7 Operation

WARNING.

Do not run the unit with the lid of the terminal box open. After cabling (when applicable), do not forget to close it. Ignoring this danger warning may cause electrical discharges.

To properly check the motor, it must be properly secured and disconnected from the machine load. Then, run the pertinent checks and connect the machine load again. Ignoring this warning may cause personal injury.

In case of error or alarm, correct its cause. First verify the safety conditions and then resume the operation after eliminating the error. See the «safety conditions» section of the “man_dds_hard.pdf” manual and chapter 14. «error codes and messages» of the drive manual “man_dds_ soft.pdf”.

If there is a momentary power loss, disconnect the power supply. The machine may run suddenly causing personal injury.

MANDATORY.

Do not attempt to move the motor while it is attached to another unit without freeing it first.

Use only the eyebolts of the motor to lift it up or move it.

8 Maintenance and inspection

DANGER.

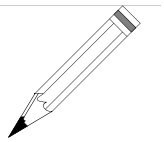
Only authorized personnel may take the unit apart and repair the unit.

Contact your FAGOR representative before taking the motor apart.

See the instruction of the following table to carry out the inspection and daily maintenance of the motor. The AC spindle motor only needs a simple daily inspection. The inspection periods indicated in the table are only a guideline. Adjust the inspection periods depending on the operating conditions and work environment.

Inspection items	Frequency	Operation	Remarks
Vibration & noise	Daily	Touch & listen	Vibration and noise must not exceed normal values.
Outside	According to requirements	Clean with a dry cloth or compressed air	
Insulation resistance	Annual	Disconnect the motor from the drive and verify that the resistance is > 10 MΩ measured with 500 V tester	If the resistance is < 10 MΩ, contact FAGOR. Do not measure the isolation resistance or test the limit voltage at the encoder
Overrall	Every 12000 hours or 5 years (whichever comes first)	Contact your FAGOR agent	Do not try to solve failures or do any cleaning by third parties

Note. *Measure the isolation resistance between each phase U, V and W of the power cables and the armature ground (FG).*



DESCRIPTION

1

1.1 Features and design

FAGOR FM7/FM9 series motors are asynchronous, also called induction motors, with a two-pole-pair (4 pole) squirrel cage rotor and are especially designed to work on machine tool spindles.

These motor families group different series. Thus, the FM7 family has the (E01, E02 and E03) series depending on the maximum speed they can reach. There is also a fourth series (HS3) with a hollow shaft for cooling the tool from the spindle.

The FM9 family only has the E01 series.

Its features are:

Wide range of rated power

Its highly robust design, the use of high precision bearings (special bearings) and other elements used in their design make it possible to use this motor in the following ranges of power.

Hence, we refer to the:

FM7-□□□□-□□□□-E01 series

T. 1/1 Range of rated power in S1 for the maximum speed of the FM7-□□□□-□□□□-E01 series.

Max. speed (rpm)	Range of rated power in S1 duty cycle (kW)
9000	3.7 to 11
8000	12 to 22
6500	22 to 37 (except that of 21.5)
5000	21.5, 27, 51 and 60

FM9-□□□□-C5C□-E01-X series

T. 1/2 Range of rated power in S1 for the maximum speed of the FM9-□□□□-C5C□-E01-X series.

Max. speed (rpm)	Range of rated power in S1 duty cycle (kW)
5000	37, 55
4500	71, 100, 113, 130

FM7-□□□□- □□□□-E02 series

T. 1/3 Range of rated power in S1 for the maximum speed of the FM7-□□□□-□□□□-E02 series.

Max. speed (rpm)	Range of rated power in S1 duty cycle (kW)
12000	3,7
10000	5.5 to 11
9000	12 to 22 (except that of 21.5)
6500	22
6000	21.5, 27 and 51

FM7-□□□□-□□□□-E03 series

T. 1/4 Range of rated power in S1 for the maximum speed of the FM7-□□□□-□□□□-E03 series.

Max. speed (rpm)	Range of rated power in S1 duty cycle (kW)
15000	5.5 to 7.5
12000	11 to 22

FM7-□□□□-□□□□-HS3 series

T. 1/5 Range of rated power in S1 for the maximum speed of the FM7-□□□□-□□□□-HS3 series.

Max. speed (rpm)	Range of rated power in S1 duty cycle (kW)
15000	7.5
12000	11 to 22

The mounting methods are:

T. 1/6 Mounting methods.

Series	Mounting type
FM7-□□□□-□□□□-E01	Foot, flange, foot+flange
FM9-□□□□-C5C□-E01-X	Foot+flange
FM7-□□□□-□□□□-E02	Foot, flange, foot+flange
FM7-□□□□-□□□□-E03	Flange
FM7-□□□□-□□□□-HS3	Flange

Low vibration

A low level of vibration is achieved by reducing the size of the motor and adjusting the balancing for high speed.

High reliability

For the FM7 family, the motor protection level meets the IP 44 standard and may have a standard magnetic TTL encoder in all the series (except in the E600) or a C axis 1024 ppt SinCos™ Stegmann™ sinusoidal encoder that is optional in E01 series (except in the E600 that is optional) and E02 series that are very reliable for velocity and position feedback. The E03/HS3 series do not have the "C axis encoder" feedback as an option.

For the FM9 family, the motor protection level meets IP 54 and offers a C axis 1024 ppt SinCos™ Stegmann™ sinusoidal encoder.

Cooling

For the FM7 family, all series have a fan connected to three-phase 400 V AC (50/60Hz) as independent cooling system. The cooling air goes in through the machine load end and goes out through its opposite end, hence avoiding orienting the machine in the direction of the air output.

All models of the HS3 series have air cooling and are especially designed to be mounted directly on the spindle. It has a hollow shaft that allows the cooling air flow to the tool that has internal cooling directly from the spindle itself.

For the FM9 family, all the models of the E01 series (except the B037) come with a three-phase fanthat may be connected to 230/400 V AC (Δ/Y) - 50 Hz or to 460 VAC (Y) - 60 Hz as an independent cooling system. The cooling air goes in through the machine load end and goes out through its opposite end, hence avoiding orienting the machine in the direction of the air output.

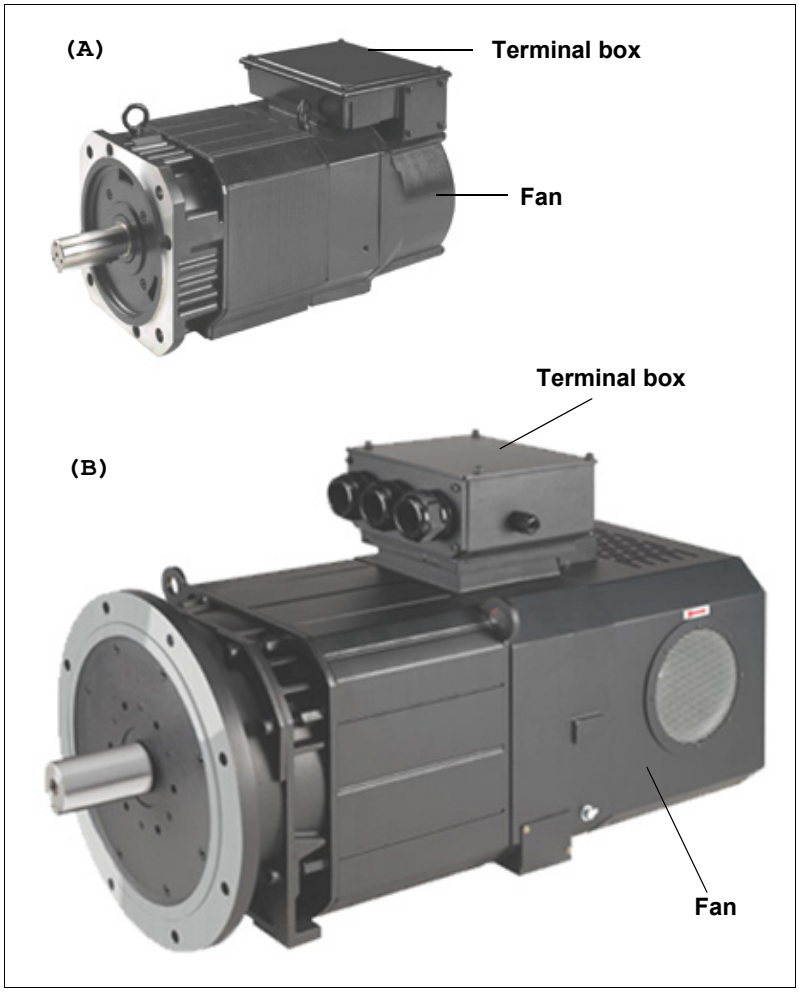
Star delta winding connection

For the la familia FM7, the E03/HS3 series have a winding with 6 different terminals for star (Y) or delta (triangle) connection. It is also possible to toggle from one to the other without stopping the motor using a maneuver with two external magnetic contactors located between the motor and the drive make it possible to select material removing conditions at low speed and high torque (star winding connection) or fine machining at high speed and low torque (delta winding connection).

For the FM9 family, although the E01 series also has 6-terminal winding, only consider the star (Y) connnection as the motors leave the factory.

1.2 Outside appearance

The following figure shows the external appearance of FAGOR FM7/FM9 asynchronous spindle motors and the location of the terminal box that has the connectors for connecting power, the motor feedback and the fan.



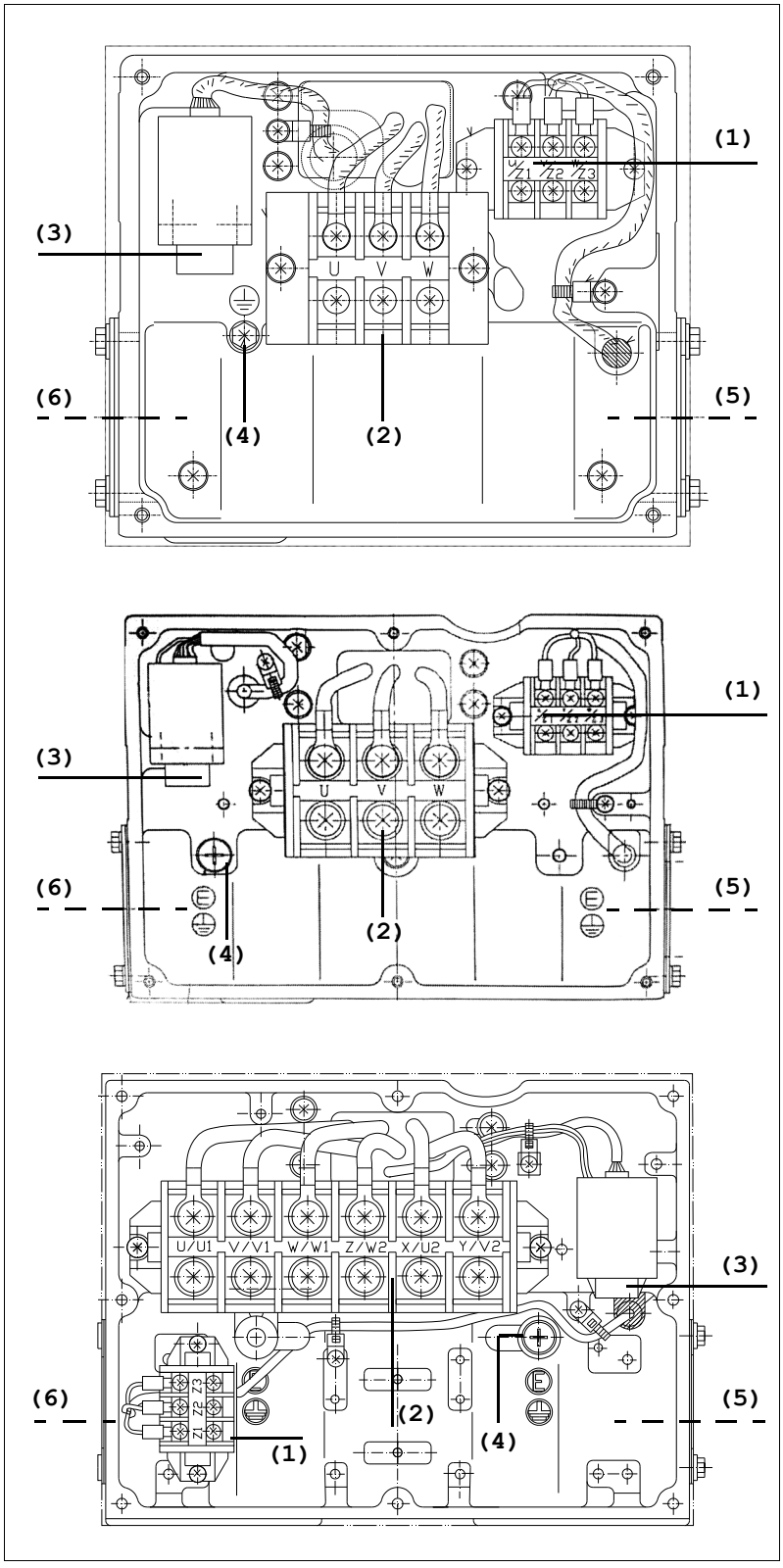
F. 1/1

Asynchronous spindle motors. **A.** FM7 family. **B.** FM9 family.

1.3 Terminal box. Layout and identification

Connection identification on FM7 models

The layout of the terminals in the box on top of the motor depends on the type of motor. Figure **F. 1/2** (top images) shows the terminal box that may be found in 279 mm and 250 mm wide series FM7-□□□□-□□□□-E01 and FM7-□□□□-□□□□-E02. Figure **F. 1/2** the lower image shows the terminal box for the FM7-□□□□-□□□□-E03 and FM7-□□□□-□□□□-HS3 series.



F. 1/2

Layout of the terminals and connectors inside the terminal box.

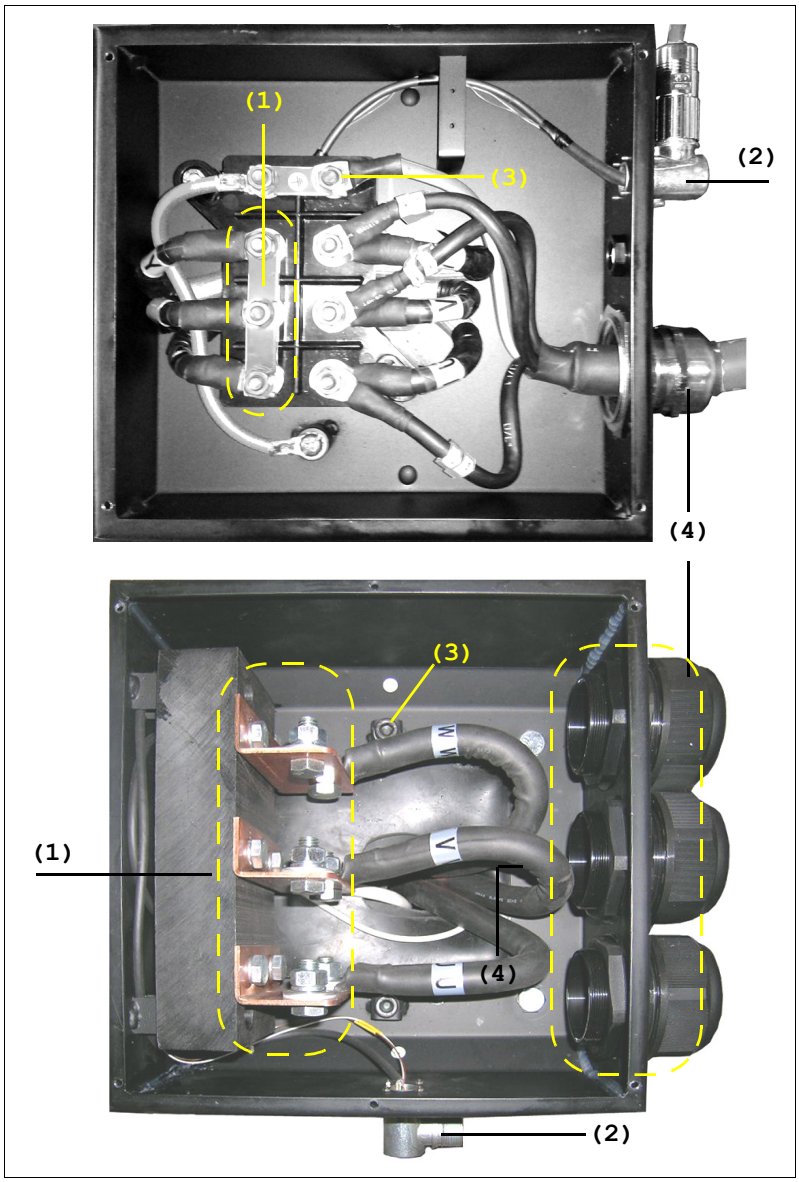
T. 1/7 Terminal box.

Nr	Name
1	3 terminals for connecting the fan
2	6 terminals for connecting the motor
3	Feedback (encoder) connecting connector
4	Ground bolt
5	Cable input
6	Cable input

NOTE. Note that it is possible to find other layouts of the connection terminals very similar to the ones on the figure. They are so similar that the user will have no trouble identifying them.

Connection identification on FM9 models

The layout of the terminals in the box on top of the motor depends on the type of motor. **F. 1/3** the upper image shows the terminal box for the FM9-B037-C5C☐-E01 and FM9-B055-C5C☐-E01-A models. **F. 1/3** the lower image shows the terminal box for the FM9-B071-C5C☐-E01, FM9-A100-C5C☐-E01, FM9-B113-C5C☐-E01 and FM9-A130-C5C☐-E01 models.



F. 1/3

Layout of the terminals and connectors inside the terminal box depending on motor model.

T. 1/8 Terminal box.

Nr	Name
1	Terminals/plates for motor power connection
2	Connector for encoder connection
3	Ground bolt
4	Cable gland(s) of the power cable hose

NOTE. Observe that the fan connecting terminals are in another smaller terminal box attached to the fan.

1.4 General characteristics

General technical data of FM7 models

T. 1/9 General technical data. FM7, E01/E02 series.

FM7-□□□□-□□□□-E01 / FM7-□□□□-□□□□-E02	
Motor type	Induction. Squirrel cage
Thermal protection (meets IEC 60034-6 standard)	NTC thermistor
Level of vibration (meets IEC 60034-14 standard)	V5 - V10 (standard) V3 - V5 (optional)
Type of construction (meets IEC 60034-7 standard)	Horizontal: IM B3, IM B5, IM B35 Vertical: IM V1, IM V5, IM V15
Electrical insulation of the winding (meets IEC 60034 standard)	Class F (155 °C / 311 °F)
Degree of protection (meets IEC 60034-5 standard)	IP 44
Storage temperature	From 0 °C to 60 °C (-32 °F to 140 °F)
Ambient temperature allowed	From 0 °C to 40 °C (-32 °F to 104 °F)
Working ambient humidity	95 % max. (non condensing)
Maximum recommended altitude	1000 m (3281 ft) above sea level
Fan voltage	400 V AC (three phase) - 50/60 Hz Independent voltage supply
Withstanding of the isolation voltage	1800 V AC in one minute
Insulation resistance	500 V AC, 10 MΩ
Feedback	Magnetic TTL encoder. Standard. C axis sinusoidal 1024 ppt SinCos™ Stegmann™ encoder. Optional.
Conformity standard	IEC 34-1

T. 1/10 General technical data. FM7, E03/HS3 series.

FM7-□□□□-□□□□-E03 / FM7-□□□□-□□□□-HS3	
Motor type	Induction. Squirrel cage
Thermal protection (meets IEC 60034-6 standard)	NTC thermistor
Level of vibration (meets IEC 60034-14 standard)	V3 (standard)
Type of construction (meets IEC 60034-7 standard)	Horizontal: IM B5 Vertical: IM V1
Electrical insulation of the winding (meets IEC 60034 standard)	Class F (155 °C / 311 °F)
Degree of protection (meets IEC 60034-5 standard)	IP 44
Storage temperature	From 0 °C to 60 °C (-32 °F to 140 °F)
Ambient temperature allowed	From 0 °C to 40 °C (-32 °F to 104 °F)
Working ambient humidity	95 % max. (non condensing)
Maximum recommended altitude	1000 m (3281 ft) above sea level
Fan voltage	400 V AC (three phase) - 50/60 Hz Independent voltage supply
Withstanding of the isolation voltage	1800 V AC in one minute
Insulation resistance	500 V AC, 10 MΩ
Feedback	Magnetic TTL encoder (standard)
Conformity standard	IEC 34-1

General technical data of FM9 models

T. 1/11 General technical data. FM9, E01 series.

FM9-□□□□-C5C□-E01-□	
Motor type	Induction. Squirrel cage
Thermal protection (meets IEC 60034-6 standard)	KTY84-130 thermistor
Level of vibration (meets IEC 60034-14 standard)	V5 (standard)
Type of construction (meets IEC 60034-7 standard)	Horizontal: IM B3, IM B5, IM B35 Vertical: IM V1, IM V5, IM V15 IM V3, IM V6, IM V36
Electrical insulation of the winding (meets IEC 60034 standard)	Class F (155 °C / 311 °F)
Degree of protection (meets IEC 60034-5 standard)	IP 54
Storage temperature	From -10 °C to +60 °C (14 °F to 140 °F)
Ambient temperature allowed	From -15 °C to +40 °C (5 °F to 104 °F)
Working ambient humidity	80 % max. (non condensing)
Maximum recommended altitude	1000 m (3281 ft) above sea level
Fan voltage	230/400 V AC (Δ/Y) (three-phase) - 50 Hz 460 V AC (Y) (three phase) - 60 Hz Independent voltage supply
Withstanding of the isolation voltage	1200 V AC
Insulation resistance	30 MΩ
Feedback	C axis 1024 ppt sinusoidal SinCos™ Stegmann™ encoder. Standard.
Conformity standard	IEC 34-1

Notes

The “F” classification of the winding isolation is based on its maximum running temperature capability.

This temperature is 155 °C (311 °F) and represents the maximum operating temperature for the winding. At this temperature, if the motor were running in a clean and dry environment for up to 40 hours a week, it would have a life expectancy of 10 to 20 years before the isolation would get damaged due to heat and would no longer withstand the applied voltage.

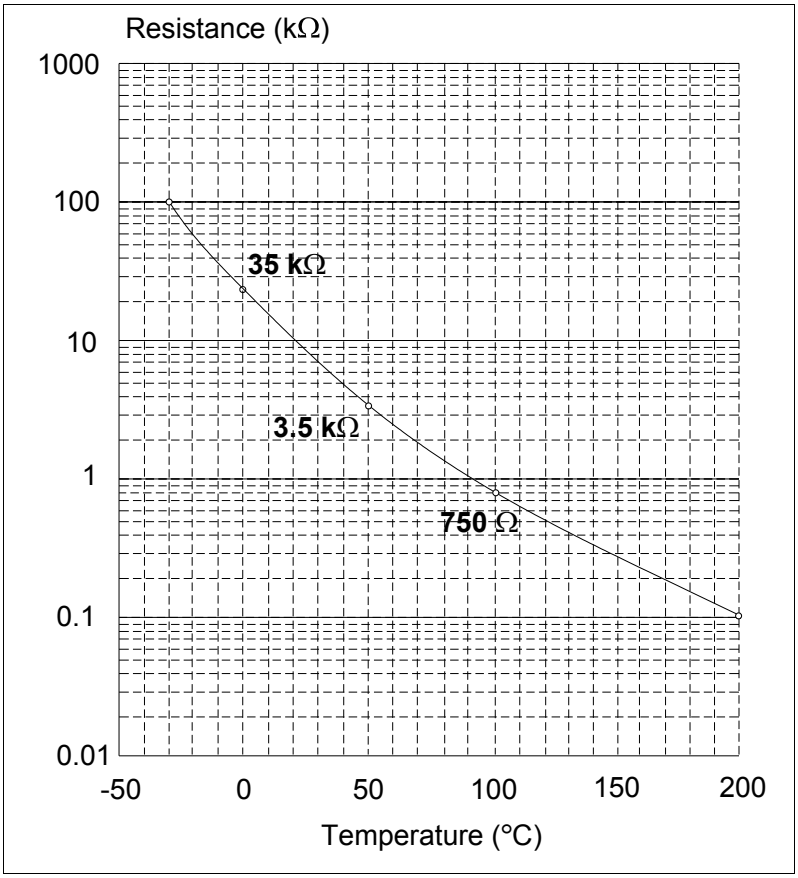
1.5 Temperature sensors

1.5.1 Simple NTC thermistor

The temperature sensor installed in FM7 motors is a simple thermistor with a negative temperature coefficient (NTC). It works in the temperature range between -50 °C (-58 °F) and 200 °C (392 °F).

T. 1/12 Characteristics of the temperature sensor.

Sensor type	NTC thermistor
Resistance at 20 °C (68 °F)	10 kΩ
Resistance at 100 °C (212 °F)	750 Ω
Sensor connection	Feedback cable



F. 1/4

Characteristics of the simple NTC thermistor. Resistance - temperature.

WARNING. Only temperature sensors that meet the safety specifications given by regulation EN 61800-5-1 may be connected to pins 21 (temp) and 22 (temp) of drive connector X4. Ignoring this warning may cause risk of electrical shock and/or damage to the unit.

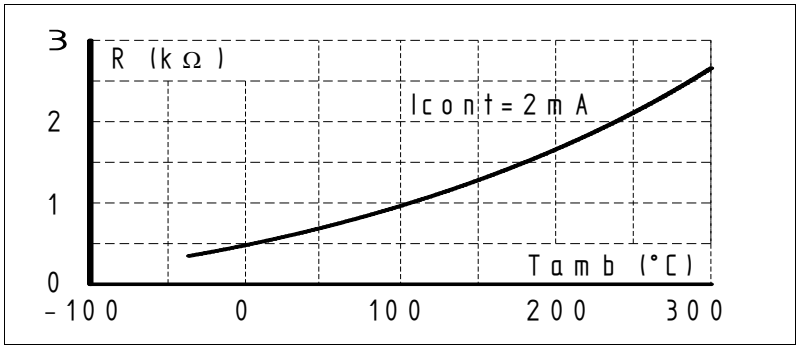
1.5.2 KTY84-130 thermistor

The temperature sensor in FM9 is a KTY84-130 thermistor used as thermal protection of the motor and it is located in the stator winding. It has a positive temperature coefficient (PTC) and they should be used in control and measurement systems within a range between -40 °C (-40 °F) and +300 °C (+572 °F).

T. 1/13 Characteristics of the temperature sensor.

Sensor type	KTY84-130
Approx. resistance at 20 °C (68 °F)	581 Ω
Approx. resistance at 100 °C (212 °F)	1000 Ω
Sensor connection	Feedback cable
Motor series	In all FM9 models

The following figure shows the graph of the resistance variation of the sensor as a function of the ambient temperature (average values):



F. 1/5

KTY84-130 sensor resistance depending on room (ambient) temperature.

NOTE. The two wires of the temperature sensor are included in the feedback cable and it will be connected to the corresponding connector of the drive.

WARNING. The temperature sensor KTY84-130 has polarity. If you wish to manufacture your own feedback cable, make sure that the polarity is correct when soldering these two wires to the corresponding pins of the connector. See the motor feedback connector diagrams later on.

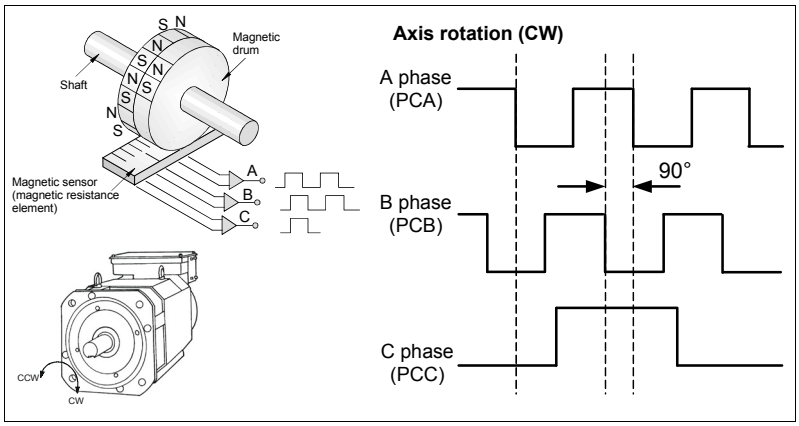
Only temperature sensors that meet the safety specifications given by regulation EN 61800-5-1 may be connected to pins 21 (temp) and 22 (temp) of drive connector X4. Ignoring this warning may cause risk of electrical shock and/or damage to the unit.

1.6 Feedback devices

1.6.1 Magnetic TTL encoder

Standard feedback device in all FM7 spindle motors. It consists of a magnetic disk used as a position detector. There are three feedback signals. Two signals for the A and B phases of 1024 pulses per turn and one pulse per turn (C signal) to indicate the starting position.

The following diagram shows the relationship between the encoder configuration and the output phase when turning the shaft clockwise (CW).



F. 1/6

Magnetic TTL encoder configuration. Output phases.

Feedback direction

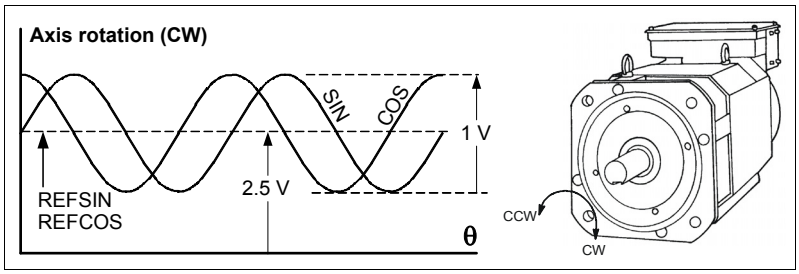
The convention of the motor shaft turning direction is established according to:

Shaft turning convention	CW (+ turning direction)	CCW (- turning direction)

1.6.2 C axis SinCos encoder

It is the optional feedback device of the E01 (except for the FM7-E600 which is the standard feedback device) and E02 series of FM7 spindle motors. It is also the standard feedback device in the E01 series of FM9 spindle motors. It consists of a non-magnetic disk used as a position detector. There are four feedback signals. Two reference signals RefSin and RefCos and two Sin and Cos signals of 1024 pulses per turn whose composition determines the absolute position of the axis per turn.

The following diagram shows the relationship between the configuration of the C axis SinCos encoder and the output phase when turning the shaft clockwise (CW):



F. 1/7

C axis SinCos™ encoder configuration. Output phases.

Feedback direction

The convention of the motor shaft turning direction is established according to:

Shaft turning convention	CW (+ turning direction)	CCW (- turning direction)

ELECTRICAL CHARACTERISTICS

2

2.1 Definitions

Maximum turning speed allowed. nmax

The maximum speed allowed nmax is determined by mechanical design (bearing designed in terms of fatigue, short-circuit ring of the squirrel-cage rotor) and electrical design (restricting voltage characteristics).

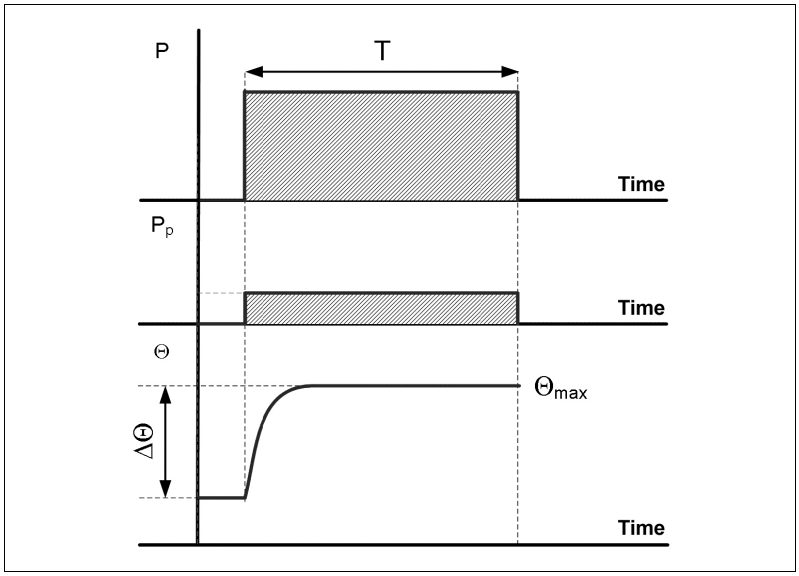
MANDATORY. Never exceed this speed value!

Maximum permanent turning speed. n1

It is the maximum speed allowed in permanent mode without any speed duty cycle.

Duty cycle S1. Continuous duty cycle

Operation with constant load long enough for the motor temperature to stabilize. Meets the EN 60034-1 standard.



F. 2/1

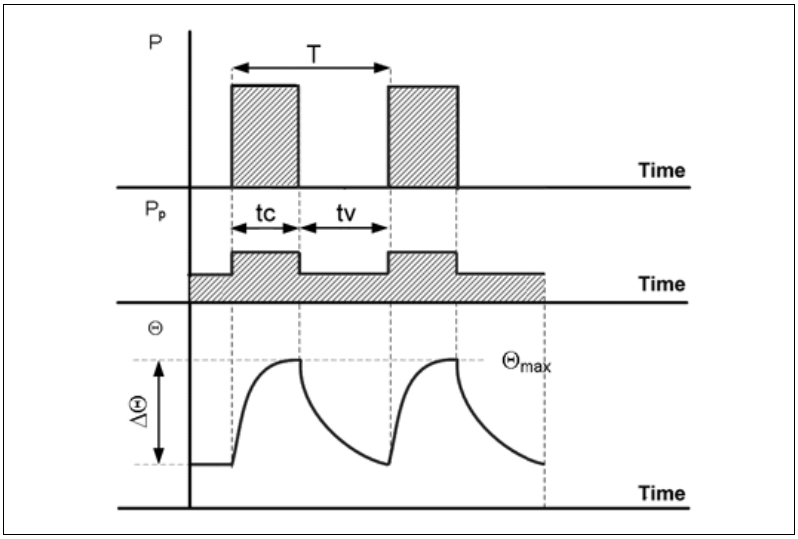
Continuous duty S1.

T	Cycle duration
P	Power of the load
Pp	Electrical power lost
ΔΘ	Temperature increase over room temperature
Θmax	Maximum temperature that the motor can reach without jeopardizing its insulation

S6 duty. Intermittent duty cycle

Uninterrupted periodic service with intermittent load, also called continuous service with intermittent load. It consists of a succession of identical cycles that have a constant-load period and another one without load, there are no rest intervals nor stop intervals. If no other value is indicated, the load duty cycle will be referred to a time of 10 minutes. Meets the EN 60034-1 standard. Hence:

S6 -40%	tc = 4 minutes with load tc = 6 minutes without load



F. 2/2

Periodic uninterrupted duty cycle with intermittent load S6.

T	Cycle duration
tc	Load time
tv	Time without load
tc / T	Running factor (e.g. 4 min / 10 min = 0.4) ➔ running f.: 40%
P	Power of the load
Pp	Electrical power lost
ΔΘ	Temperature increase over room temperature
Θmax	Maximum temperature that the motor can reach without jeopardizing its insulation.

Motor limits

On induction motors, the speed and power values are limited by thermal and mechanical reasons. The maximum current is only limited by the thermal characteristics of the motor windings.

Thermal limitation

Heat losses are stored in the motor and dissipated by cooling systems. The motor temperature depends on, among other things, the load duty.

MANDATORY. Never exceed the critical temperature of the motor!

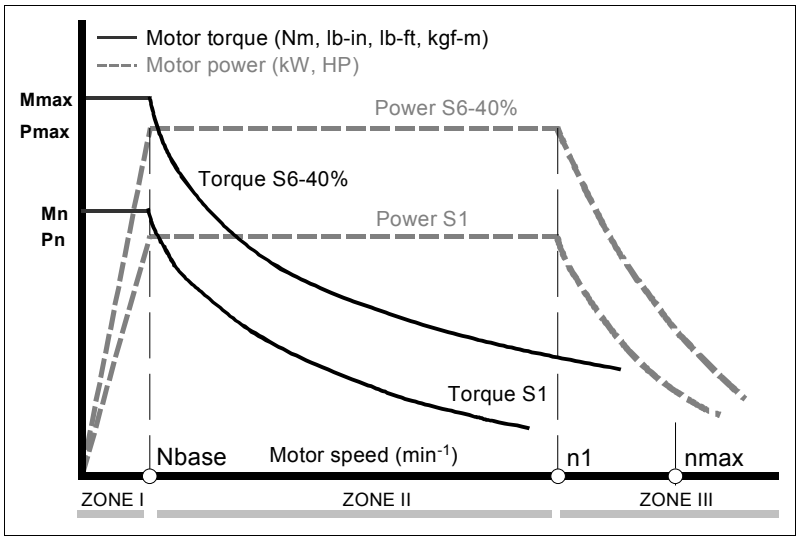
The characteristics for continuous duty S1 and intermittent duty S6-40% define the outputs allowed for a room temperature of up to 40 °C (104 °F). For this case, the temperature increase of the winding is 100 °C (212 °F).

Mechanical limitation

MANDATORY. Never exceed the mechanical speed limit (nmax) because it could damage the bearings!

2.2 Operating modes

We now define the operating modes of the motor shown in the figure with the power/speed and torque/speed graphs and identifying the zones where they are established. The behavior characteristics of the motor will be different depending on the zone where its operating point falls into.



F. 2/3

Operating modes. Power and torque characteristics according to speed.

2.2.1 Operating zones

ZONE I. Constant torque range.

This zone is set from the resting state (0 rpm) to the rated operation point (rated or base speed).

The torque developed by the motor matches the rated torque Mn and is constant in the whole zone. Its value is obtained as a result from the rated power P_N generated by the motor (directly proportional to the current circulating through the rotor until reaching the rated operating point) divided by its corresponding turning speed.

The power developed by the motor is directly proportional to the turning speed up to the rated operating point where it reaches its rated power Pn.

ZONE II. Constant power range.

This zone is defined as the constant power zone and is set from the rated operation point up to where the motor voltage reaches the maximum available.

The torque decreases inversely proportional to the speed.

Power remains constant.

From the motor base speed on, the torque decreases. The torque cannot be kept constant in the whole range because of the limitation set by the design point. Voltage is limited beyond the base frequency. Power is kept constant and this means that an increase in speed means a decrease in torque, so their product provides a constant power value.

ZONE III.

This zone begins when the voltage at the terminals of the motor has reached the maximum voltage that the drive that governs it can provide.

The torque decreases with the square of the speed.

Power decreases with speed.

2.3 Influence of supply voltage

The supply voltage of the bus sets one of the electrical limitations on the operation mode of the motor.

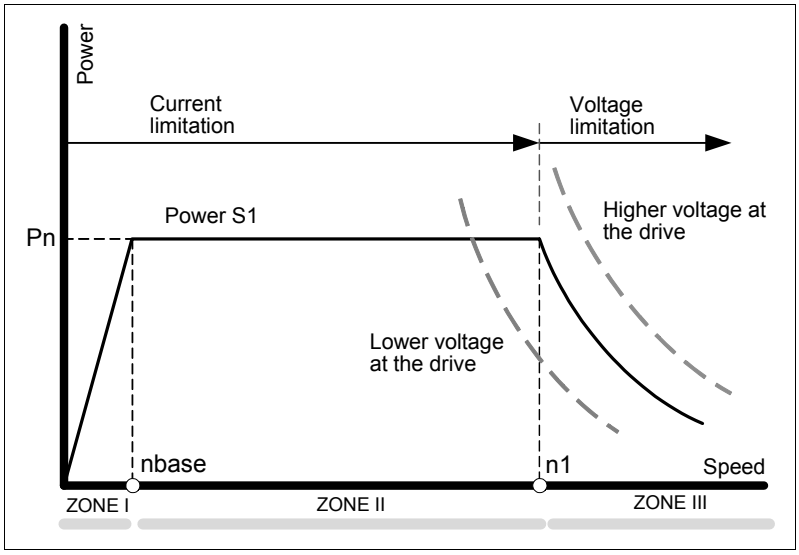
In operating ZONE II, power remains constant. However, in ZONE III, it decreases as the speed increases. Knowing that in most spindle applications the operation point is kept in ZONE II, constant power, this zone should be as wide as possible.

Going from ZONE II to ZONE III takes place due to the lack of enough voltage to keep compensating for the voltage drop on the stator impedance.

Therefore, in general, the higher the voltage the drive can provide, the wider ZONE II, constant power, will be.

When the motor's operation point is located in ZONE III and it does not provide the necessary power, select a larger motor or increase the voltage supplied to the drive.

See figure **F. 2/4** that shows these limitations.



F. 2/4

Limited by voltage.

At first, when wishing to get high cutting torque at low speed, a speed gear reduction was used in order to increase the spindle torque. This caused a higher price and complicated the design of the system. A second option was to use a larger motor, hence increasing the cost.

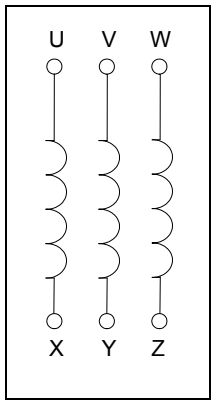
Likewise, obtaining a high torque at high speed meant a current increase due to the voltage limitation (maximum limited voltage) to keep the VI product constant in ZONE II (constant power zone) and required a larger drive, hence higher cost.

Thanks to the Y-Δ (star-triangle) winding switching technology described next, it is possible to cover all the needs mentioned earlier without having to resource to the solutions mentioned earlier.

2.4 Y-Δ winding connection switching

NOTE. Only the E03/HS3 series of asynchronous spindle motors of the FM7 family have a 6-lead winding that allows star-delta switching of the connection.

2.4.1 Y winding and Δ winding



Built

6-Lead winding motor where U, V and, W are at one end of the winding and X, Y, Z at the other end.

Usage

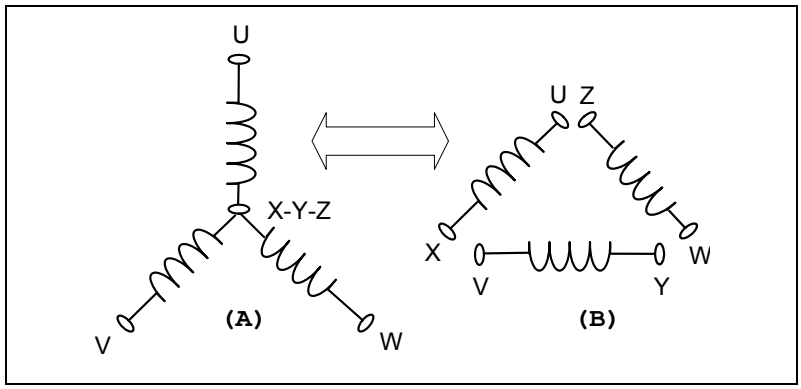
A 6-lead winding may be connected according to a configuration:

- **In star**
- **In triangle**

See figure **F. 2/6**.

F. 2/5

6-lead winding.

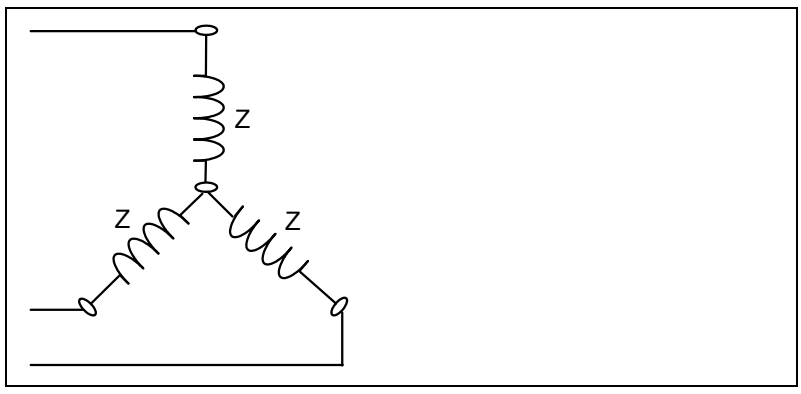


F. 2/6

Possible winding connections. **A.** Star (Y). **B.**Triangle (Δ).

Y (star) connection

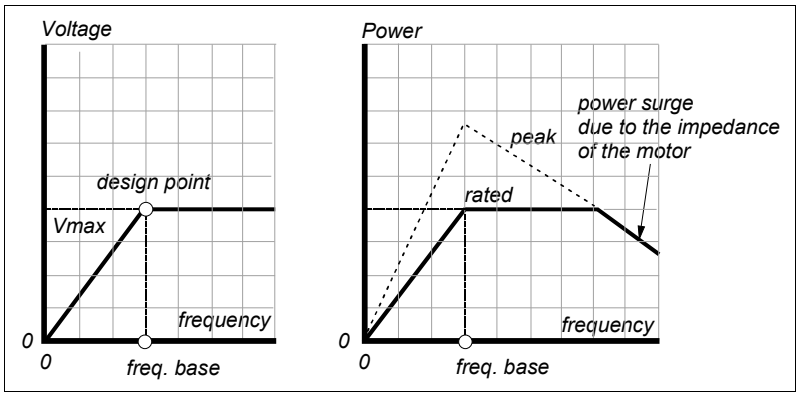
This connection is commonly used for AC induction motors. The motor torque and base speed depend on the motor impedance Z.



F. 2/7

Y (star) connection. Impedance Z.

The voltage/frequency ratio (V/f) of this connection is based on the motor operation point. At the high frequency, a power drop occurs due to motor impedance.

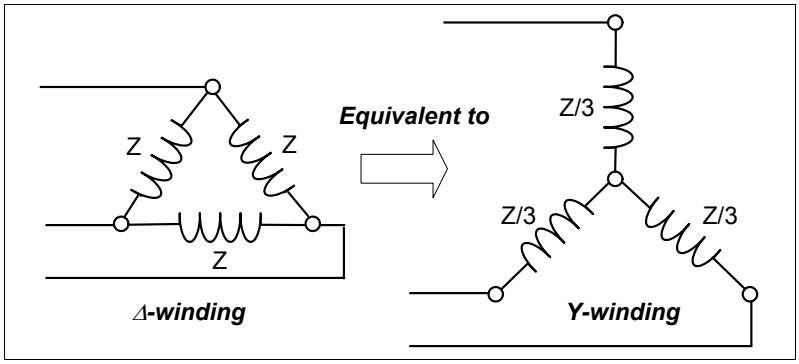


F. 2/8

Voltage/frequency and power/frequency diagrams.

Δ (triangle) connection

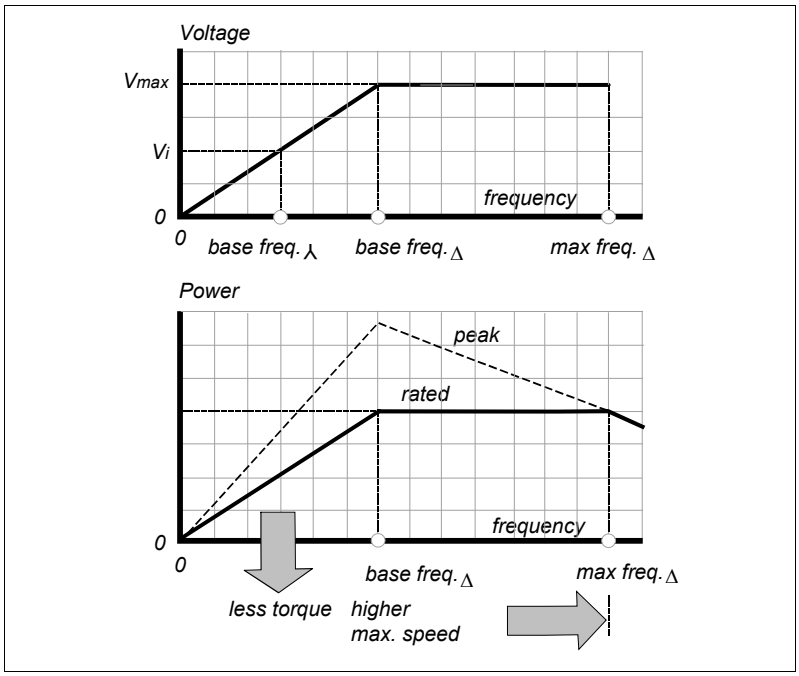
When using this connection, the impedance Z of the motor is much lower than in the previous case. The impedance equivalent to Z in a Y connection is Z/3.



F. 2/9

Δ (triangle) connection. Equivalent impedance in a Y connection.

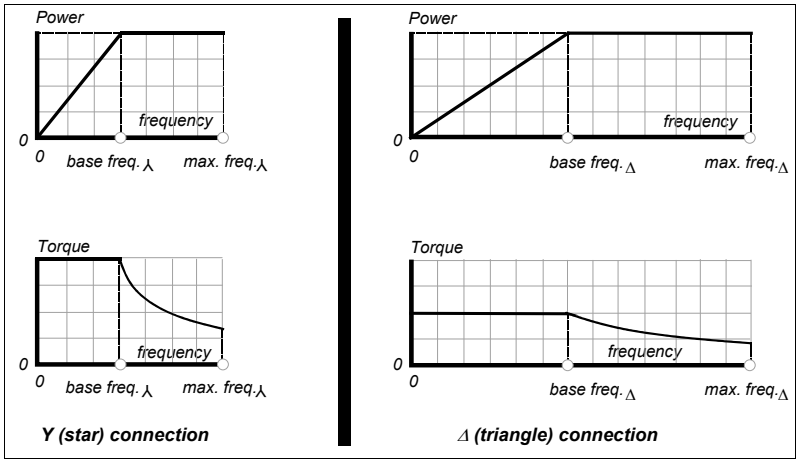
A lower motor impedance means higher base frequency (base speed) and higher maximum frequency, but remember that the maximum voltage is limited beyond the base speed.



F. 2/10

Comparison diagrams of voltage/frequency and power/frequency for delta connection.

2.4.2 Comparison charts F/f and M/f depending on Y-Δ connection



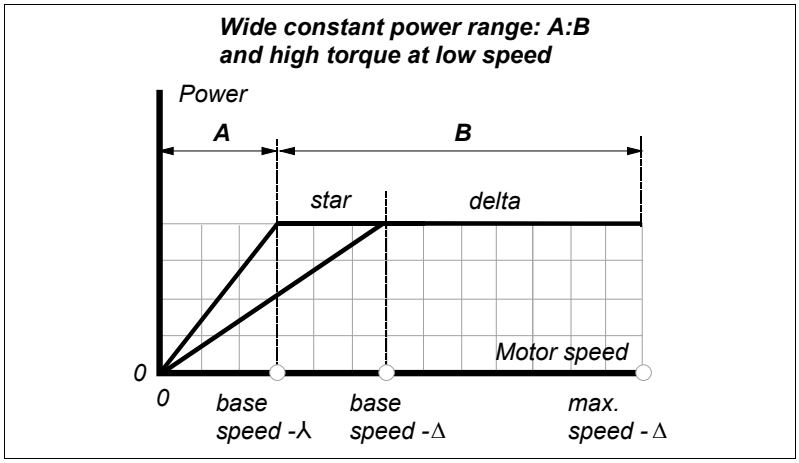
F. 2/11

Comparison charts P/f and M/f depending on Y or Δ connection.

It is therefore, interesting to be able to combine the advantages of both windings, i.e, to use Y-winding at low speed to provide high torque and delta winding at high speed.

The Y-Δ winding change will be carried out through two external magnetic contactors placed between the drive and the motor. If the user has a software version 06.18 or higher, this switch can be made without stopping the motor (at non-zero speed), in other cases, it will have to be done stopping the motor (zero speed).

NOTE. The winding change provides high torque and wide constant power range with relatively small size drive.



F. 2/12

Power/speed graphs applying the winding connection change.

For further details on the connection diagram of the “motor-contactors- drive” system in the electrical cabinet, see the relevant section in the installation chapter of this manual.

2.5 Technical data. Power/torque-speed graphs

This section describes the power and torque graphs for the S1 and S6 40% duty cycles (cycle times of 10 minutes).

NOTE. Remember that when mentioning an S6 cycle in this manual, it always refers to this cycle with a 40% running factor.

The tables that come with the graphs give the most important technical data that characterize each model of this family of motors.

This section also classifies the FM7 and FM9 spindle motors by series. Therefore, the user must check his motor with the series it belongs to in order to find the specific power/torque-speed graph for that motor.

Remember that there are five series:

- FM7-□□□□-□□□□-E01
- FM9-□□□□-C5C□-E01-□
- FM7-□□□□-□□□□-E02
- FM7-□□□□-S1D0-E03
- FM7-□□□□-S1D0-HS3

All the models belonging to the 5 series have 2 pairs of poles (4 poles).

NOTE. The maximum power and speed ranges covered by each series were already shown in chapter **1. DESCRIPTION**.

Important notes

Note that, with FM9 motors larger than the B055:

- the «FM9 motor + associated drive» combination is designed to work in duty cycle S1.
- a torque overload at high speed is allowed depending on the maximum current allowed for the combination (power supply+drive). To estimate its value, use the smallest rated power of the drive and that of the power supplied minus 7 %.

Also keep in mind that, with FM9 motors larger than the B037, the DC BUS must be configured at 675 V DC (for RPS power supplies) in order to obtain the graph of rated power at high speed.

Explanatory notes

- Motors whose maximum speed equal to or higher than 8000 rpm should have a keyless shaft and should be balanced under these conditions.
- Chapter **6. SELECTION** describes how to select the modular or compact drive that will be governing the motor. Selection. Hence, the motor - drive association for all the models has been already defined.
- All AC motors of the FM7/FM9 families governed by main spindle drives must be continuously ventilated while running, regardless of the duty cycle demanded by the application.
- The windings of the FM7 of the FM7-□□□□-□□□□-E01/E02 series have a permanent Delta (triangle) connection.

  NOTE. The windings of the FM7 motors “E01/E02 series” cannot have a Y (star) connection. They are internally connected in triangle and cannot be changed.
- The windings of the FM7 motors of the FM7-D□□□-S1D0-E03/HS3 series may be configured either in triangle or in star using two external contactors installed between the motor and the drive.
- FM9 motor windings have a Y connection.

Symbols used

The following symbols appearing in the technical data tables mean:

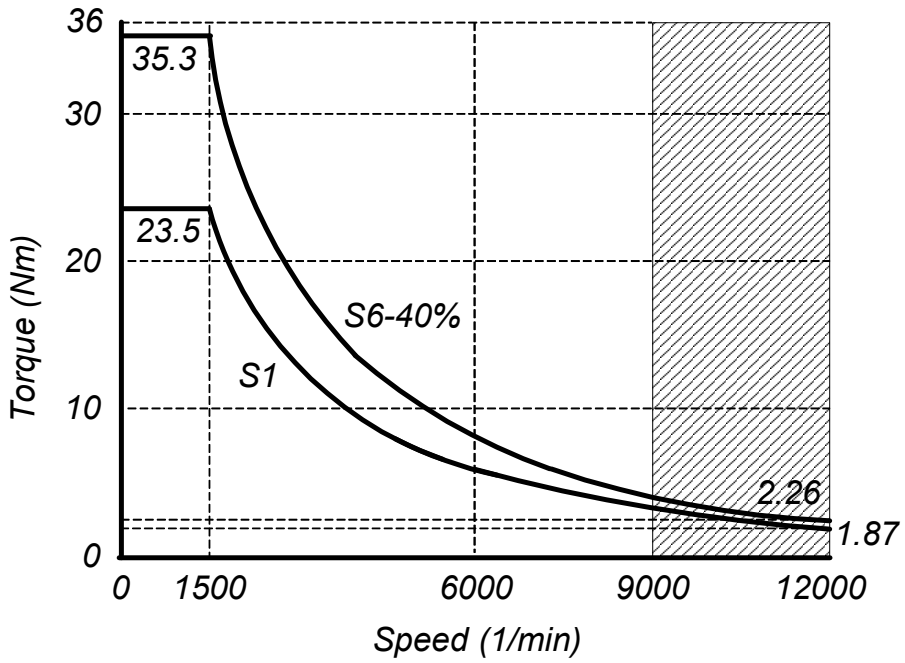
⅄	Y (star) connection
Δ	Delta (triangle) connection

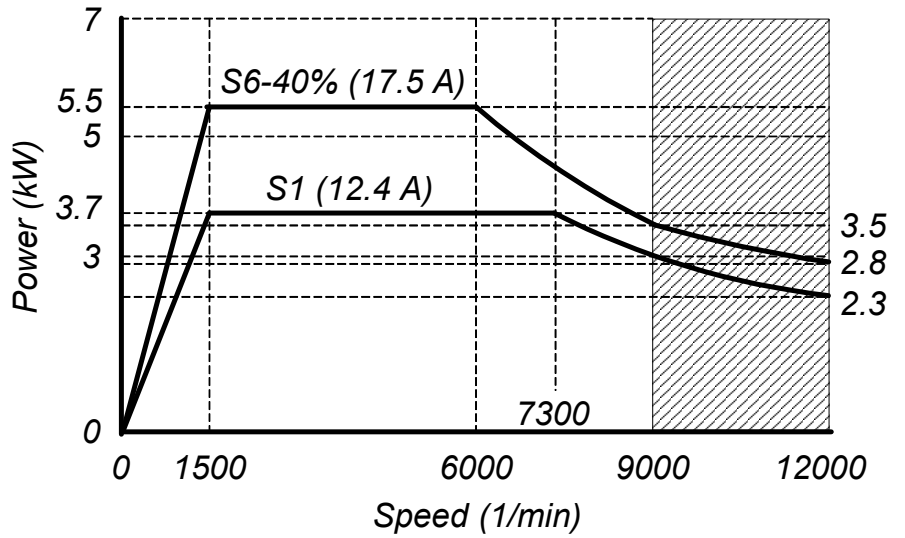
The mass of the motor shown in the technical data tables appears for some models with the letters **B/P/B+P**. The values provided correspond to the approximate mass of the motor depending on whether it is flange mount (B) or foot mount (P) or flange+foot mount (B+P). Hence, for example, when only showing **B**, it corresponds to the approximate mass of the motor that can only be flange mounted.

2.5.1 FM7-XXXX-XXXX-E01/E02 series

T. 2/1 AC spindle motor FM7-A037-□□□□-E01/E02.

FM7-A037-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
3.7	1500	23.5	12.4	9000	12000	140	47/49



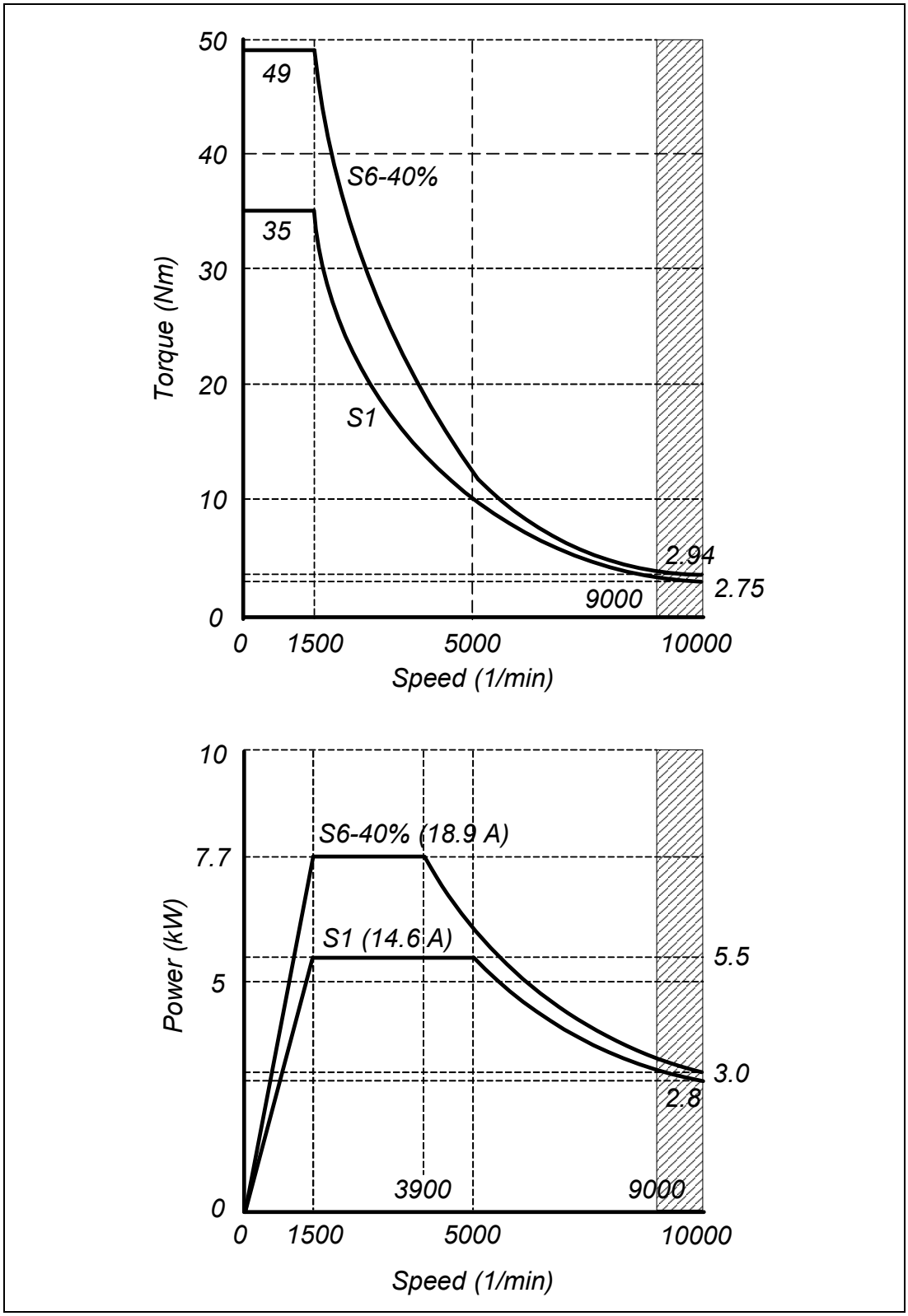


F. 2/13

Power/torque-speed graph. FM7-A037-□□□□-E01/E02.

T. 2/2 AC spindle motor FM7-A055-□□□□-E01/E02.

FM7-A055-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
5.5	1500	35.0	14.6	9000	10000	210	52/56

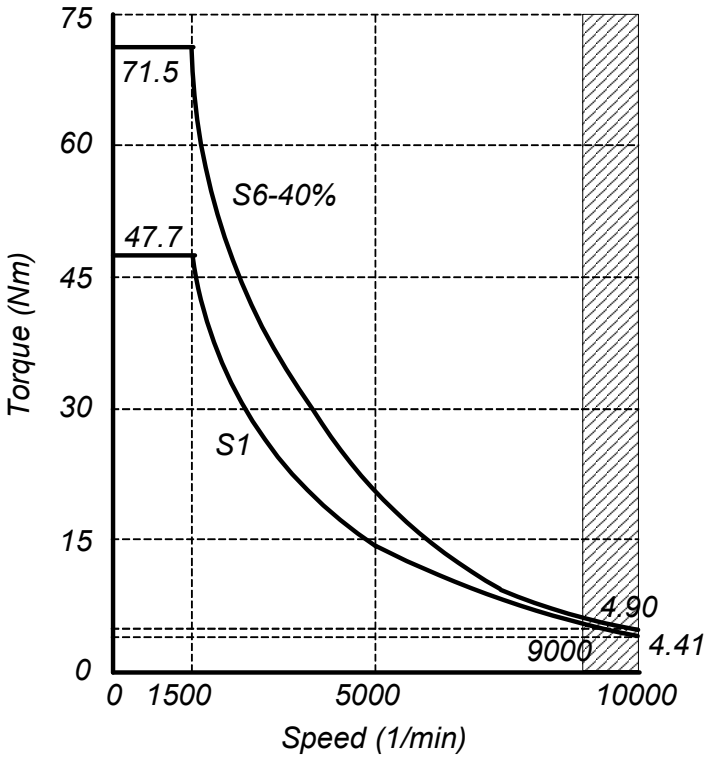


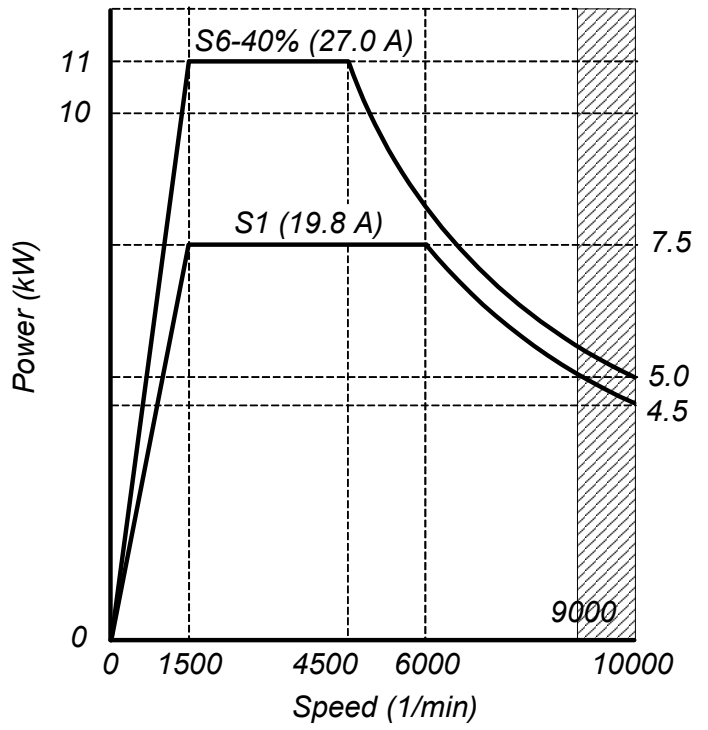
F. 2/14

Power/torque-speed graph. FM7-A055-□□□□-E01/E02.

T. 2/3 AC spindle motor FM7-A075-□□□□-E01/E02.

FM7-A075-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
7.5	1500	47.7	19.8	9000	10000	260	59/64



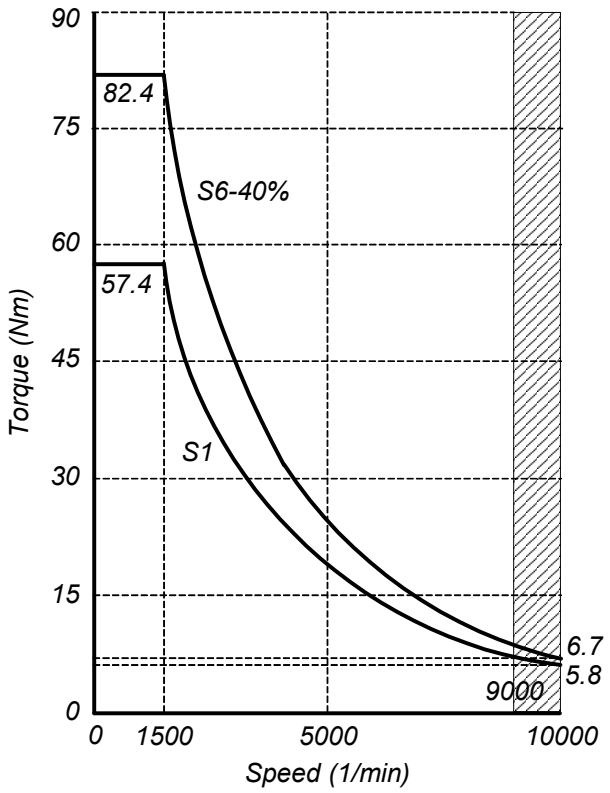


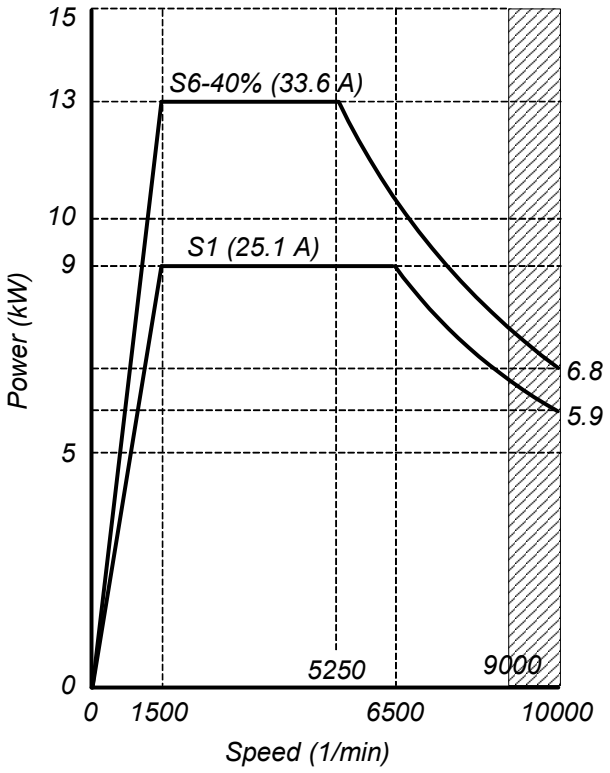
F. 2/15

Power/torque-speed graph. FM7-A075-□□□□-E01/E02.

T. 2/4 AC spindle motor FM7-A090-□□□□-E01/E02.

FM7-A090-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
9.0	1500	57.4	25.1	9000	10000	330	68/73



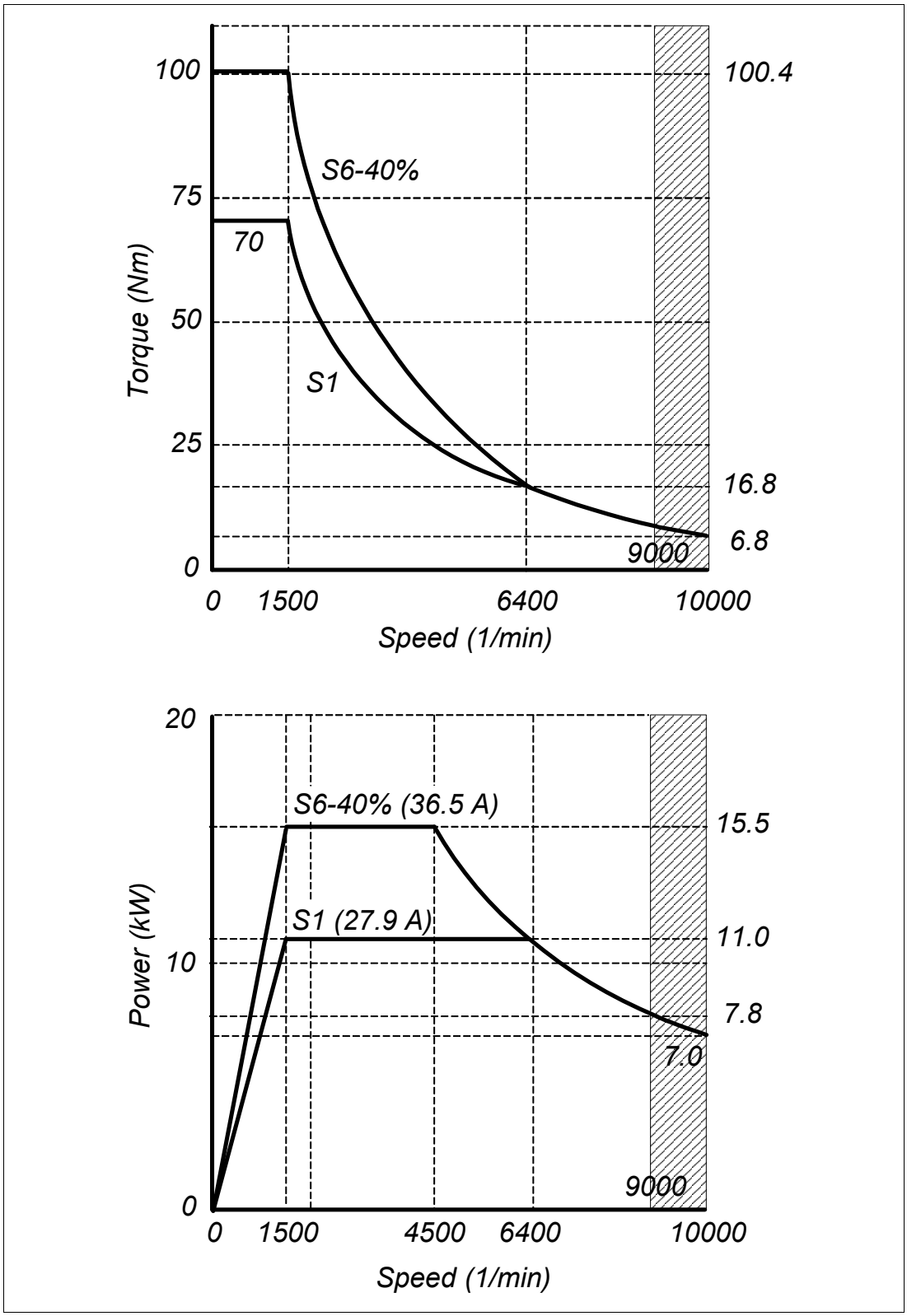


F. 2/16

Power/torque-speed graph. FM7-A090-□□□□-E01/E02.

T. 2/5 AC spindle motor FM7-A110-□□□□-E01/E02.

FM7-A110-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
11.0	1500	70.0	27.9	9000	10000	690	94/110

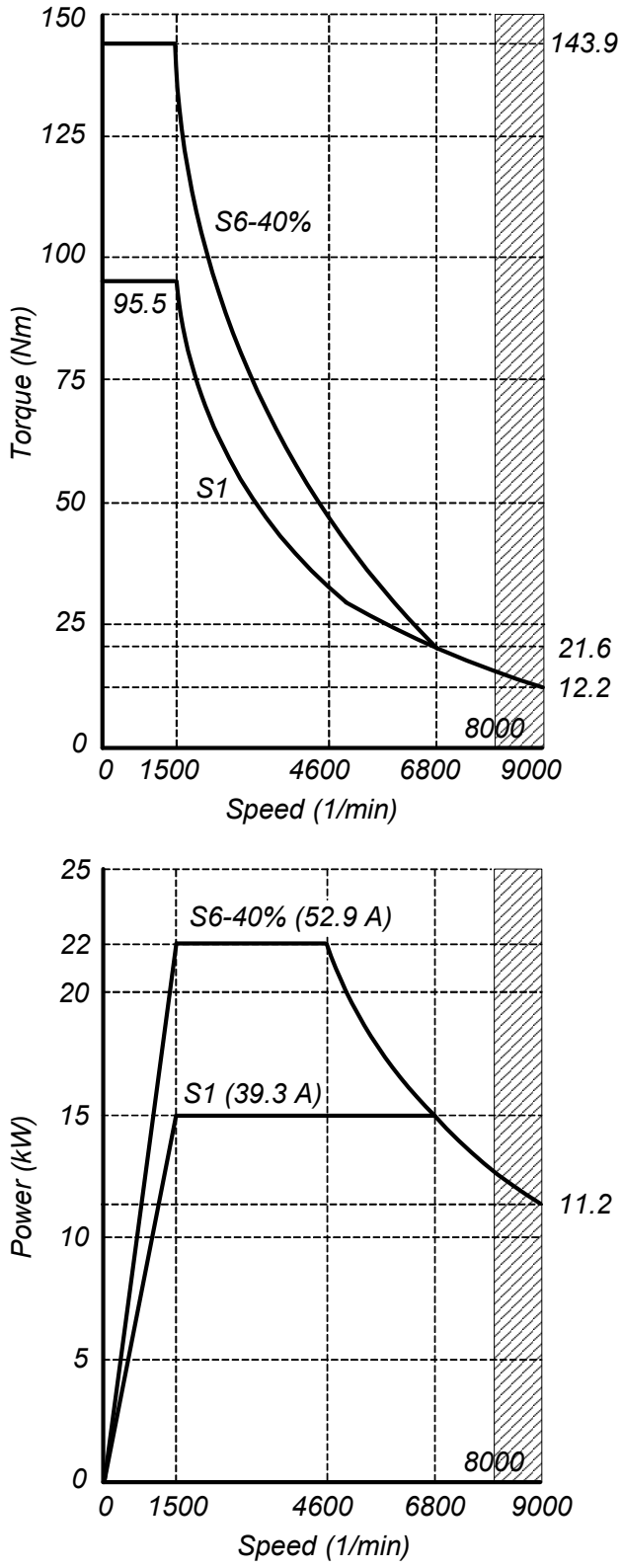


F. 2/17

Power/torque-speed graph. FM7-A110-□□□□-E01/E02.

T. 2/6 AC spindle motor FM7-A150-□□□□-E01/E02.

FM7-A150-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
15.0	1500	95.5	39.3	8000	9000	690	94/110

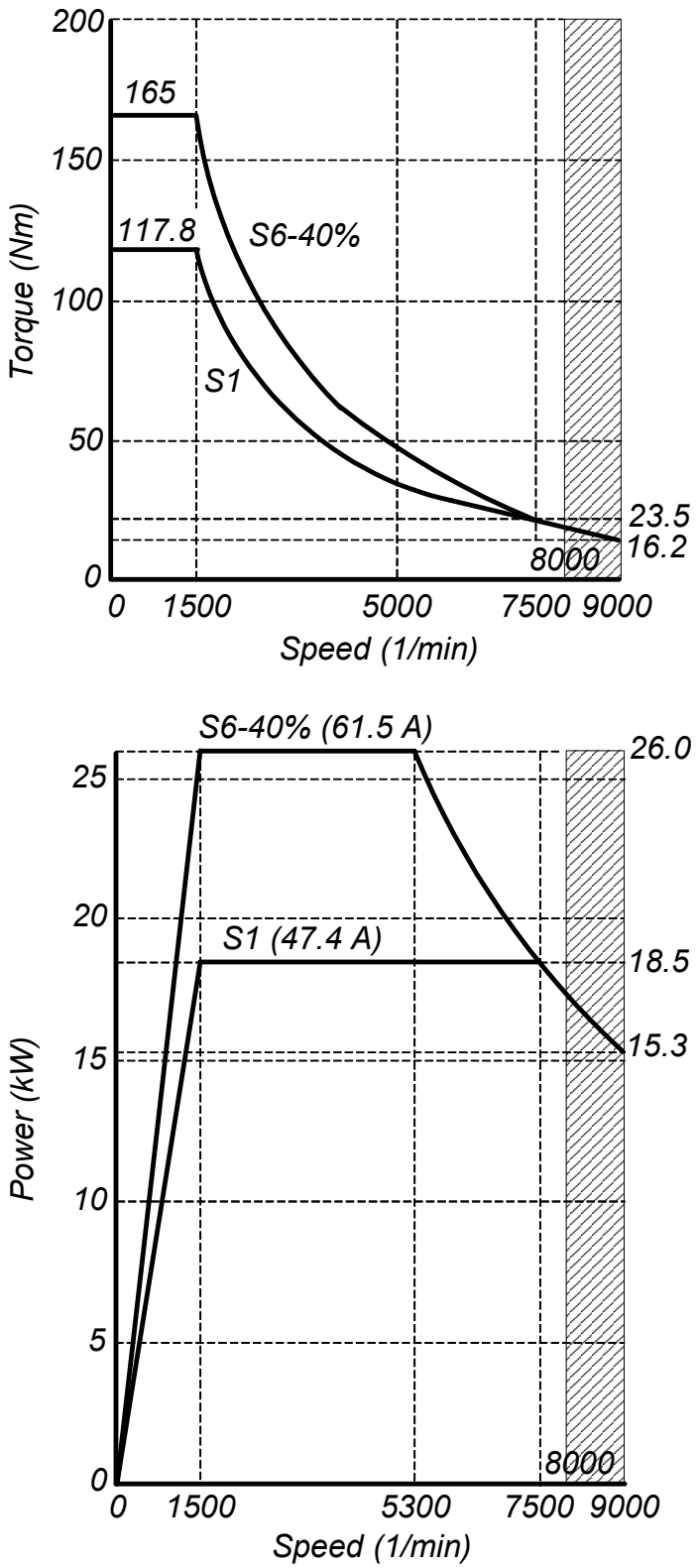


F. 2/18

Power/torque-speed graph. FM7-A150-□□□□-E01/E02.

T. 2/7 AC spindle motor FM7-A185-□□□□-E01/E02.

FM7-A185-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
18.5	1500	117.8	47.4	8000	9000	890	120/130

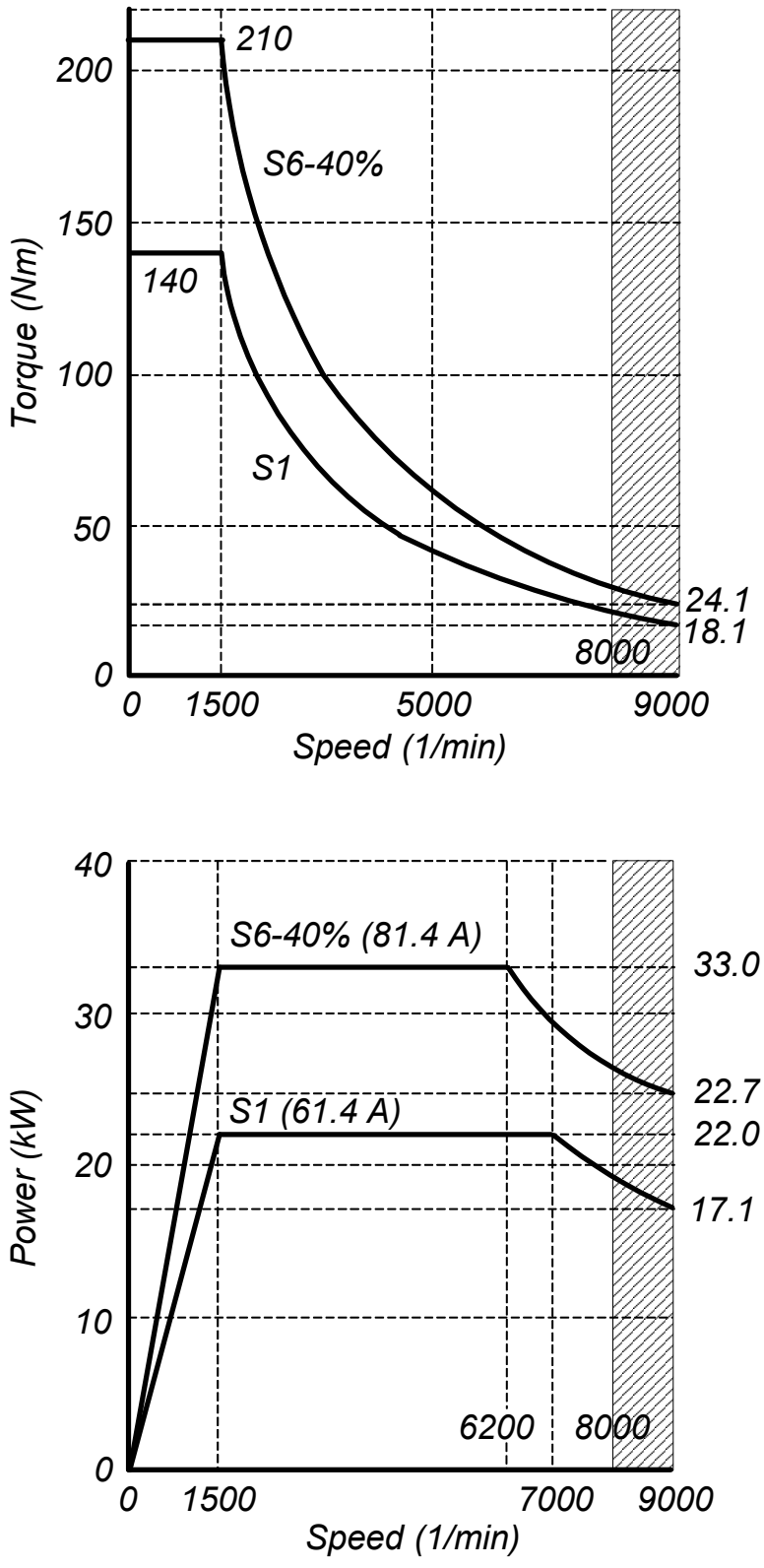


F. 2/19

Power/torque-speed graph. FM7-A185-□□□□-E01/E02.

T. 2/8 AC spindle motor FM7-A220-□□□□-E01/E02.

FM7-A220-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
22.0	1500	140.0	61.4	8000	9000	1080	135/145

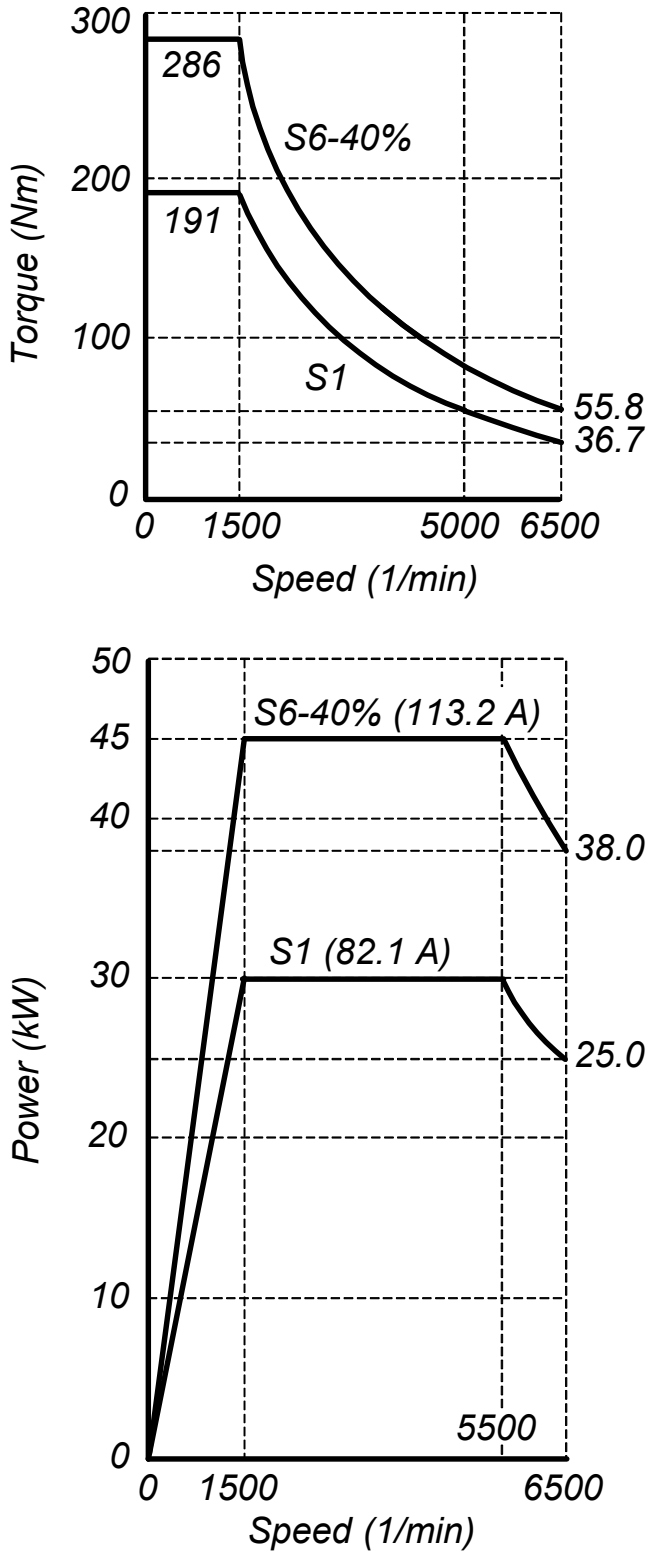


F. 2/20

Power/torque-speed graph. FM7-A220-□□□□-E01/E02.

T. 2/9 AC spindle motor FM7-A300-□□□□-E01.

FM7-A300-□□□□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
30.0	1500	191.0	82.1	6500	-	2310	220/230

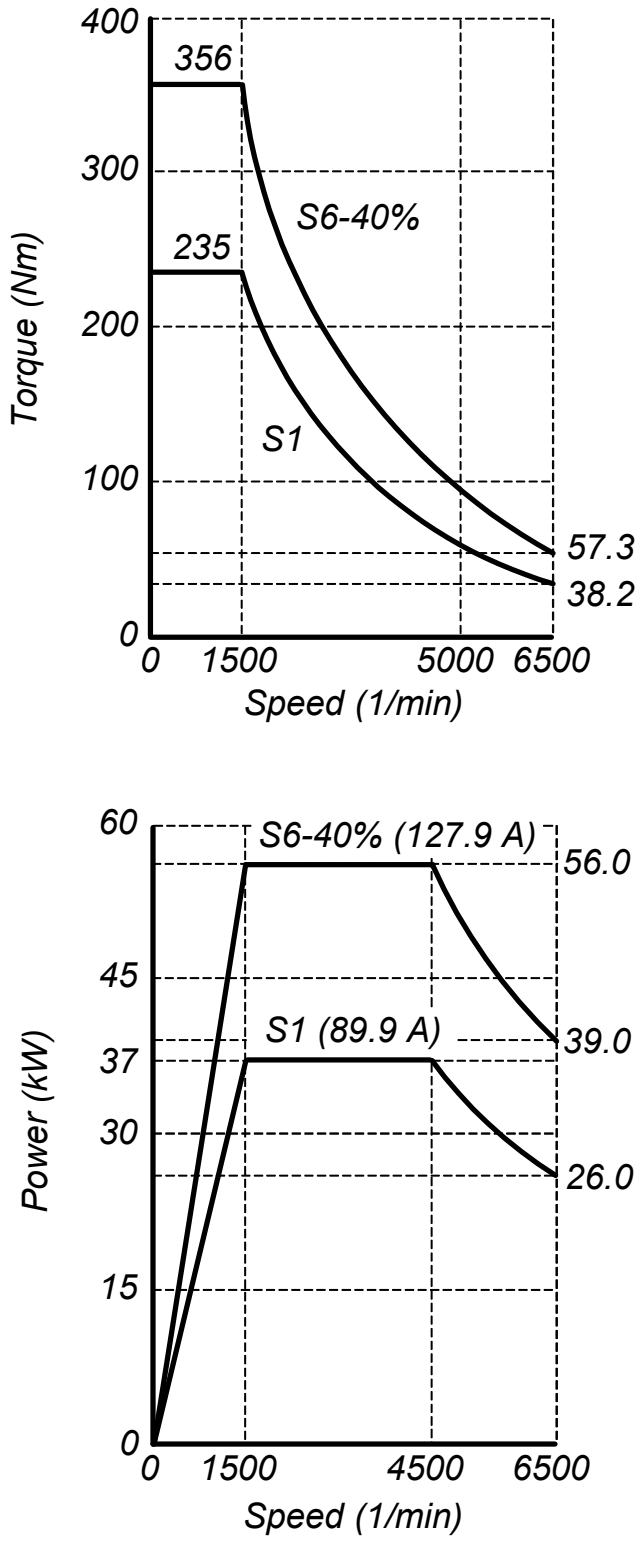


F. 2/21

Power/torque-speed graph. FM7-A300-□□□□-E01.

T. 2/10 AC spindle motor FM7-A370-□□□□-E01.

FM7-A370-□□□□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
37.0	1500	235.0	89.9	6500	-	2660	250/260

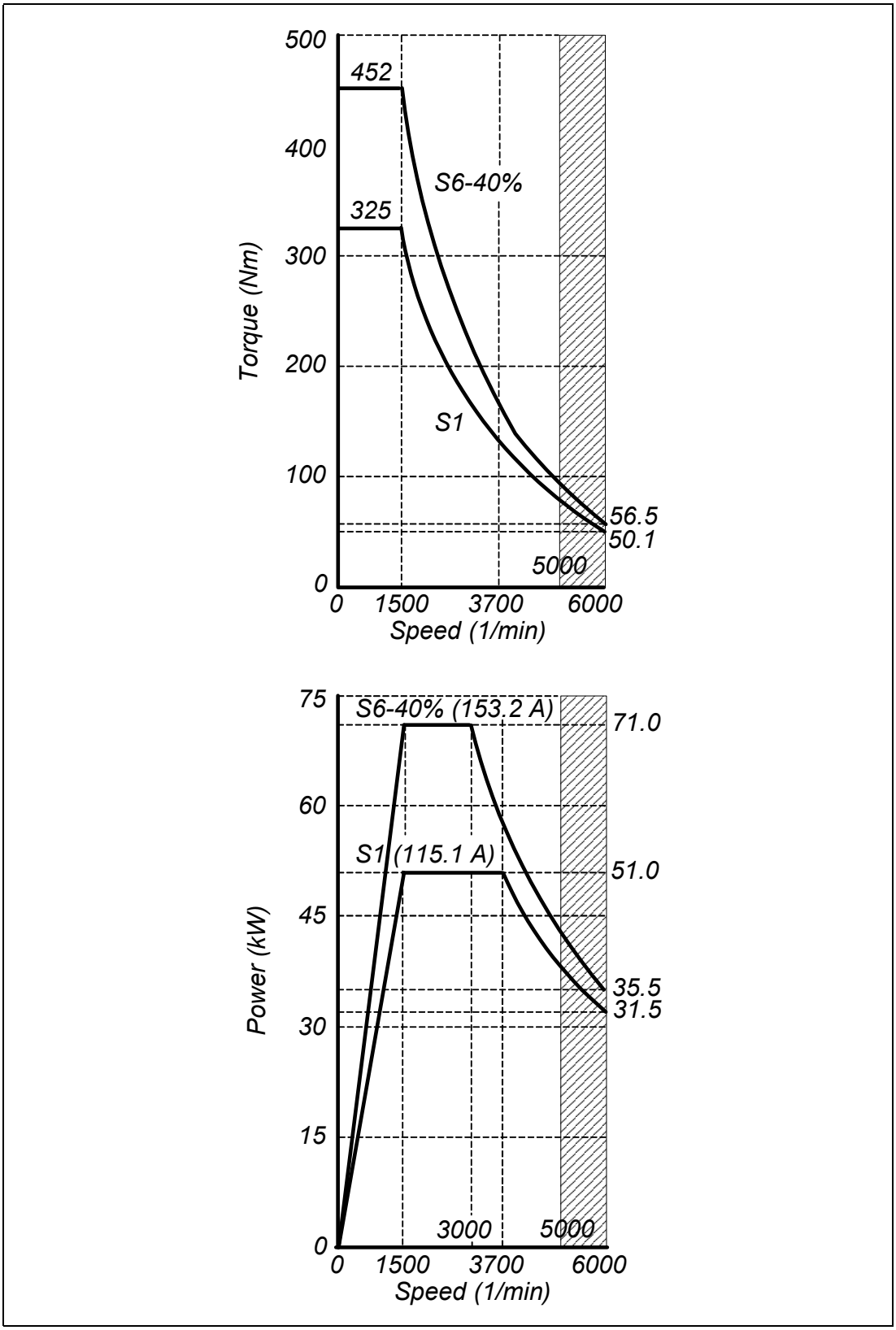


F. 2/22

Power/torque-speed graph. FM7-A370-□□□□-E01.

T. 2/11 AC spindle motor FM7-A510-□□□□-E01/E02.

FM7-A510-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
51.0	1500	325.0	115.1	5000	6000	4730	340/350

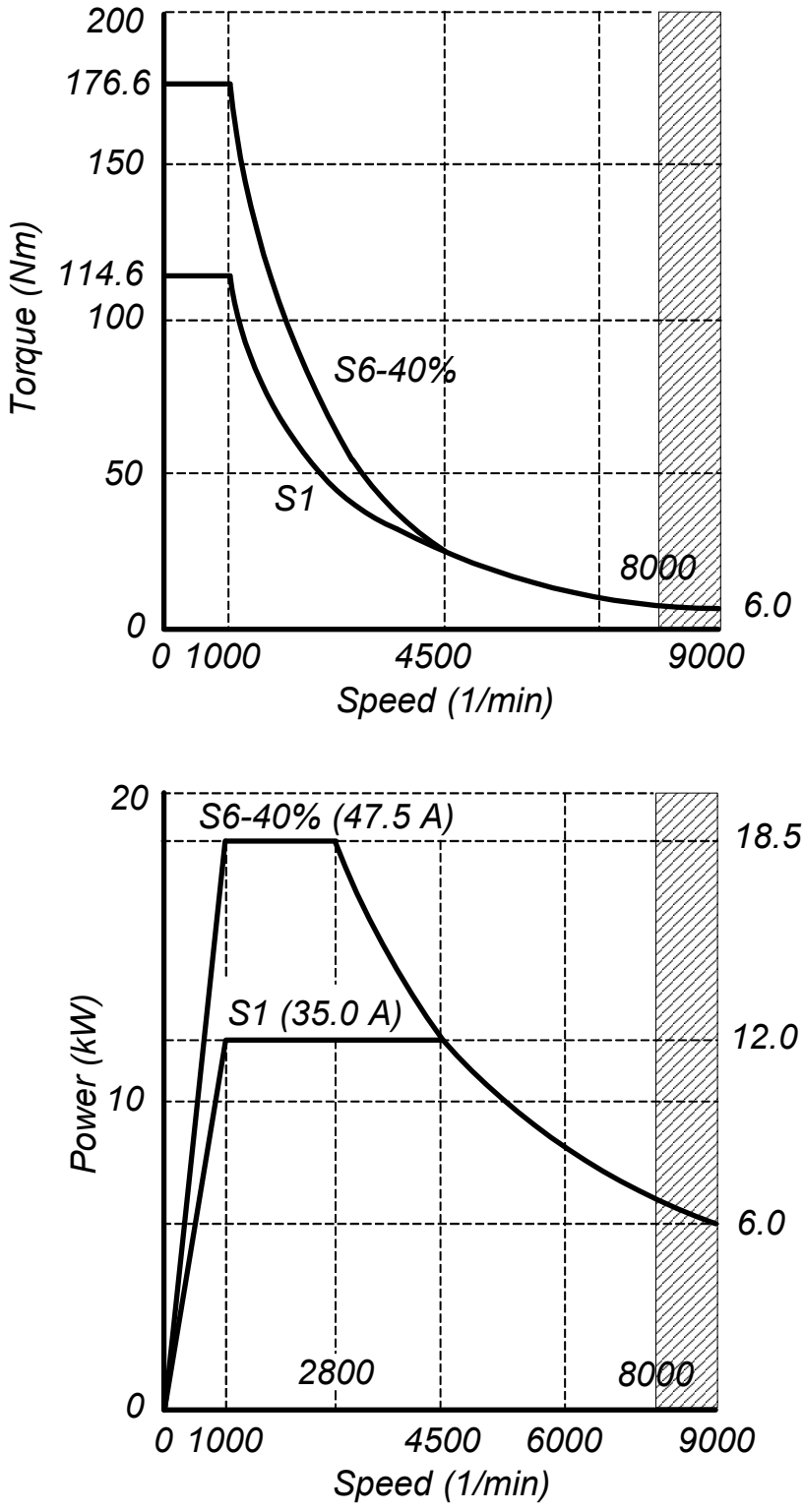


F. 2/23

Power/torque-speed graph. FM7-A510-□□□□-E01/E02.

T. 2/12 AC spindle motor FM7-B120-□□□□-E01/E02.

FM7-B120-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
12.0	1000	114.6	35.0	8000	9000	890	120/130

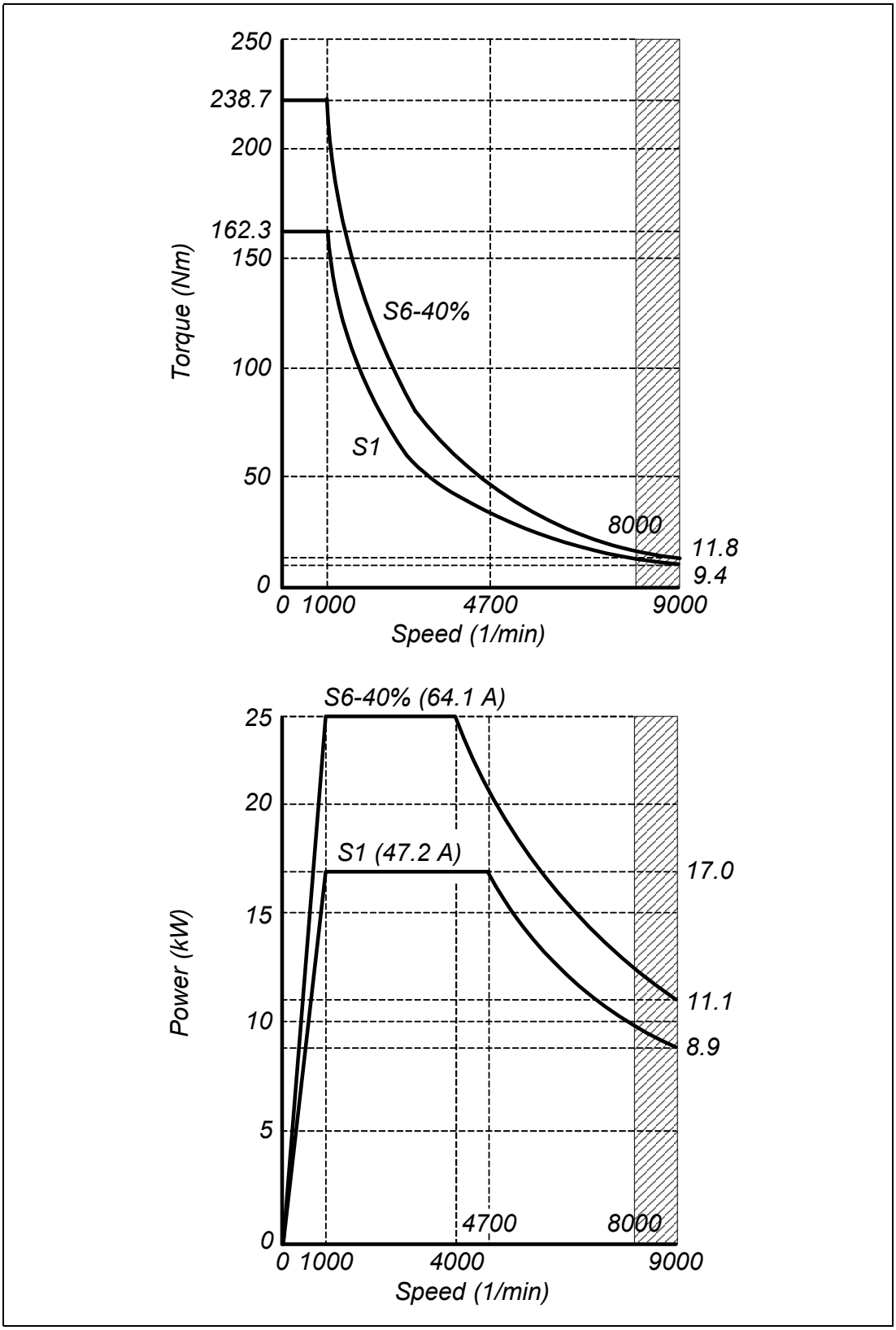


F. 2/24

Power/torque-speed graph. FM7-B120-□□□□-E01/E02.

T. 2/13 AC spindle motor FM7-B170-□□□□-E01/E02.

FM7-B170-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
17.0	1000	162.3	47.2	8000	9000	1080	135/145

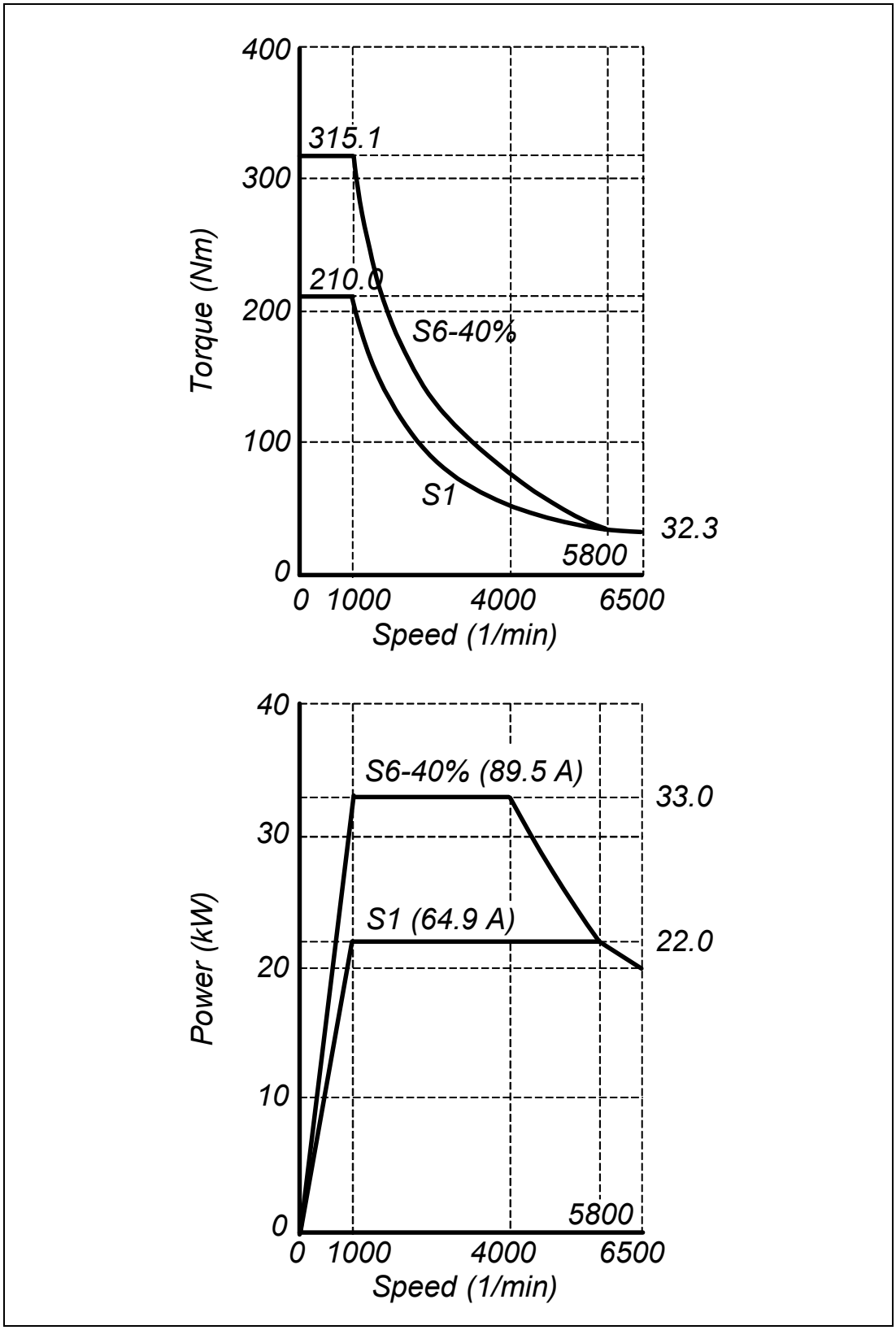


F. 2/25

Power/torque-speed graph. FM7-B170-□□□□-E01/E02.

T. 2/14 AC spindle motor FM7-B220-□□□□-E01.

FM7-B220-□□□□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
22.0	1000	210.0	64.9	6500	-	2310	220/230

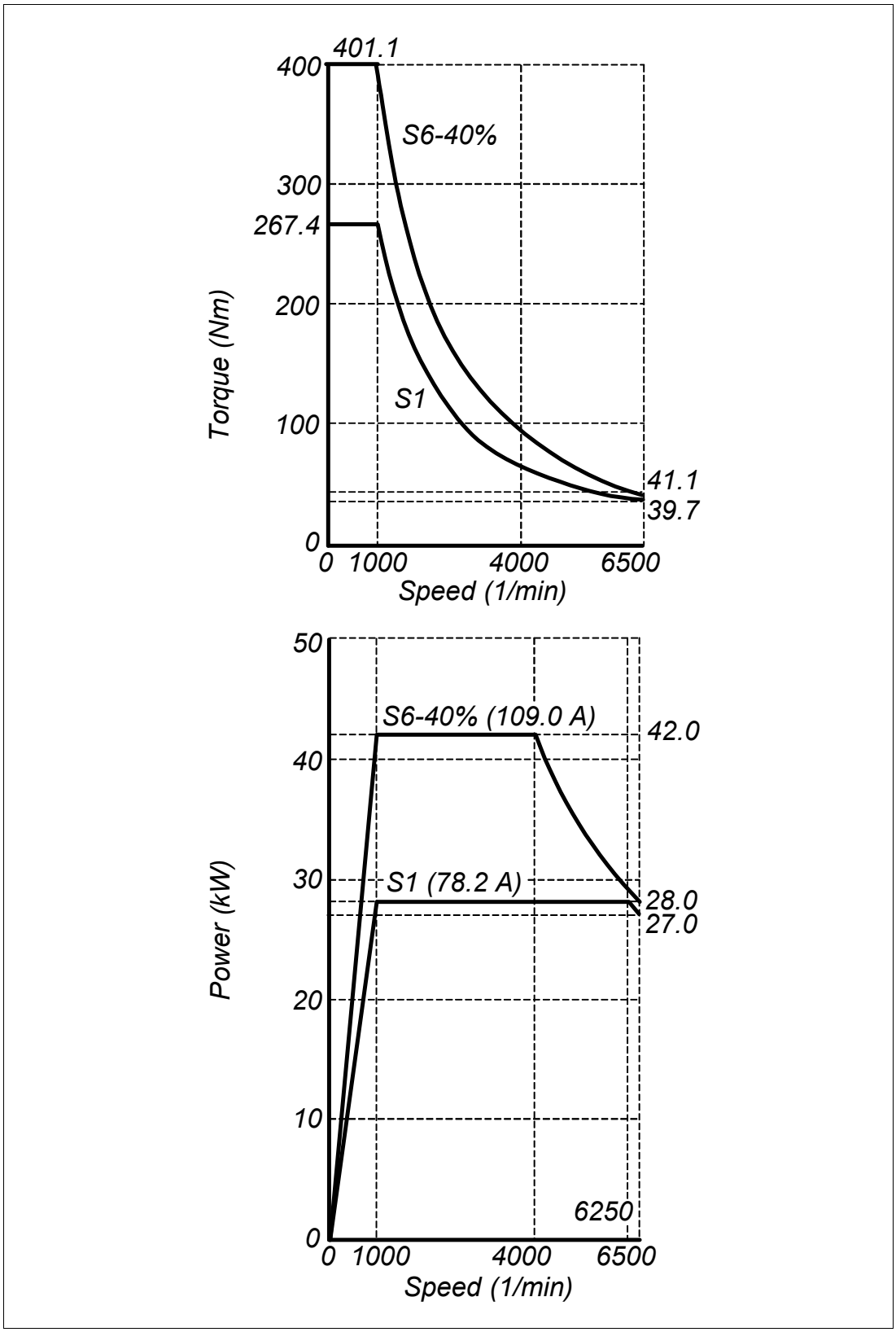


F. 2/26

Power/torque-speed graph. FM7-B220-□□□□-E01.

T. 2/15 AC spindle motor FM7-B280-□□□□-E01.

FM7-B280-□□□□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
28.0	1000	267.4	78.2	6500	-	2660	250/260

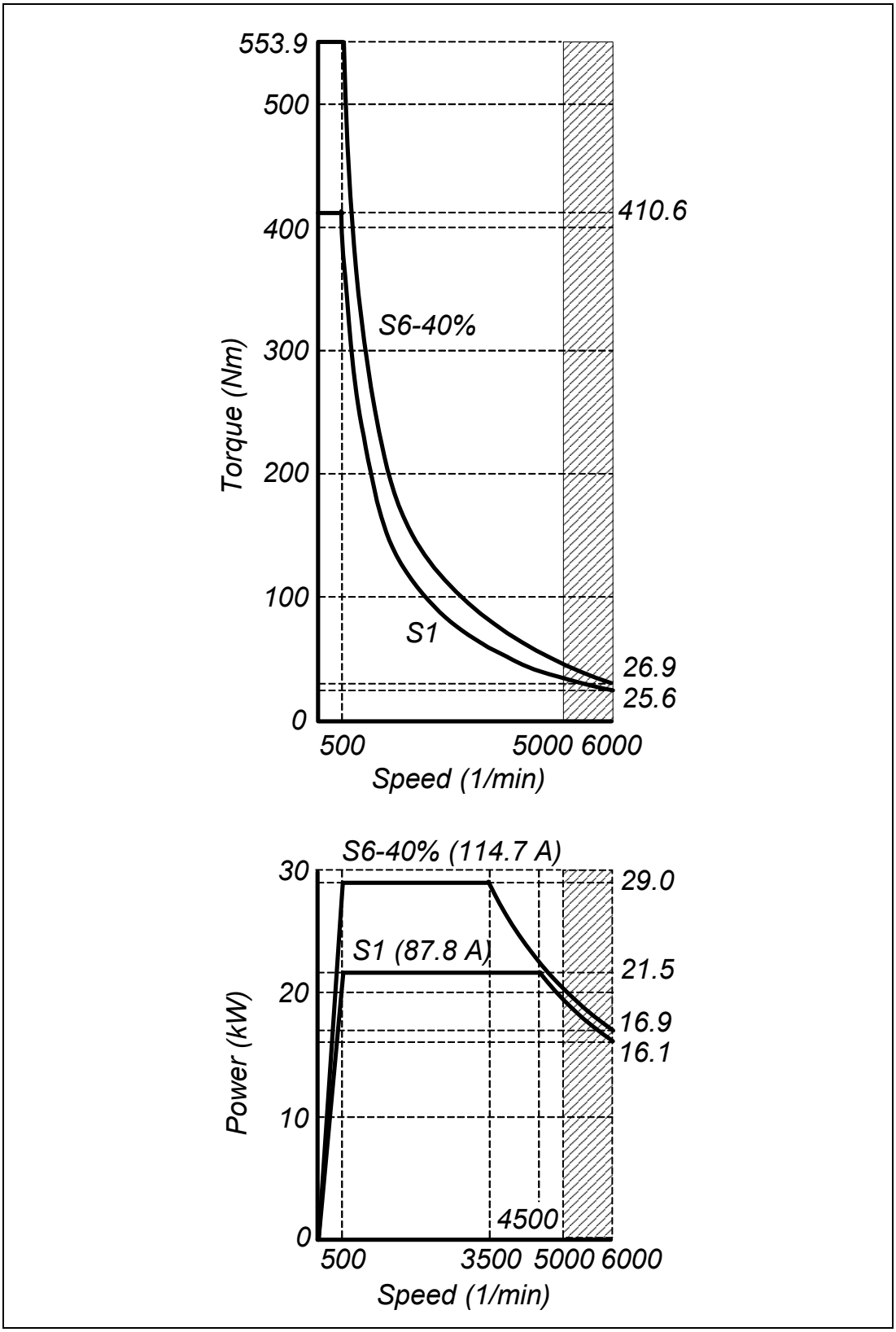


F. 2/27

Power/torque-speed graph. FM7-B280-□□□□-E01.

T. 2/16 AC spindle motor FM7-C215-□□□□-E01/E02.

FM7-C215-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
21.5	500	410.6	87.8	5000	6000	4730	340/350

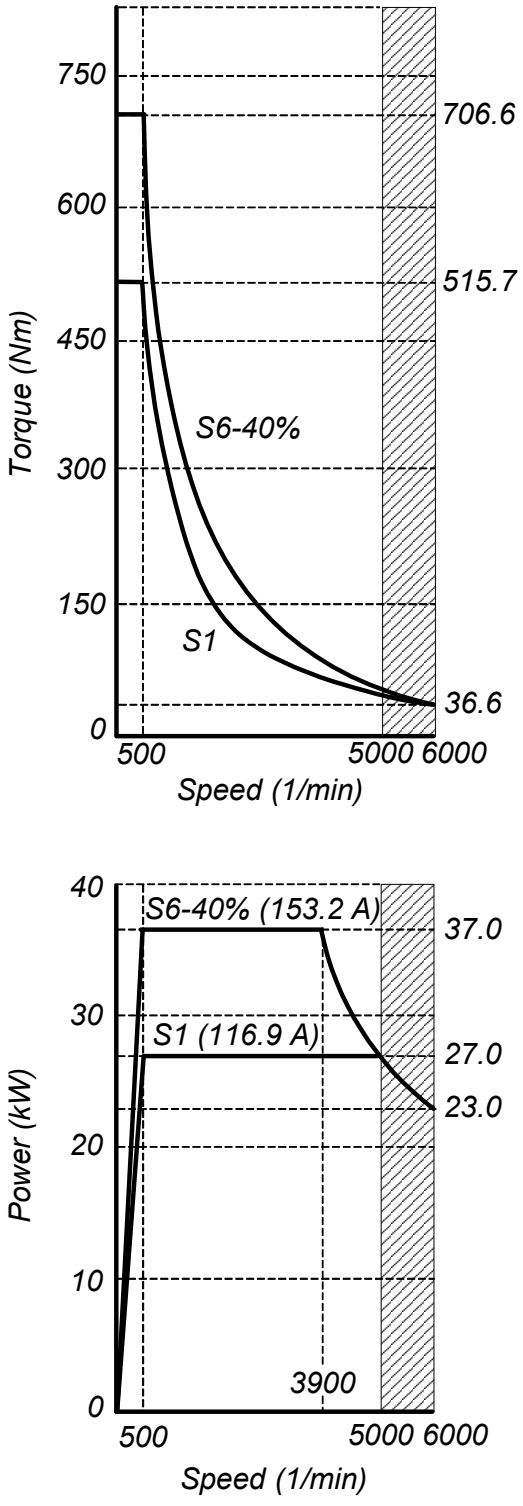


F. 2/28

Power/torque-speed graph. FM7-C215-□□□□-E01/E02.

T. 2/17 AC spindle motor FM7-C270-□□□□-E01/E02.

FM7-C270-□□□□-E01/E02							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P (kg)
27.0	500	515.7	116.9	5000	6000	5840	380/390

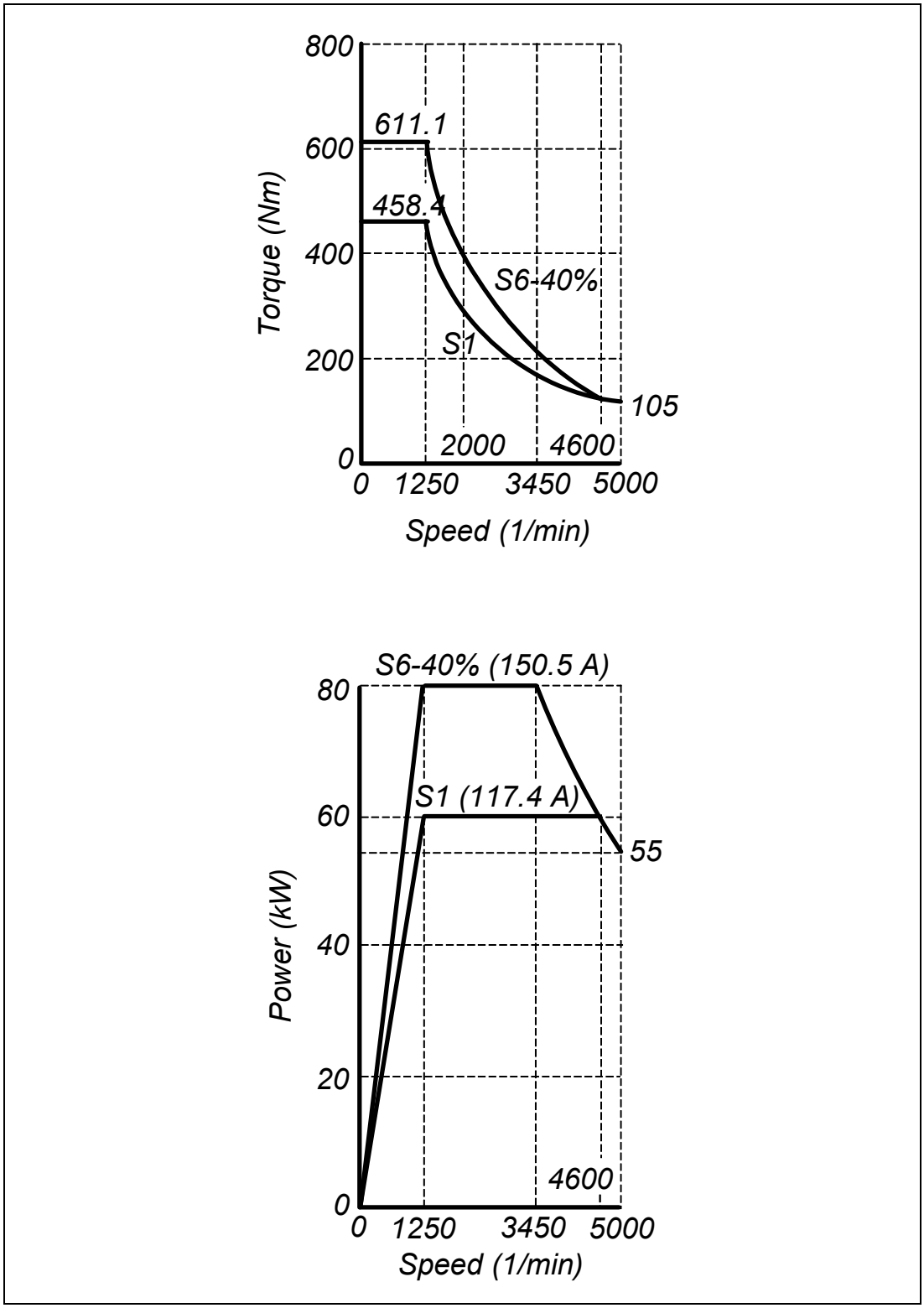


F. 2/29

Power/torque-speed graph. FM7-C270-□□□□-E01/E02.

T. 2/18 AC spindle motor FM7-E600-C□B□-E01.

FM7-E600-C□B□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B/P/B+P(kg)
60.0	1250	458.4	117.4	5000	-	8720	525/540/545



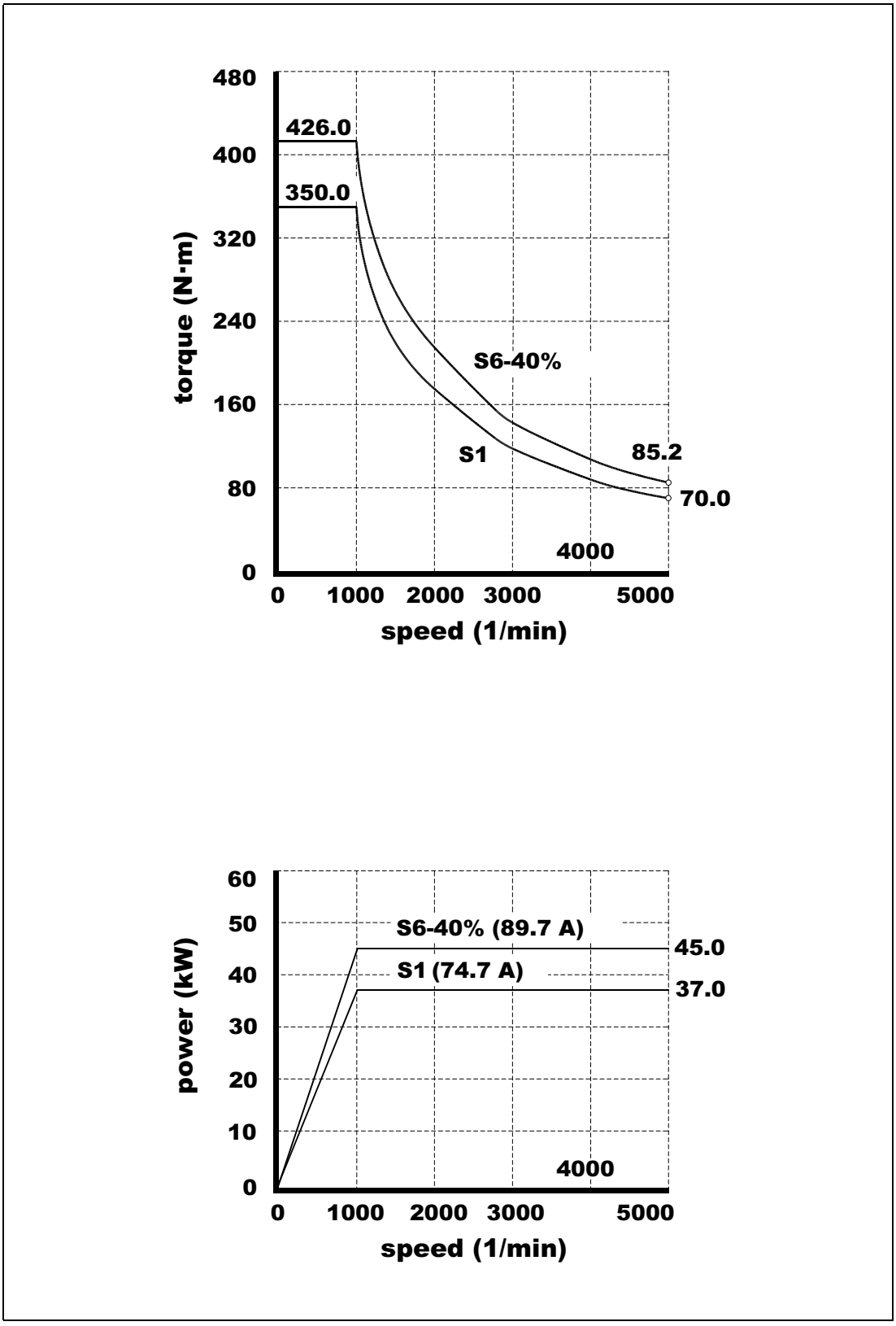
F. 2/30

Power/torque-speed graph. FM7-E600-C□B□-E01.

2.5.2 FM9-XXXX-C5CX-E01-X series

T. 2/19 AC spindle motor FM9-B037-C5C□-E01.

FM9-B037-C5C□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
37	1000	350.0	74.7	5000	-	3000	265

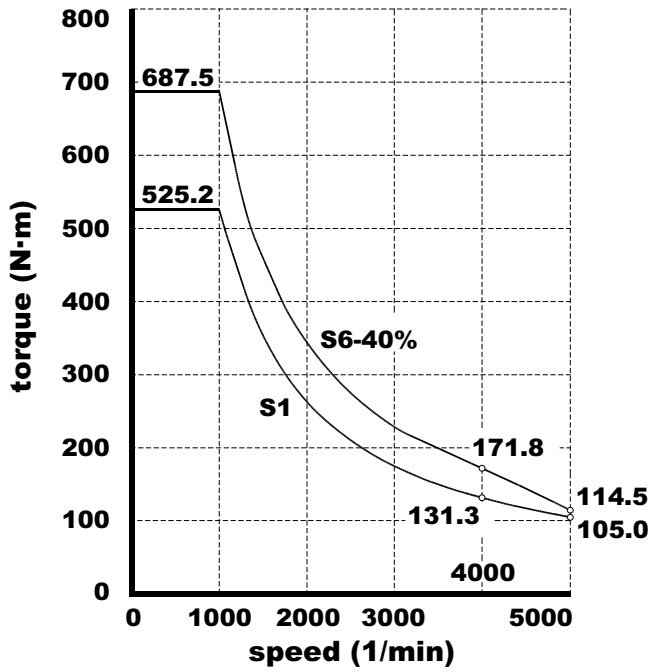


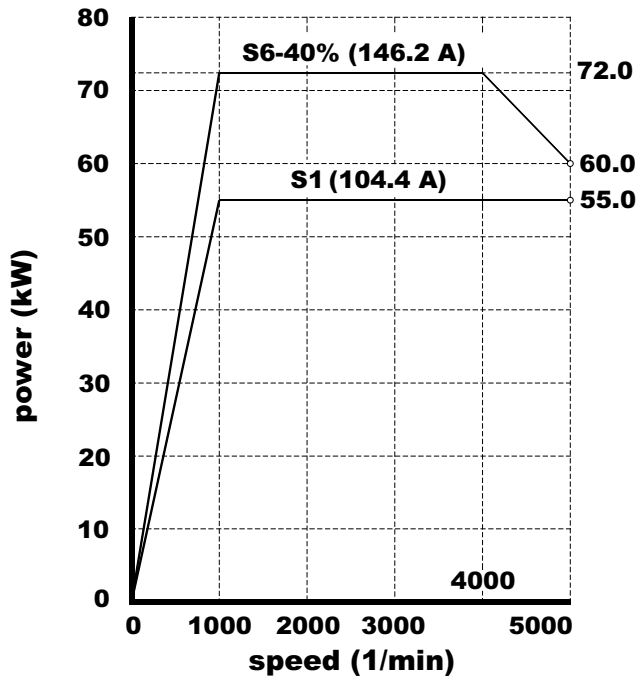
F. 2/31

Power/torque-speed graph. FM9-B037-C5C□-E01.

T. 2/20 AC spindle motor FM9-B055-C5C□-E01-A.

FM9-B055-C5C□-E01-A							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
55.0	1000	525.2	104.4	5000	-	6900	440



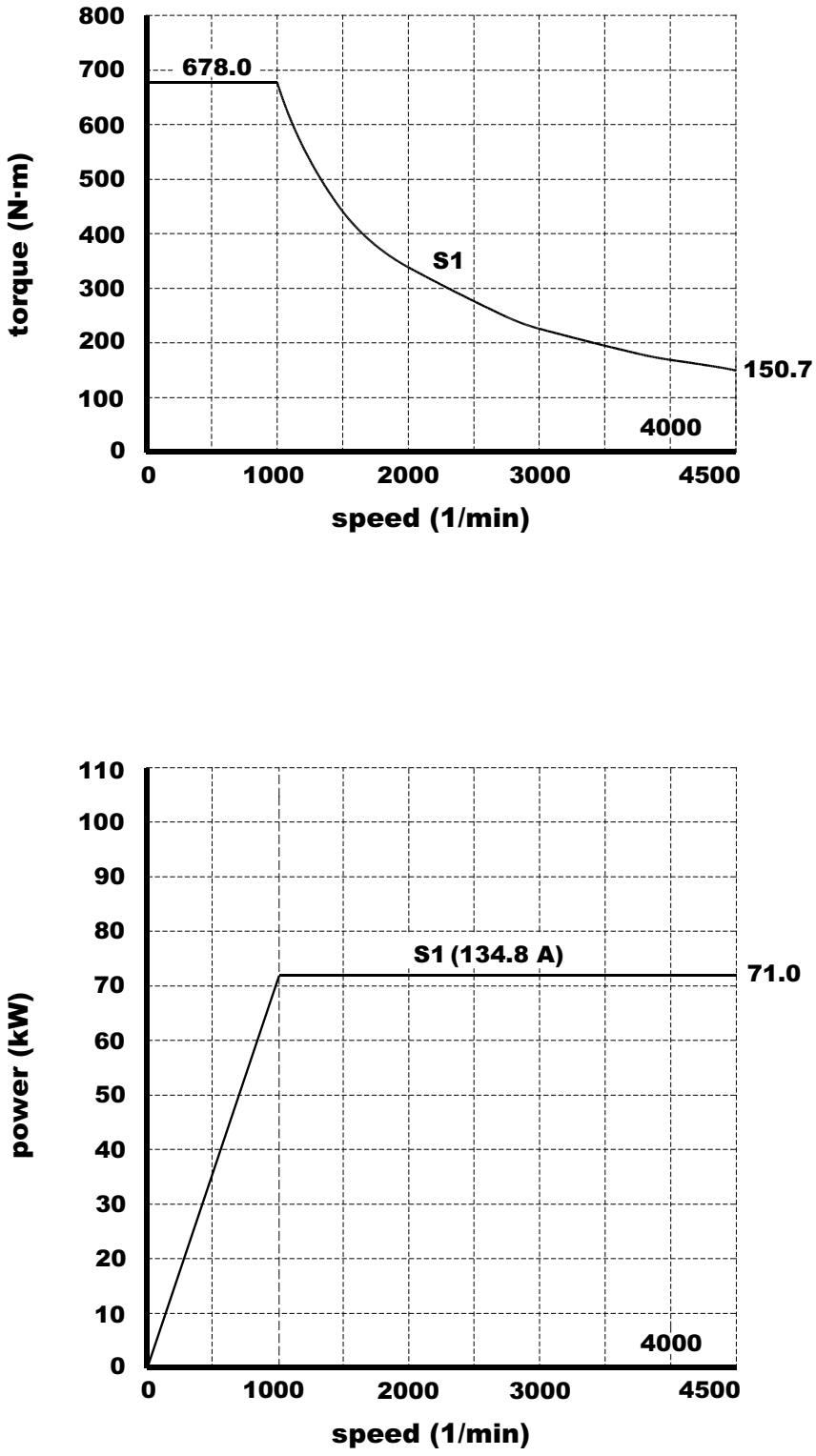


F. 2/32

Power/torque-speed graph. FM9-B055-C5C□-E01-A.

T. 2/21 AC spindle motor FM9-B071-C5C□-E01.

FM9-B071-C5C□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
71.0	1000	678	134.8	4500	-	14790	680

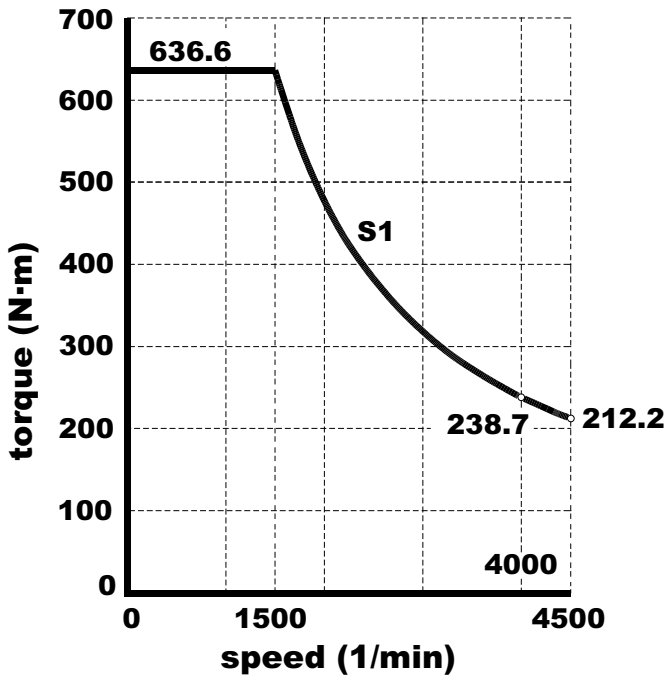


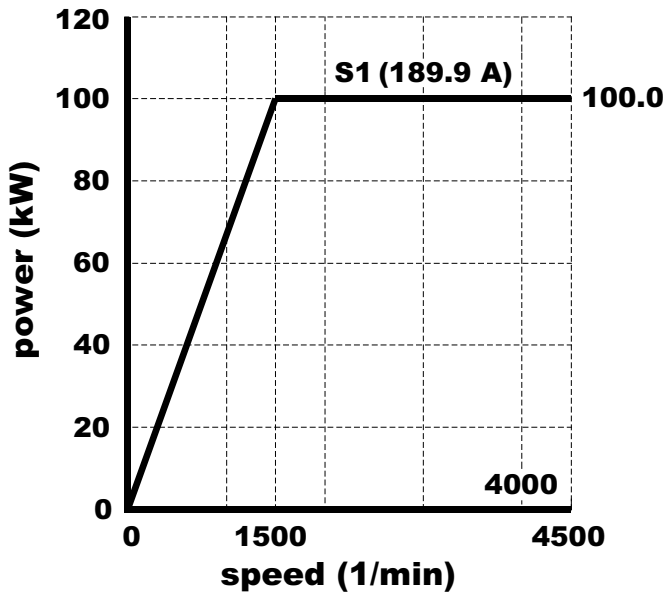
F. 2/33

Power/torque-speed graph. FM9-B071-C5C□-E01.

T. 2/22 AC spindle motor FM9-A100-C5C□-E01.

FM9-A100-C5C□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
100	1500	636.6	190	4500	-	14790	635



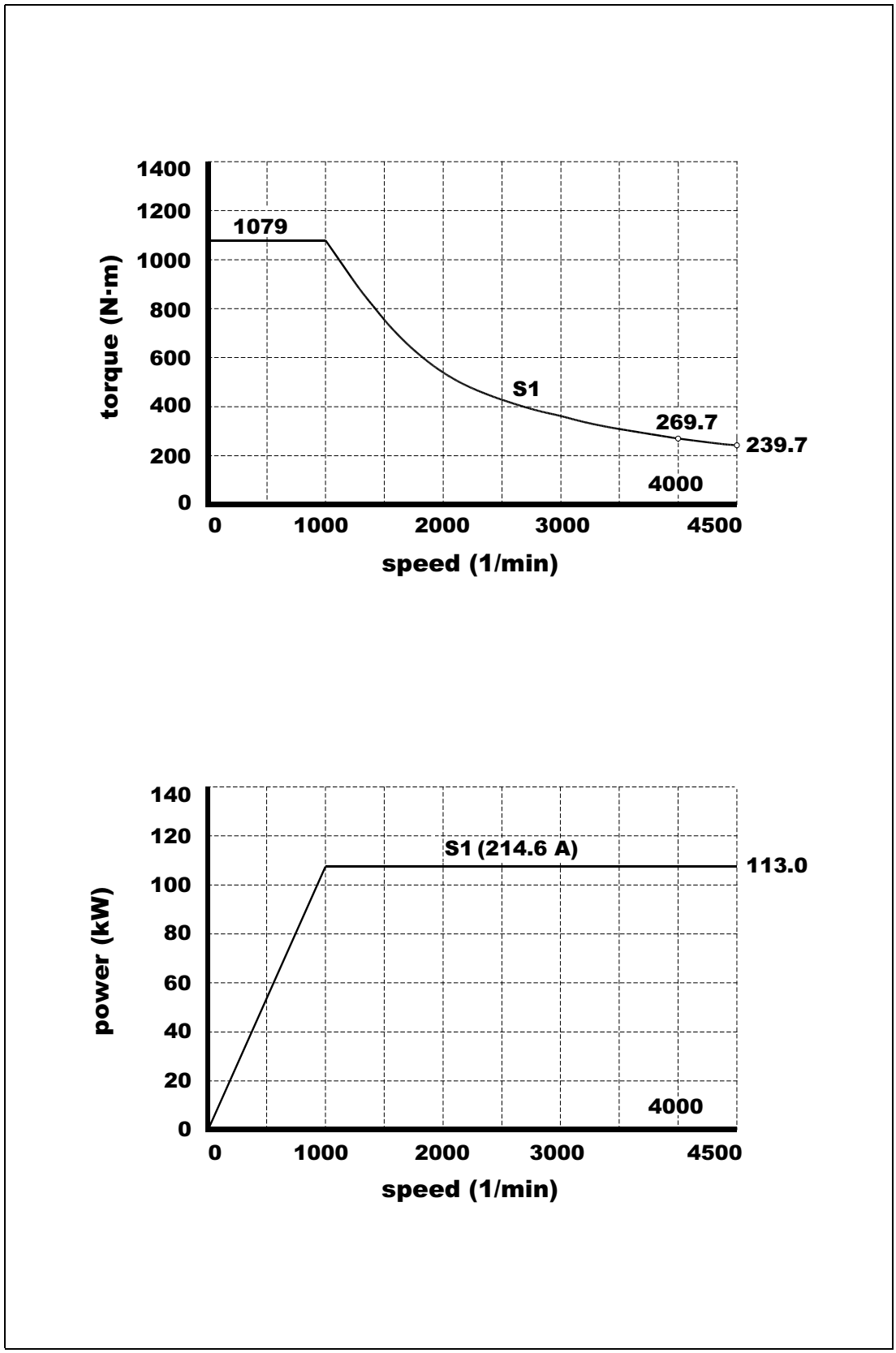


F. 2/34

Power/torque-speed graph. FM9-A100-C5C□-E01.

T. 2/23 AC spindle motor FM9-B113-C5C□-E01.

FM9-B113-C5C□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
113	1000	1079	215	4500	-	23260	860

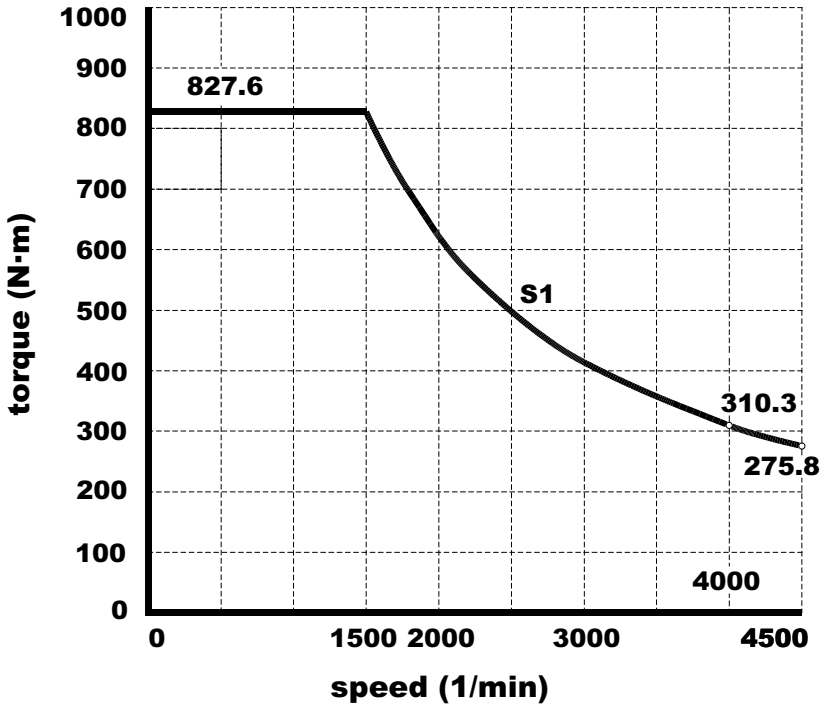


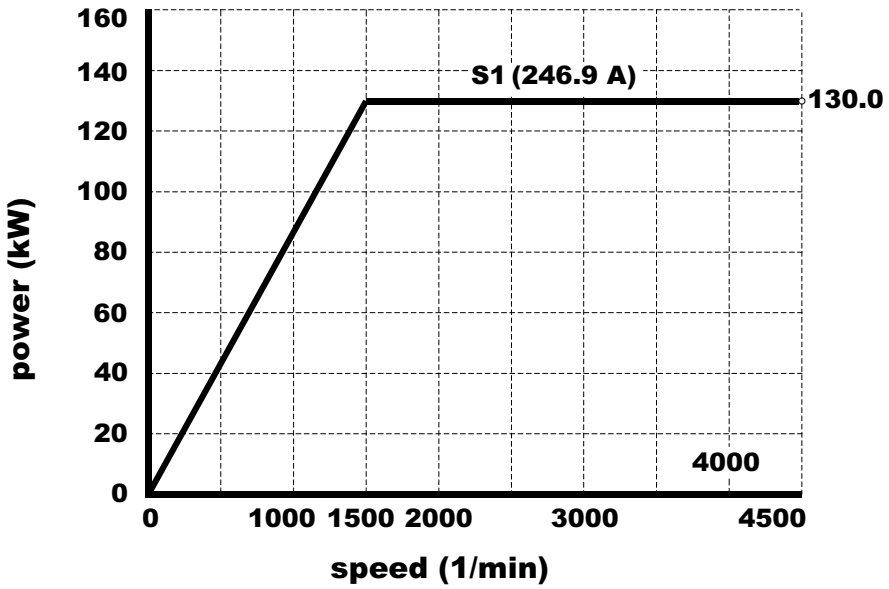
F. 2/35

Power/torque-speed graph. FM9-B113-C5C□-E01.

T. 2/24 AC spindle motor FM9-A130-C5C□-E01.

FM9-A130-C5C□-E01							
Rated power	Base speed	Rated torque	Rated current	Max. speed		Inertia	Approx. mass
				E01	E02		
Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)		J (kg·cm²)	B+P (kg)
130	1500	827.6	246.9	4500	-	19300	745





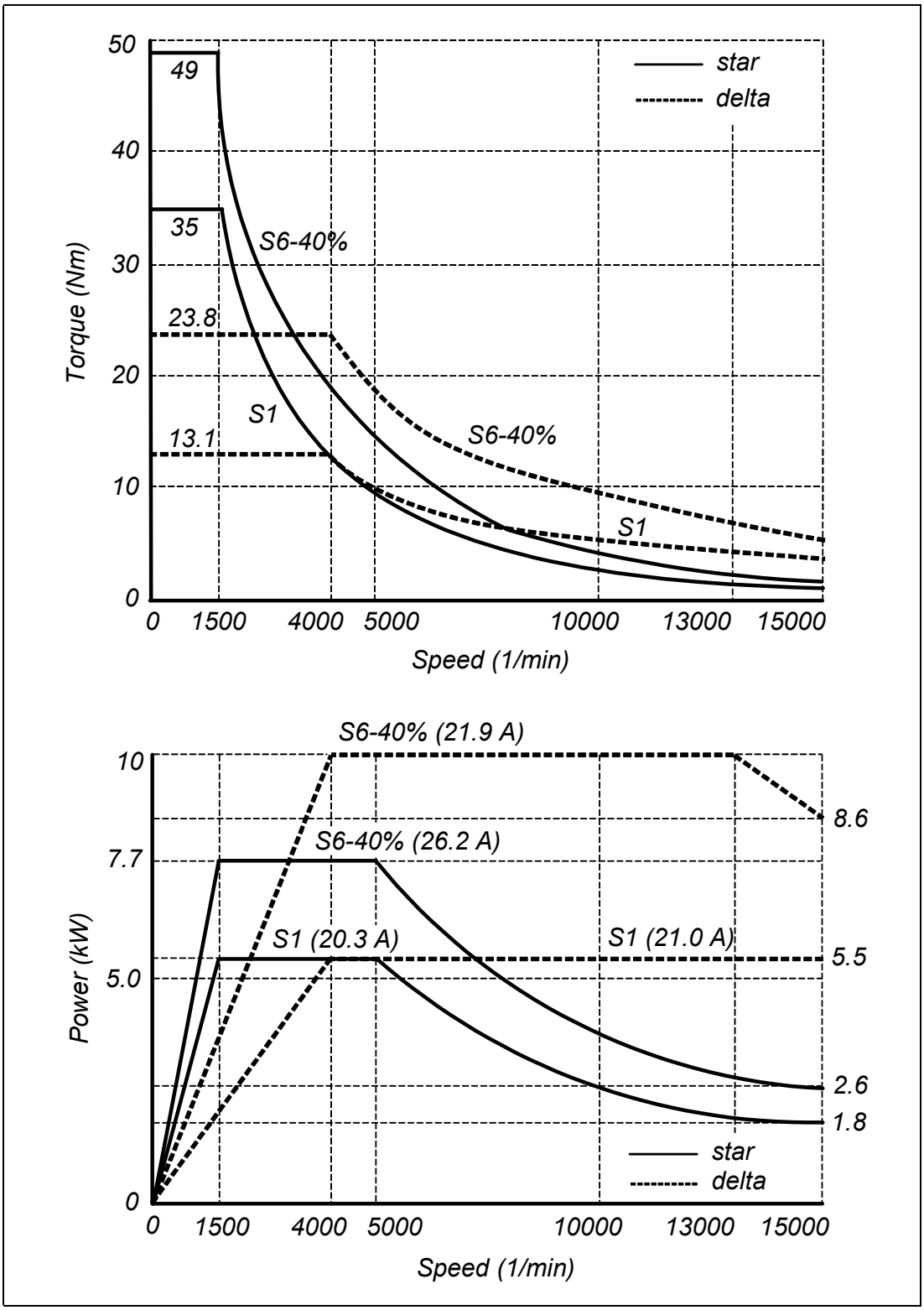
F. 2/36

Power/torque-speed graph. FM9-A130-C5C□-E01.

2.5.3 FM7-DXXX-S1D0-E03 series

T. 2/25 AC spindle motor FM7-D055-S1D0-E03.

FM7-D055-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)	J (kg·cm²)	B (kg)
Y	5.5	1500	35.0	20.3	15000	210	67
Δ	5.5	4000	13.1	20.7	15000	210	67

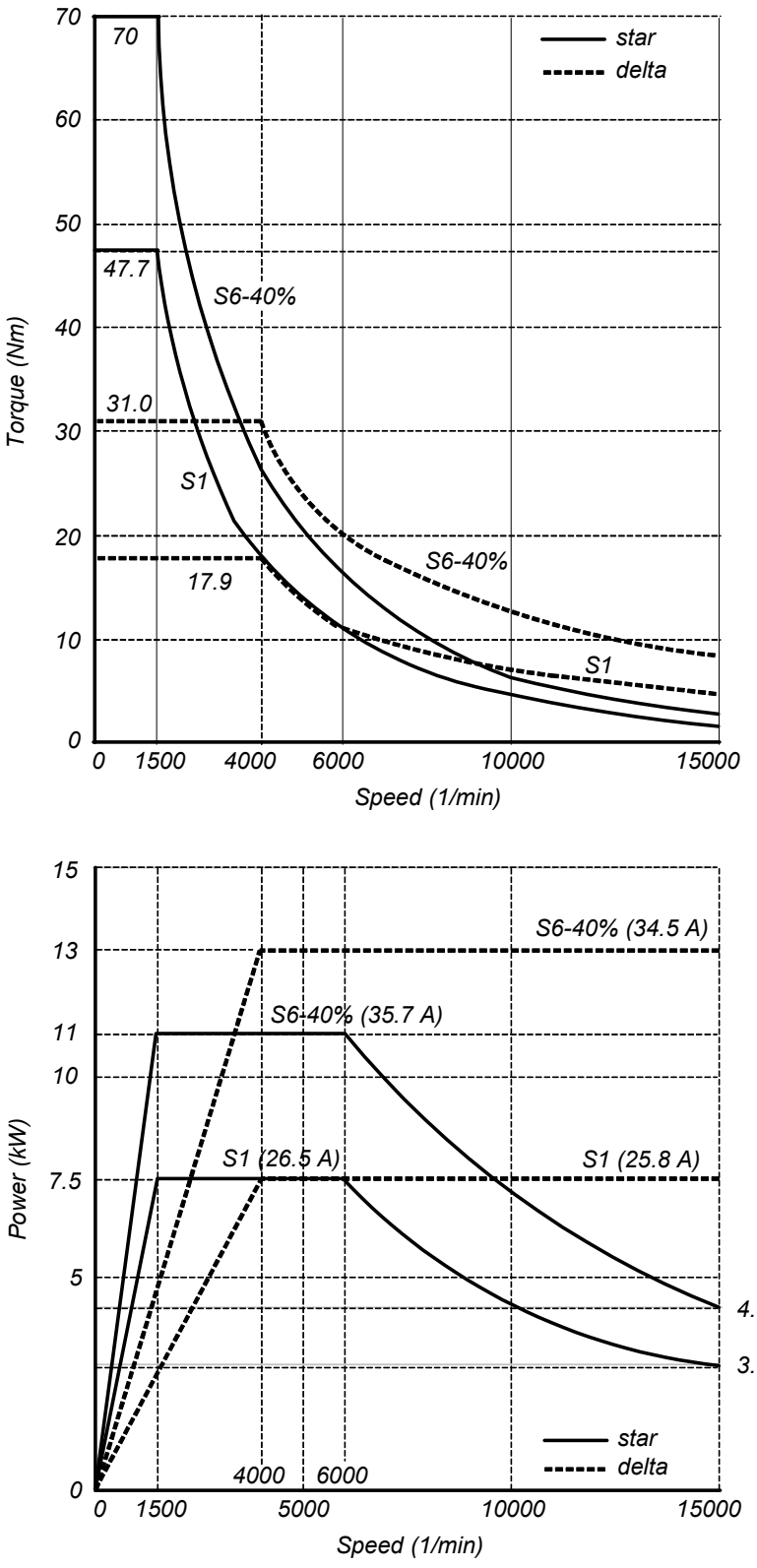


F. 2/37

Power/torque-speed graph. FM7-D055-S1D0-E03.

T. 2/26 AC spindle motor FM7-D075-S1D0-E03.

FM7-D075-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax. (1/min)	J (kg·cm²)	B (kg)
Y	7.5	1500	47.7	26.5	15000	260	74
Δ	7.5	4000	17.9	25.8	15000	260	74

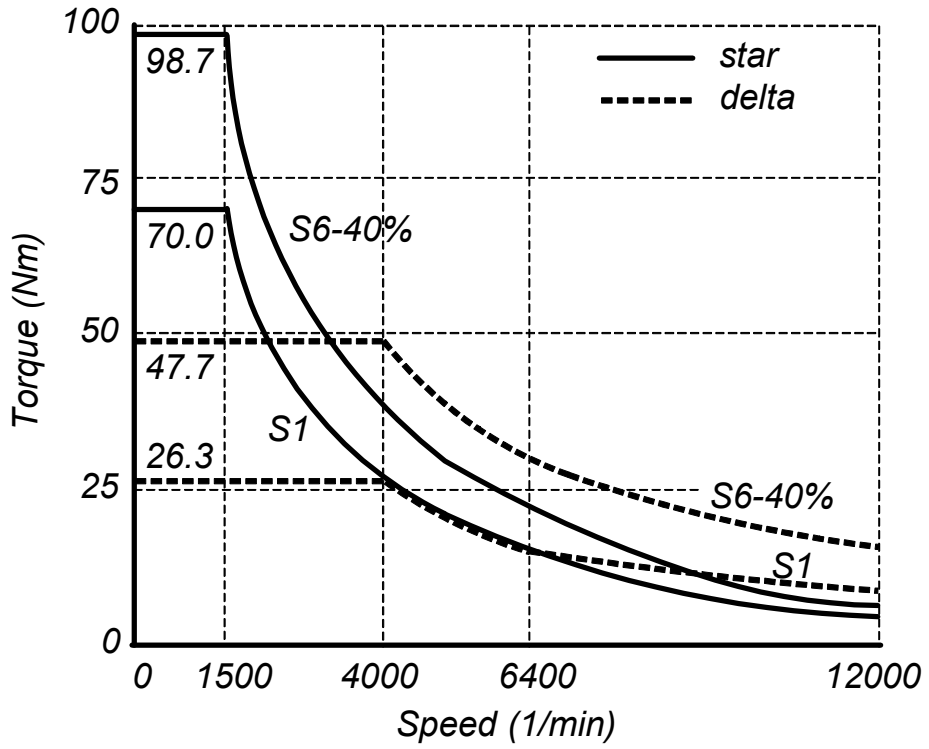


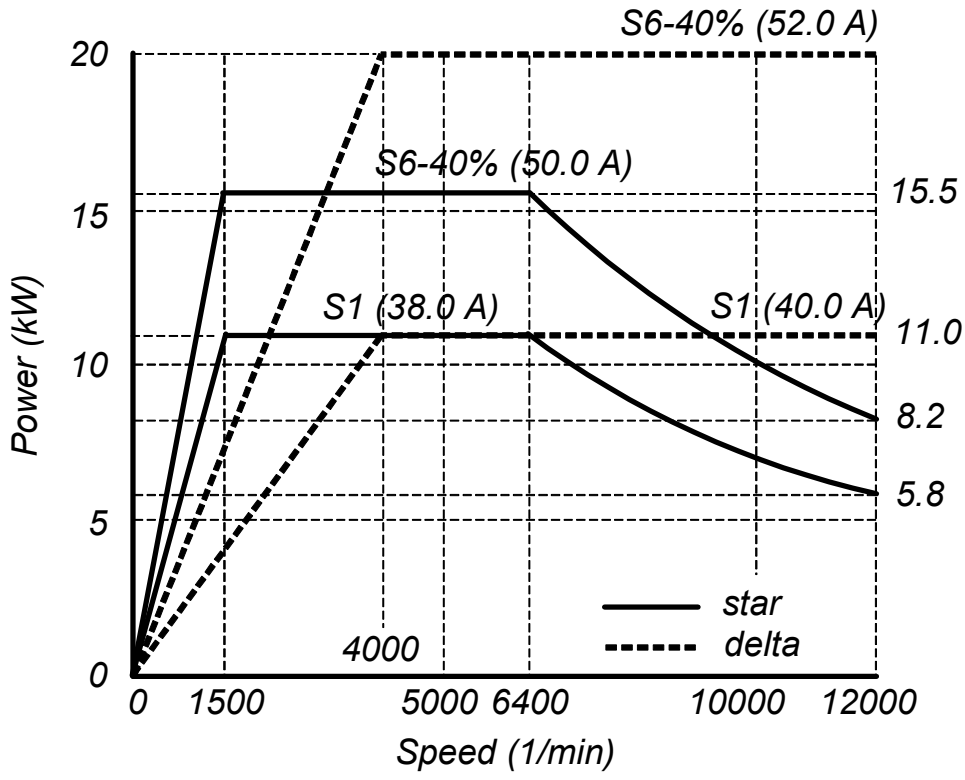
F. 2/38

Power/torque-speed graph. FM7-D075-S1D0-E03.

T. 2/27 AC spindle motor FM7-D110-S1D0-E03.

FM7-D110-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax. (1/min)	J (kg·cm²)	B (kg)
Y	11.0	1500	70.0	38.0	12000	690	110
Δ	11.0	4000	26.3	40.0	12000	690	110



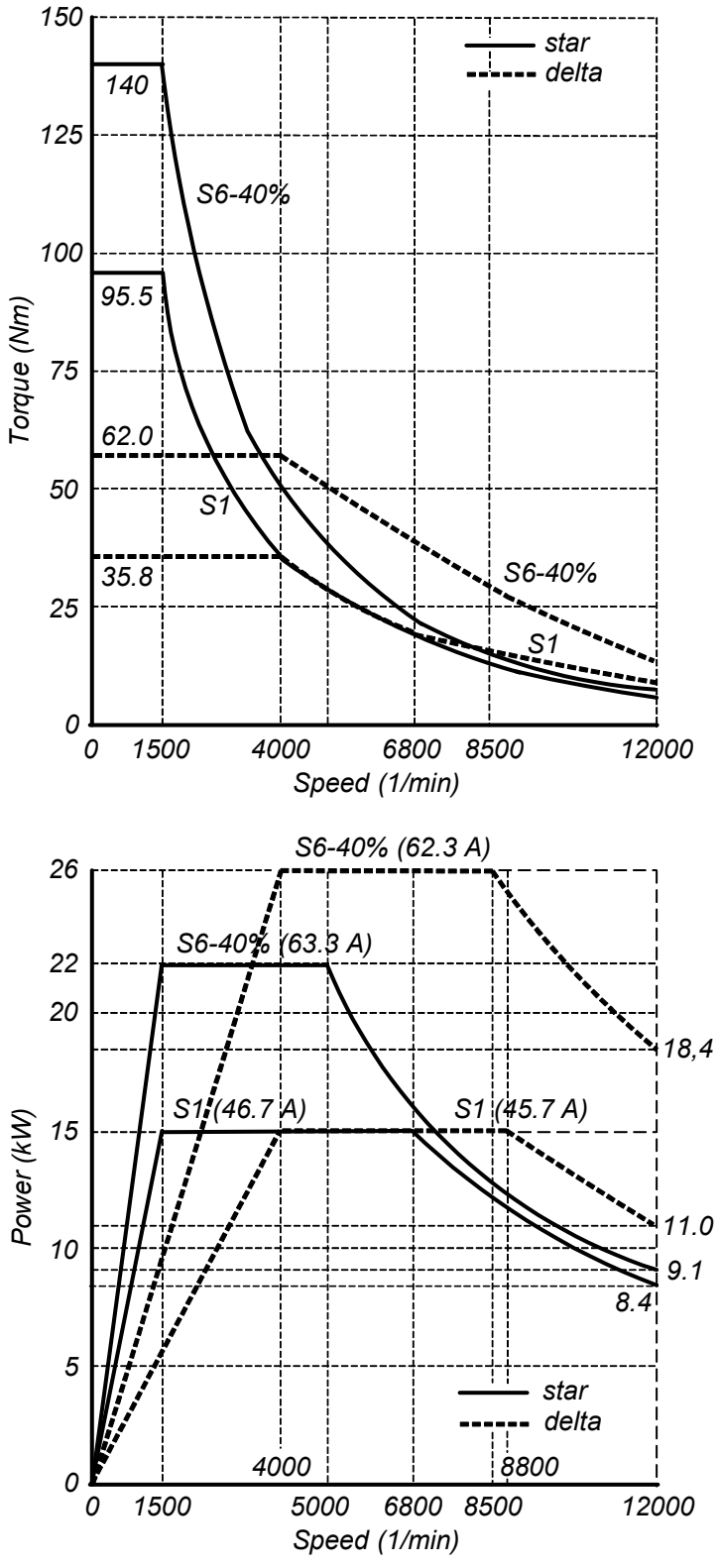


F. 2/39

Power/torque-speed graph. FM7-D110-S1D0-E03.

T. 2/28 AC spindle motor FM7-D150-S1D0-E03.

FM7-D150-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax. (1/min)	J (kg·cm²)	B (kg)
Y	15.0	1500	95.5	46.4	12000	690	110
Δ	15.0	4000	35.8	45.7	12000	690	110

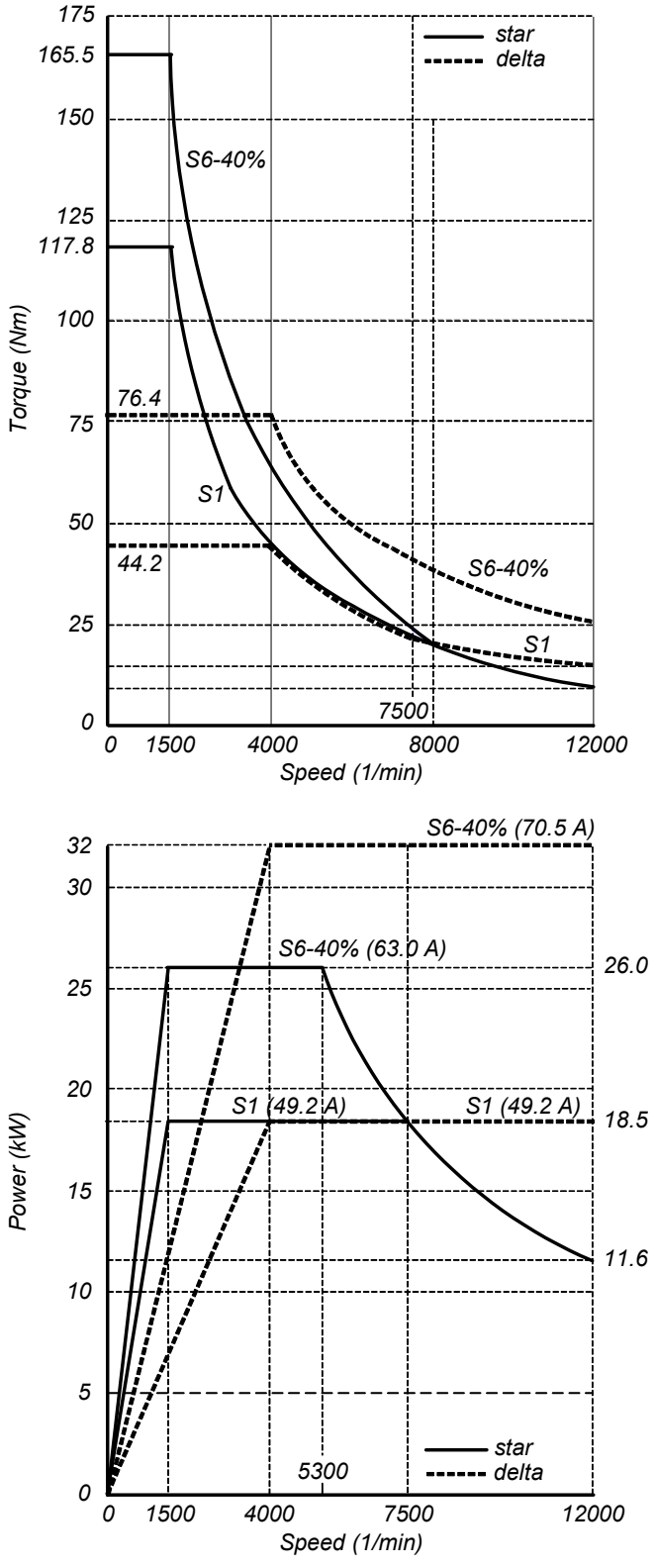


F. 2/40

Power/torque-speed graph. FM7-D150-S1D0-E03.

T. 2/29 AC spindle motor FM7-D185-S1D0-E03.

FM7-D185-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax. (1/min)	J (kg·cm²)	B (kg)
Y	18.5	1500	117.8	49.2	12000	890	135
Δ	18.5	4000	44.2	49.2	12000	890	135

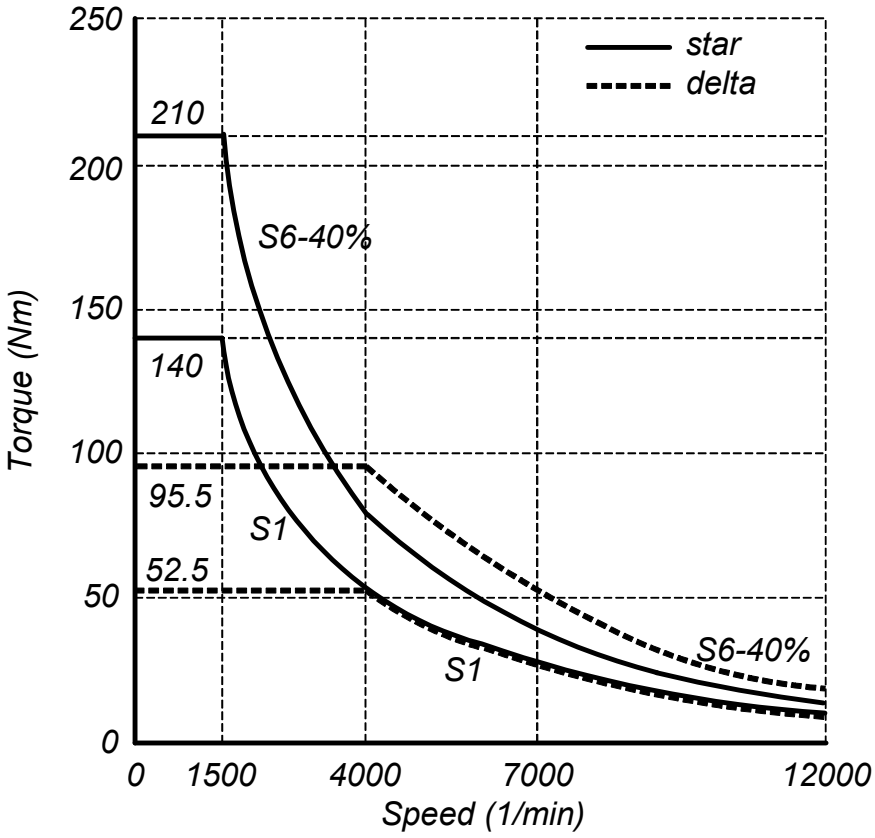


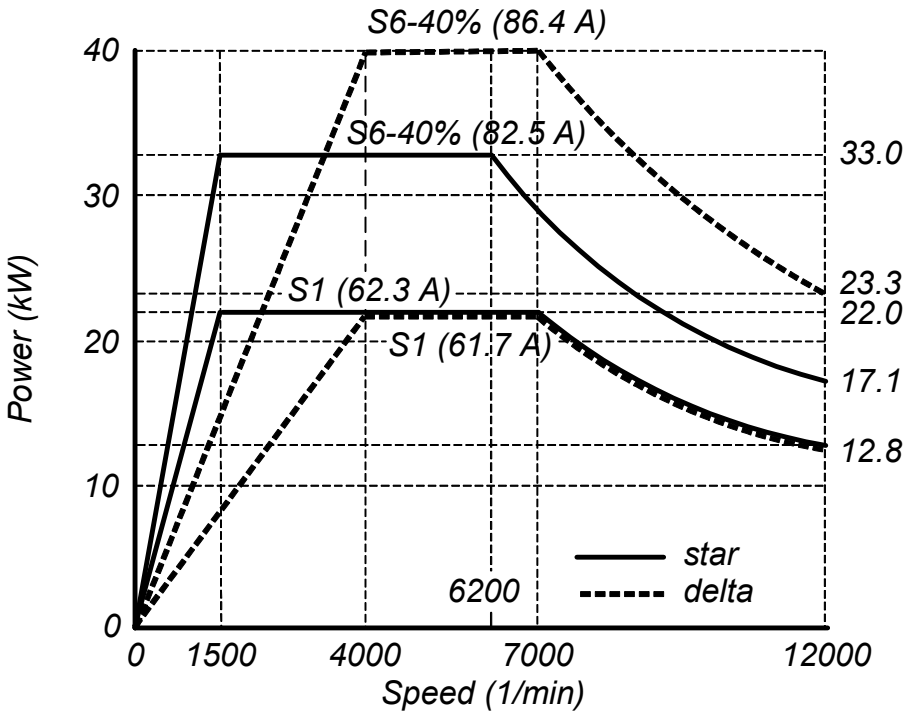
F. 2/41

Power/torque-speed graph. FM7-D185-S1D0-E03.

T. 2/30 AC spindle motor FM7-D220-S1D0-E03.

FM7-D220-S1D0-E03							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed E03	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax. (1/min)	J (kg·cm²)	B (kg)
Y	22.0	1500	140.1	62.3	12000	1080	150
Δ	22.0	4000	52.2	61.7	12000	1080	150





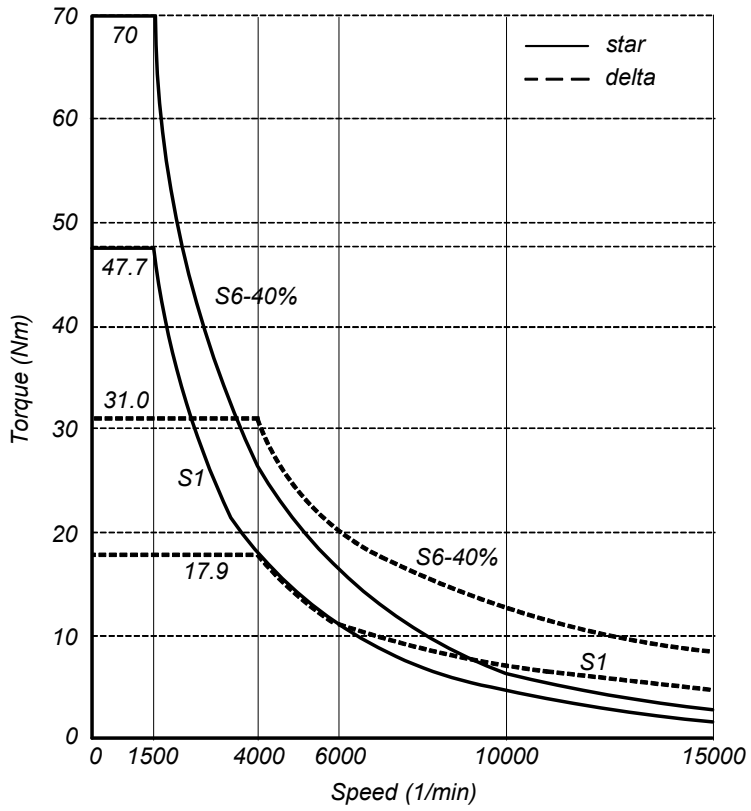
F. 2/42

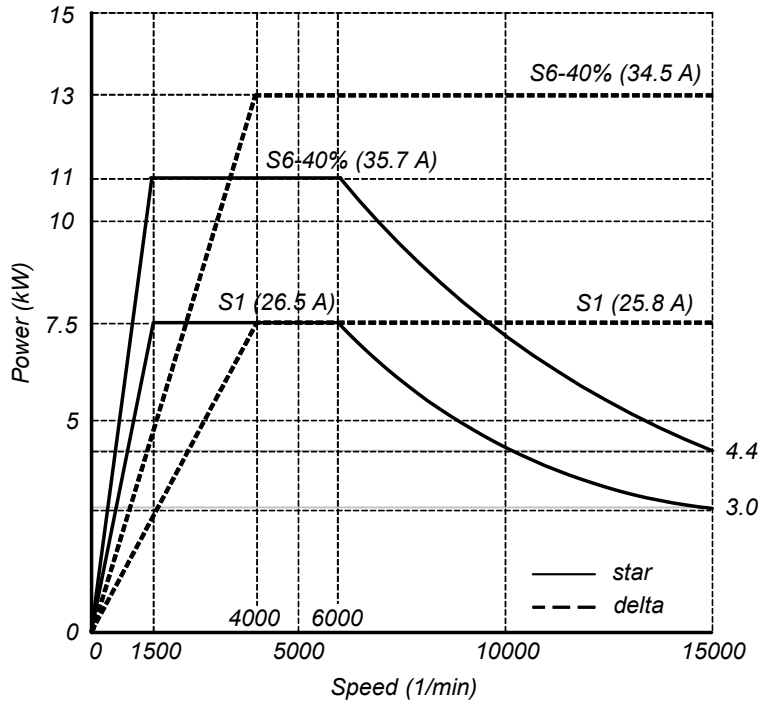
Power/torque-speed graph. FM7-D220-S1D0-E03.

2.5.4 FM7-DXXX-S1D0-HS3 series

T. 2/31 AC spindle motor FM7-D075-S1D0-HS3.

FM7-D075-S1D0-HS3							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed HS3	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)	J (kg·cm²)	B (kg)
Y	7.5	1500	47.7	26.5	15000	260	77
Δ	7.5	4000	17.9	25.8	15000	260	77



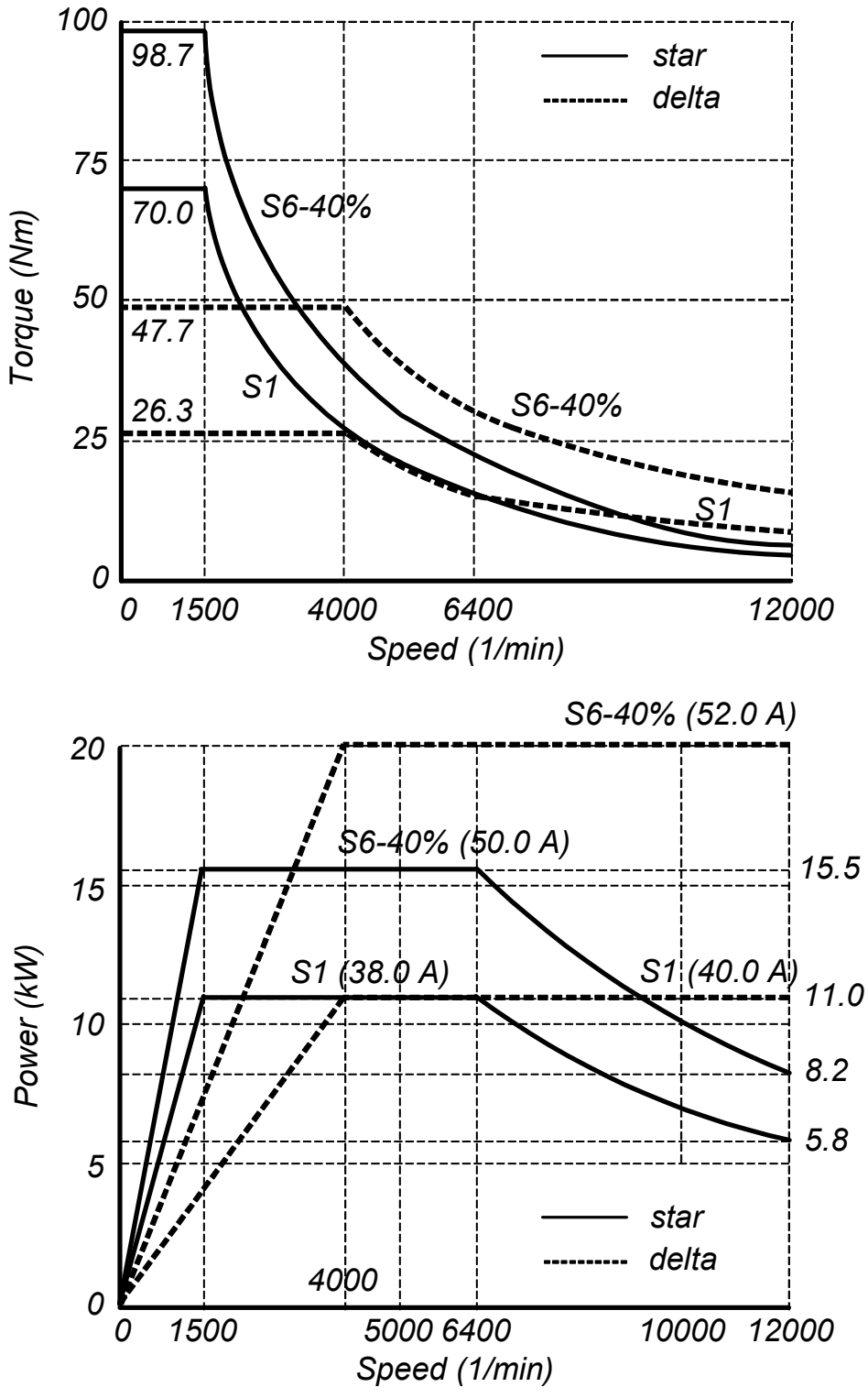


F. 2/43

Power/torque-speed graph. FM7-D075-S1D0-HS3.

T. 2/32 AC spindle motor FM7-D110-S1D0-HS3.

FM7-D110-S1D0-HS3							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed HS3	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)	J (kg·cm²)	B (kg)
⅄	11.0	1500	70.0	38.0	12000	690	115
Δ	11.0	4000	26.3	40.0	12000	690	115

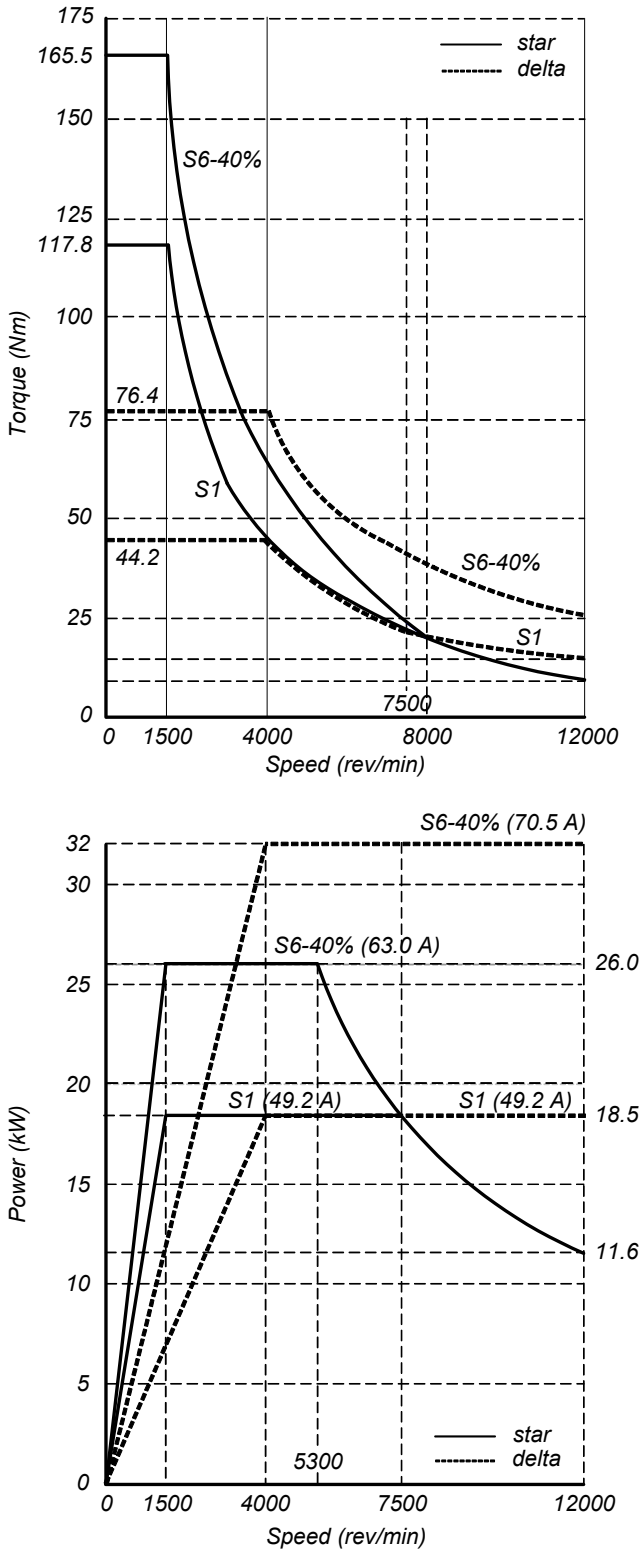


F. 2/44

Power/torque-speed graph. FM7-D110-S1D0-HS3.

T. 2/33 AC spindle motor FM7-D185-S1D0-HS3.

FM7-D185-S1D0-HS3							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed HS3	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)	J (kg·cm²)	B (kg)
Y	18.5	1500	117.8	49.2	12000	890	140
Δ	18.5	4000	44.2	49.2	12000	890	140

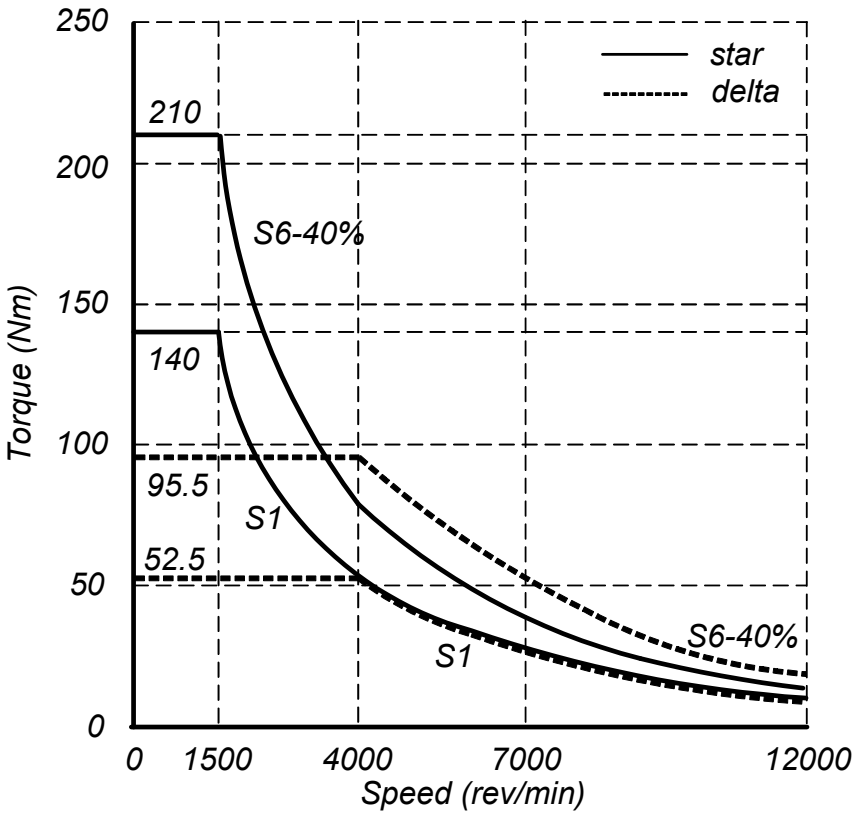


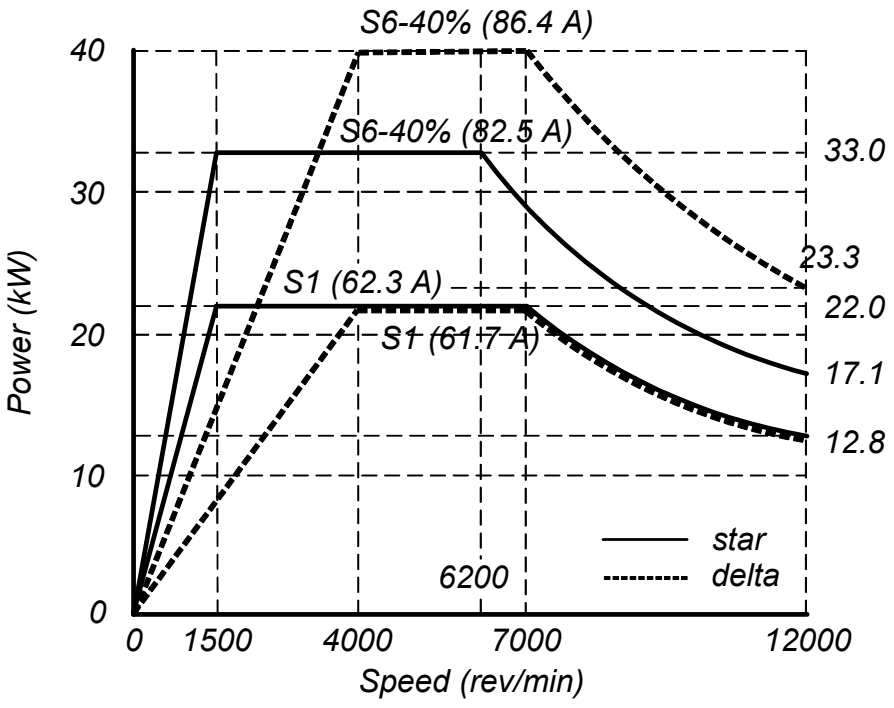
F. 2/45

Power/torque-speed graph. FM7-D185-S1D0-HS3.

T. 2/34 AC spindle motor FM7-D220-S1D0-HS3.

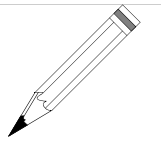
FM7-D220-S1D0-HS3							
Type of connection	Rated power	Base speed	Rated torque	Rated current	Max. speed HS3	Inertia	Approx. mass
	Pn (kW)	nN (1/min)	Mn (N·m)	In (A)	nmax (1/min)	J (kg·cm²)	B (kg)
Y	22.0	1500	140.1	62.3	12000	1080	155
Δ	22.0	4000	52.2	61.7	12000	1080	155





F. 2/46

Power/torque-speed graph. FM7-D220-S1D0-HS3.

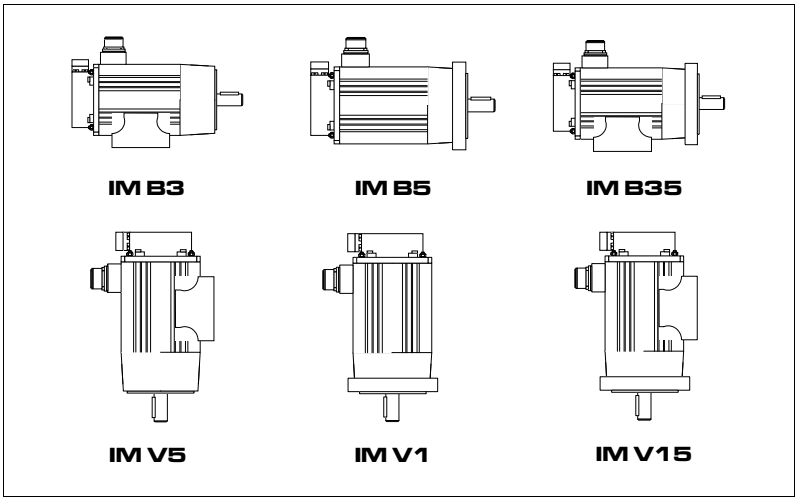


MECHANICAL CHARACTERISTICS 3

3.1 Built

FM7 FAMILY

The following figure shows the mounting possibilities for these AC spindle motors:



F. 3/1

FM7 motor mounting methods.

where the meaning of this nomenclature according to IEC 60034-7 is:

Code. I	Code. II	Built
IM B3	**IM 1001**	Foot mounting, horizontal shaft.
IM B5	**IM 3001**	Flange mounting, horizontal shaft.
IM V1	**IM 3011**	Flange mounting, vertical shaft facing down.
IM V5	**IM 1011**	Foot mounting, vertical shaft facing down.
IM B35	**IM 2001**	Foot & flange mount. Large flange with through holes. Horizontal shaft.
IM V15	**IM 2011**	Foot & flange mount. Large flange with through holes. Vertical shaft facing down.

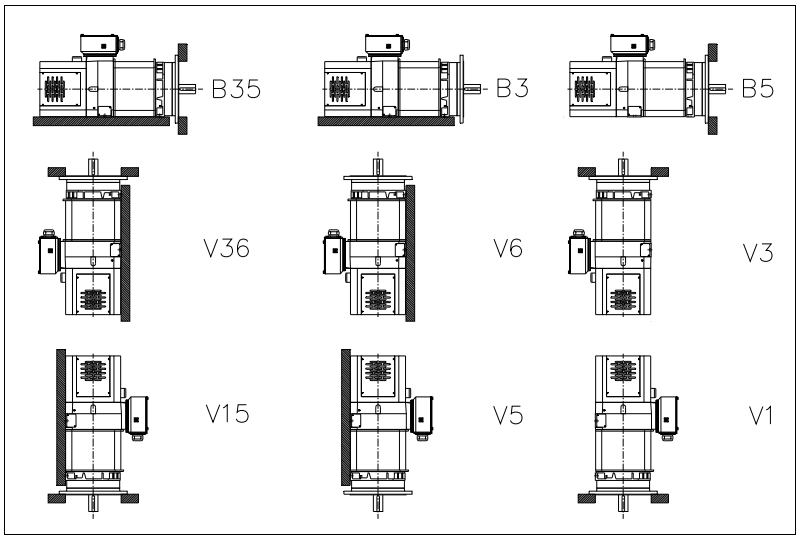
The possibilities for these motor series are:

FM7-□□□□-□□□□-E01	IM B3, IM B5, IM B35, IM V1, IM V5, IM V15
FM7-□□□□-□□□□-E02	IM B3, IM B5, IM B35, IM V1, IM V5, IM V15
FM7-D□□□-S1D0-E03	IM B5, IM V1
FM7-D□□□-S1D0-HS3	IM B5, IM V1

DANGER. Make sure you don't mount an asynchronous spindle motor of the FM7 family (no matter the series or the model) with its shaft facing up.

FM9 FAMILY

The following figure shows the mounting possibilities for these AC spindle motors:



F. 3/2

FM9 motor mounting methods.

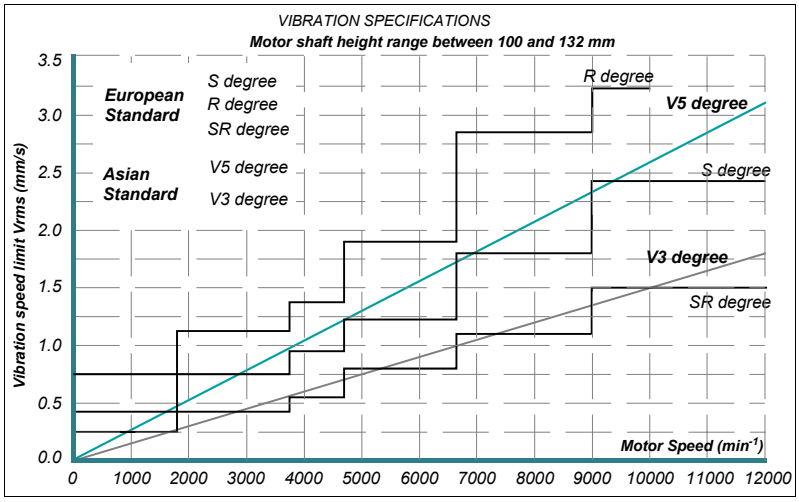
where the meaning of this nomenclature according to IEC 60034-7 is:

Code I	Code II	Built
IM B3	**IM 1001**	Foot mounting, horizontal shaft.
IM B5	**IM 3001**	Flange mounting, horizontal shaft.
IM V1	**IM 3011**	Flange mounting, vertical shaft facing down.
IM V5	**IM 1011**	Foot mounting, vertical shaft facing down.
IM V3	**IM 3031**	Flange mounting, vertical shaft facing up.
IM V6	**IM 1031**	Foot mounting, vertical shaft facing up.
IM B35	**IM 2001**	Foot & flange mount. Large flange with through holes. Horizontal shaft.
IM V15	**IM 2011**	Foot & flange mount. Large flange with through holes. Vertical shaft facing down.
IM V36	**IM 2031**	Foot & flange mount. Large flange with through holes. Vertical shaft facing up.

3.2 Level of vibration

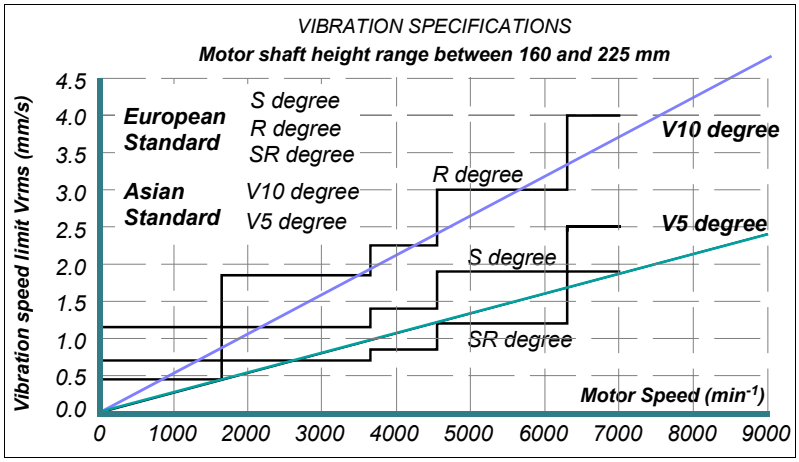
It is not possible to apply a high radial load value (perpendicular) to the motor shaft and obtain high speed and optimum vibration levels. This limitation is because the two properties require different designs of bearings and they conflict with each other.

Hence, the following graphs show the vibration limits for the available standard balancing degrees.



F. 3/3

Limit values of vibration levels on motors with shaft heights between 110 mm and 132 mm.



F. 3/4

Limit values of vibration levels on motors with shaft heights between 160 mm and 225 mm.

The following table shows the degrees of vibration for each motor model within its corresponding series.

NOTE. Observe that either one or the other of the previous graphs must be considered depending on the shaft height of the motor being considered.

Hence:

T. 3/1 Degrees of vibration.

Series FM7-D□□□-S1D0-E03		
Model	**Standard**	**Optional**
FM7-D□□□-S1D0-E03	V3	-

Series FM7-□□□□-□□□□-E01/E02		
Model	**Standard**	**Optional**
FM7-A037-□□□□-E01/E02	V5	V3
FM7-A055-□□□□-E01/E02	V5	V3
FM7-A075-□□□□-E01/E02	V5	V3
FM7-A090-□□□□-E01/E02	V5	V3
FM7-A110-□□□□-E01/E02	V5	V3
FM7-A150-□□□□-E01/E02	V5	V3
FM7-A185-□□□□-E01/E02	V5	V3
FM7-A220-□□□□-E01/E02	V5	V3
FM7-A300-□□□□-E01	V10	V5
FM7-A370-□□□□-E01	V10	V5
FM7-A510-□□□□-E01/E02	V10	V5
FM7-B120-□□□□-E01/E02	V5	V3
FM7-B170-□□□□-E01/E02	V5	V3
FM7-B220-□□□□-E01	V10	V5
FM7-B280-□□□□-E01	V10	V5
FM7-C215-□□□□-E01/E02	V10	V5
FM7-C270-□□□□-E01/E02	V10	V5
FM7-E600-C□B□-E01	V10	-

FM9-□□□□-□-E01-□ series		
Model	**Standard**	
FM9-A□□□-C5C□-E01-A	V5	
FM9-B□□□-C5C□-E01	V5	

Series FM7-D□□□-S1D0-HS3		
Model	**Standard**	**Optional**
FM7-D□□□-S1D0-HS3	V3	-

NOTE. Remember that the shaft height of a motor “with flange” (without feet) or of any vertical motor, will be considered equal to the shaft height of a motor with the same base armature, but of the foot-mount type with horizontal shaft.

See the dimensions drawing of the corresponding motor model in the section “**DIMENSIONS**” of this chapter, to obtain the shaft height. This value is given by the “c” dimension.

3.3 Balancing

For motors with:

- Maximum speed nmax < 8000 rev/min, we recommend the shaft to have a keyway and to be balanced halfkey.

  When performing the half-key balancing, a rectangular full-length, half height keyway as well as a full height, half length keyway are acceptable. The keyway will be centered along the shaft regardless of the option being considered.

- Maximum speed nmax ≥ 8000 rev/min the shaft should be cylindrical, i.e. keyless and the balancing must be performed in these conditions.

3.4 Bearings

The useful life of the bearings will be approximately 12000 hours of continuous running and at maximum speed for all the models of FM7 spindle motors and 5000 hours for FM9 motors.

The references of the bearings located at the shaft end and at the fan end are indicated on the identifications plate stuck on one side of the motor.

For further detail, see section **CHARACTERISTICS PLATE** of chapter **6. SELECTION** in this manual.

When starting the motor up for the first time, run it first trying to:

- Gradually increase the speed of the motor from 0 to 70% of the maximum speed in about 20 minutes.
- Do not run the motor for too long at its maximum speed.
- Watch the temperature values and possible unusual noises.
- It may make too much noise at first, in the few initial minutes because the bearings are not evenly lubricated. At the end of this initial running, it will go back to normal.

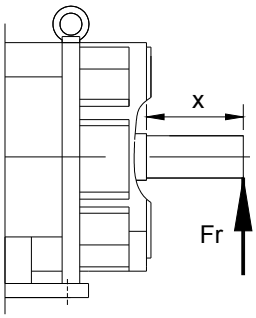
NOTE. It is not necessary to lubricate the bearings during the whole period of the useful life of the bearing indicated earlier. These motors do not have a lubrication system.

MANDATORY. Blows will affect negatively the performance of the motor, hence reducing the useful life of the bearings. Do not strike any part off the motor, especially the extension of the shaft.

3.5 Radial loads

A poor alignment between the motor shaft and the machine axis increases vibration of the shaft and reduces the useful life of bearings and couplings. Likewise, exceeding certain maximum radial load values on the bearings has a similar effect.

In order to avoid these incidences, do not exceed the permitted radial load values given in the following table considering that these loads are applied at the end of the shaft extension and for a maximum turning speed of the motor.



T. 3/2 Radial load tolerance at the end of the shaft extension for its max. turning speed (nmax).

Series FM7-□□□□-□□□□-E01/E02				
Models	**Radial force Fr (N)**		**X distance (mm)**	
●●●	E01	E02	E01	E02
FM7-A037-□□□□-●●●	1370	1140	60	60
FM7-A055-□□□□-●●●	1570	1510	80	80
FM7-A075-□□□□-●●●	1570	1510	110	110
FM7-A090-□□□□-●●●	1570	1470	110	110
FM7-A110-□□□□-●●●	1715	590	110	110
FM7-A150-□□□□-●●●	2640	1715	110	110
FM7-A185-□□□□-●●●	2640	1715	110	110
FM7-A220-□□□□-●●●	2640	1715	110	110
FM7-A300-□□□□-●●●	3920	-	140	-
FM7-A370-□□□□-●●●	3920	-	140	-
FM7-A510-□□□□-●●●	4900	4500	140	140
FM7-B120-□□□□-●●●	2640	1715	110	110
FM7-B170-□□□□-●●●	2640	1715	110	110
FM7-B220-□□□□-●●●	3920	-	140	-
FM7-B280-□□□□-●●●	3920	-	140	-
FM7-C215-□□□□-●●●	4900	4500	140	140
FM7-C270-□□□□-●●●	4900	4500	140	140
FM7-E600-□□□□-●●●	8820	-	140	-

Series FM7-D□□□-S1D0-E03/HS3				
Models	**Radial force Fr (N)**		**X distance (mm)**	
●●●	E03	HS3	E03	HS3
FM7-D055-S1D0-●●●	196	-	60	-
FM7-D075-S1D0-●●●	196	196	60	60
FM7-D110-S1D0-●●●	290	290	80	70
FM7-D150-S1D0-●●●	290	-	80	-
FM7-D185-S1D0-●●●	290	290	80	70
FM7-D220-S1D0-●●●	290	290	80	70

MANDATORY. When installing transmission pulleys or gears, any blow on the shaft reduces its useful life, the useful life of the bearings and can also damage the feedback device (encoder). Therefore, do not strike the shaft extension under any circumstances.

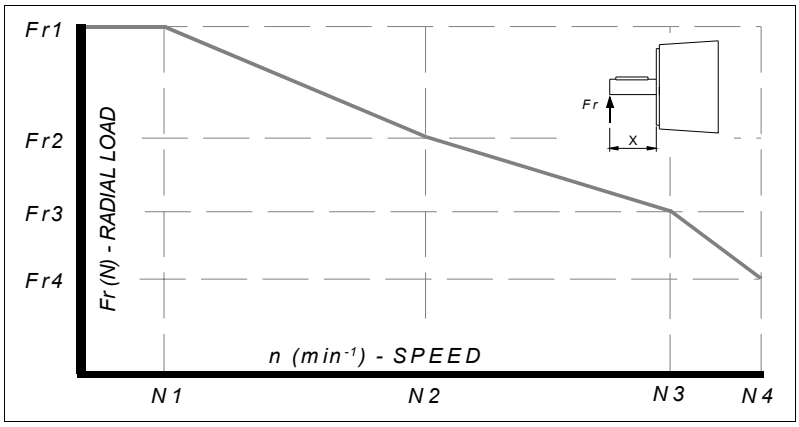
3.5.1 “Radial load - turning speed” diagrams

Usually, mechanical elements (spindles) or transmission elements (gear boxes) will be coupled to the end of the motor shaft extension. In dynamic conditions, the motor shaft will be subject to forces due to radial loads. If these dynamic forces exceed a certain limit that the shaft was designed for, its useful life will be reduced due to damage caused by fatigue while it's running. Therefore:

DANGER. Make sure that the maximum values of the radial loads applied in dynamic conditions on to the motor shaft extension never exceed the admissible values given by the diagrams depending on the turning speed of the shaft.

NOTE. Exceeding the radial load limit value on the shaft will increase motor vibration and decrease the life span of its bearings and couplings.

FM7-□□□□-□□□□-E01/E02 series



F. 3/5

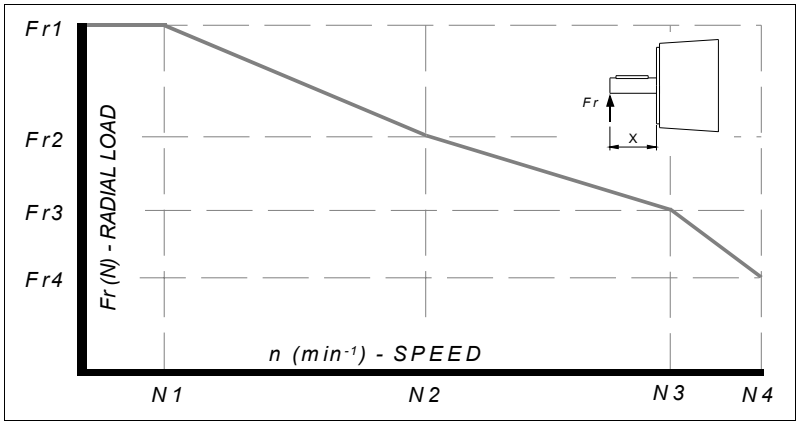
FM7-□□□□-□□□□-E01/E02 series. Diagram for maximum radial load as a function of turning speed.

T. 3/3 Particular Fri and Ni values according to motor model.

Series FM7-□□□□-□□□□-E01/E02								
Model	Radial force Fri (N)				Turning speed Ni (1/min)			
	Fr1	Fr2	Fr3	Fr4 (*)	N1	N2	N3	N4 (*)
FM7-A037	1610	1467	1370	1140	5630	7190	9000	12000
FM7-A055	1910	1890	1570	1510	4880	5000	9000	10000
FM7-A075	1990	1890	1570	1510	4310	5965	9000	10000
FM7-A090	1990	1890	1570	1470	4610	5625	9000	10000
FM7-A110	2810	2150	1715	590	1500	4560	9000	10000
FM7-A150	3230	3195	2640	1715	4360	4560	8000	9000
FM7-A185	3880	3000	2640	1715	2340	5265	8000	9000
FM7-A220	3930	2935	2640	1715	1500	6140	8000	9000
FM7-A300	5570	4175	3920	-	1500	5440	6500	-
FM7-A370	5720	4435	3920	-	1640	4385	6500	-
FM7-A510	5720	5390	4900	4500	2960	3510	5000	6000
FM7-B120	3530	3130	2640	1715	2990	5000	8000	9000
FM7-B170	3530	3130	2640	1715	2990	5000	8000	9000
FM7-B220	5720	4610	3920	-	2080	3947	6500	-
FM7-B280	5720	4520	3920	-	2220	4210	6500	-
FM7-C215	5720	5565	4900	4500	3340	3510	5000	6000
FM7-C270	5720	5305	4900	4500	3600	3860	5000	6000
FM7-E600	8820	8820	8820	-	1250	3450	5000	-

NOTE. The Fr4 and N4 values are only valid for E02 series motors.

FM7-□□□□-S1D0-E03/HS3 series



F. 3/6

FM7-D□□□-S1D0-E03 series and FM7-D□□□-S1D0-HS3 series. Diagram for maximum radial load as a function of turning speed.

T. 3/4 Particular Fri and Ni values according to motor model.

Series FM7-D□□□-S1D0-E03								
Model	**Radial force Fri (N)**				**Turning speed Ni (1/min)**			
	Fr1	Fr2	Fr3	Fr4	N1	N2	N3	N4
FM7-D055	1910	1890	1570	196	4880	5000	9000	15000
FM7-D075	1990	1890	1570	196	4310	5965	9000	15000
FM7-D110	2810	2150	1715	290	1500	4560	9000	12000
FM7-D150	3230	3195	2640	290	4360	4560	8000	12000
FM7-D185	3880	3000	2640	290	2340	5265	8000	12000
FM7-D220	3930	2935	2640	290	1500	6140	8000	12000

T. 3/5 Particular Fri and Ni values according to motor model.

Series FM7-D□□□-S1D0-HS3								
Model	**Radial force Fri (N)**				**Turning speed Ni (1/min)**			
	Fr1	Fr2	Fr3	Fr4	N1	N2	N3	N4
FM7-D075	1990	1890	1570	196	4310	5965	9000	15000
FM7-D110	2810	2150	1715	290	1500	4560	9000	12000
FM7-D185	3880	3000	2640	290	2340	5265	8000	12000
FM7-D220	3930	2935	2640	290	1500	6140	8000	12000

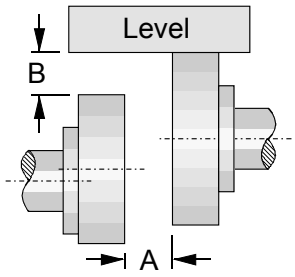
3.6 Couplings

3.6.1 Direct coupling

We recommend to follow these indications when coupling the motor shaft directly to the machine axis or to the mechanical spindle itself:

- Couple the motor to the machine whenever the centers of the motor shaft and that of the machine are perfectly aligned. Insert a coupling to make the adjustment if necessary.

WARNING. Do not apply any torsion when aligning it (if the center line of the motor shaft is not in line with that of the machine) because it could damage the bearings and reduce their useful service life.



Tolerance A: 0.03 mm (0.0012 in) max.
Roughness B: 0.03 mm (0.0012 in) max.

F. 3/7

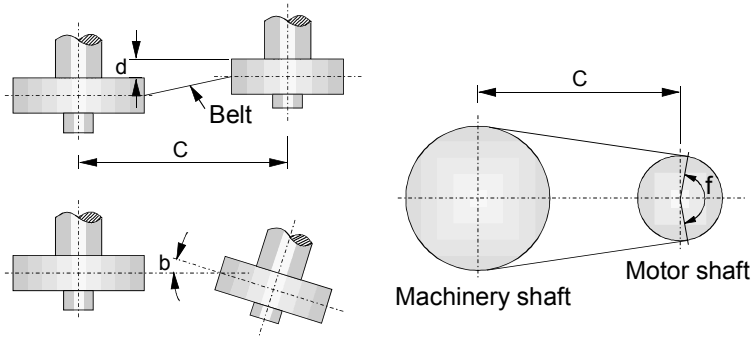
Precision of direct "motor shaft-machine axis" coupling.

3.6.2 Belt coupling

NOTE. Note that it makes no sense to talk about this type of coupling when using FM7-D□□□-S1D0-HS3 series motors because they are meant to be coupled directly to the mechanical spindle for air cooling the tool when it starts machining the part, hence avoiding overheating and improving the quality of the part finish.

We recommend to follow these indications when coupling the motor shaft to the machine axis through a belt.

- Make sure that the motor shaft extension is placed parallel to the machine axis and that the center lines of the pulleys and the shafts are at 90º from each other. See figure **F. 3/8**.



If C ≤ 1.000 mm (39.4 in), then d ≤ 1 mm (0.039 in).
If C > 1.000 mm (39.4 in), then d / C < 1 / 1.000.
β < 1/3°.

F. 3/8

Belt coupling.

- Verify that the belt angle is the right one, otherwise it may cause vibration or it may slip.
- Make sure that the contact angle between the belt and the pulley it rests on is ϕ =140° or greater; otherwise, it may slip. See figure **F. 3/8**.

WARNING. Do not exceed the permissible radial load values on the motor shaft specified in the tables given earlier. Applying to much radial load on the motor shaft extension can seriously affect the life of the bearings reducing their useful service life. See the section on radial loads in this chapter.

3.6.3 Gear coupling

NOTE. Note that it makes no sense to talk about this type of coupling when using FM7-D□□□-S1D0-HS3 series motors because they are meant to be coupled directly to the mechanical spindle for air cooling the tool when it starts machining the part, hence avoiding overheating and improving the quality of the part finish.

We recommend to follow these indications when coupling the motor shaft to the machine axis through gears.

- Make sure that the motor shaft extension is placed parallel to the machine axis and that the centers of the gears are aligned in parallel fitting perfectly.

WARNING. If the gears do not engage properly, they will deteriorate reducing their useful service life causing vibrations and jeopardizing the dynamic performance of the system.

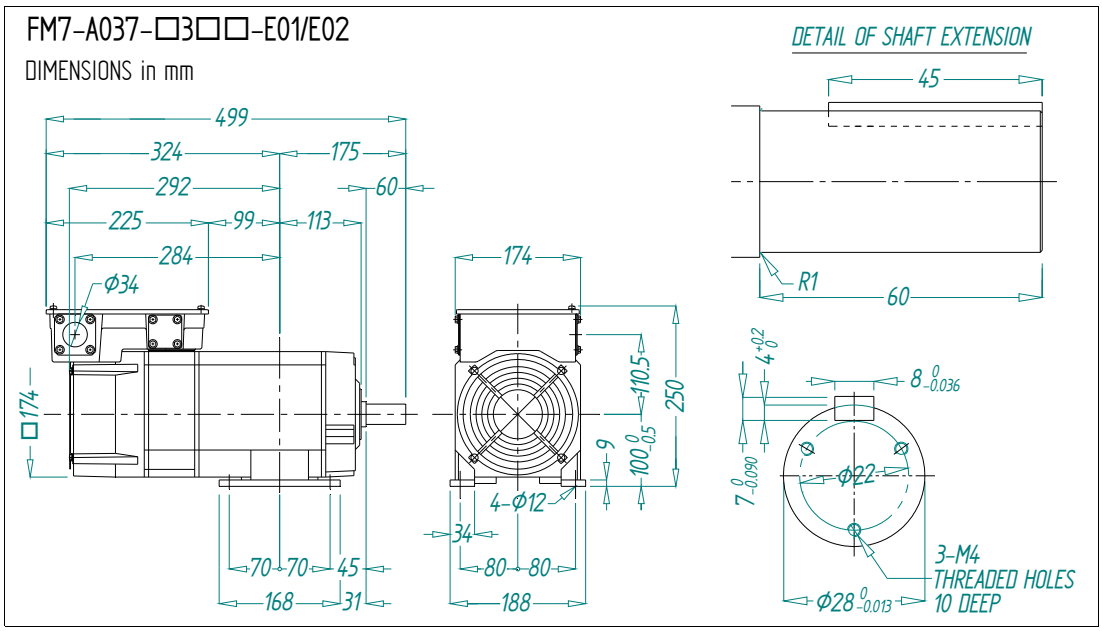
3.6.4 Mounting a pulley or gears

These indications should be followed when mounting a pulley or gears to the motor shaft.

- Before installing a pulley or gears to the motor shaft, it must be properly balanced.
- Half-key balancing (on shafts with a key) is done with a key that is half as thick as the key specified on the dimensions diagram in this chapter and located in the axial middle of the keyway.
- Avoid mechanical disturbances that could generate vibrations, especially when the motor turns at high speed.

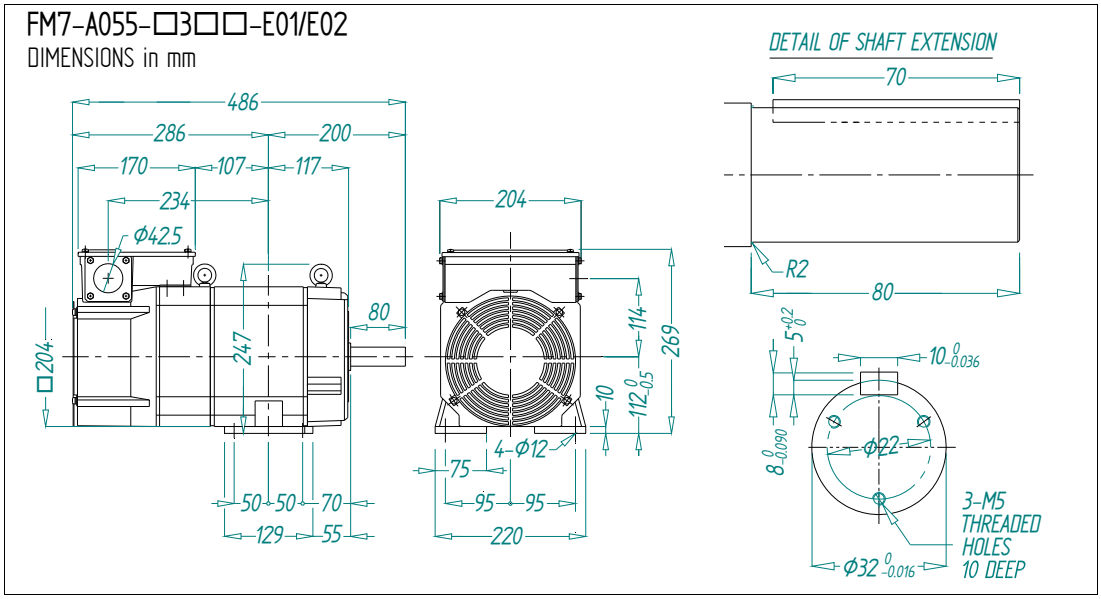
3.7 Dimensions

3.7.1 FM7-XXXX-X3XX-E01/E02



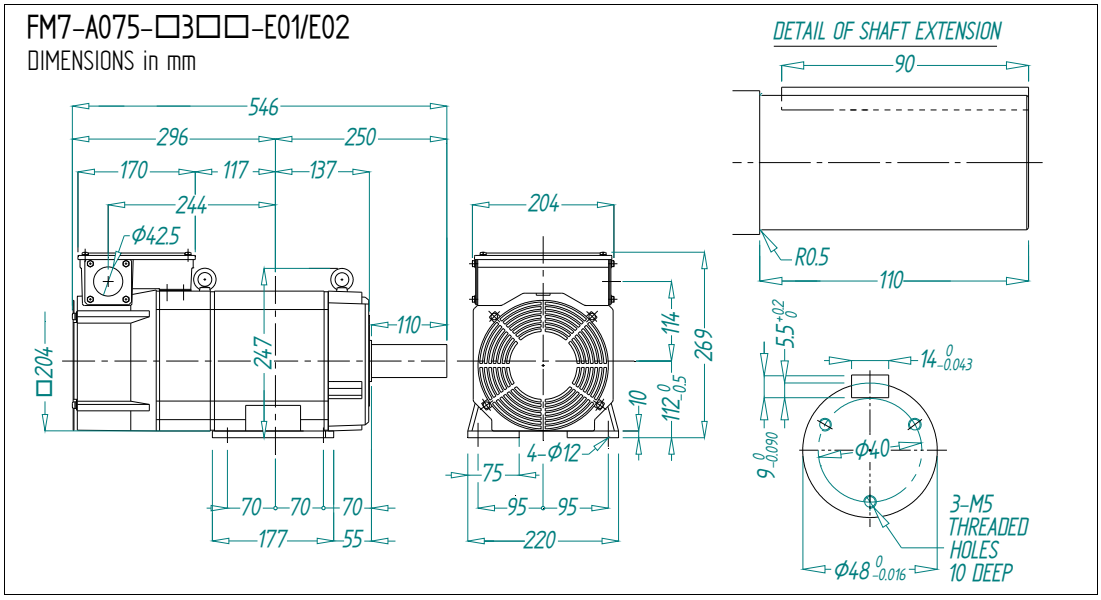
F. 3/9

Dimensions diagram. FM7-A037-□**3**□□-E01/E02. Foot mount.



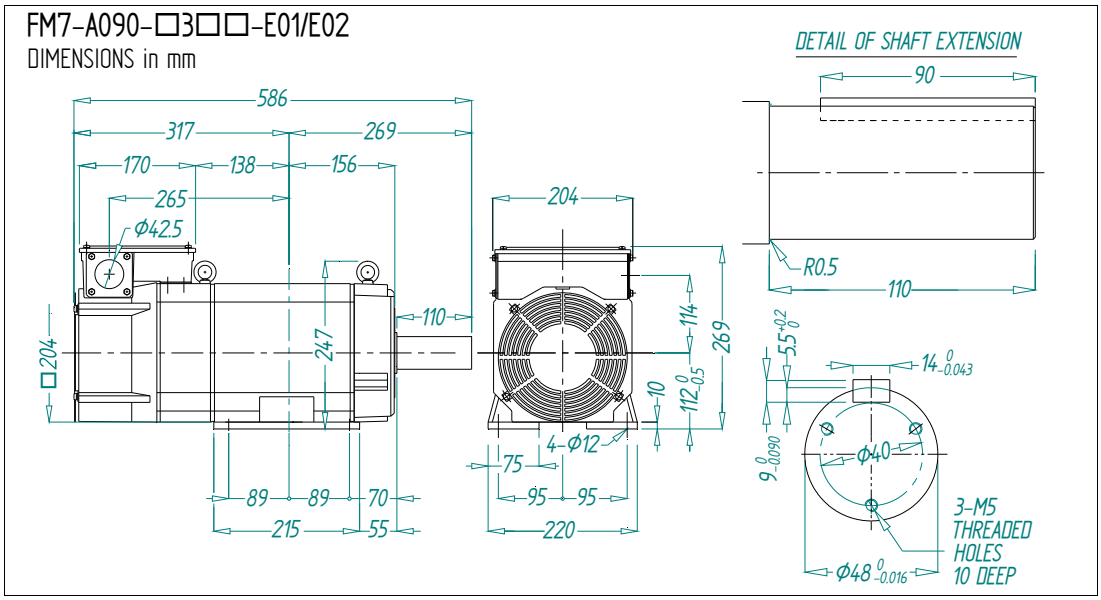
F. 3/10

Dimensions diagram. FM7-A055-□**3**□□-E01/E02. Foot mount.



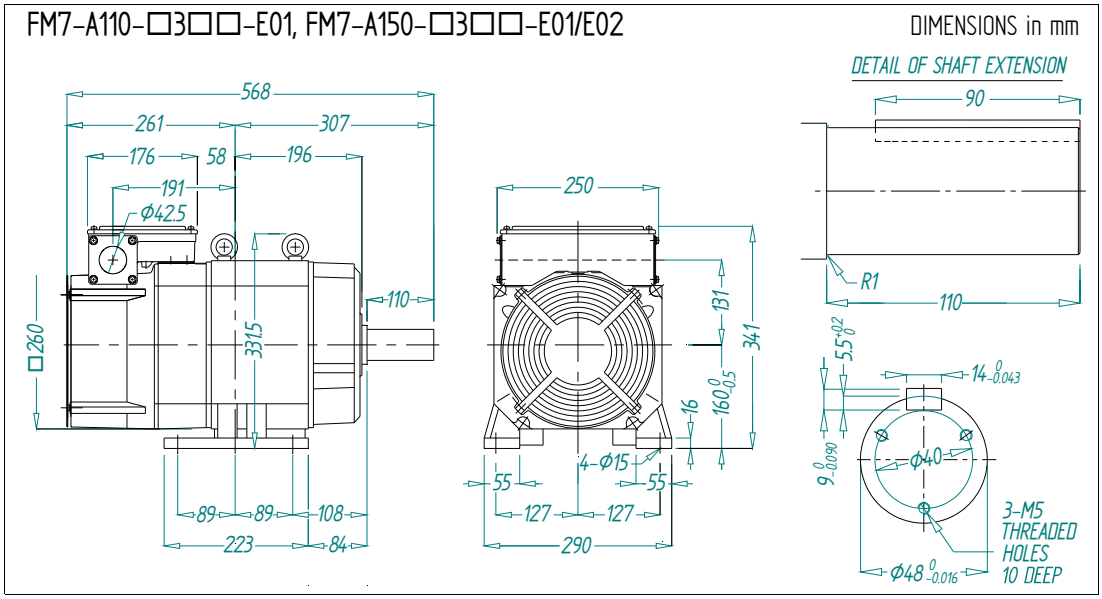
F. 3/11

Dimensions diagram. FM7-A075-□**3**□□-E01/E02. Foot mount.



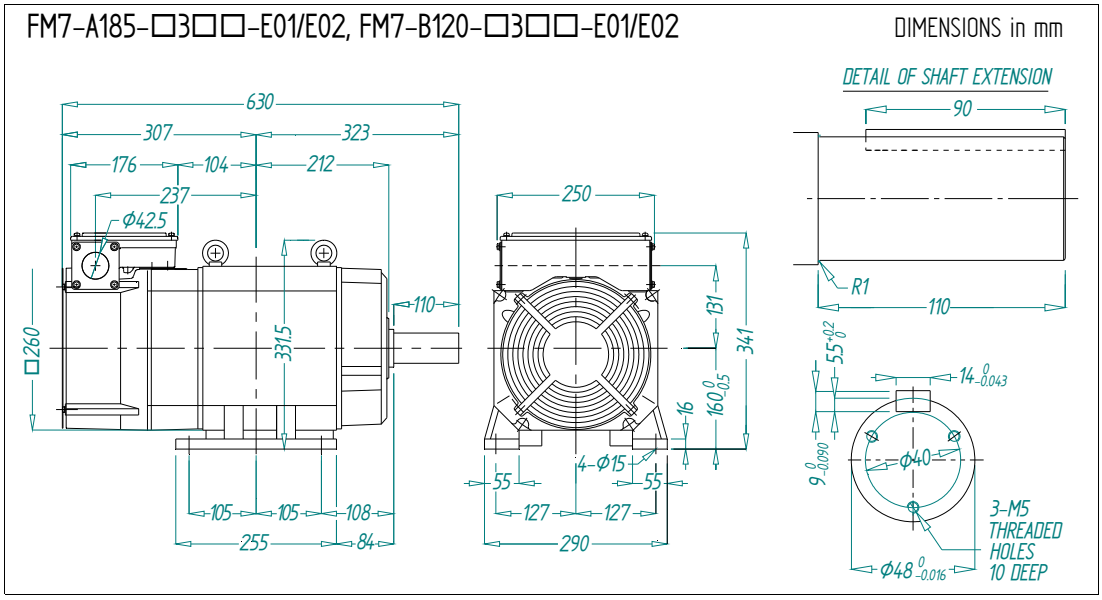
F. 3/12

Dimensions diagram. FM7-A090-□**3**□□-E01/E02. Foot mount.



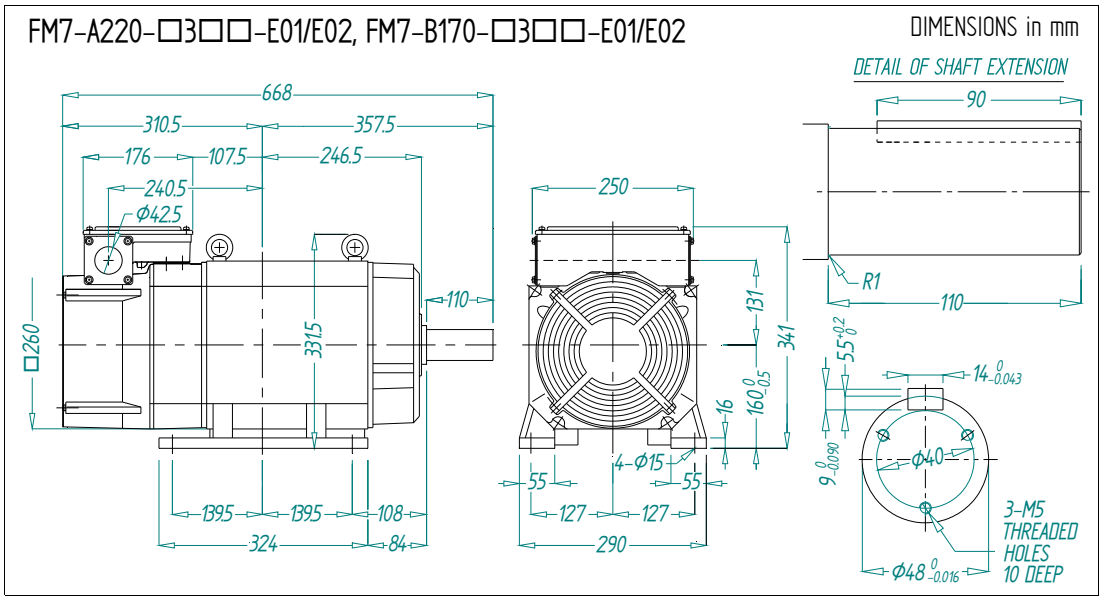
F. 3/13

Dimensions diagram. FM7-A110-□**3**□□-E01, FM7-A150-□**3**□□-E01/E02. Foot mount.



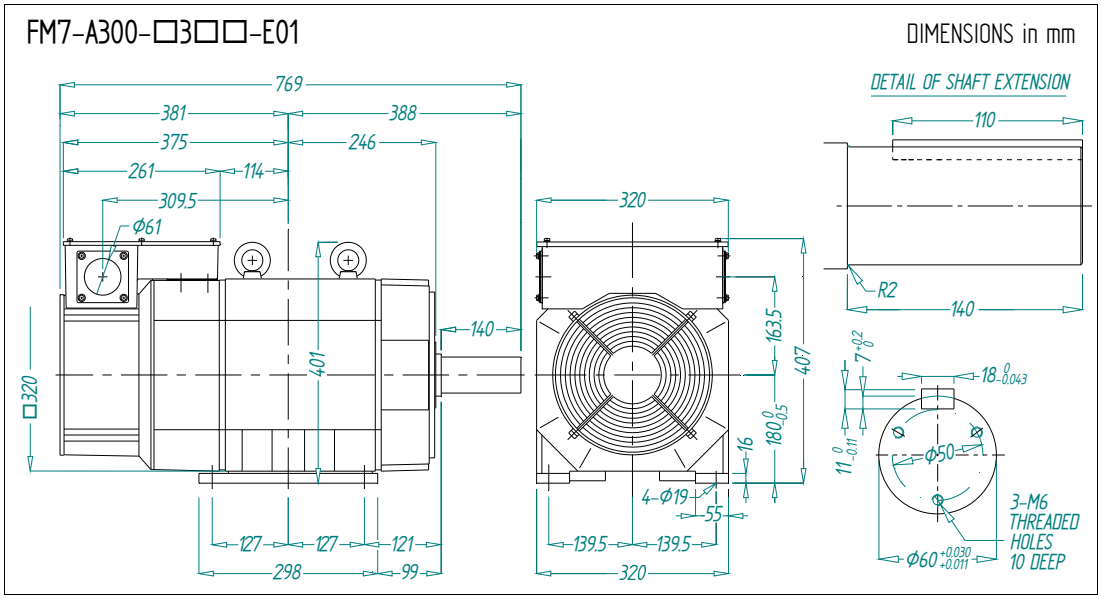
F. 3/14

Dimensions diagram. FM7-A185-□**3**□□-E01, FM7-B120-□**3**□□-E01/E02. Foot mount.



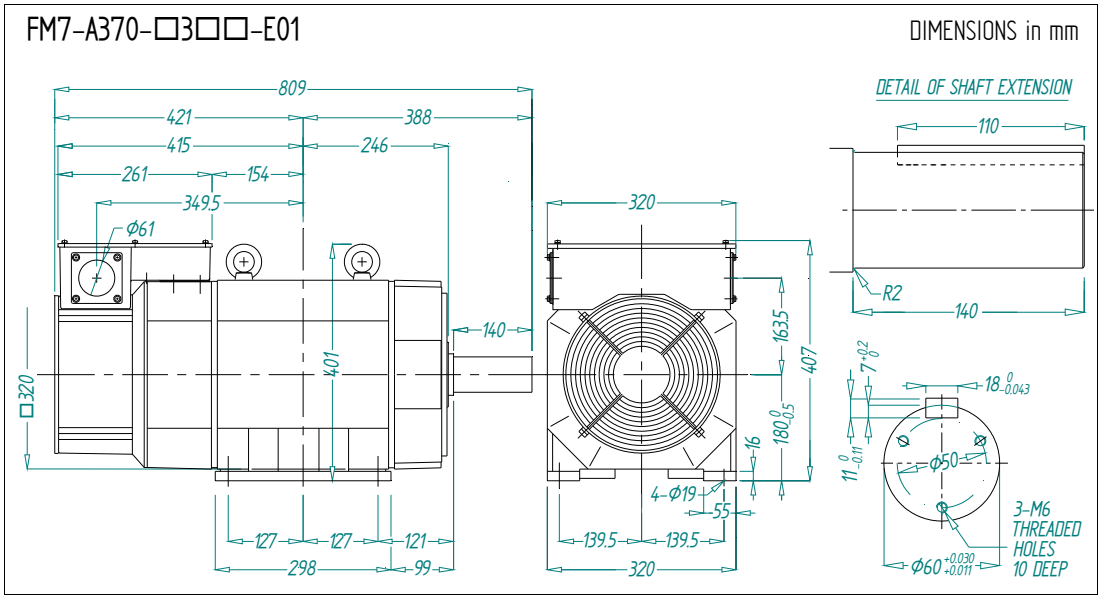
F. 3/15

Dimensions diagram. FM7-A220-□**3**□□-E01, FM7-B170-□**3**□□-E01/E02. Foot mount.



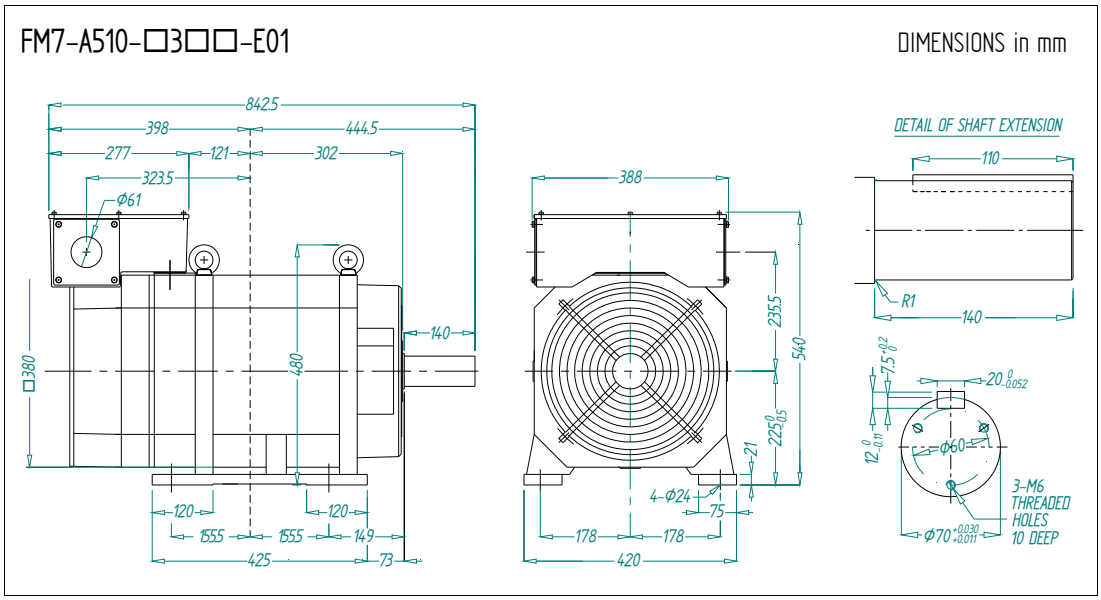
F. 3/16

Dimensions diagram. FM7-A300-□**3**□□-E01. Foot mount.



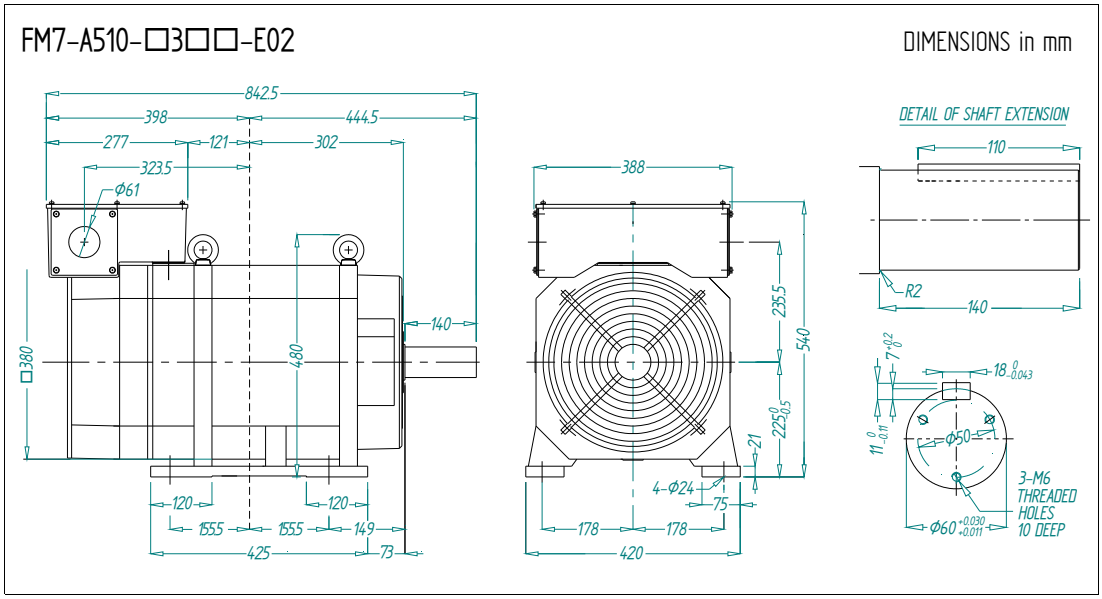
F. 3/17

Dimensions diagram. FM7-A370-□**3**□□-E01. Foot mount.



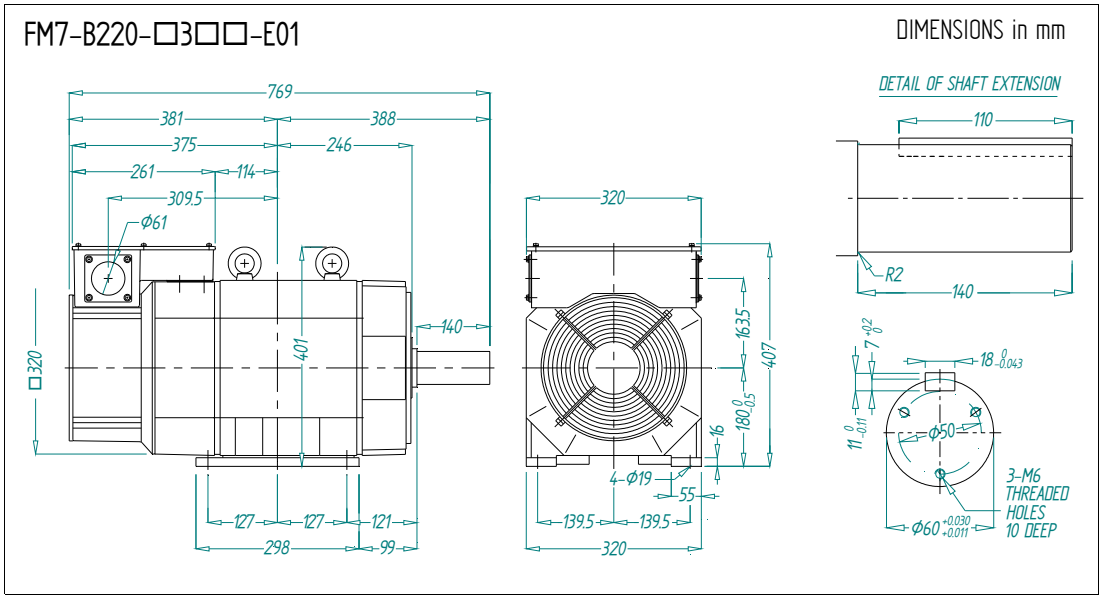
F. 3/18

Dimensions diagram. FM7-A510-□**3**□□-E01. Foot mount.



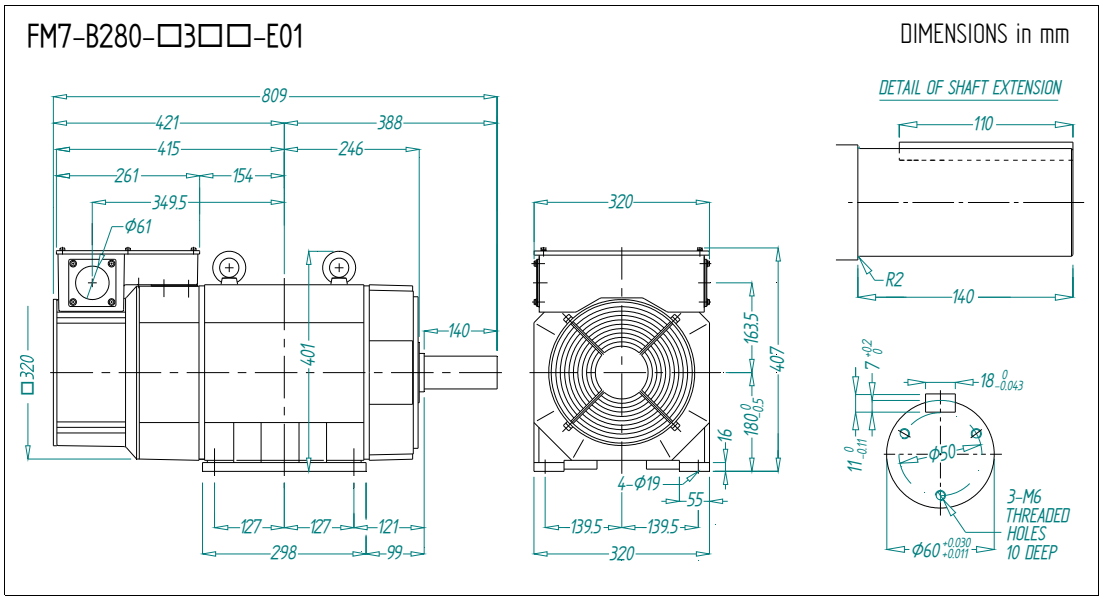
F. 3/19

Dimensions diagram. FM7-A510-□**3**□□-E02. Foot mount.



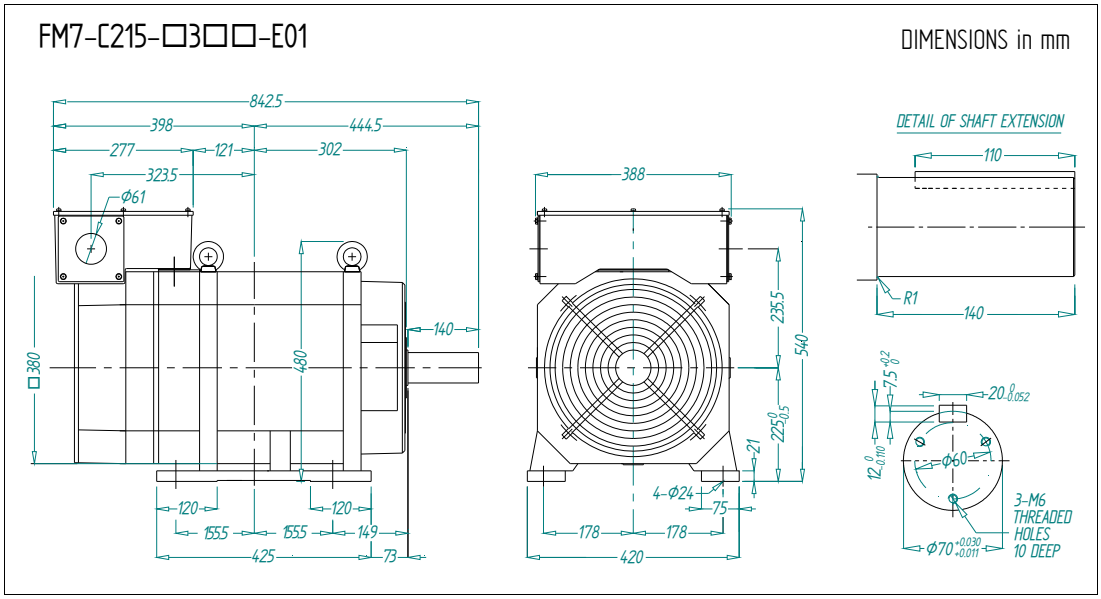
F. 3/20

Dimensions diagram. FM7-B220-□**3**□□-E01. Foot mount.



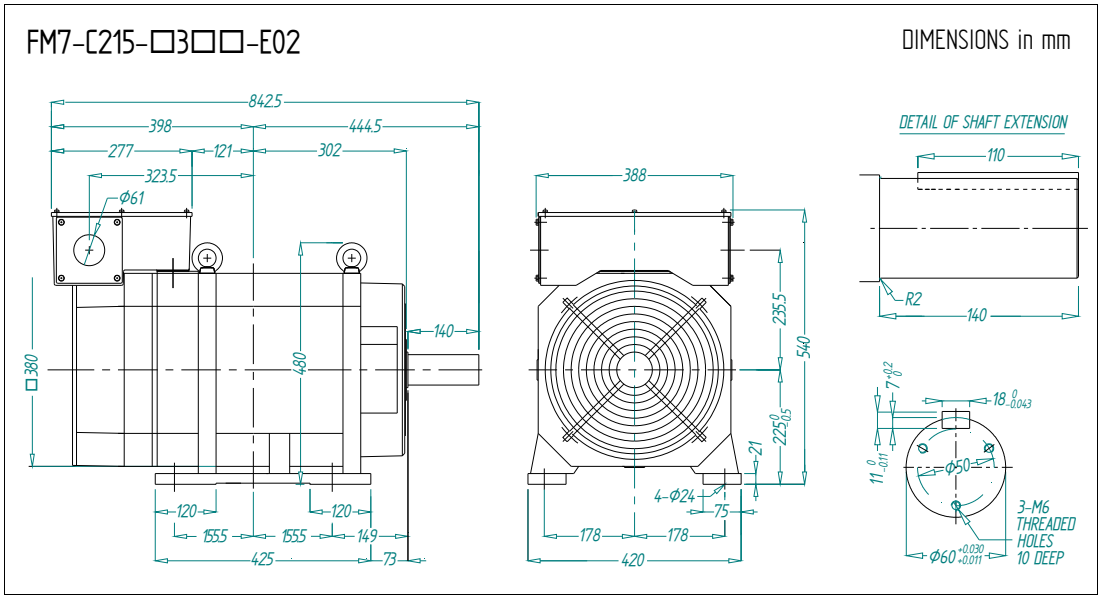
F. 3/21

Dimensions diagram. FM7-B280-□**3**□□-E01. Foot mount.



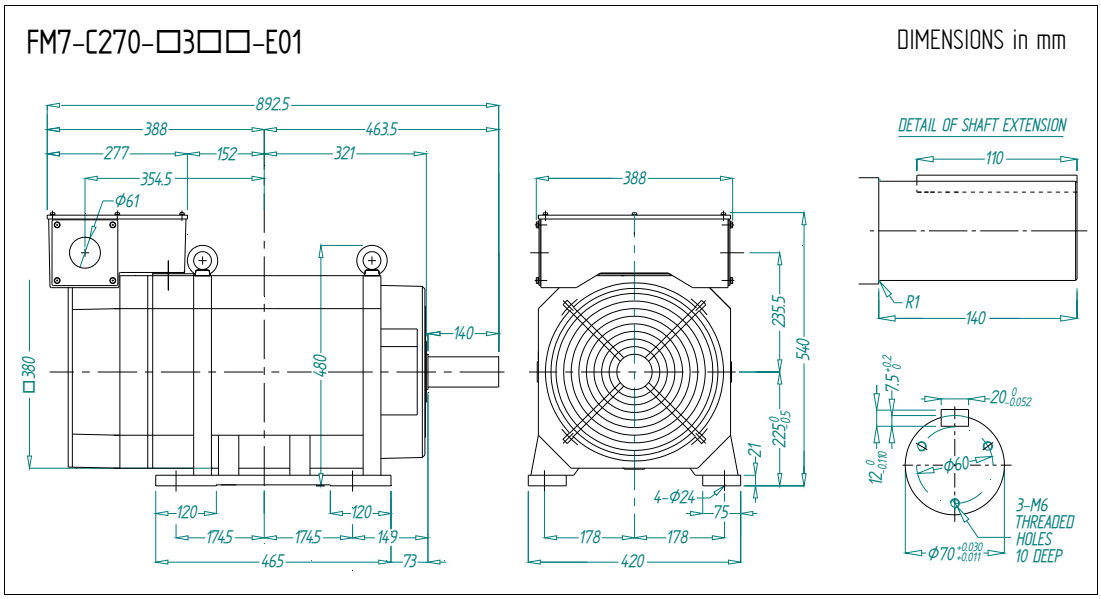
F. 3/22

Dimensions diagram. FM7-C215-□**3**□□-E01. Foot mount.



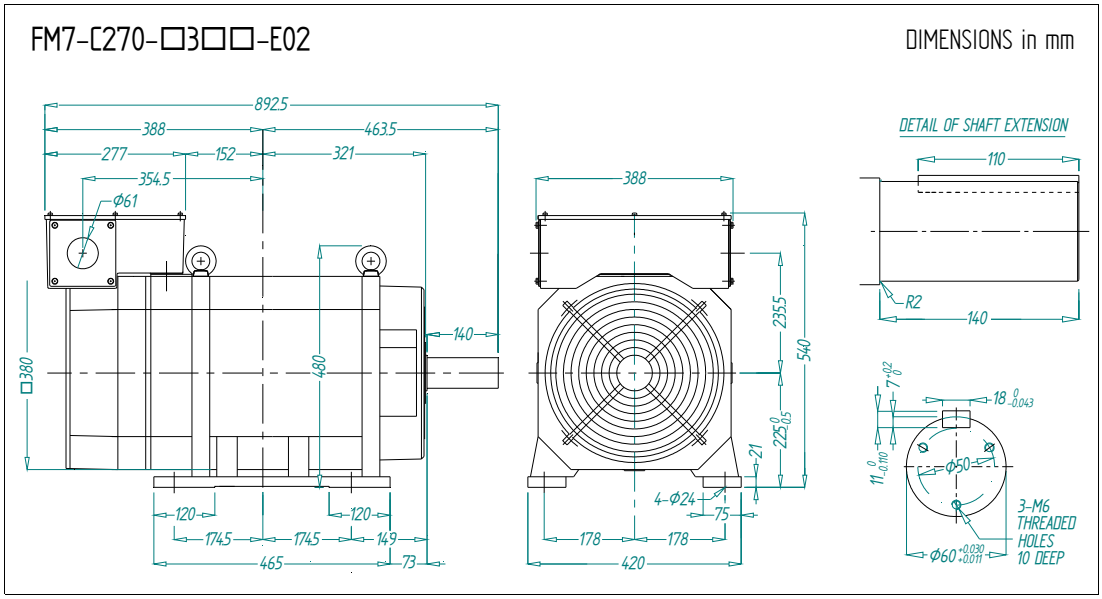
F. 3/23

Dimensions diagram. FM7-C215-□**3**□□-E02. Foot mount.



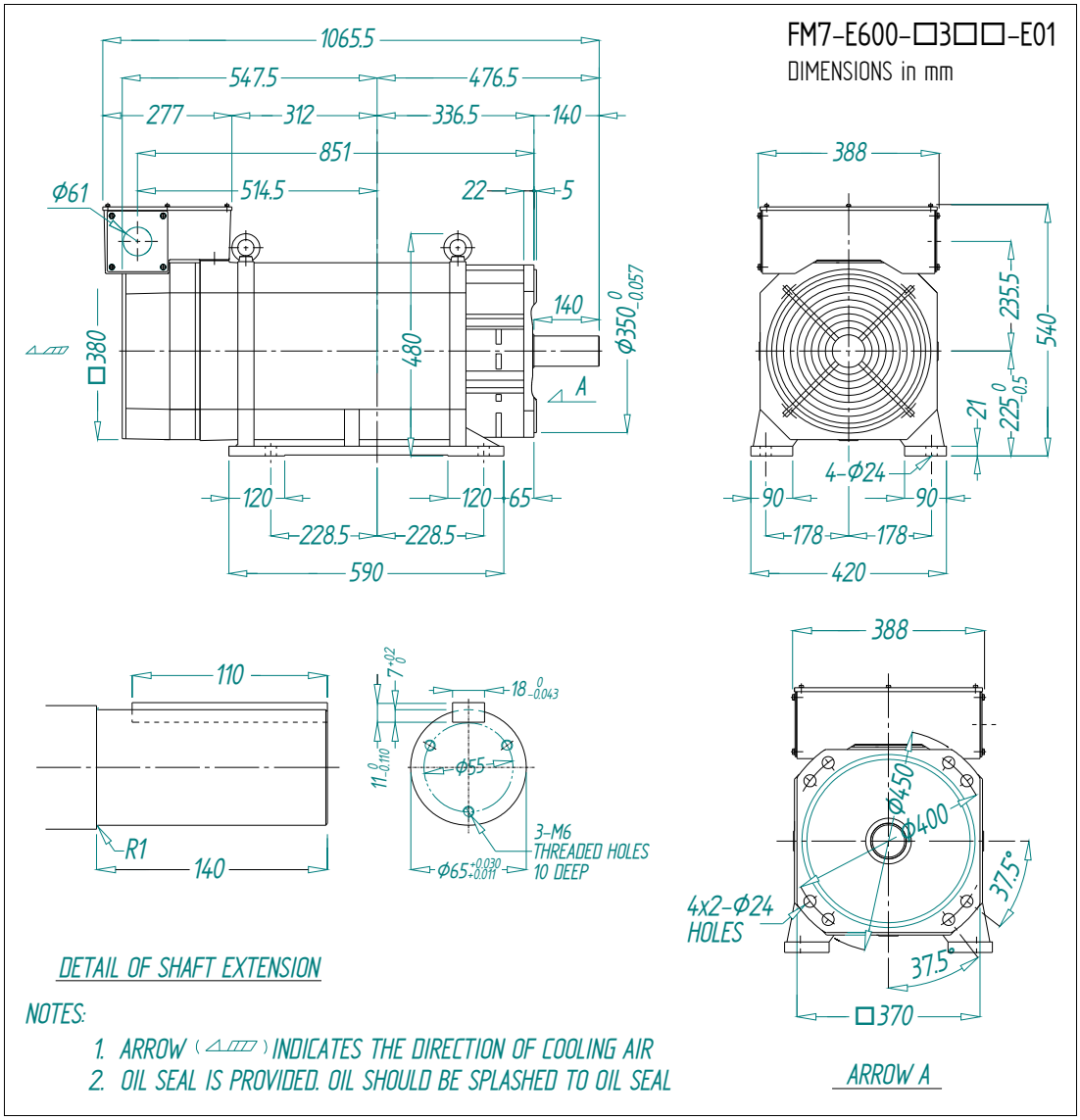
F. 3/24

Dimensions diagram. FM7-C270-□**3**□□-E01. Foot mount.



F. 3/25

Dimensions diagram. FM7-C270-□**3**□□-E02. Foot mount.



F. 3/26

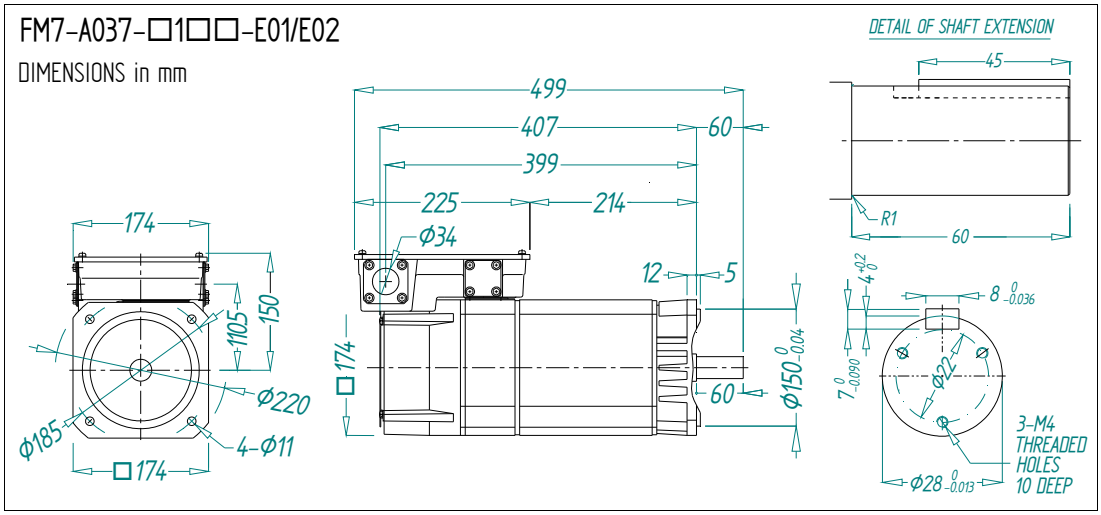
Dimensions diagram. FM7-E600-□**3**□□-E01. Foot mount.

3.7.2 Assembling precision

T. 3/6 Assembling precision in mm. FM7-□□□□-□3□□-E01/E02 series. Foot mount.

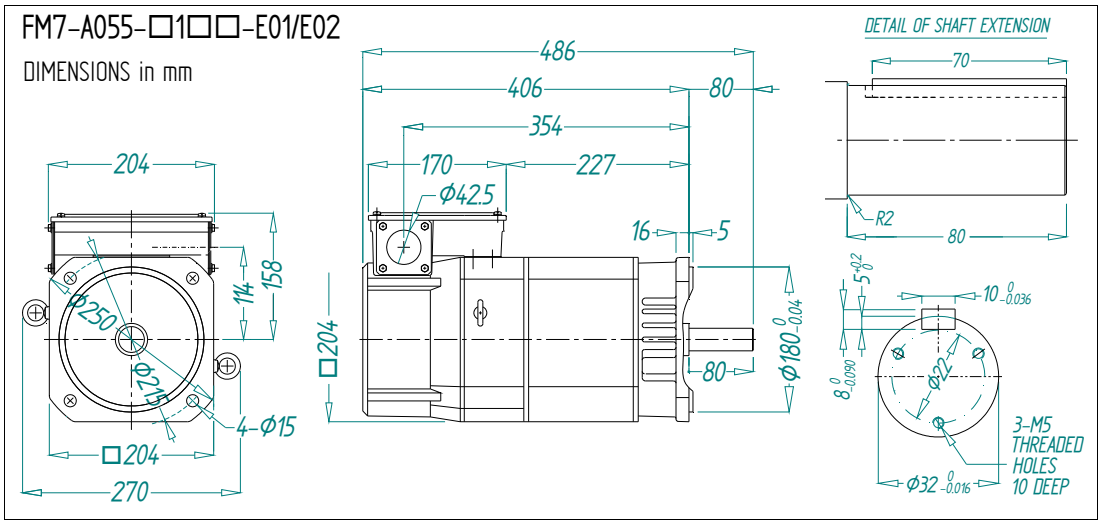
Model	Parallelism of the shaft extension	Runout of the shaft extension		
FM7-A037-□3□□-E01/E02	0.030	0.020		
FM7-A055-□3□□-E01/E02	0.030	0.020		
FM7-A075-□3□□-E01/E02	0.033	0.022		
FM7-A090-□3□□-E01/E02	0.033	0.022		
FM7-A110-□3□□-E01	0.033	0.022		
FM7-A150-□3□□-E01/E02	0.033	0.022		
FM7-A185-□3□□-E01/E02	0.033	0.022		
FM7-A220-□3□□-E01/E02	0.033	0.022		
FM7-A300-□3□□-E01	0.042	0.028		
FM7-A370-□3□□-E01	0.042	0.028		
FM7-A510-□3□□-E01/E02	0.042	0.028		
FM7-B120-□3□□-E01/E02	0.033	0.022		
FM7-B170-□3□□-E01/E02	0.033	0.022		
FM7-B220-□3□□-E01	0.042	0.028		
FM7-B280-□3□□-E01	0.042	0.028		
FM7-C215-□3□□-E01/E02	0.042	0.028		
FM7-C270-□3□□-E01/E02	0.042	0.028		
FM7-E600-C3B□-E01	0.042	0.028		

3.7.3 FM7-XXXX-X1XX-E01/E02



F. 3/27

Dimensions diagram. FM7-A037-□**1**□□-E01/E02. Flange mount.



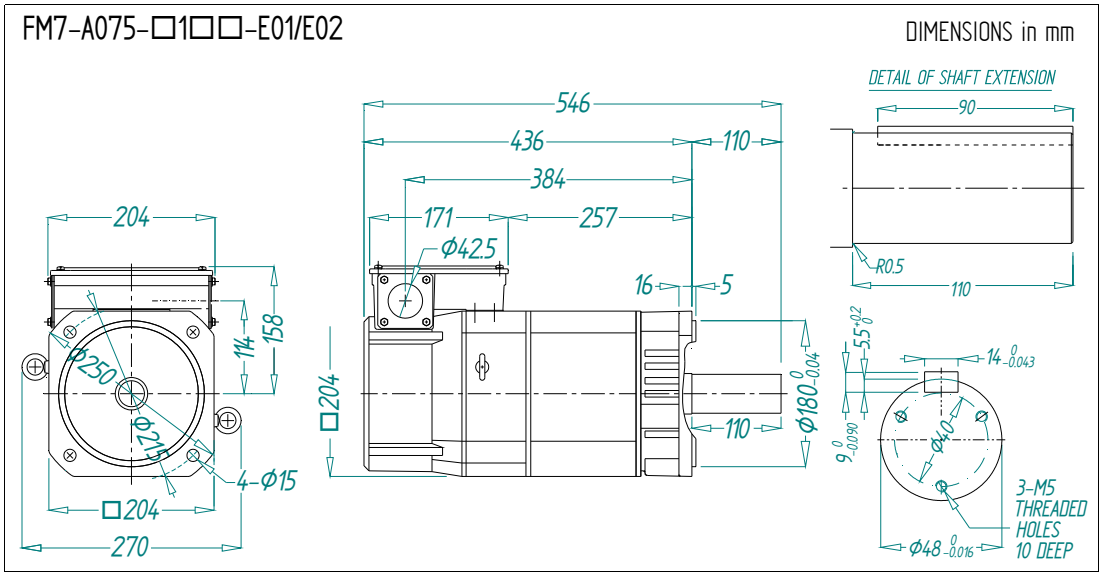
F. 3/28

Dimensions diagram. FM7-A055-□**1**□□-E01/E02. Flange mount.

FAGOR
FAGOR AUTOMATION

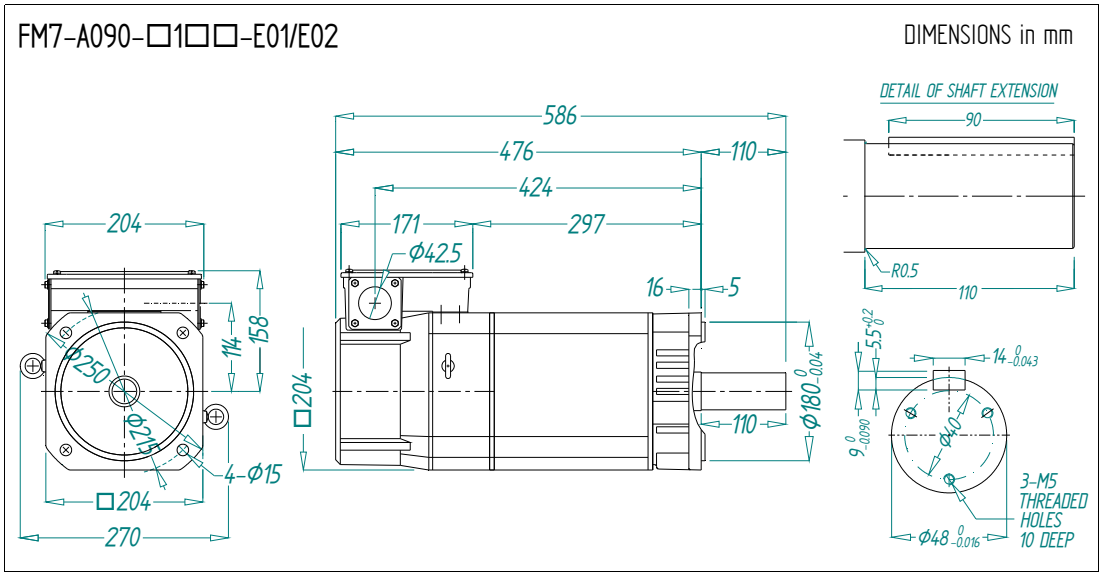
FM7/FM9

Ref.1707



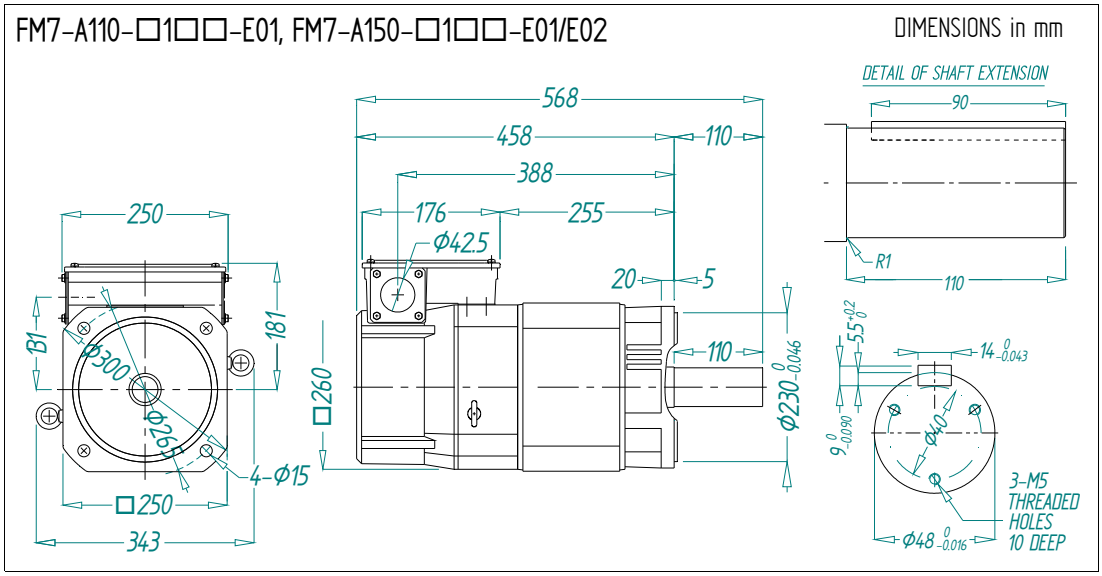
F. 3/29

Dimensions diagram. FM7-A075-□**1**□□-E01/E02. Flange mount.



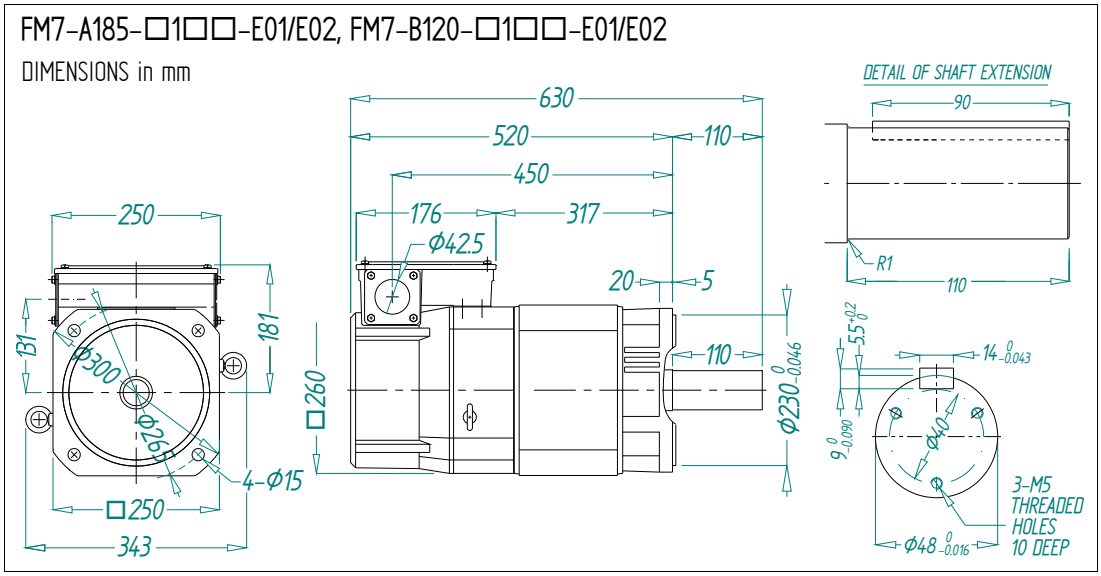
F. 3/30

Dimensions diagram. FM7-A090-□**1**□□-E01/E02. Flange mount.



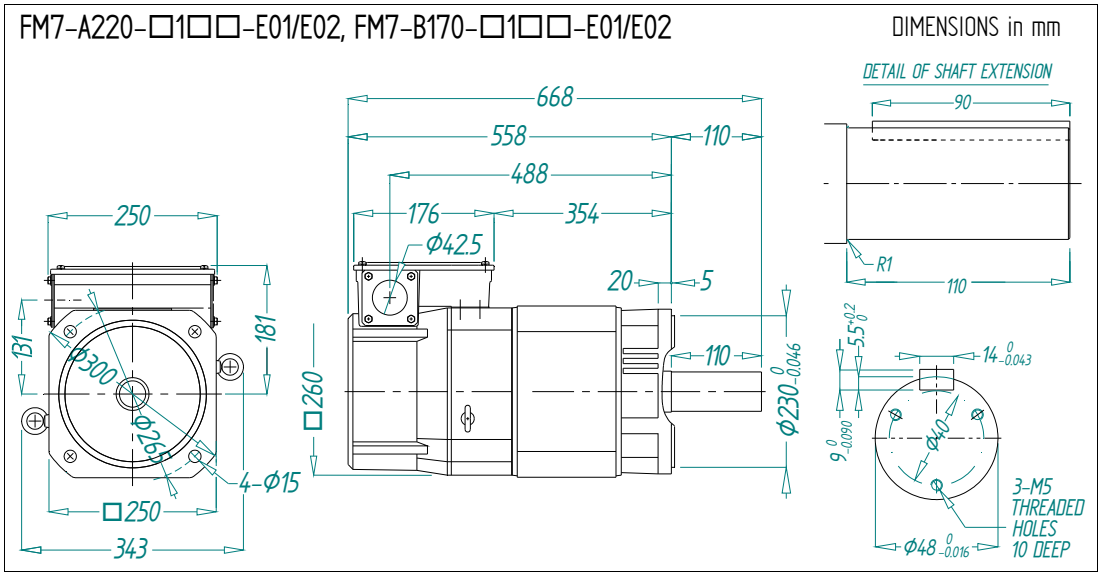
F. 3/31

Dimensions diagram. FM7-A110-□**1**□□-E01, FM7-A150-□**1**□□-E01/E02. Flange mount.



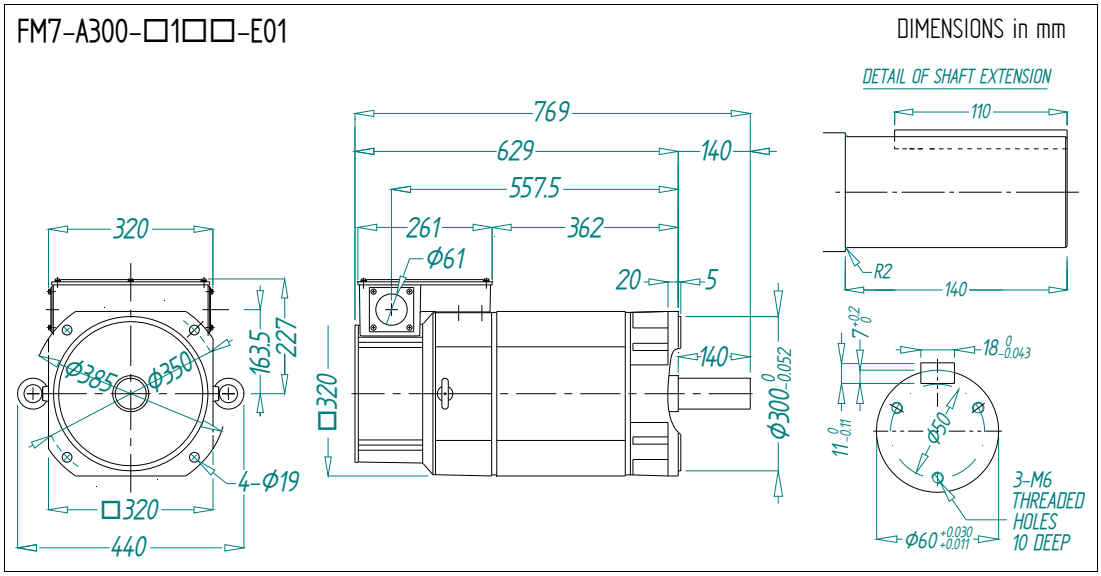
F. 3/32

Dimensions diagram. FM7-A185-□**1**□□-E01, FM7-B120-□**1**□□-E01/E02. Flange mount.



F. 3/33

Dimensions diagram. FM7-A220-□**1**□□-E01, FM7-B170-□**1**□□-E01/E02. Flange mount.



F. 3/34

Dimensions diagram. FM7-A300-□**1**□□-E01. Flange mount.

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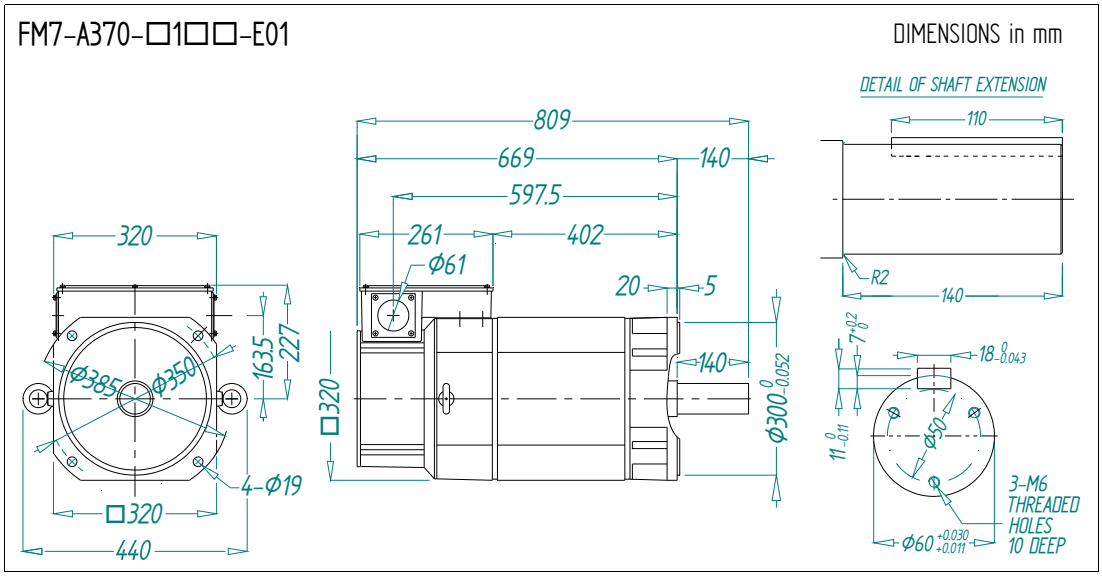
FAGOR AUTOMATION

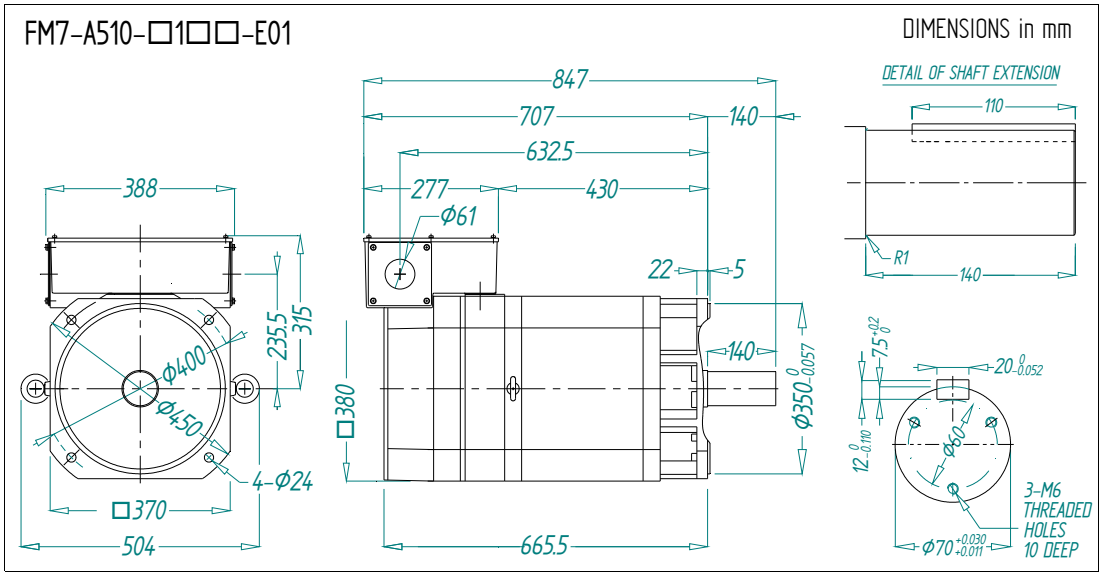
FM7/FM9

Ref.1707



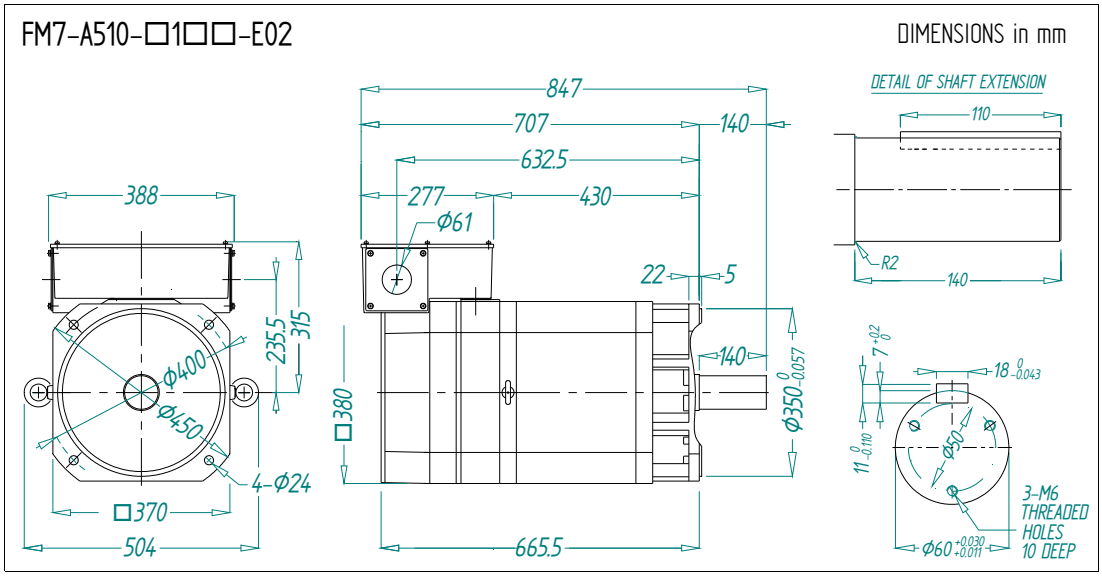
F. 3/35

Dimensions diagram. FM7-A370-□**1**□□-E01. Flange mount.



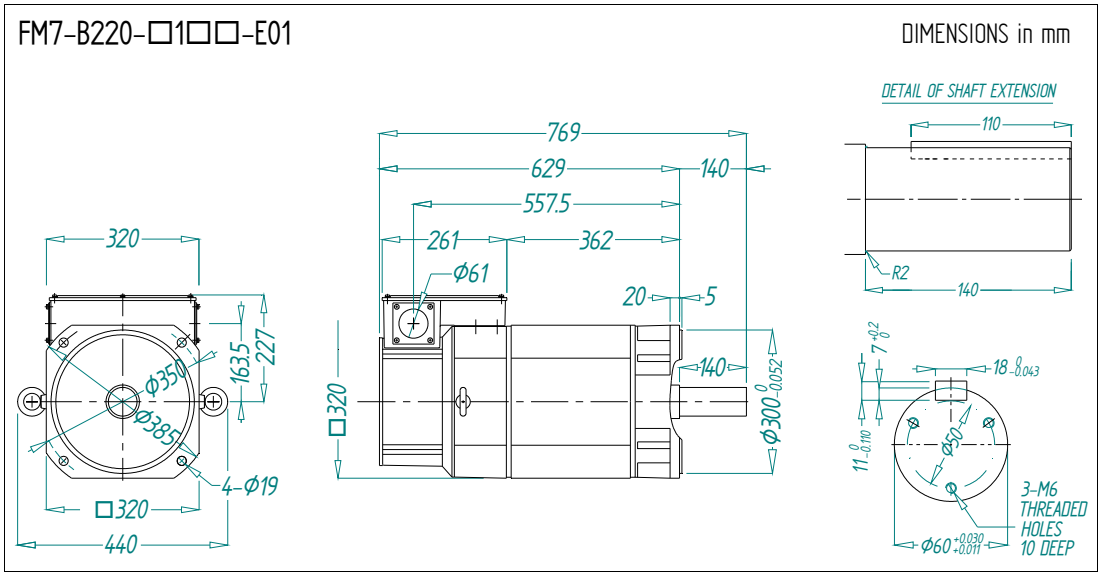
F. 3/36

Dimensions diagram. FM7-A510-□**1**□□-E01. Flange mount.



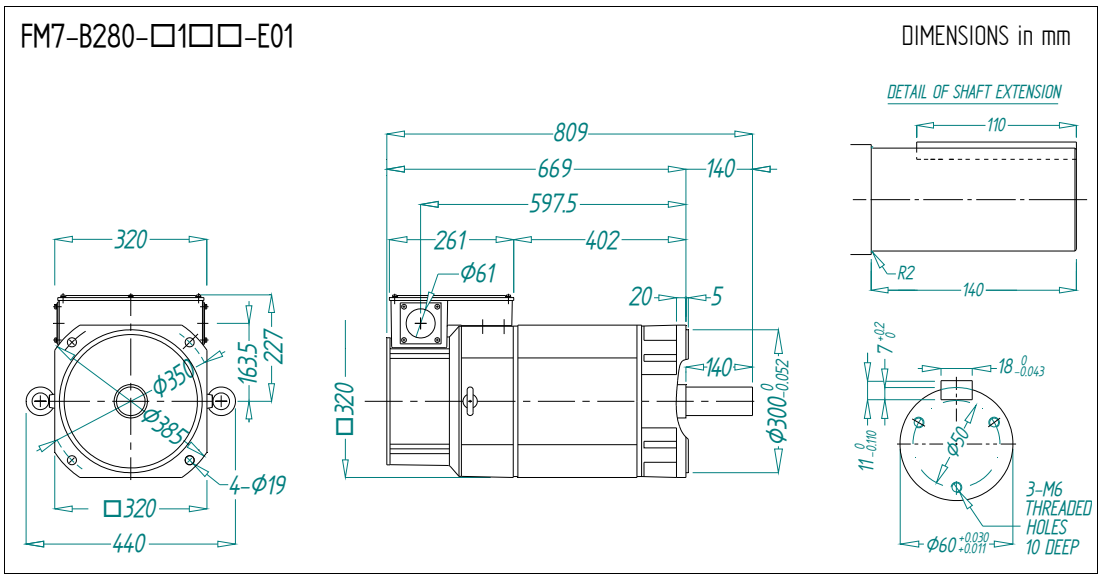
F. 3/37

Dimensions diagram. FM7-A510-□**1**□□-E02. Flange mount.



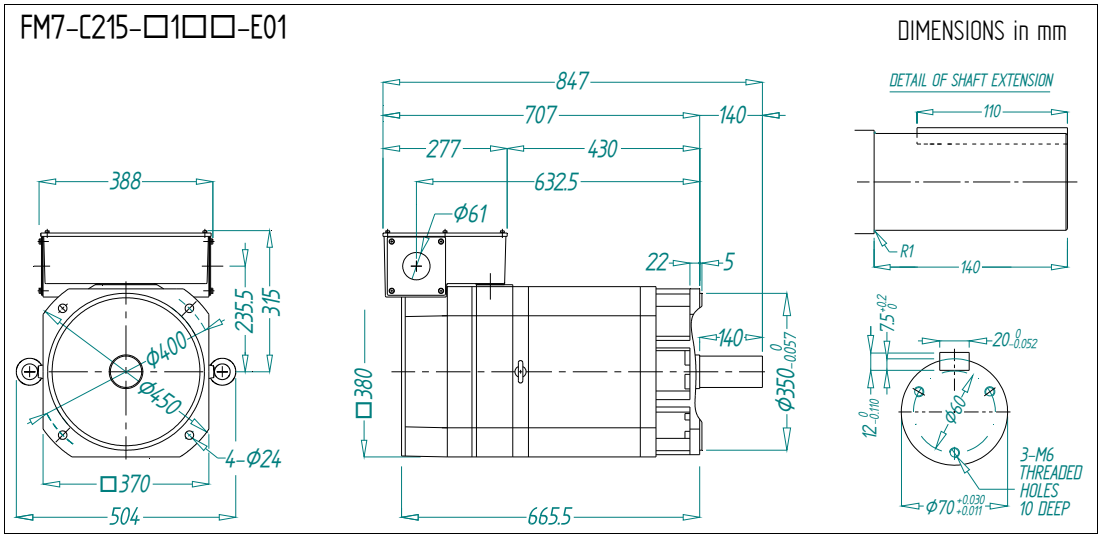
F. 3/38

Dimensions diagram. FM7-B220-□**1**□□-E01. Flange mount.



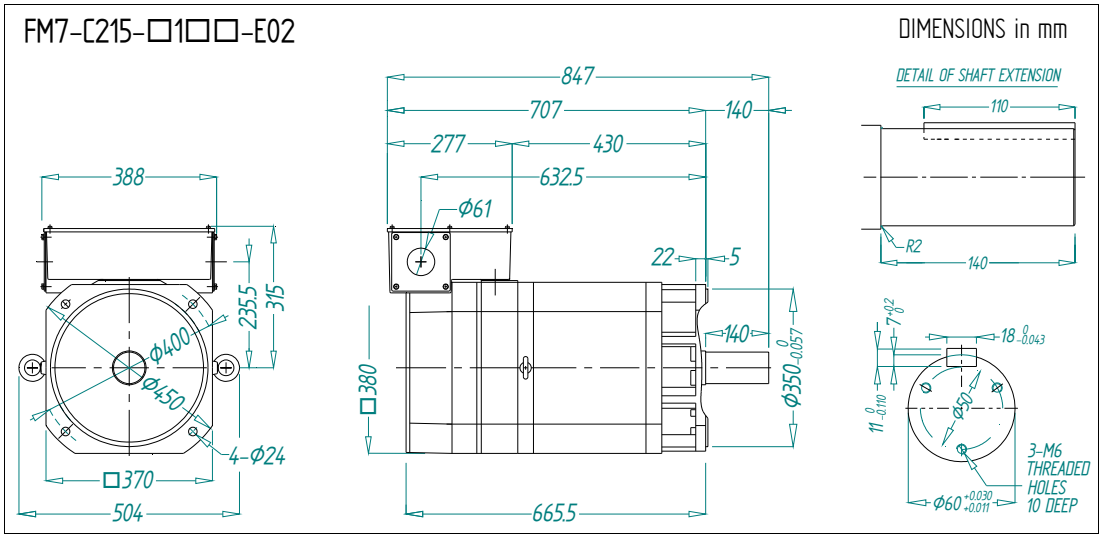
F. 3/39

Dimensions diagram. FM7-B280-□**1**□□-E01. Flange mount.



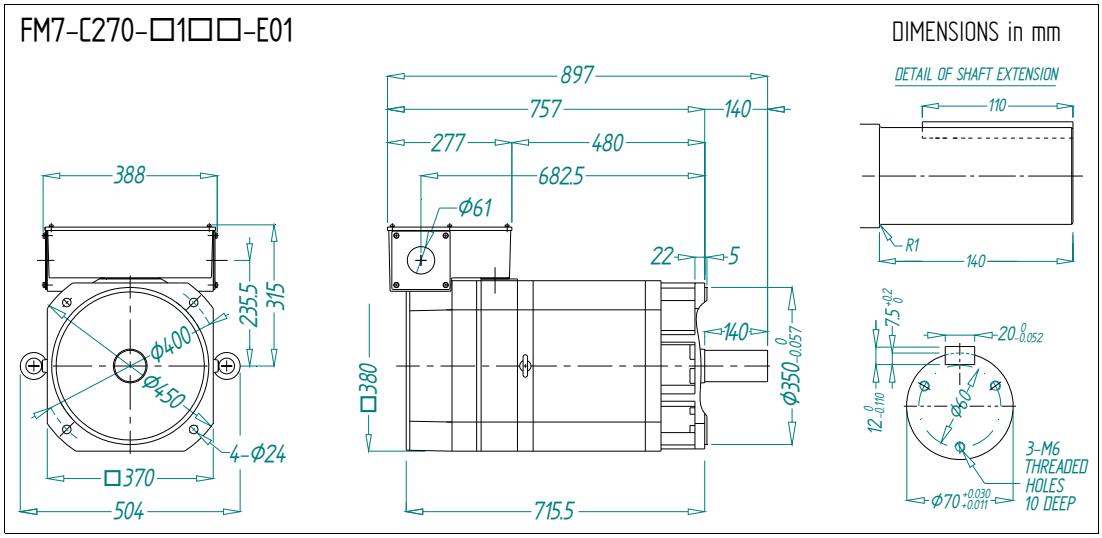
F. 3/40

Dimensions diagram. FM7-C215-□**1**□□-E01. Flange mount.



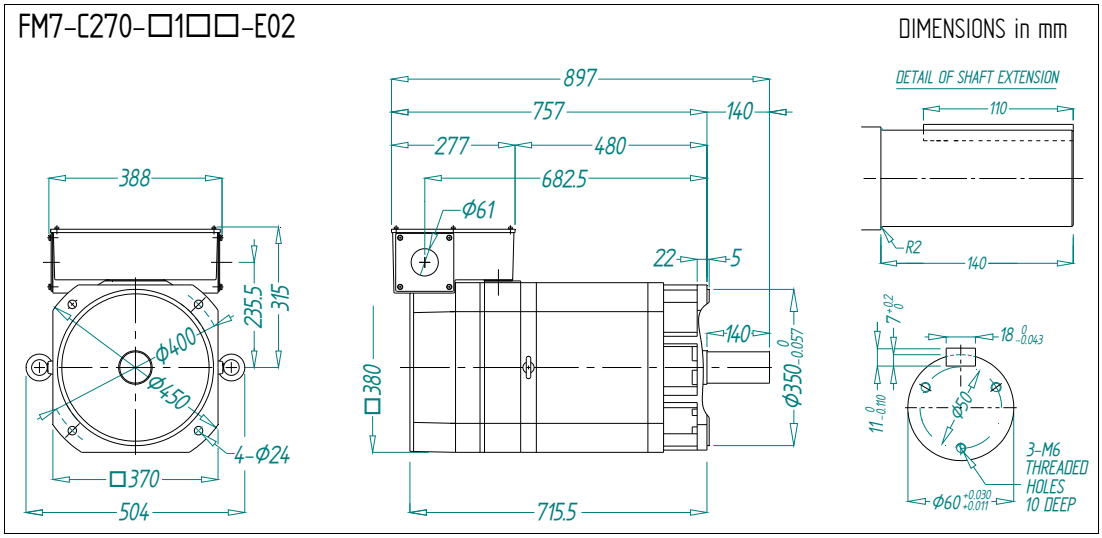
F. 3/41

Dimensions diagram. FM7-C215-□**1**□□-E02. Flange mount.



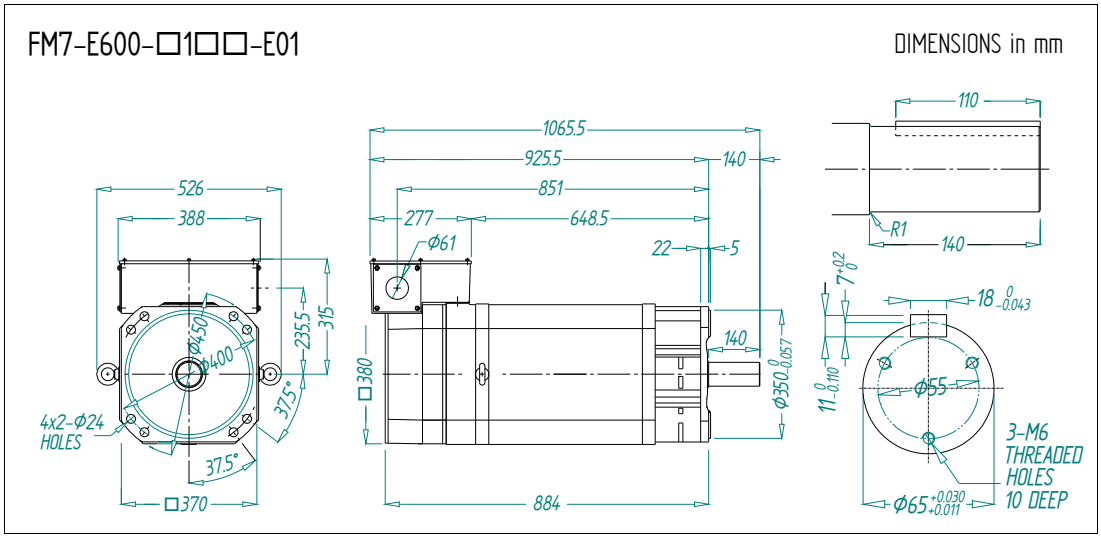
F. 3/42

Dimensions diagram. FM7-C270-□**1**□□-E01. Flange mount.



F. 3/43

Dimensions diagram. FM7-C270-□**1**□□-E02. Flange mount.



F. 3/44

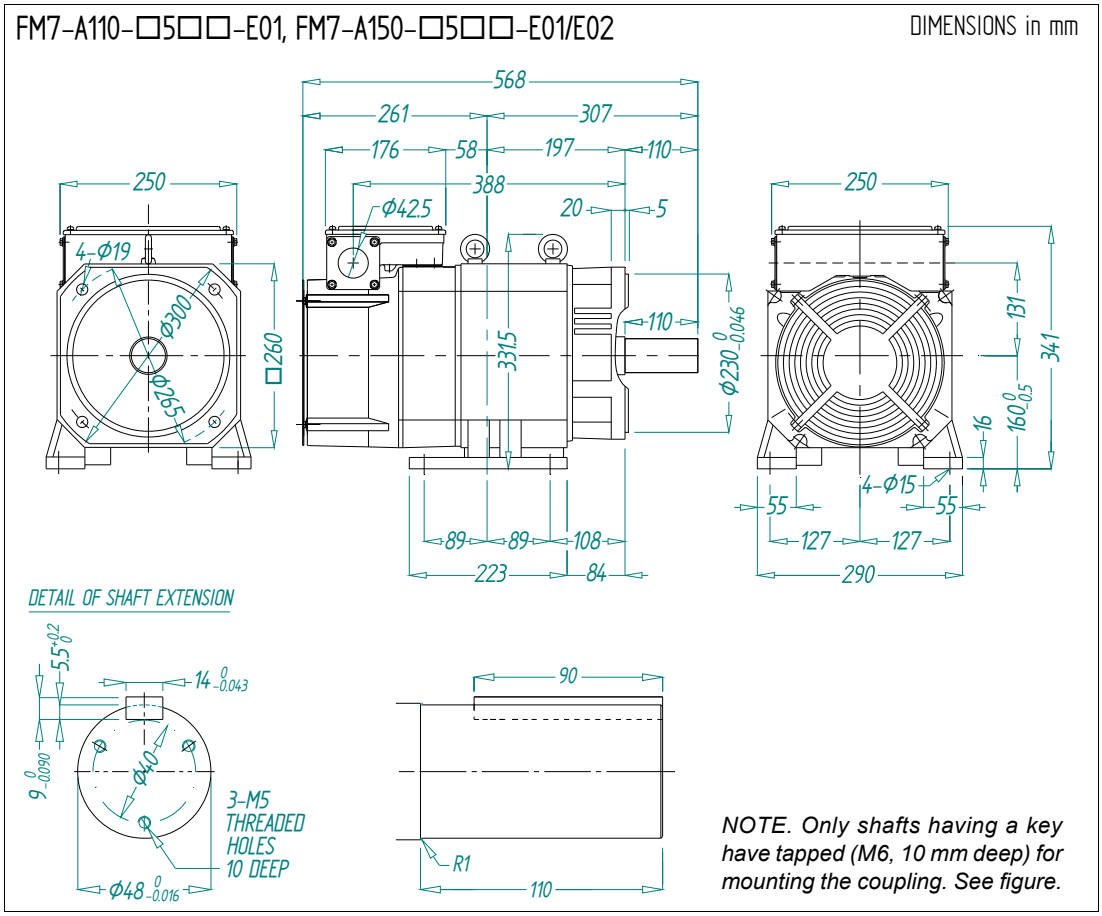
Dimensions diagram. FM7-E600-□**1**□□-E01. Flange mount.

3.7.4 Assembling precision

T. 3/7 Assembling precision in mm. FM7-□□□□-□1□□-E01/E02 models. Flange mount.

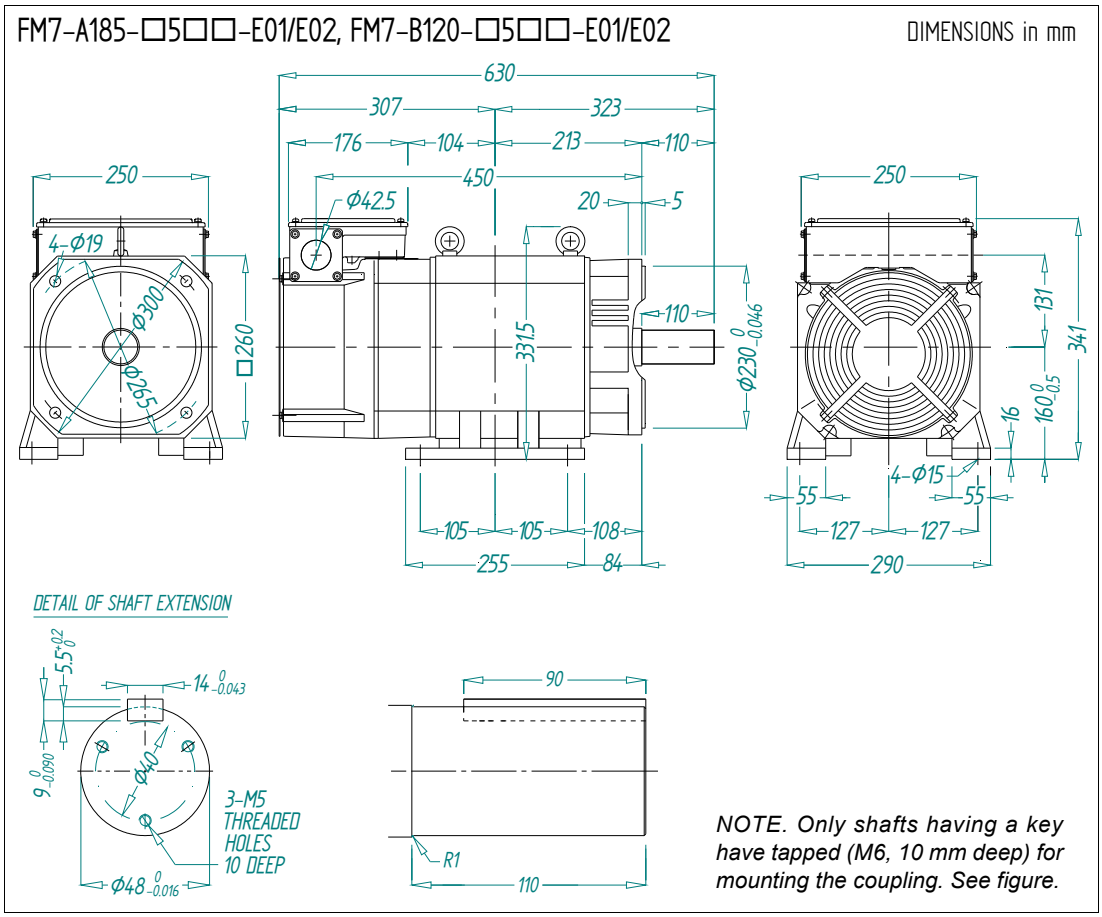
Models	Runout of the shaft extension	Concentricity of the fitting diameter between the flange and the shaft	Concentricity of the support face of the flange with respect to the machine axis
FM7-A037-□1□□-E01/E02	0.020	0.040	0.040
FM7-A055-□1□□-E01/E02	0.020	0.040	0.040
FM7-A075-□1□□-E01/E02	0.022	0.040	0.040
FM7-A090-□1□□-E01/E02	0.022	0.040	0.040
FM7-A110-□1□□-E01/E02	0.022	0.046	0.040
FM7-A150-□1□□-E01/E02	0.022	0.046	0.040
FM7-A185-□1□□-E01/E02	0.022	0.046	0.040
FM7-A220-□1□□-E01/E02	0.022	0.046	0.040
FM7-A300-□1□□-E01	0.028	0.048	0.060
FM7-A370-□1□□-E01	0.028	0.048	0.060
FM7-A510-□1□□-E01/E02	0.028	0.070	0.072
FM7-B120-□1□□-E01/E02	0.022	0.046	0.040
FM7-B170-□1□□-E01/E02	0.022	0.046	0.040
FM7-B220-□1□□-E01	0.028	0.048	0.060
FM7-B280-□1□□-E01	0.028	0.048	0.060
FM7-C215-□1□□-E01/E02	0.028	0.070	0.072
FM7-C270-□1□□-E01/E02	0.028	0.070	0.072
FM7-E600-C1B□-E01	0.028	0.070	0.072

3.7.5 FM7-XXXX-X5XX-E01/E02



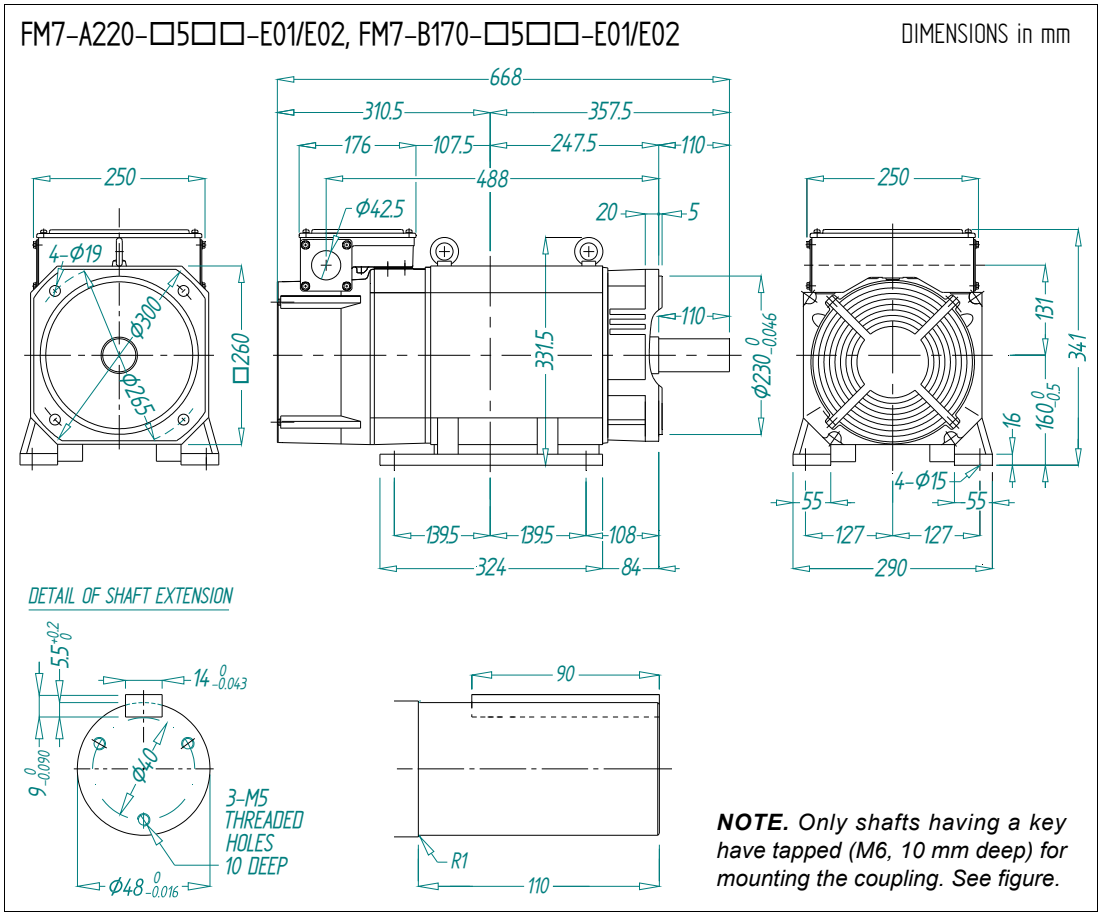
F. 3/45

Dimensions diagram. FM7-A110-□**5**□□-E01, FM7-A150-□**5**□□-E01/E02. Foot+Flange mount.



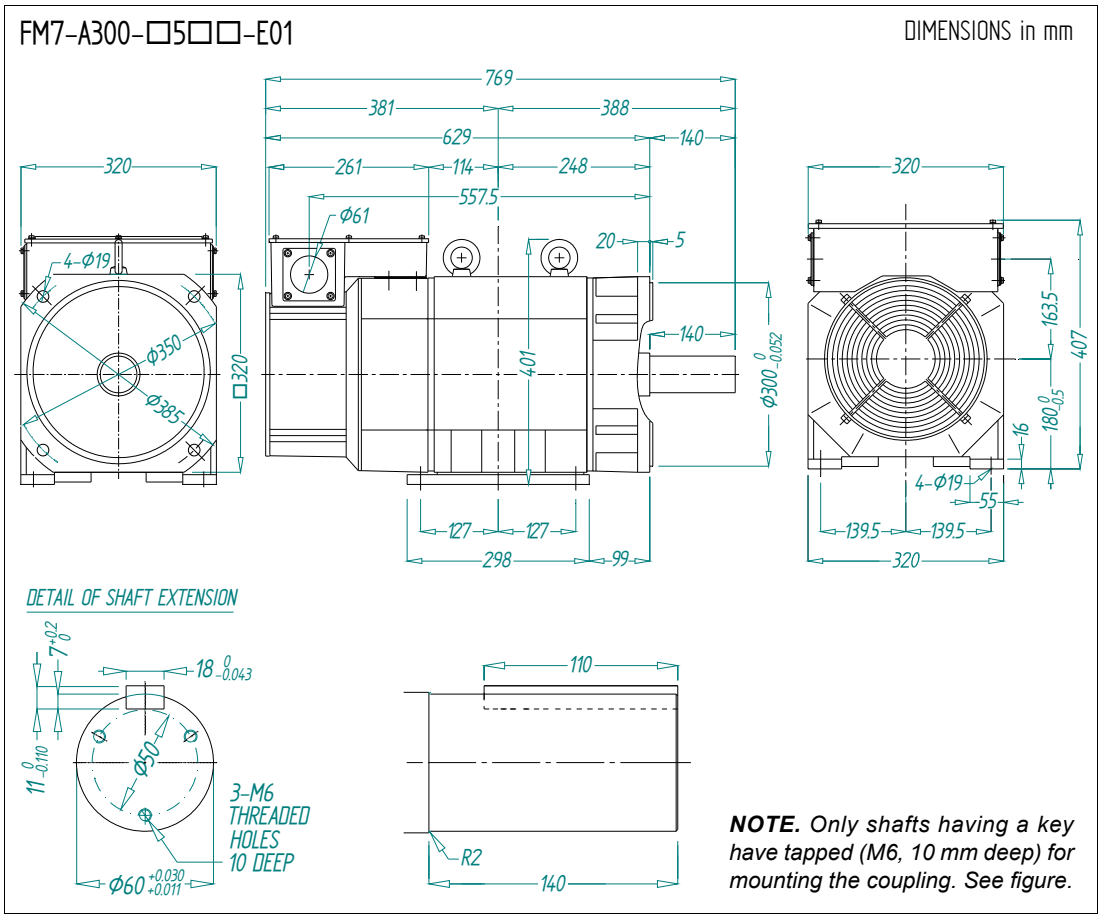
F. 3/46

Dimensions diagram. FM7-A185-□**5**□□-E01, FM7-B120-□**5**□□-E01/E02. Foot+Flange mount.



F. 3/47

Dimensions diagram. FM7-A220-□**5**□□-E01/E02, FM7-B170-□**5**□□-E01/E02. Foot+Flange mount.



F. 3/48

Dimensions diagram. FM7-A300-□**5**□□-E01. Foot+Flange mount.

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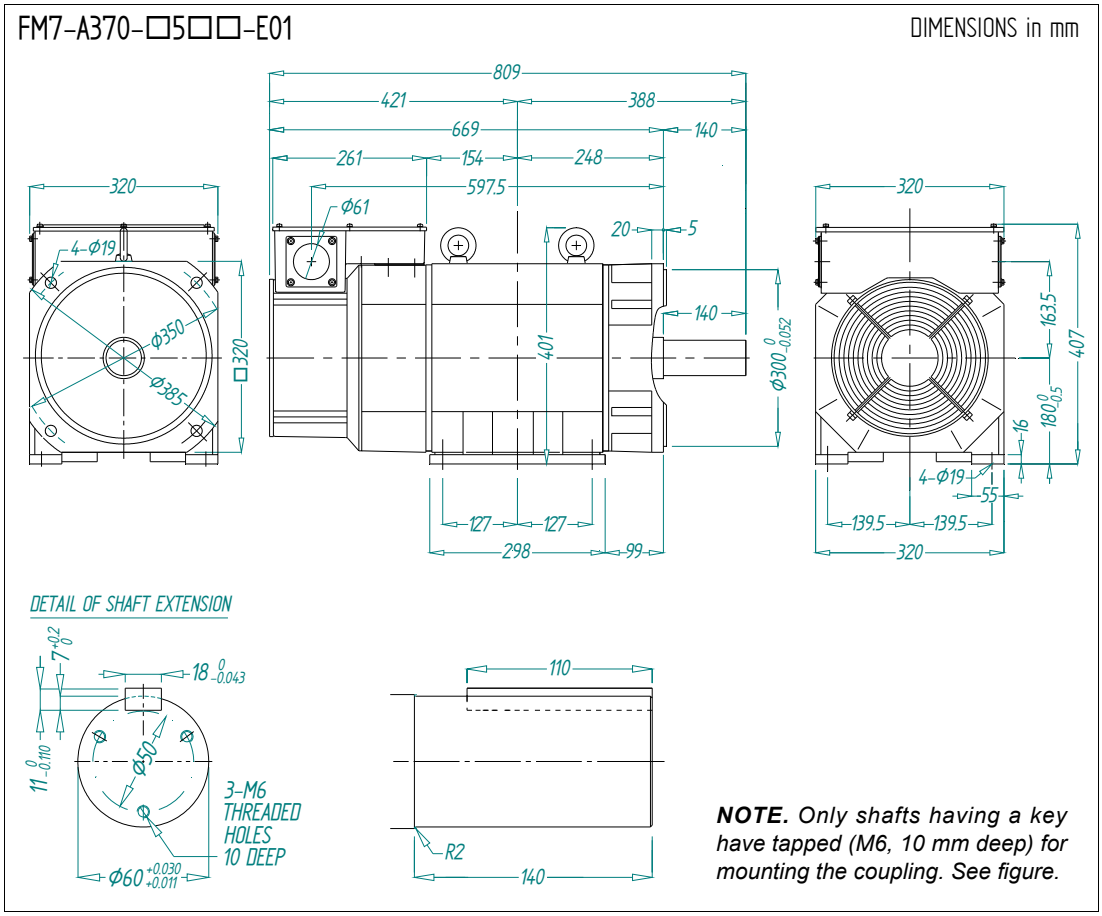
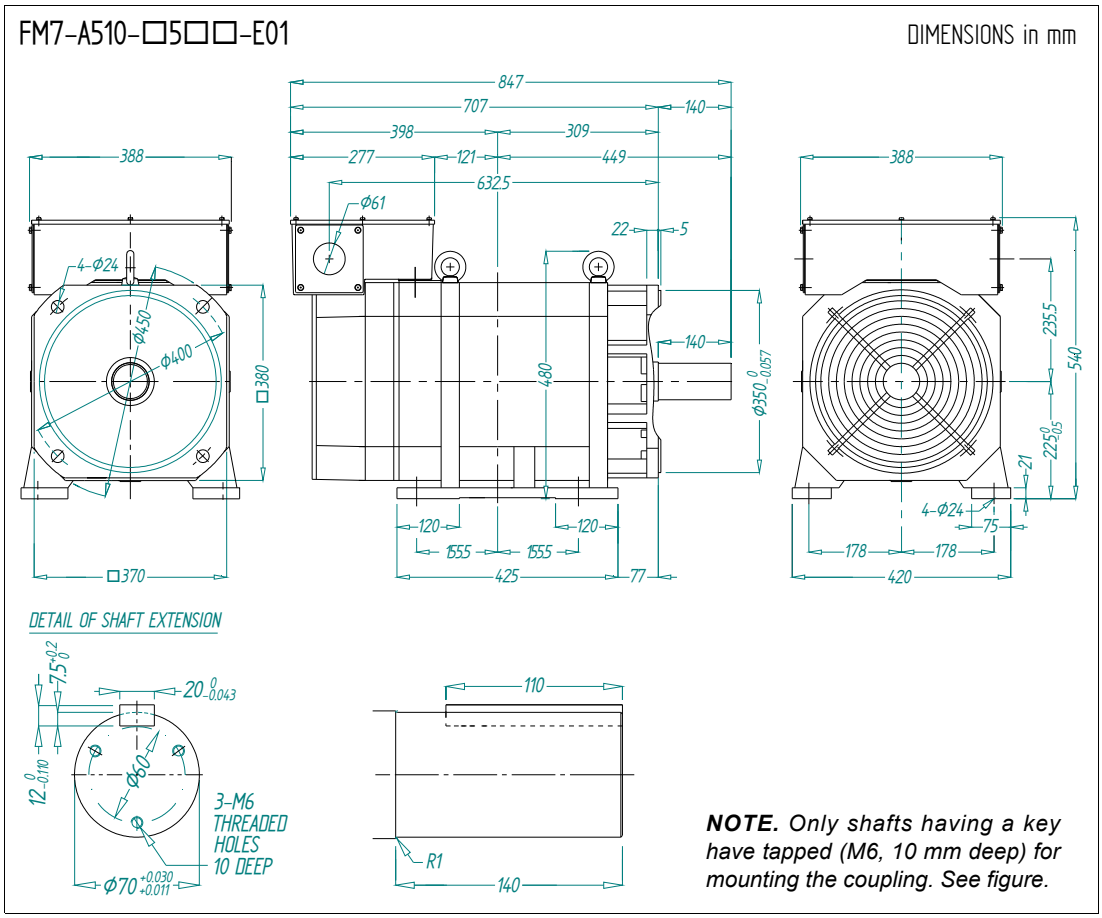
FM7/FM9

Ref.1707



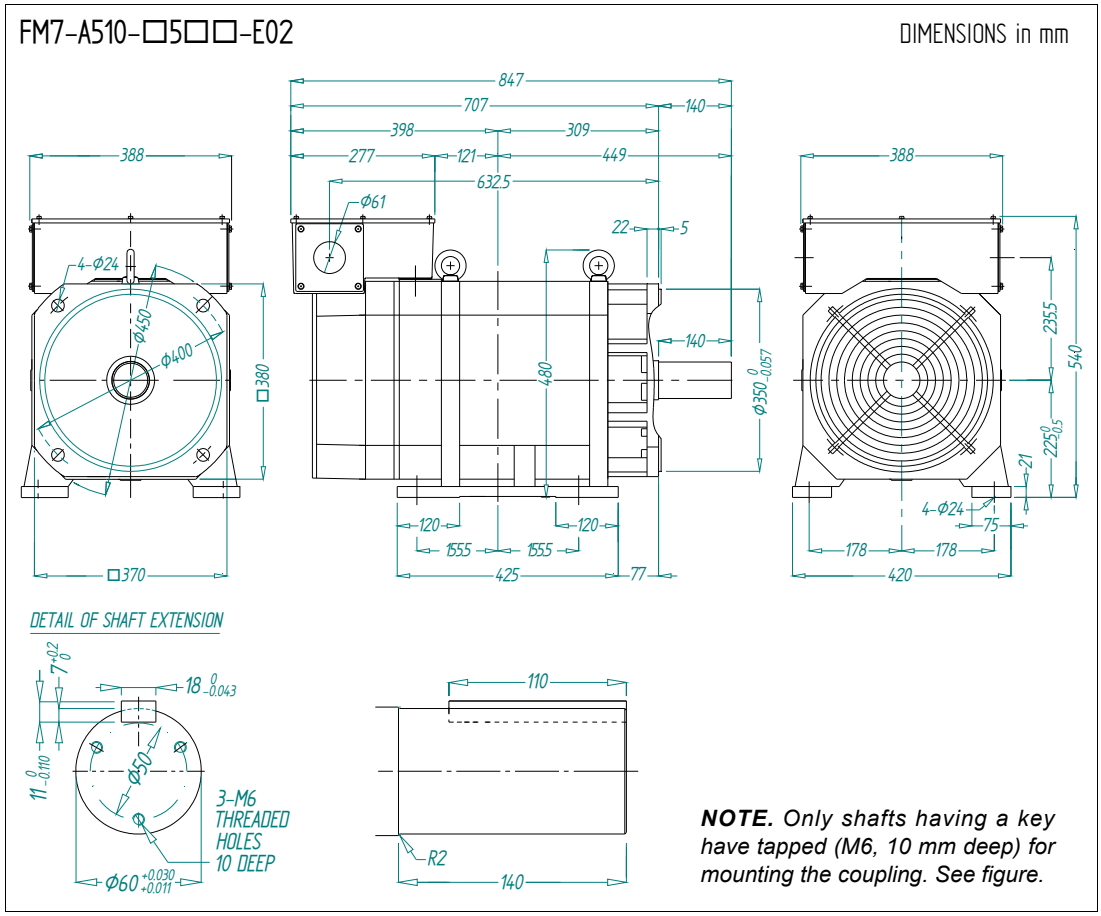
F. 3/49

Dimensions diagram. FM7-A370-□**5**□□-E01. Foot+Flange mount.



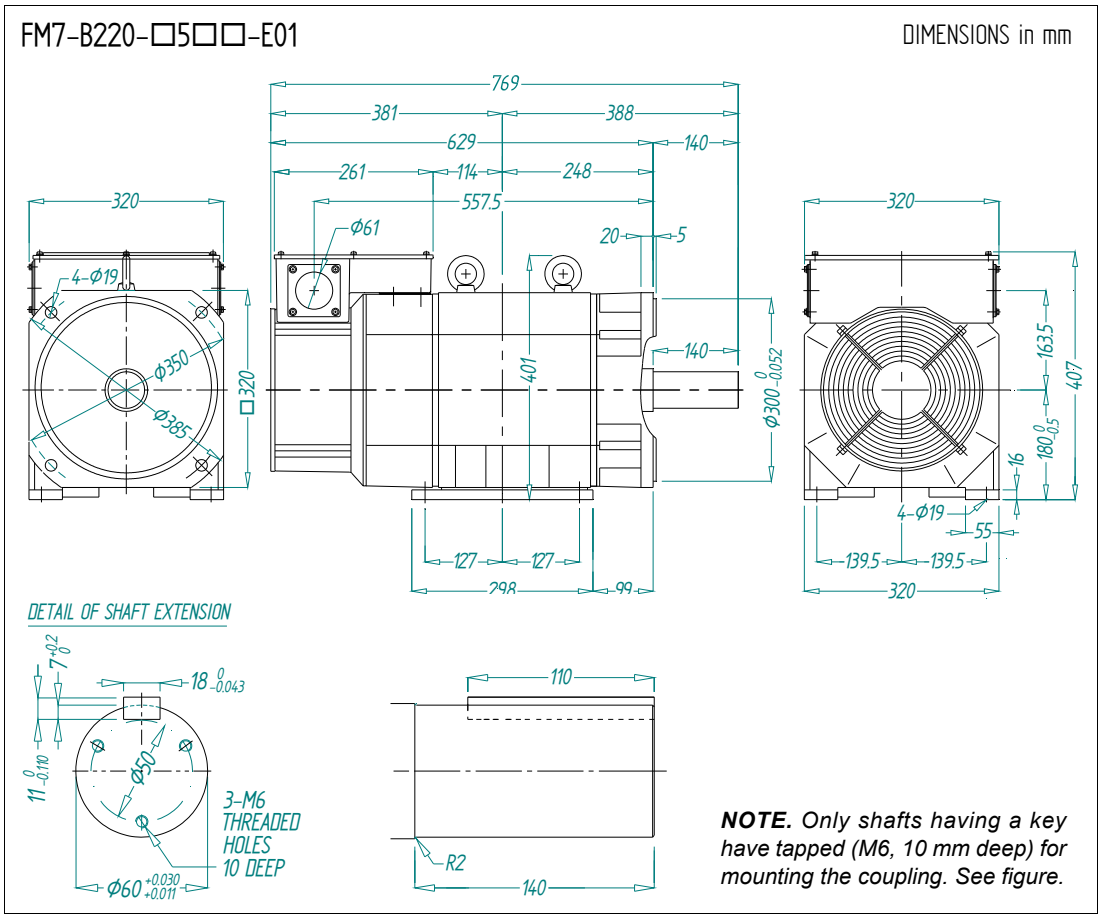
F. 3/50

Dimensions diagram. FM7-A510-□**5**□□-E01. Foot+Flange mount.



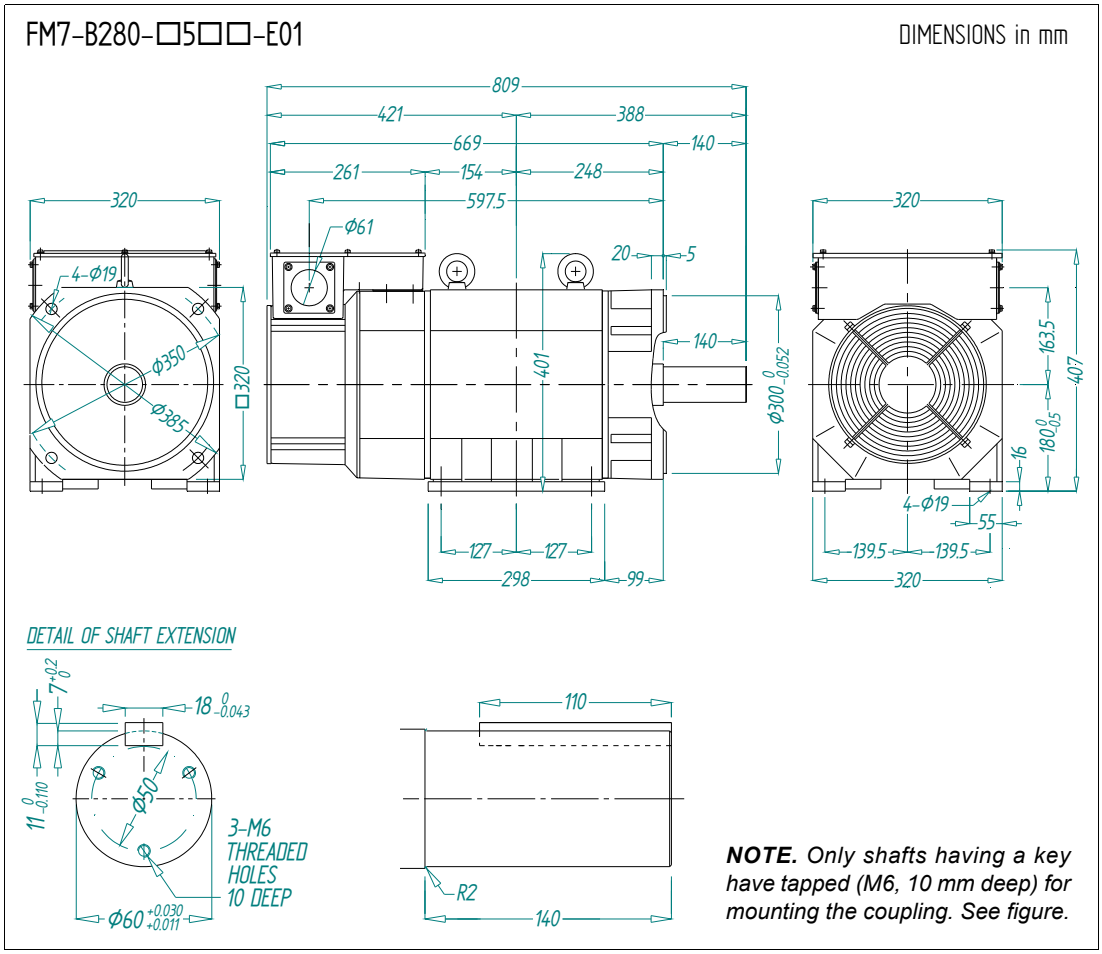
F. 3/51

Dimensions diagram. FM7-A510-□**5**□□-E02. Foot+Flange mount.



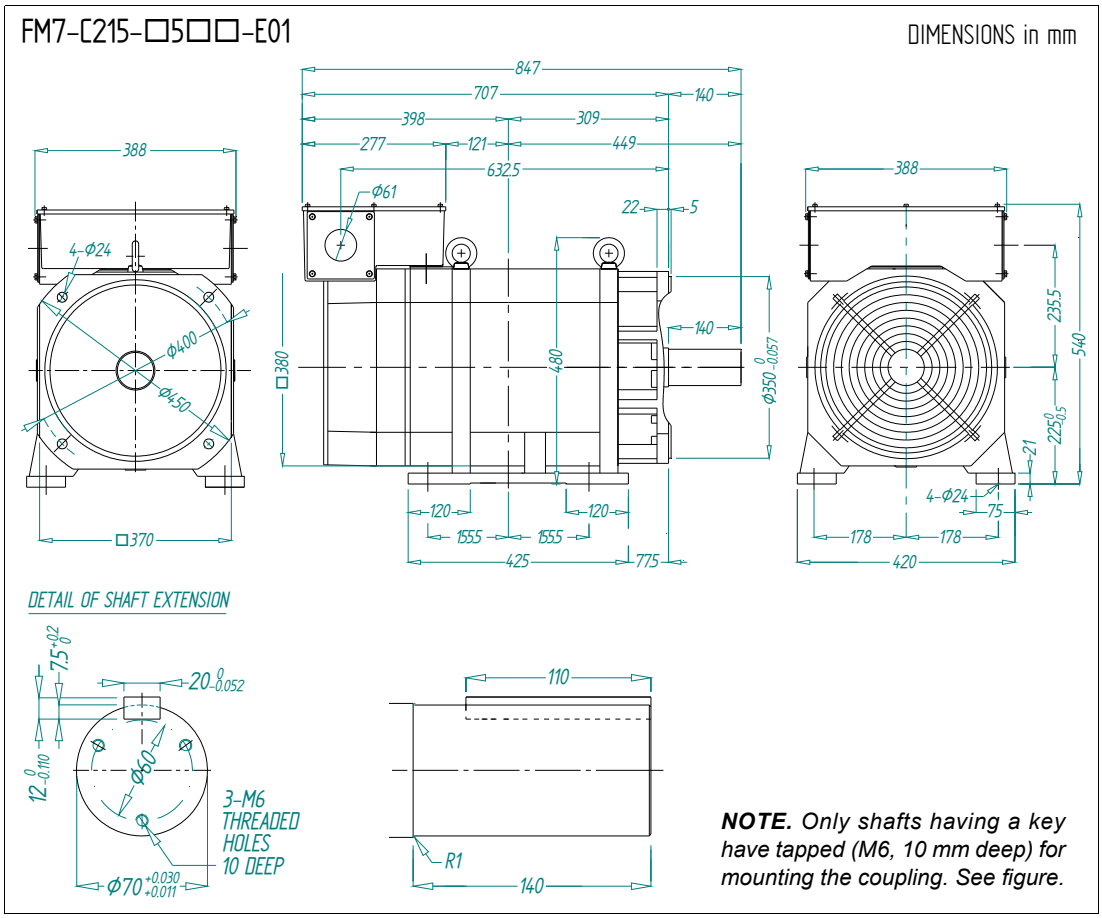
F. 3/52

Dimensions diagram. FM7-B220-□**5**□□-E01. Foot+Flange mount.



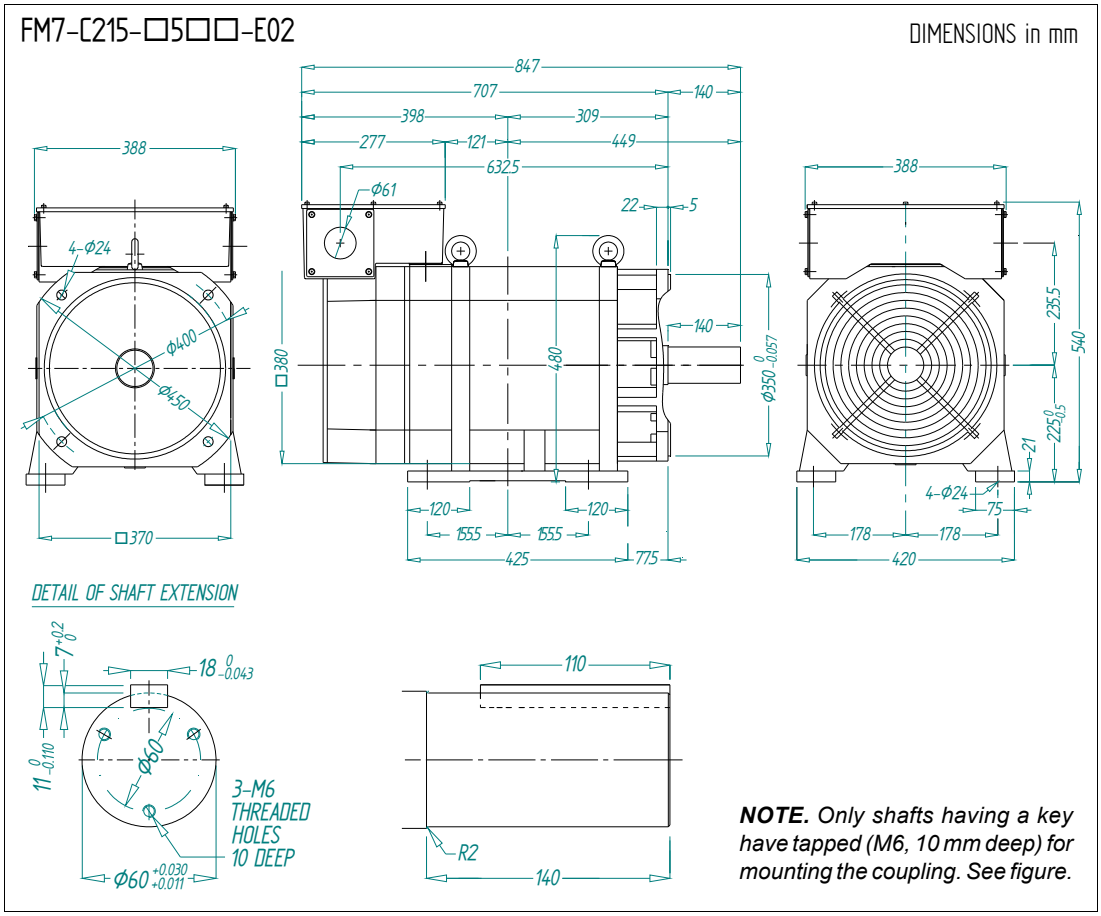
F. 3/53

Dimensions diagram. FM7-B280-□**5**□□-E01. Foot+Flange mount.



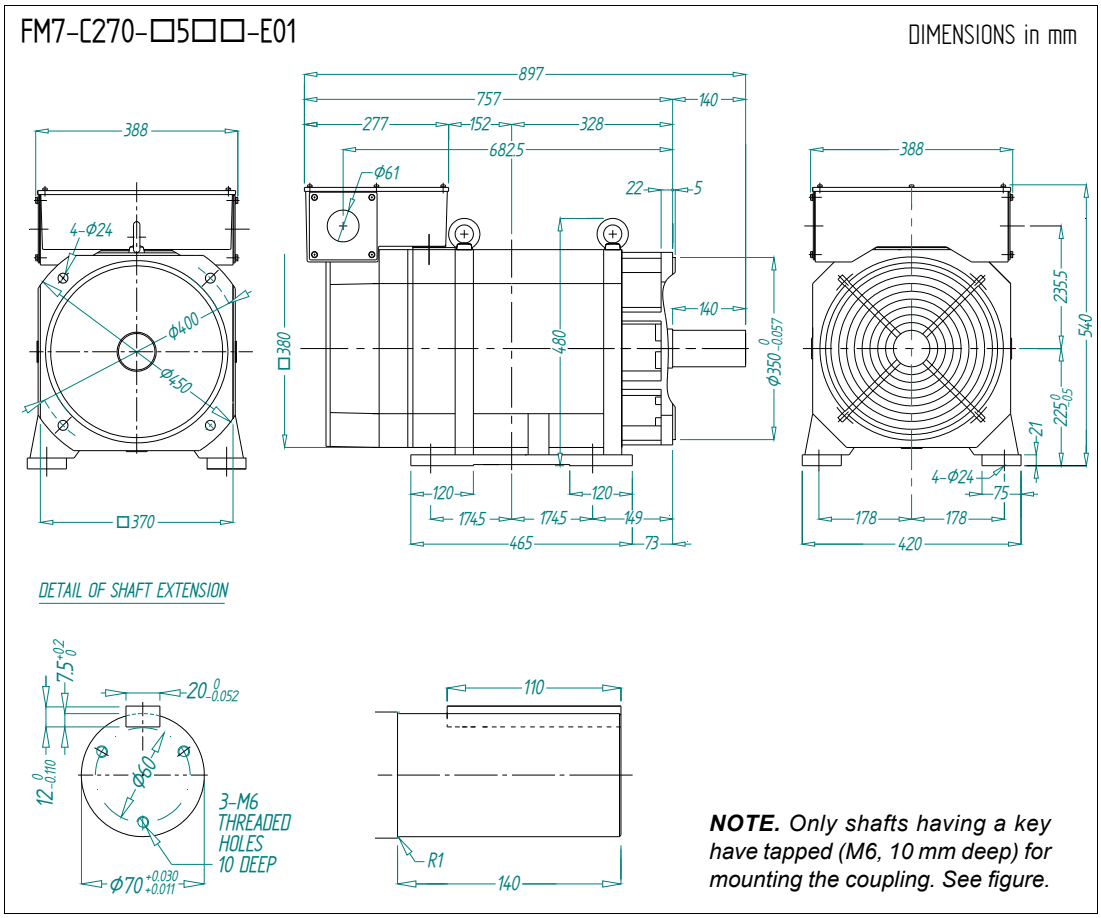
F. 3/54

Dimensions diagram. FM7-C215-□**5**□□-E01. Foot+Flange mount.



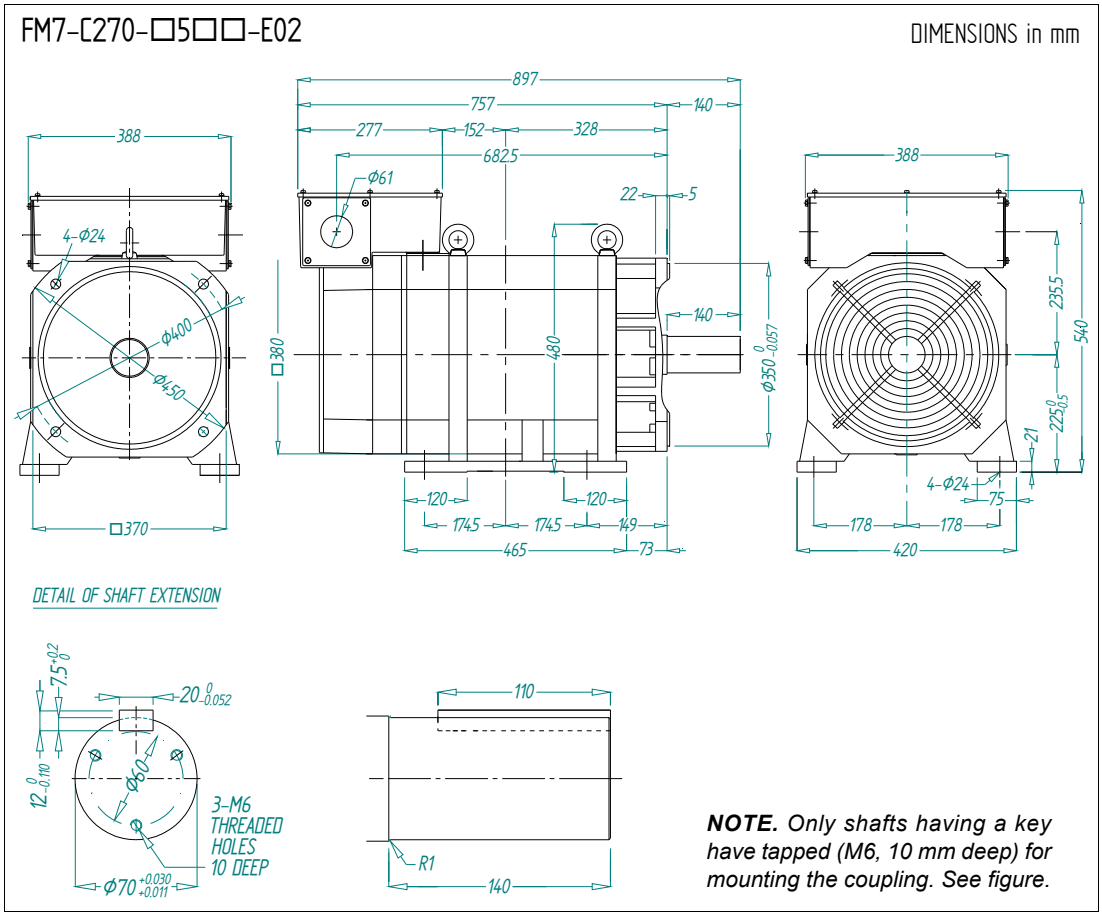
F. 3/55

Dimensions diagram. FM7-C215-□**5**□□-E02. Foot+Flange mount.



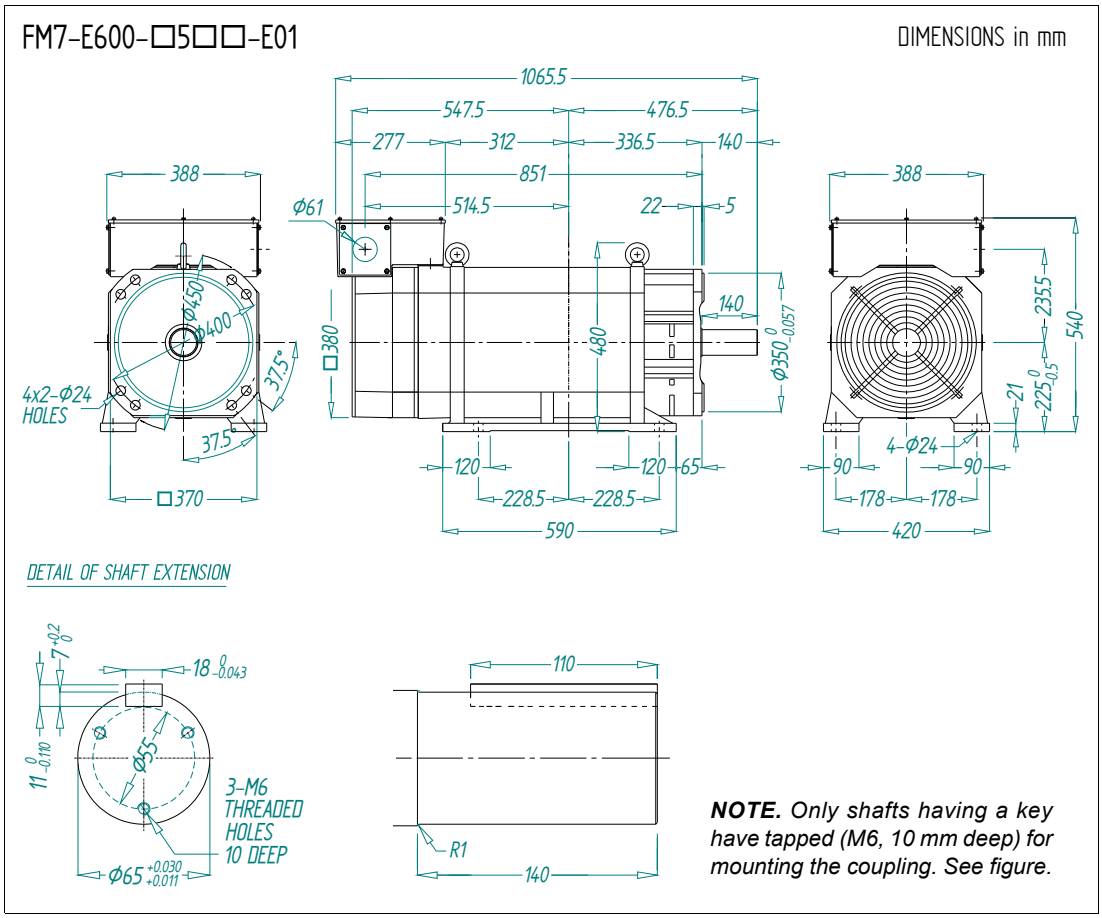
F. 3/56

Dimensions diagram. FM7-C270-□**5**□□-E01. Foot+Flange mount.



F. 3/57

Dimensions diagram. FM7-C270-□**5**□□-E02. Foot+Flange mount.



F. 3/58

Dimensions diagram. FM7-E600-□**5**□□-E01. Foot+Flange mount.

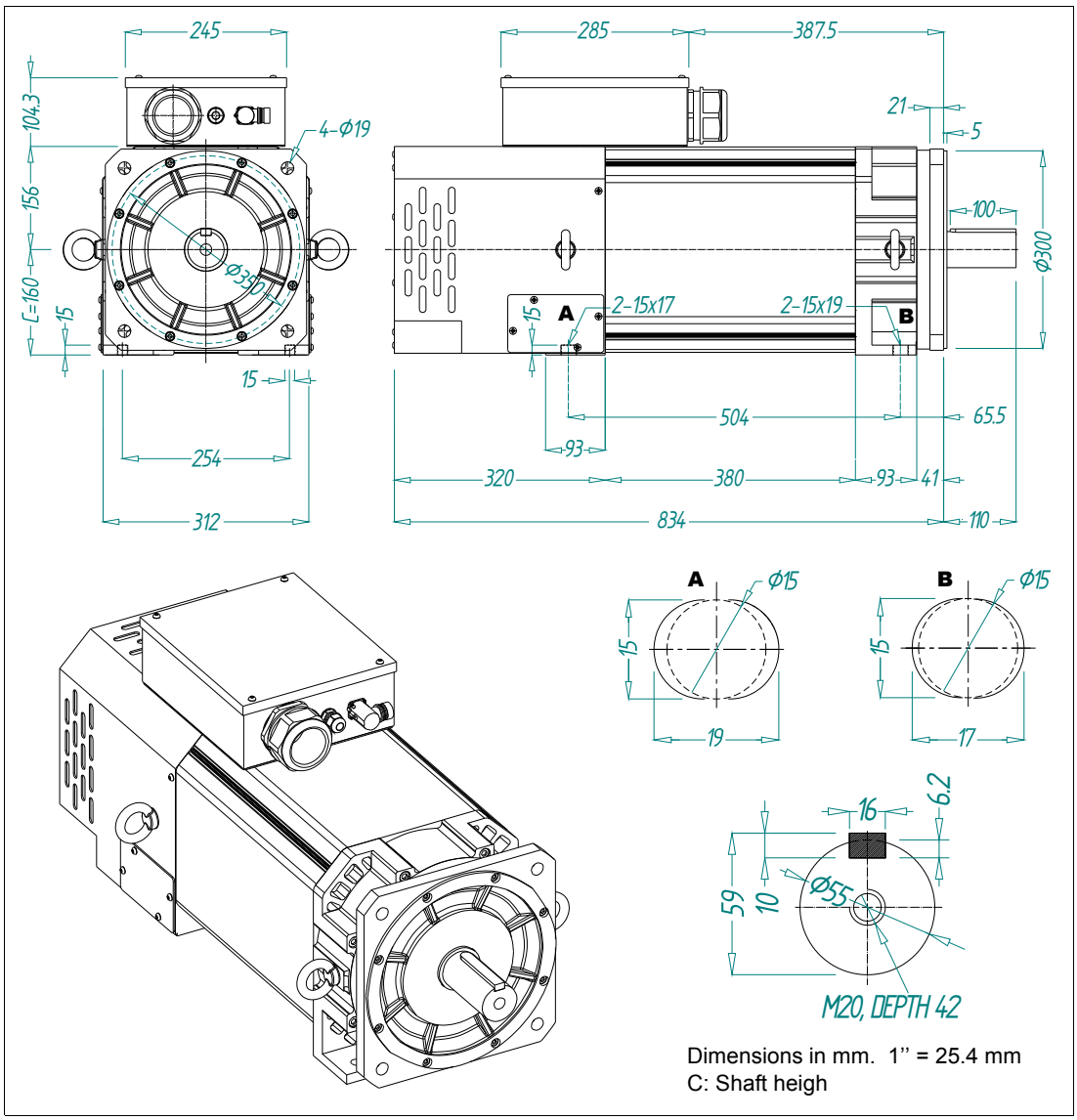
3.7.6 Assembling precision

T. 3/8 Assembling precision in mm. FM7-□□□□-□**5**□□-E01/E02. Foot+Flange mount.

Model	Parallelism of the shaft extension	Runout of the shaft extension	Concentricity of the fitting diameter between the flange and the shaft	Concentricity of the support face of the flange with respect to the machine axis	Perpendicularity of the support side of the flange with respect to the foot
FM7-A110-□5□□-E01	0.033	0.022	0.046	0.040	0.130
FM7-A150-□5□□-E01/E02	0.033	0.022	0.046	0.040	0.130
FM7-A185-□5□□-E01/E02	0.033	0.022	0.046	0.040	0.130
FM7-A220-□5□□-E01/E02	0.033	0.022	0.046	0.040	0.130
FM7-A300-□5□□-E01	0.042	0.028	0.048	0.060	0.176
FM7-A370-□5□□-E01	0.042	0.028	0.048	0.060	0.176
FM7-A510-□5□□-E01/E02	0.042	0.028	0.048	0.060	0.176
FM7-B120-□5□□-E01/E02	0.033	0.022	0.046	0.040	0.130
FM7-B170-□5□□-E01/E02	0.033	0.022	0.046	0.040	0.130
FM7-B220-□5□□-E01	0.042	0.028	0.048	0.060	0.176
FM7-B280-□5□□-E01	0.042	0.028	0.048	0.060	0.176
FM7-C215-□5□□-E01/E02	0.042	0.028	0.048	0.060	0.176
FM7-C270-□5□□-E01/E02	0.042	0.028	0.048	0.060	0.176
FM7-E600-C5B□-E01	0.042	0.028	0.070	0.072	0.207

3.7.7 FM9-XXXX-C5CX-E01-X

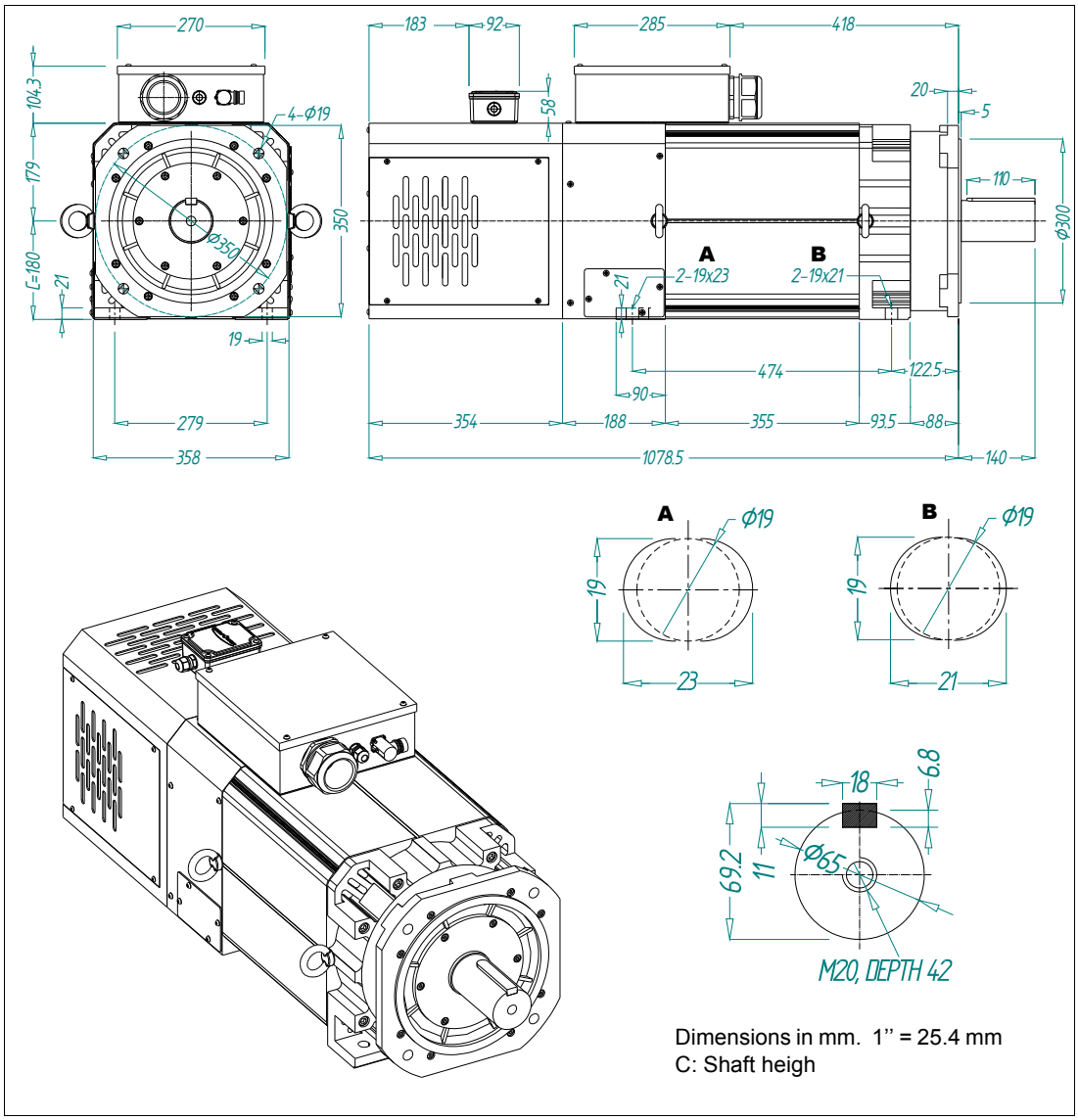
FM9-B037-C5CX-E01



F. 3/59

Dimensions diagram. FM9-B037-C**5**C□-E01. Foot+flange mount.

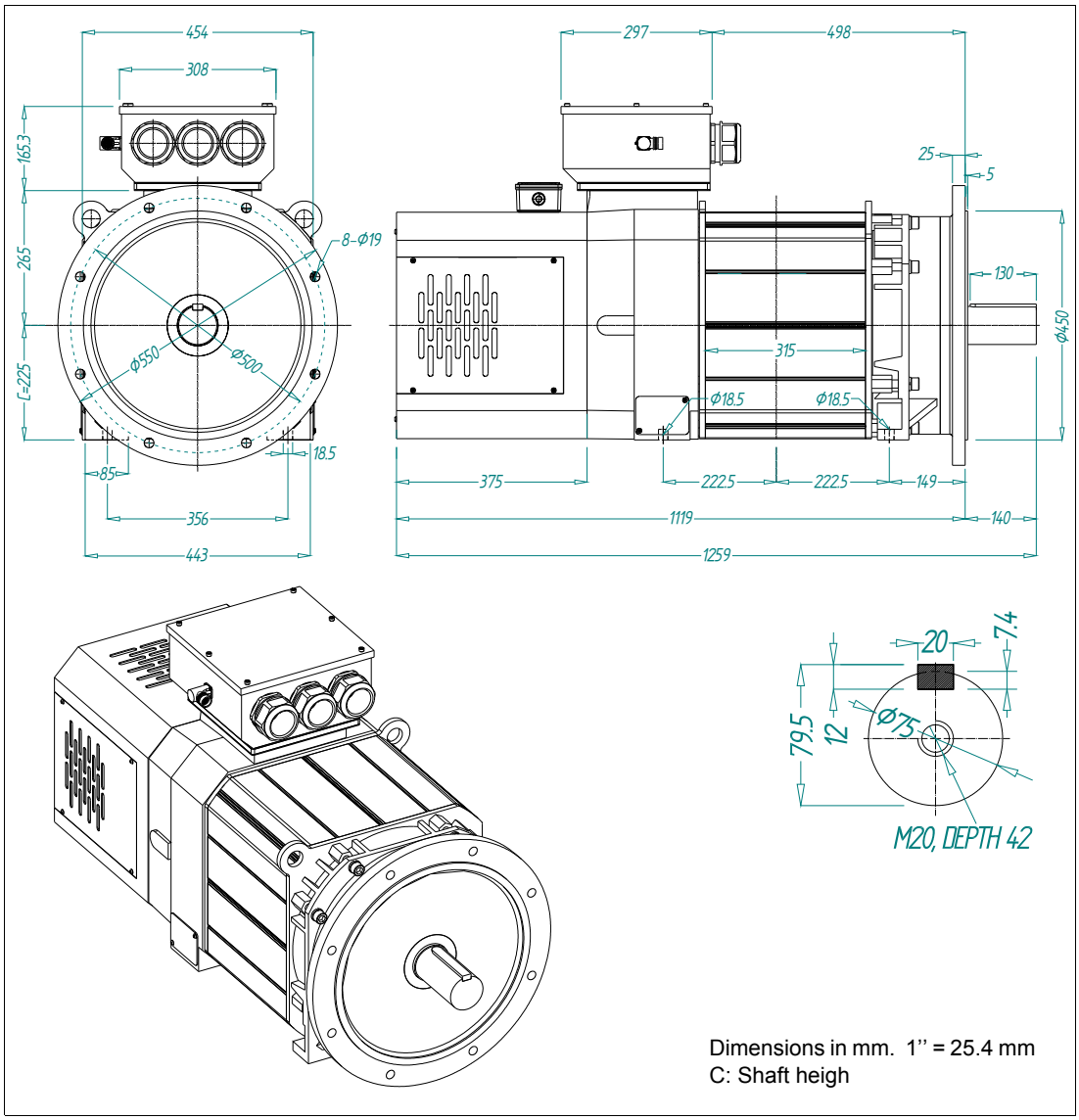
FM9-B055-C5CX-E01-A



F. 3/60

Dimensions diagram. FM9-B055-C**5**C☐-E01-A. Foot+flange mount.

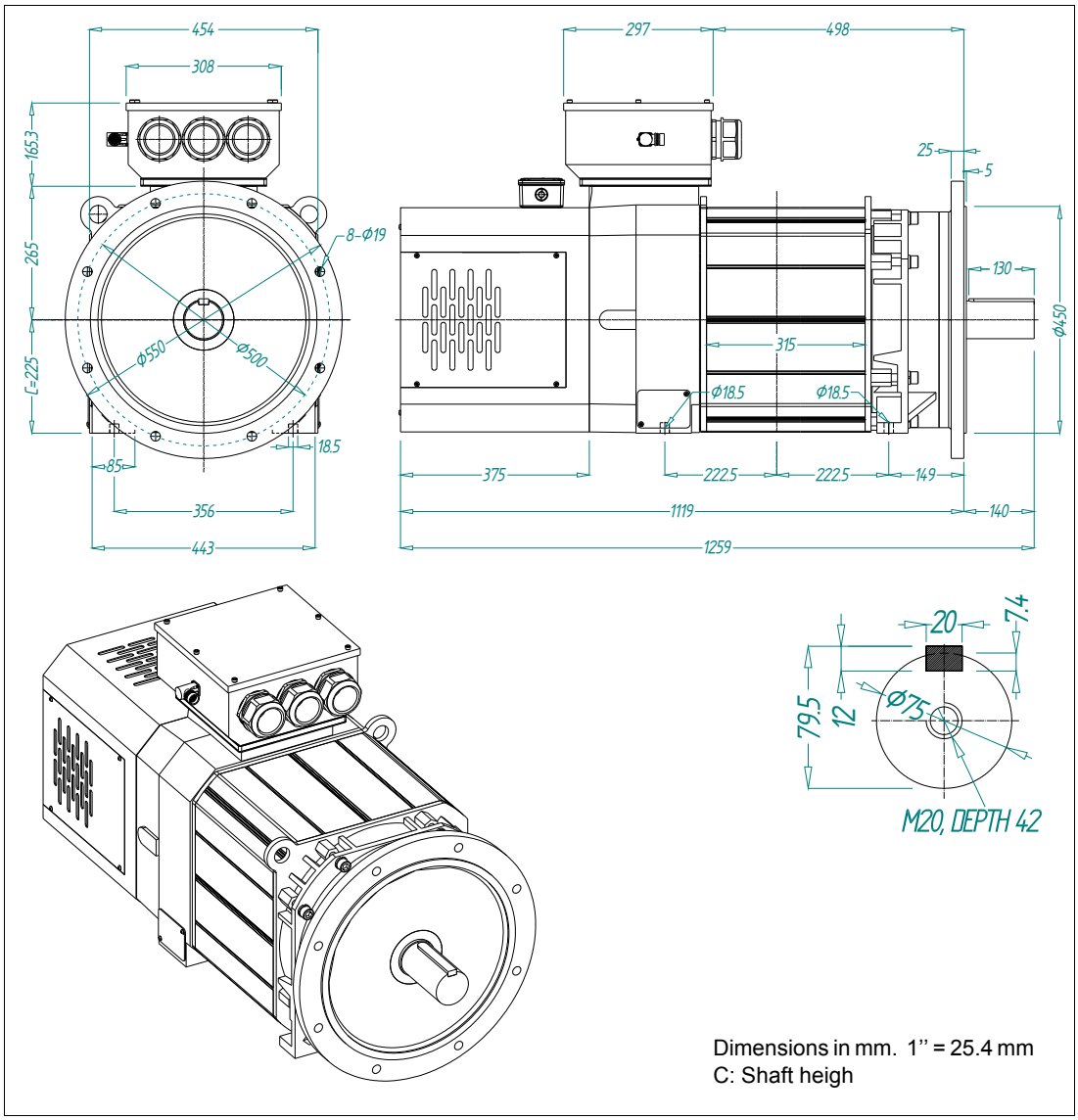
FM9-B071-C5CX-E01



F. 3/61

Dimensions diagram. FM9-B071-C**5**C☐-E01. Foot+Flange mount.

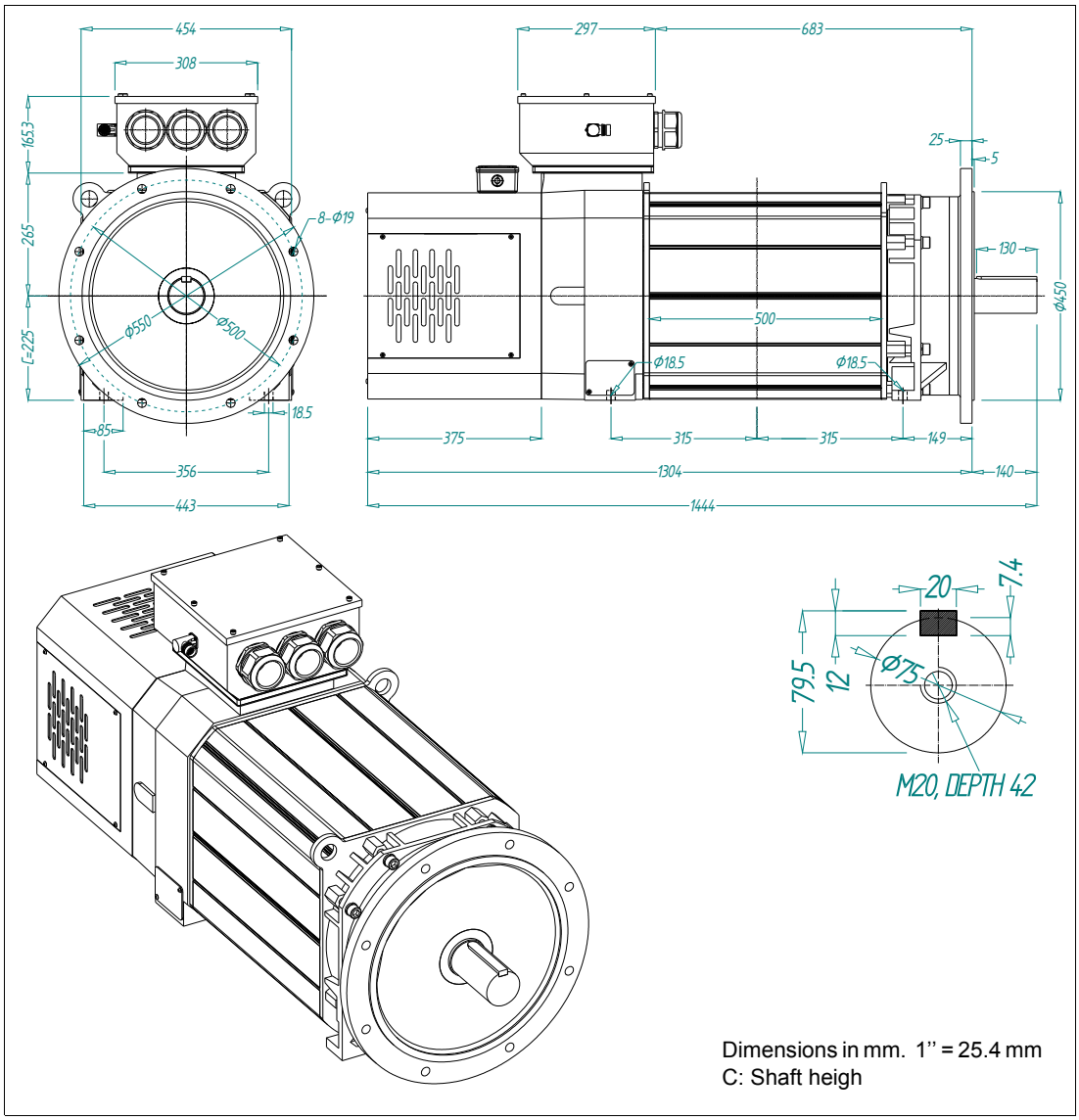
FM9-A100-C5CX-E01



F. 3/62

Dimensions diagram. FM9-A100-C**5**C☐-E01. Foot+Flange mount.

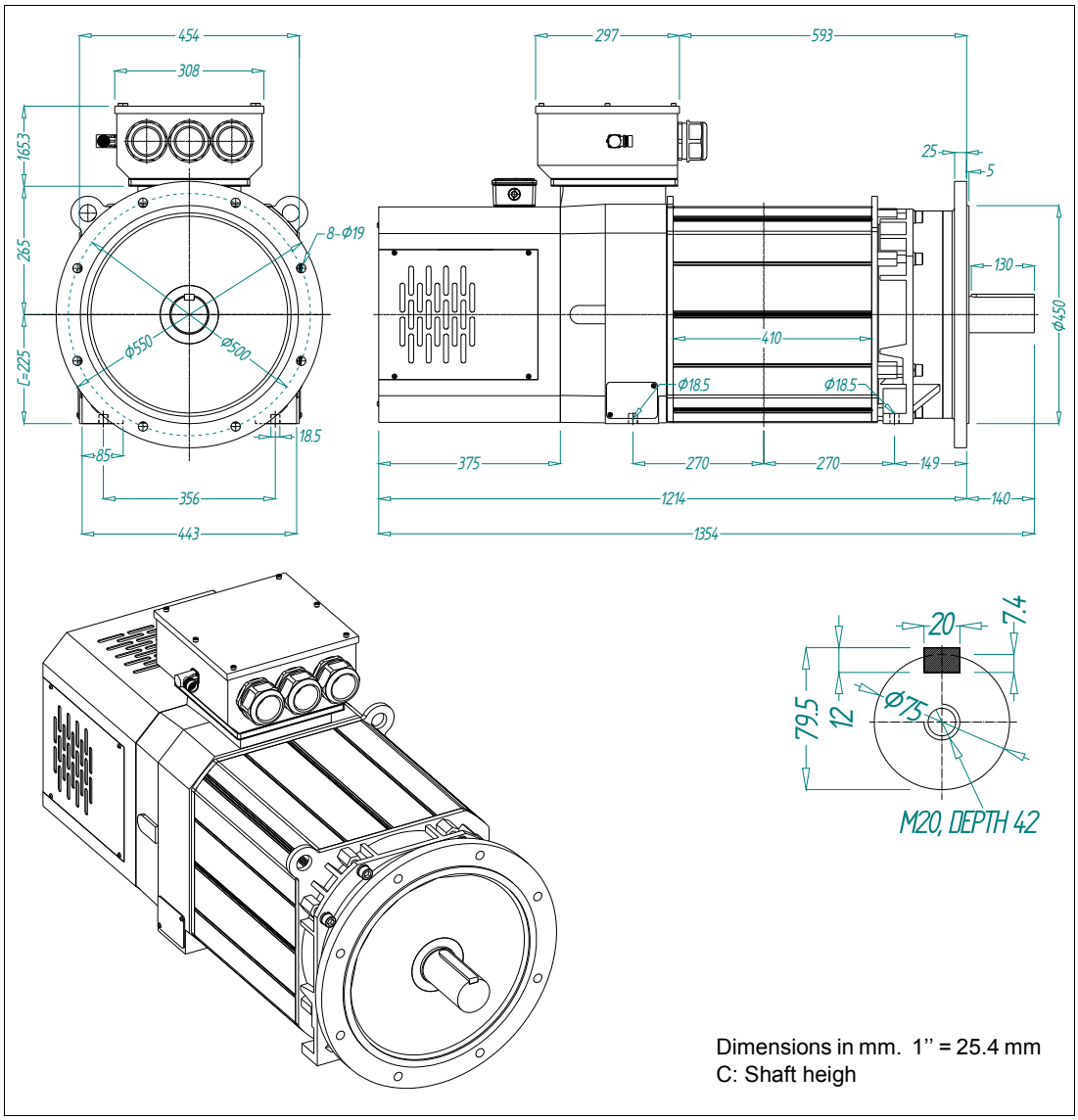
FM9-B113-C5CX-E01



F. 3/63

Dimensions diagram. FM9-B113-C**5**C☐-E01. Foot+Flange mount.

FM9-A130-C5CX-E01



F. 3/64

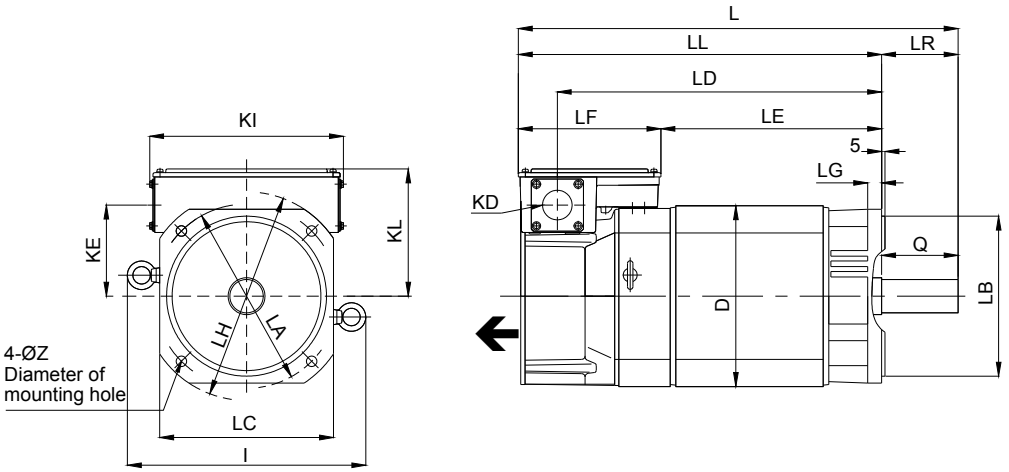
Dimensions diagram. FM9-A130-C**5**C☐-E01. Foot+Flange mount.

3.7.8 Assembling precision

T. 3/9 Assembling precision in mm. FM9-□□□□-C5C□-E01. Foot+Flange mount.

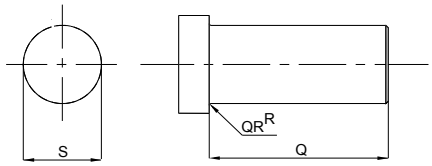
Models	Runout of the shaft extension	Concentricity of the fitting diameter between the flange and the shaft	Concentricity of the support face of the flange with respect to the machine axis	Perpendicularity of the support side of the flange with respect to the foot
FM9-B037-C5C□-E01	0.05	0.13	0.08	0.1
FM9-B055-C5C□-E01-A	0.05	0.13	0.08	0.1
FM9-B071-C5C□-E01	0.05	0.13	0.08	0.1
FM9-A100-C5C□-E01	0.05	0.13	0.08	0.1
FM9-B113-C5C□-E01	0.05	0.13	0.08	0.1
FM9-A130-C5C□-E01	0.05	0.13	0.08	0.1

3.7.9 FM7-DXXX-S1D0-E03



Symbol indicating the direction of the cooling air

Detail of the shaft extension



NOTE. This series does not allow the keyed shaft option and, therefore, will not have tapped holes on the shaft for mounting the coupling. See figure.

F. 3/65

Dimensions diagram. FM7-D□□□-S1D0-E03. Flange mount.

T. 3/10 Motor dimensions in mm. FM7-D□□□-S1D0-E03. Flange mount.

Models	L	LA	LB	LC	LG	LH	LL	LR	LD	LE	LF
FM7-D055-S1D0-E03	475	215	180 h7	204	20	250	415	60	353	226	171
FM7-D075-S1D0-E03	506	215	180 h7	204	20	250	446	60	401	256	190
FM7-D110-S1D0-E03	556	265	230 h7	250	25	300	476	80	420	271	205
FM7-D150-S1D0-E03	556	265	230 h7	250	25	300	476	80	420	271	205
FM7-D185-S1D0-E03	618	265	230 h7	250	25	300	538	80	482	333	205
FM7-D220-S1D0-E03	656	265	230 h7	250	25	300	576	80	520	371	205

T. 3/11 Motor and shaft dimensions in mm. FM7-D□□□-S1D0-E03. Flange mount.

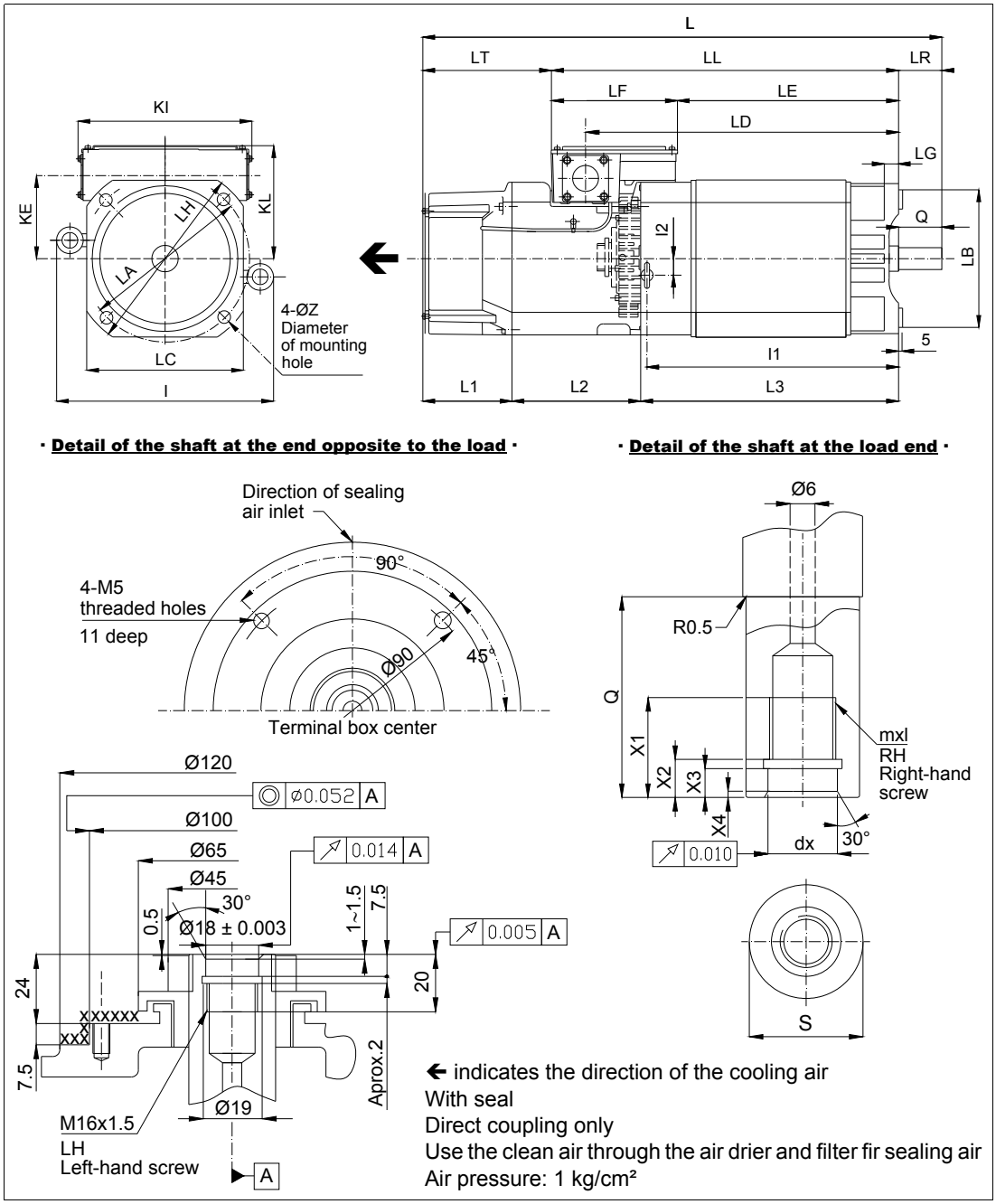
Models	Z	D	l	KD	KL	KI	KE	Q	QR	S
FM7-D055-S1D0-E03	15	204	270	42.5	158	204	114	60	0.5	28 h6
FM7-D075-S1D0-E03	15	204	270	42.5	164	250	114	60	0.5	28 h6
FM7-D110-S1D0-E03	15	260	343	42.5	183	279	131	80	0.5	38 h6
FM7-D150-S1D0-E03	15	260	343	42.5	183	279	131	80	0.5	38 h6
FM7-D185-S1D0-E03	15	260	343	42.5	183	279	131	80	0.5	38 h6
FM7-D220-S1D0-E03	15	260	343	42.5	183	279	131	80	0.5	38 h6

3.7.10 Assembling precision

T. 3/12 Assembling precision in mm. FM7-D□□□-S1D0-E03. Flange mount.

Models	Runout of the shaft extension	Concentricity of the fitting diameter between the flange and the shaft	Concentricity of the support face of the flange with respect to the machine axis	
FM7-D055-S1D0-E03	0.020	0.040	0.04	
FM7-D075-S1D0-E03	0.022	0.040	0.04	
FM7-D110-S1D0-E03	0.022	0.046	0.04	
FM7-D150-S1D0-E03	0.022	0.046	0.04	
FM7-D185-S1D0-E03	0.022	0.046	0.04	
FM7-D220-S1D0-E03	0.022	0.046	0.04	

3.7.11 FM7-DXXX-S1D0-HS3



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Dimensions diagram. FM7-D□□□-S1D0-HS3. Flange mount.

T. 3/13 Motor dimensions in mm. FM7-D□□□-S1D0-HS3. Flange mount.

FM7-D□□□-S1D0-HS3											
Model	**L**	**LA**	**LB**	**LC**	**LG**	**LH**	**LL**	**LR**	**LD**	**LE**	**LF**
FM7-D075-S1D0-HS3	715	215	180 h7	204	20	250	446	60	401	256	190
FM7-D110-S1D0-HS3	751	265	230 h7	250	25	300	476	70	420	271	205
FM7-D185-S1D0-HS3	813	265	230 h7	250	25	300	538	70	482	333	205
FM7-D220-S1D0-HS3	851	265	230 h7	250	25	300	576	70	520	371	205

T. 3/14 Motor dimensions in mm. FM7-D□□□-S1D0-HS3. Flange mount.

FM7-D□□□-S1D0-HS3										
Model	**Z**	**D**	**I**	**KD**	**KL**	**KI**	**KE**	**L1**	**L2**	**L3**
FM7-D075-S1D0-HS3	15	204	271	42.5	158	250	114	137	210	308
FM7-D110-S1D0-HS3	15	260	343	42.5	183	279	131	142	208	331
FM7-D185-S1D0-HS3	15	260	343	42.5	183	279	131	142	208	393
FM7-D220-S1D0-HS3	15	260	343	42.5	183	279	131	142	208	431

T. 3/15 Motor and shaft dimensions in mm. FM7-D□□□-S1D0-HS3. Flange mount.

FM7-D□□□-S1D0-HS3										
Model	**l1**	**l2**	**Q**	**mxl**	**S**	**X1**	**X2**	**X3**	**X4**	**dx**
FM7-D075-S1D0-HS3	288	33	60	M12x1.25	28 h6	31	14.5	13	1	16
FM7-D110-S1D0-HS3	320	30	70	M16x1.50	38 h6	38	17	15	1÷1.5	20
FM7-D185-S1D0-HS3	382	30	70	M16x1.50	38 h6	38	17	15	1÷1.5	20
FM7-D220-S1D0-HS3	420	30	70	M16x1.50	38 h6	38	17	15	1÷1.5	20

3.7.12 Assembling precision

T. 3/16 Assembling precision in mm. FM7-D□□□-S1D0-HS3. Flange mount.

FM7-D□□□-S1D0-HS3				
Models	Runout of the shaft extension	Concentricity of the fitting diameter between the flange and the shaft	Concentricity of the support face of the flange with respect to the machine axis	
FM7-D075-S1D0-HS3	0.022	0.040	0.04	
FM7-D110-S1D0-HS3	0.022	0.046	0.04	
FM7-D185-S1D0-HS3	0.022	0.046	0.04	
FM7-D220-S1D0-HS3	0.022	0.046	0.04	

4.1 Overview

4.1.1 Motor installation

Before installing the motor, read the recommendations regarding its installation environment and install it according to them.

- Leave enough room around the motor for the air to be collected by the cooling fan integrated into the motor.
- Keep a minimum gap of 100 mm (3.94 inches) between the machine and motor cooling output.
- Install it in a clean place, away from areas with oil and water. If there is a chance for the motor to be in contact with these elements, protect it with some type of cover.

WARNING. If water or dirty oil gets inside the motor, its insulation resistance may decrease causing a ground fault.

- Make sure that the motor is firmly mounted either by feet or by flange because the weight of the motor or that of the dynamic load attached to its shaft can generate vibrations when it is running.
- Install it in a place free from dust and metal particles. The motor has an integrated fan with an internal structure that supplies cooling air to the motor.

WARNING. Blocking the air flow with dust particles or other strange elements can lower the efficiency of the cooling system.

- Clean the flange, the shaft and the keyway (if it has one) before installing the motor.

INFORMATION. The flange and the motor's rotor shaft contain a layer of anticorrosive paint or grease.

- Flange-mounted FM7 motor models may be installed with their shaft at the load end forming an angle between the horizontal and the vertical always with their shaft facing down.

DANGER. The motor cannot be installed with its shaft facing up on FM7 motors.

- Foot-mounted FM7 motors must be installed with their feet secured to the floor. When mounting the motor vertically, its shaft must always be facing down.

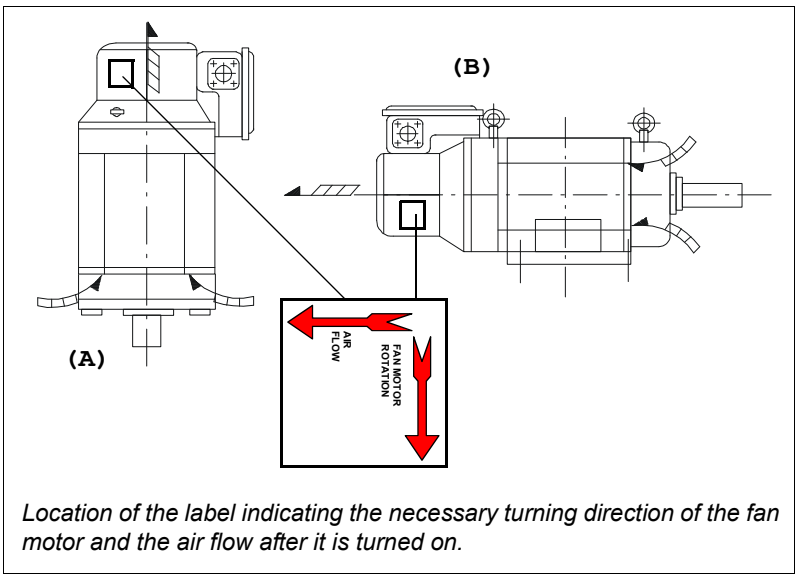
DANGER. The motor cannot be installed with its shaft facing up on FM7 motors.

4.1.2 Fan installation

All AC spindle motors of the FM7/FM9 family have an electric fan that generates a constant air flow regardless of the turning speed of the motor with a heat evacuation system. This ensures proper motor cooling in all its duty cycles.

When connecting the fan to the three-phase line, it starts turning.

WARNING. On FM7 models, make sure that the fan turns in the direction indicated on the label located on the outside of the fan housing and the direction of the air flow is the one shown in figure **F. 4/1**.



Location of the label indicating the necessary turning direction of the fan motor and the air flow after it is turned on.

F. 4/1

Cooling air direction. Mounting: **A.** Flange, **B.** Feet.

Also take the following considerations into account:

- The air sucked by the fan must be dry, clean and cool.
- The air absorbed from the atmosphere through the conduction systems or channels for motors installed inside the structure of another machine protected by panels or other types of cover must be thrown out through the cooling hole.
- The intake of cool air and the output of hot air must be as far away from each other as possible to keep them from mixing.

4.1.3 Brake

No motor of the FM7/FM9 family has the brake option. Therefore, any sales reference MPC-4x motor-drive power cable will only have 4 wires and a shield, never 6 wires.

4.2 Connections

All the connections to be made to run the motor are made in the terminal box of the motor.

WARNING. Before removing the lid of the terminal box, make sure that both the motor and the internal fan have no voltage. Ignoring this warning may cause serious personal injury and even death.

4.2.1 Power. MOTOR-DRIVE

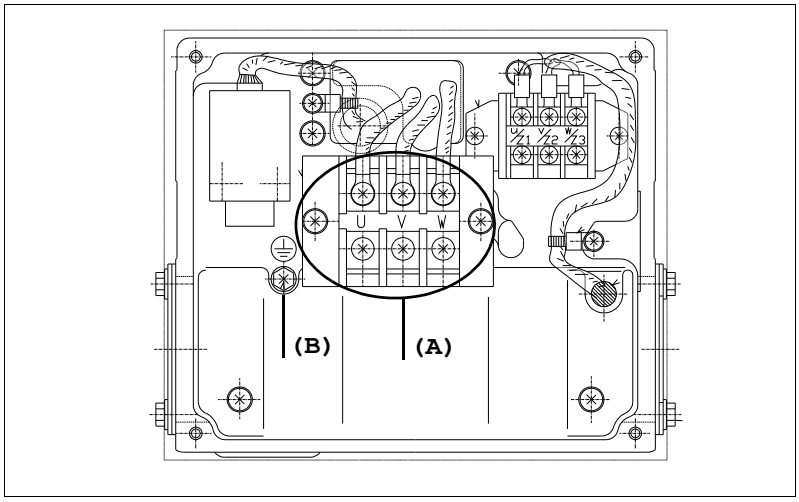
To make this connection, first remove the lid of the terminal box by removing the screws that fix it to it.

WARNING. Before removing the lid, make sure that both the motor and the internal fan have no voltage.

Power connection of the drive with FM7 models

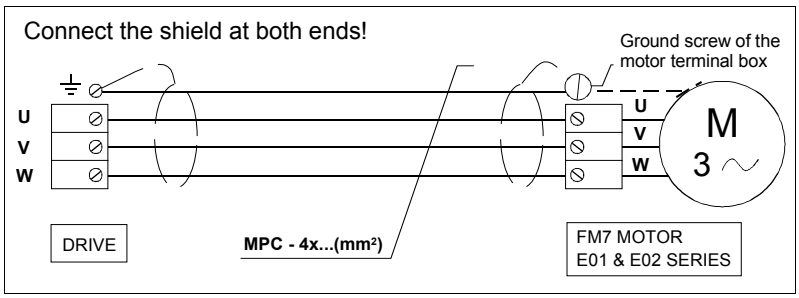
The connection between a motor of the FM7 family and its associated drive module must always be done using the corresponding terminals located inside the terminal box of the motor.

Two configurations are possible depending on the motor series. Hence, for E01/E02 series motors, the stator windings must have a delta (triangle) connection and cannot be changed. It will have three terminals U, V and W plus a ground terminal to connect with the U, V, W and PE terminals on top of the drive. See figures **F. 4/2** and **F. 4/3**.



F. 4/2

Terminals to connect an FM7 motor (E01/02 series) to its associated drive. **A.** Power terminals U, V, W. **B.** Ground bolt.



F. 4/3

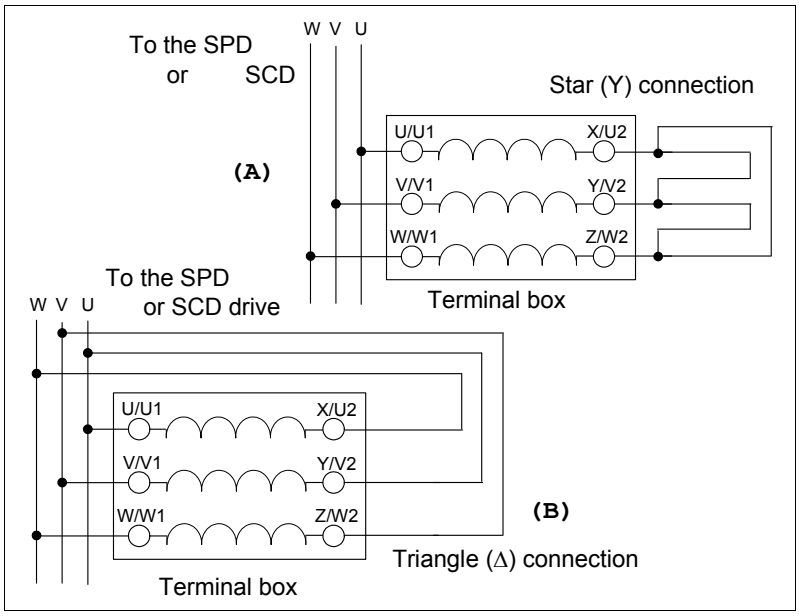
Connection between the motor and the drive. FM7 family, E01/E02 series.

WARNING. Remember that when connecting the drive module with its corresponding FM7 motor connect terminal U of the drive module with the terminal corresponding to the U phase of the motor. Proceed the same way with the terminals V-V, W-W and PE-PE.

MANDATORY. In order for the system to comply with the European Directive on Electromagnetic Compatibility, the hose grouping all four unipolar cables U, V, W and ground must be shielded and must be connected at both ends, i.e. at the drive end and at the motor end.

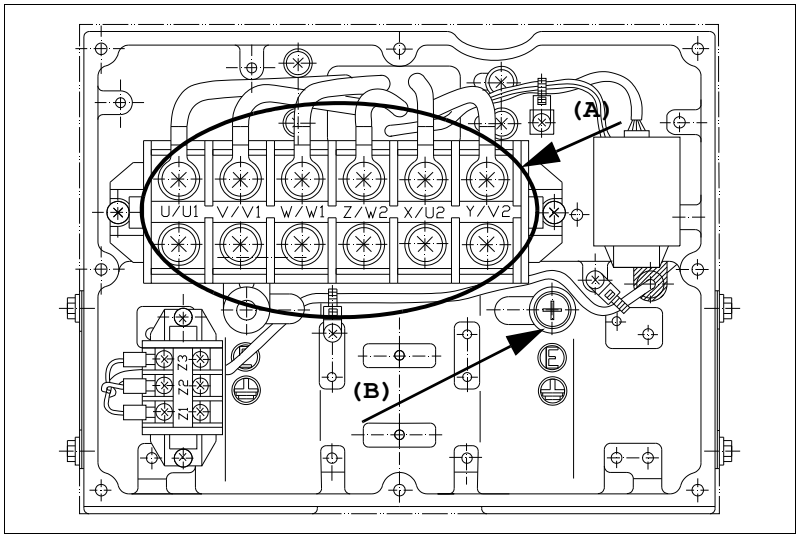
For E03/HS3 series motors of the FM7 family, the stator windings may be configured in a Y (star) or Δ (triangle) connection. Hence, a unipolar cable is extended from each of the six terminals of the terminal box to two external magnetic contactors which will switch from one to the other type of connection through an electrical maneuver.

NOTE. Observe that if the whole application needs a fixed winding configuration, make the desired winding connection (star or delta) shown in figure **F. 4/4**. See the diagram.



F. 4/4

Selecting the winding configuration with an electrical maneuver using two external magnetic contactors. **A.** Star (Y), **B.** Triangle (Δ).



F. 4/5

Terminals to connect an FM7 motor (E03/HS3 series) to its associated SCD drive. **A.** Power terminales U/U1, V/V1, W/W1, Z/W2, X/U2 and Y/V2. **B.** Ground bolt.

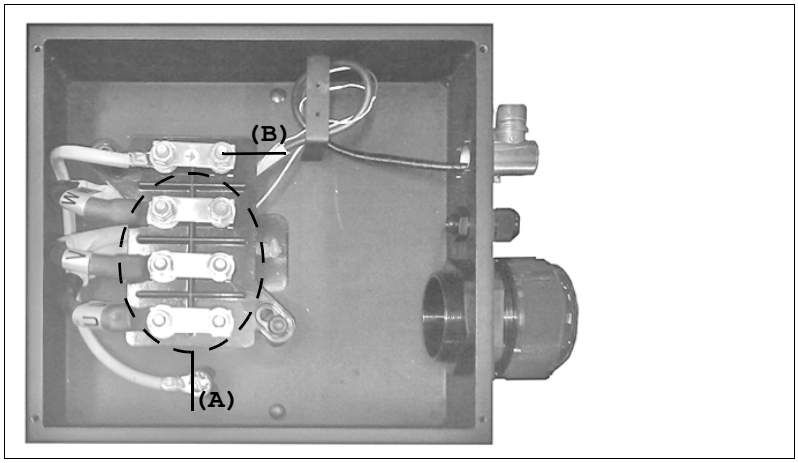
The six terminals are defined by the labels U/U1, V/V1, W/W1, Z/W2, X/U2 and Y/V2. It also has a ground bolt to connect the ground cable coming from the MPC power cable hose of the drive. The thee phase wires of this cable hose U, V and W must be connected to terminals U/U1, V/V1 and W/W1 of the terminal box of the motor. In turn, six cables go from these six terminals located inside the terminal box of the motor to two external magnetic contactors according to figure **F. 4/12** to set the winding as star or delta.

Power connection of the drive with FM9 models

FM9-B037-C5CX-E01 and FM9-B055-C5CX-E01-A

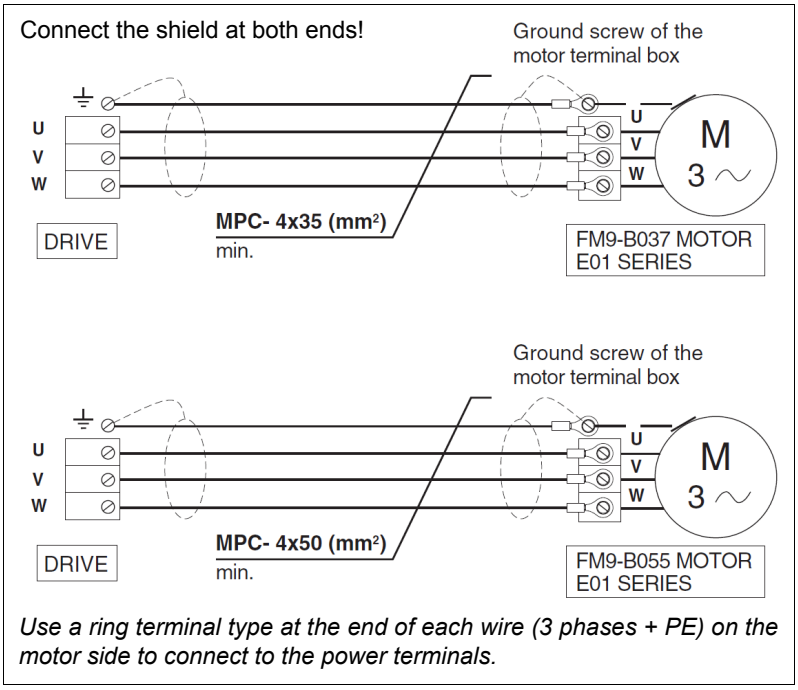
The connection between the modules of the FM9-B037 and FM9-B055 motors and its associated drive module must always be done using the corresponding terminals located inside the terminal box of the motor. See figure **F. 4/6**.

The stator windings have a Y (star) connection. It has three terminals U, V and W plus a ground terminal to connect with the U, V, W and PE terminals on top of the drive.



F. 4/6

Terminals to connect an FM9 motor (E01 series, B037 and B055 models) to its associated drive. **A.** Power terminals U, V, W. **B.** Ground bolt.



Use a ring terminal type at the end of each wire (3 phases + PE) on the motor side to connect to the power terminals.

F. 4/7

Power connection between motor and drive. FM9-B037 and FM9-B055 models, E01 series.

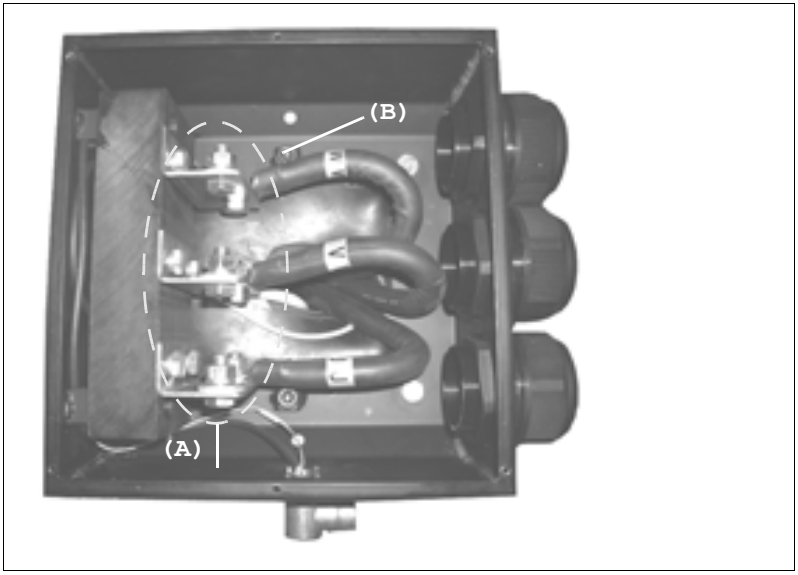
WARNING. Remember that when connecting the drive module with its corresponding motor connect terminal U of the drive module with the terminal corresponding to the U phase of the motor. Proceed the same way with the terminals V-V, W-W and PE-PE.

MANDATORY. In order for the system to comply with the European Directive on Electromagnetic Compatibility, the MPC-4x... hose grouping all four unipolar cables U, V, W and PE must be shielded and must be connected at both ends, i.e. at the drive end and at the motor end.

FM9-B071-C5CX-E01

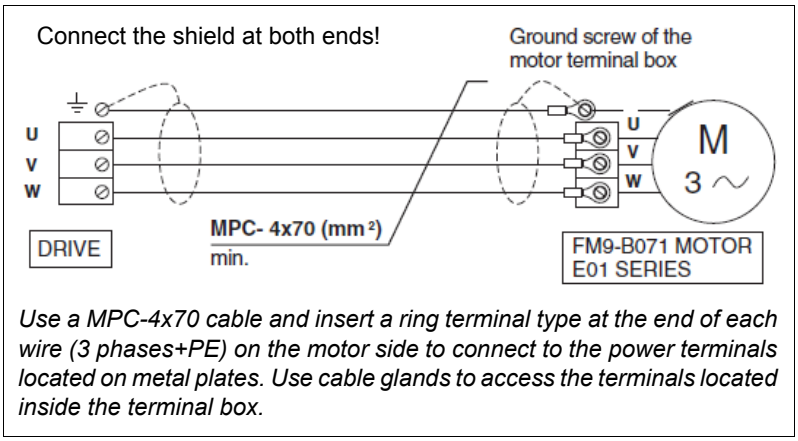
The connection between an FM9-B071 motor and its associated drive module must always be done using the corresponding terminals placed on metal plates and located inside the terminal box of the motor. See figure **F. 4/8**.

The stator windings have a Y (star) connection. It has three terminals U, V and W plus a ground terminal to connect with the U, V, W and PE terminals on top of the drive.



F. 4/8

Terminals to connect an FM9 motor (E01 series, B071 model) to its associated drive. **A.** Power terminals U, V, W. **B.** Ground bolt.



Use a MPC-4x70 cable and insert a ring terminal type at the end of each wire (3 phases+PE) on the motor side to connect to the power terminals located on metal plates. Use cable glands to access the terminals located inside the terminal box.

F. 4/9

Power connection between motor and drive. FM9-B071 model, E01 series.

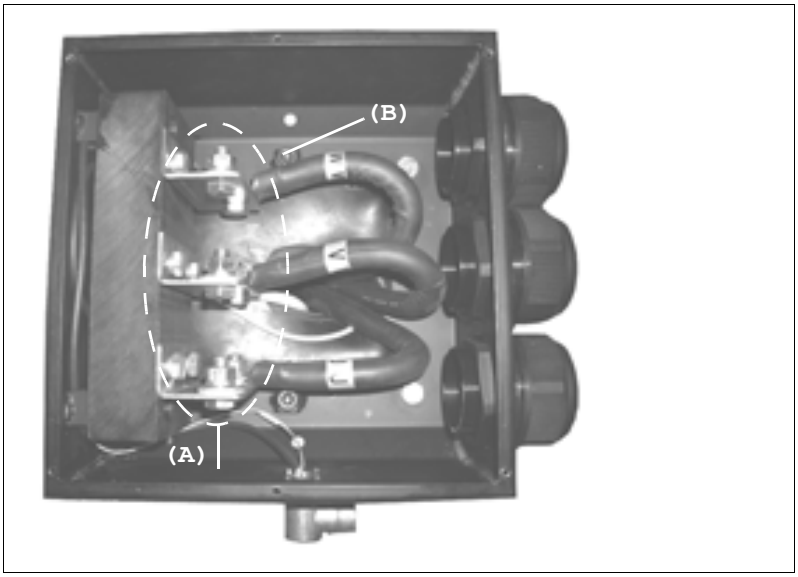
WARNING. Remember that when connecting the drive module with its corresponding motor phase U of the MPC 4x70 cable coming from terminal U of the drive module must be connected to the terminal corresponding to phase U of the motor located on the metal plate U. Insert the ring terminal type of the wire and tighten it until making contact with the **U plate** to ensure proper contact. Proceed the same way with the terminals V-V, W-W and PE-PE (at the ground screw).

MANDATORY. In order for the system to comply with the European Directive on Electromagnetic Compatibility, the MPC-4x70 hose grouping all four unipolar cables U, V, W and PE must be shielded and must be connected at both ends, i.e. at the drive end and at the motor end.

FM9-A100-C5CX-E01, FM9-B113-C5CX-E01 and FM9-A130-C5CX-E01

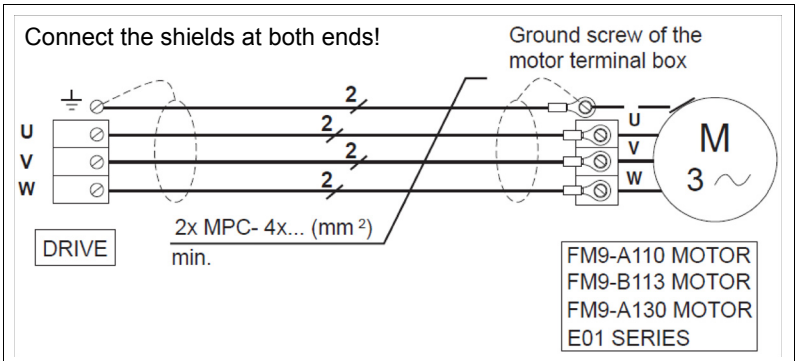
The connection between FM9-A100, FM9-B113 and FM9-A130 motors and their associated drive module must always be done using the corresponding terminals placed on metal plates and located inside the terminal box of the motor. See figure **F. 4/10**.

The stator windings have a Y (star) connection. It has three terminals U, V and W plus a ground terminal to connect with the U, V, W and PE terminals on top of the drive.



F. 4/10

Terminals to connect an FM9 motor (E01 series, A100, B113 and A130 model) to its associated drive. **A.** Power terminals U, V, W. **B.** Ground bolt.



Use two MPC-4x... cables and insert a ring terminal type at the end of each wire (3 phases+PE per cable) on the motor side to connect to the power terminals located on metal plates. Use cable glands to access the terminals located inside the terminal box.

F. 4/11

Power connection between motor and drive. Models FM9-A100, FM9-B113 and FM9-A130, E01 series.

MANDATORY. Remember that when connecting the drive module with its corresponding motor phase U of each MPC- 4x... cable coming from terminal U of the drive module must be connected to the terminal corresponding to phase U of the motor located on the metal plate U. Insert the ring terminal type terminal of each wire, **one on each side of the U plate** and tighten it to ensure proper contact. Proceed the same way with the terminals V-V, W-W and PE-PE (at the ground screw).

MANDATORY. In order for the system to comply with the European Directive on Electromagnetic Compatibility, each of the two MPC-4x... hoses grouping all four unipolar cables U, V, W and PE must be shielded and must be connected at both ends, i.e. at the drive end and at the motor end.

If the user has difficulty locating the terminals of the drive's power connector, see chapter drive modules of the corresponding servo drive manual.

Power cabling

According to the EN 60204-1 regulation to be applied to servo system installations, the range of power cables offered by Fagor Automation for these motors are:

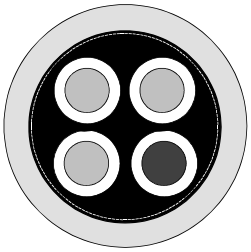
T. 4/1 Range of power cables. MPC-4x☐.

Ref. MPC - Nr of cables x section of each wire in mm²
Dmax. corresponds to outside diameter of the cable in mm.

Ref.	Dmax	Ref.	Dmax
MPC-4x2.5	11.6 mm	MPC-4x25	28.7 mm
MPC-4x4	13.1 mm	MPC-4x35	34.0 mm
MPC-4x6	15.3 mm	MPC-4x50	40.1 mm
MPC-4x10	19.2 mm	MPC-4x70	42.5 mm
MPC-4x16	24.5 mm		

Mechanical characteristics

T. 4/2 Mechanical characteristics of power cables **MPC-4x☐** with a wire section of **up to 50 mm²**.



Type	Shield. It ensures EMC Compatibility.
Flexibility	High. Special to be used in cable carrying chains with a bending radius of 10 times the Dmax under dynamic conditions and 6 times the Dmax under static conditions.
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: -20 °C to +60 °C (-4 °F to +140 °F) Storage: -50 °C to +80 °C (-58 °F to +176 °F)
Rated voltages	Uo/U: 600/1000 V.

T. 4/3 Mechanical characteristics of the power cable **MPC-4x70**.

Type	Shield. It ensures EMC Compatibility.
Flexibility	High. Special to be used in cable carrying chains with a bending radius of 7.5 times the Dmax under dynamic conditions and 4 times the Dmax under static conditions.
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: -30 °C to +80 °C (-22 °F to +176 °F) Storage: -40 °C to +90 °C (-40 °F to +194 °F)
Rated voltages	Uo/U: 600 /1000 V.

Power cable section selection

T. 4/4 Selection of the section of a unipolar unshielded cable in a three-phase configuration depending on the current In (S1).

FM7-□□□□-□□□□-E01/E02		
Motor model	**In (S1) A**	**Ref. of the power cable**
FM7-A037-□□□□-E01/E02	12.5	MPC-4x2.5
FM7-A055-□□□□-E01/E02	14.6	MPC-4x2.5
FM7-A075-□□□□-E01/E02	19.8	MPC-4x4
FM7-A090-□□□□-E01/E02	25.0	MPC-4x6
FM7-A110-□□□□-E01/E02	28.0	MPC-4x6
FM7-A150-□□□□-E01/E02	39.4	MPC-4x10
FM7-A185-□□□□-E01/E02	47.5	MPC-4x16
FM7-A220-□□□□-E01/E02	61.4	MPC-4x25
FM7-B120-□□□□-E01/E02	35.0	MPC-4x10
FM7-B170-□□□□-E01/E02	47.3	MPC-4x16
FM7-A300-□□□□-E01	82.1	MPC-4x35
FM7-B220-□□□□-E01	64.9	MPC-4x25
FM7-A370-□□□□-E01	90.0	MPC-4x50
FM7-B280-□□□□-E01	78.2	MPC-4x35
FM7-A510-□□□□-E01/E02	115.2	MPC-4x70
FM7-C215-□□□□-E01/E02	87.9	MPC-4x50
FM7-C270-□□□□-E01/E02	117.0	MPC-4x70
FM7-E600-C□B□-E01	117.4	MPC-4x70

T. 4/5 Selection of the section of a unipolar unshielded cable in a three-phase configuration depending on the current In (S1).

FM7-D□□□-S1D0-E03/HS3		
Motor model	**In (S1) A** ⅄/△	**Ref. of the power cable**
FM7-D055-S1D0-E03	20.3 / 20.7	MPC-4x4
FM7-D075-S1D0-E03	26.5 / 25.8	MPC-4x6
FM7-D110-S1D0-E03	38.0 / 40.0	MPC-4x10
FM7-D150-S1D0-E03	46.4 / 45.7	MPC-4x16
FM7-D185-S1D0-E03	49.2 / 49.2	MPC-4x16
FM7-D220-S1D0-E03	62.3 / 61.7	MPC-4x25
FM7-D075-S1D0-HS3	26.5 / 25.8	MPC-4x6
FM7-D110-S1D0-HS3	38.0 / 40.0	MPC-4x10
FM7-D185-S1D0-HS3	49.2 / 49.2	MPC-4x16
FM7-D220-S1D0-HS3	62.3 / 61.7	MPC-4x25

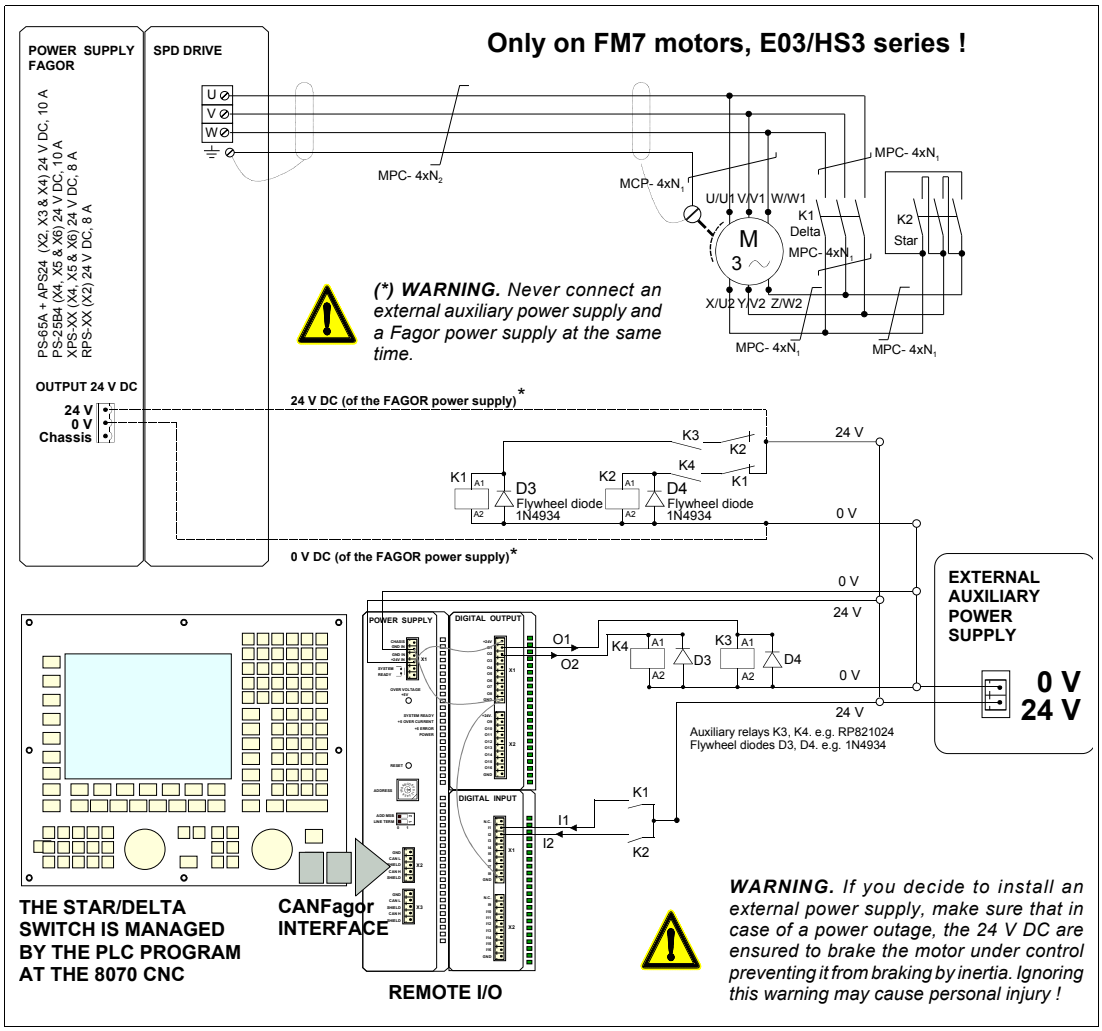
T. 4/6 Selection of the section of a unipolar unshielded cable in a three-phase configuration depending on In (S1).

FM9-□□□□-C5C□-E01-□		
Motor model	**In (S1) A**	**Ref. of the power cable**
FM9-B037-C5C□-E01	74.7	MPC-4x35
FM9-B055-C5C□-E01-A	104.4	**MPC-4x50**
FM9-B071-C5C□-E01	134.8	**MPC-4x70**
FM9-A100-C5C□-E01	189.9	2x MPC-4x50
FM9-B113-C5C□-E01	214.6	2x MPC-4x70
FM9-A130-C5C□-E01	246.9	2x MPC-4x70

Note that the sections given for three-phase lines in a PVC hose shown in this table may be installed on a machine through conduits or channels except those shown in bold letters. When installed under other more / less favorable conditions, some sections may be reduced/enlarged according to the EN 60204-1 standard.

INFORMATION. Note that all the references of the power cables for the FM7/FM9 motors always have 4 wires. They will never have 6 wires because these motors do not have a brake.

Diagram for the electrical maneuver of the on-the-fly Y-Δ switching winding



F. 4/12

Connection between the motor and the drive. FM7 family, E03/HS3 series. Diagram for the on-the-fly Y-Δ switching of the winding configuration.

Important warnings

- Either an external auxiliary power supply or a FAGOR power supply may be used to supply the 24 V DC. NEVER CONNECT BOTH AT THE SAME TIME !
- To brake the motor in a controlled way during a power failure, make sure that 24 V DC will be supplied to contactors K1 and K2 and relays K3 and K4. This situation is ensured if you have installed a FAGOR power supply next to an SPD modular drive. If you have installed an external auxiliary 24 V DC power supply, you must make sure that this condition is ensured.
- When using a compact SCD drive to govern a spindle motor, you must necessarily install an external auxiliary power supply to provide the 24 V DC. These compact drives do not have an output 24 V DC connector.
- Always join all the GND of different remote I/O modules together. The GND of the same module are already connected to each other internally.
- It is better to power the POWER SUPPLY module with an external auxiliary power supply and the DIGITAL OUTPUT module with another one. If there is only one external auxiliary power supply, always join its 24 V DC with the 24 V DC of the POWER SUPPLY module and of each module.

Sizing of power contactors K1 and K2

Contactor K1: $I_{(K1)} \geq I_N$ (⅄)

Contactor K2: $I_{(K2)} \geq (1/\sqrt{3})\ I_N$ (⅄)

Note. *See the rated currents in the selection chapter of this manual.*

Sizing of motor power cables

MPC- 4xN_1 ➔ N_1: section supporting I_N (⅄)

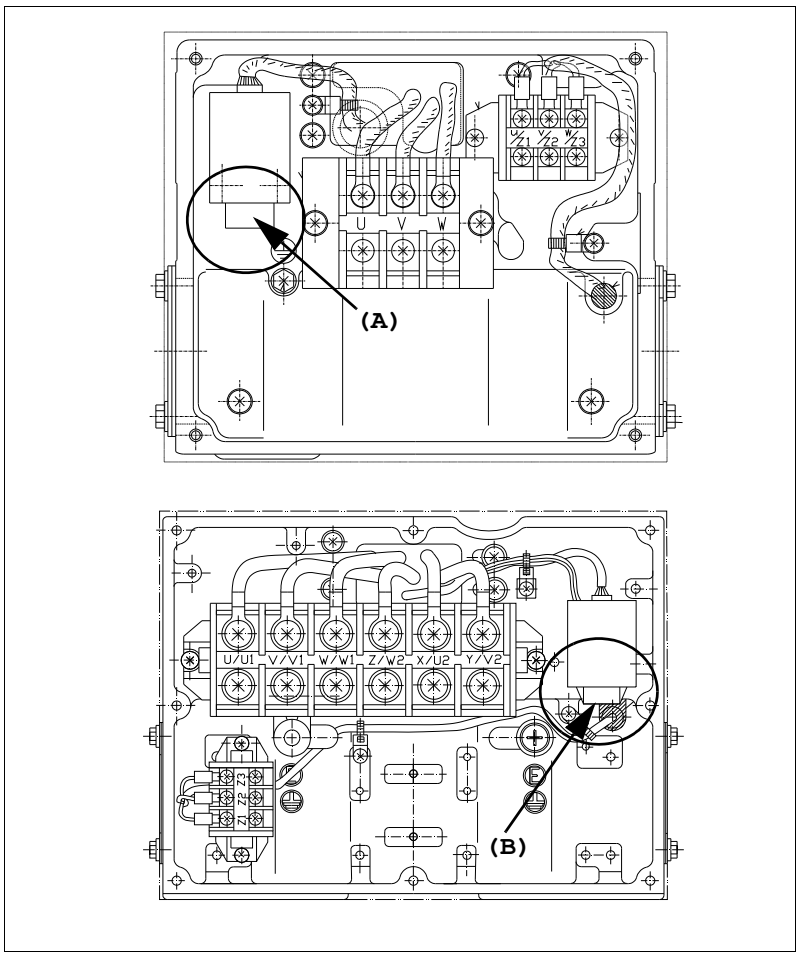
MPC- 4xN_2 ➔ N_2: section supporting I_N (Δ)

Note. *See the necessary cable section in the corresponding section of this chapter.*

4.2.2 Feedback. MOTOR-DRIVE

Connecting the feedback to the drive on FM7 models

The connection between the motor feedback and its associated drive module must always be done using the connector located inside the terminal box and drive connector X4. See figure **F. 4/13** that shows the location of the feedback connector on the motor.



F. 4/13

Motor feedback connector of the FM7 family motors.
A. Motor feedback connector of the E01/E02 series.
B. Motor feedback connector of the E03/HS3 series.

The motor feedback connector is different depending on the type of encoder that the motor has. Hence:

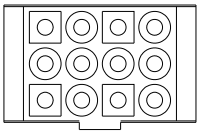
T. 4/7 Encoders available for motor series of the FM7 family.

Motor series	Type of encoder	
	Estándar, ● = S	**Optional,** ● = C
FM7-□□□□-●□□□-E01*	Magnetic TTL	C axis. 1Vpp sinusoidal SinCos™
FM7-□□□□-●□□□-E02	Magnetic TTL	C axis. 1Vpp sinusoidal SinCos™
FM7-D□□□-●1D0-E03	Magnetic TTL	-
FM7-D□□□-●1D0-HS3	Magnetic TTL	-

*FM7-E600-C□B□-E01 motors only have the C axis encoder option. The standard ·magnetic TTL encoder· option is not available for these models.

Pinout of the magnetic TTL encoder connector

Motor feedback base connector



12	11	10	9
8	7	6	5
4	3	2	1

Connector ELR-12V

Any motor series of the FM7 family from Fagor Automation having an integrated magnetic TTL encoder (standard feedback) carries an ELR-12V connector in its terminal box. Looking at this connector from the fan side, the pinout is:

1	+ 5 Volt
2	0 Volts
3	PCA
4	★PCA
5	PCB
6	★PCB

7	PCC
8	★PCC
9	Not connected
10	SS (shield)
11	THSA (thermistor NTC)
12	THSB (thermistor NTC)

NOTE. The ELR-12V connector comes already in the terminal box of the motor. It will be used to connect the feedback cable.

Magnetic TTL encoder connecting cables

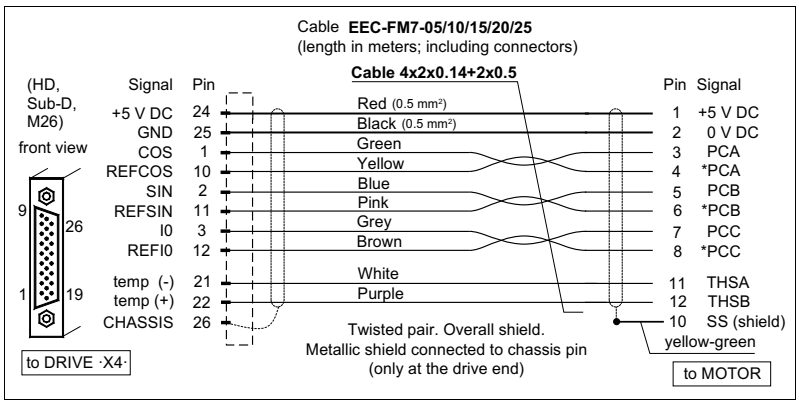
The connection between the magnetic TTL encoder and the drive module must be made using one of the following cables:

T. 4/8 Range of motor feedback cables when using a magnetic TTL encoder.

References	Description
EEC-FM7	Cable with overall shield.
EEC-FM7S (type I)	Cable with overall shield and shielded twisted pairs.
EEC-FM7S (type II)	Same as type I. Their wire colors are different.

NOTE. Observe that using an EEC-FM7S cable instead of an EEC-FM7 cable improves its flexibility and system immunity against disturbances.

EEC-FM7 cable diagram



F. 4/14

EEC-FM7-X connection cable between the motor with magnetic TTL encoder and the drive.

NOTE. Pin 9 of connector ELP-12V does not receive any wire; i.e. the wire will not be crimped at this pin.

NOTE. There is no connector at the motor end of this cable. The user must insert the pins and mount the connector at this end before connecting it. All these elements are supplied by FAGOR packed in a bag inside the terminal box.

Sales reference and code

T. 4/9 Sales references and codes of the EEC-FM7 cable.

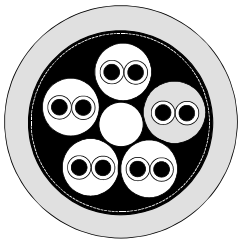
Reference	Service
EEC-FM7-05	04081010
EEC-FM7-10	04081011
EEC-FM7-15	04081012

Reference	Service
EEC-FM7-20	04081013
EEC-FM7-25	04081014

Mechanical characteristics

T. 4/10 Mechanical characteristics of the motor feedback cable. EEC-FM7.

Type	Shielded and with twisted pairs.
Approx. Dmax	8.5 mm
Flexibility	High. Special for controlling servo drives, with a minimum bending radius, when working, of 20 times its diameter Dmax (170 mm).
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: -20 °C to +70 °C (-4 °F to +158 °F) Storage: -40 °C to +80 °C (-40 °F to +176 °F)
Rated voltage	U: 150 V.

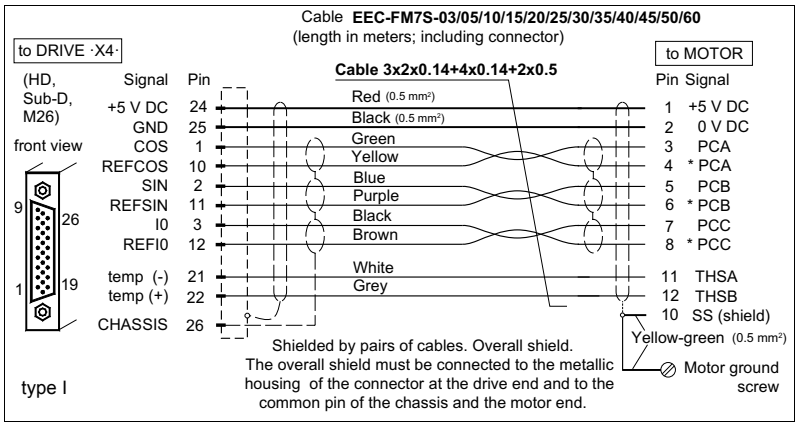


EEC-FM7S cable diagram

When having an EEC-FM7S cable to connect the motor feedback to the drive, it must be borne in mind that for the same sales reference there are two cables hoses with identical characteristics but with different color wires depending on the manufacturer of the cable. Hence, we will refer to type I and type II to point out this difference.

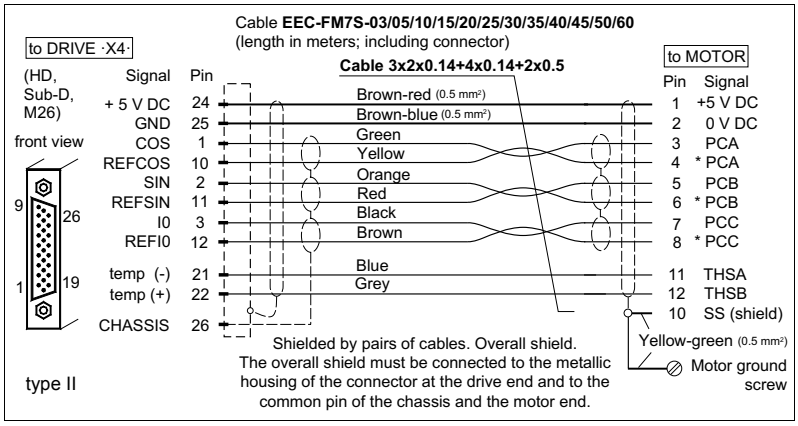
NOTE. When using an EEC-FM7S cable, first verify whether it is a type I or a type II. A quick way to check this is to see **if it has an orange wire**. If so, it is a **type II** cable; otherwise, it is a type I. Once it has been identified, mount the motor end of the cable according to the diagram for the type that has been identified. See the diagrams later on.

INFORMATION. Note that both cable hose types I and II mentioned next are the same in terms of pin-to-pin connection. Their only difference is the color of some of their wires because they are supplied by different manufacturers. The name of “cable hose” refers to a cable without connectors shown in the connection diagrams. According to these diagrams, the user must check which type matches the colors of the cable he is about to install.



F. 4/15

EEC-FM7S-X ·type I· connection cable between the magnetic TTL encoder of the motor and the drive.



F. 4/16

EEC-FM7S-X ·type II· connection cable between the motor with magnetic TTL encoder and the drive.

NOTE. Pin 9 of connector ELP-12V does not receive any wire; i.e. the wire will not be crimped at this pin.

NOTE. There is no connector at the motor end of this cable. The user must insert the pins and mount the connector at this end before connecting it. All these elements are supplied by FAGOR packed in a bag inside the terminal box.

Sales reference and code

T. 4/11 Sales references and codes of the EEC-FM7S cable.

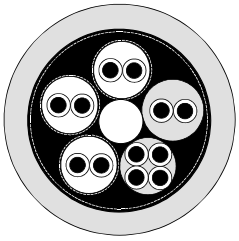
Reference	Service
EEC-FM7S-3	04080027
EEC-FM7S-5	04081000
EEC-FM7S-10	04081001
EEC-FM7S-15	04081002
EEC-FM7S-20	04081003
EEC-FM7S-25	04081004

Reference	Service
EEC-FM7S-30	04081020
EEC-FM7S-35	04081021
EEC-FM7S-40	04081022
EEC-FM7S-45	04081023
EEC-FM7S-50	04081024
EEC-FM7S-50	04081026

Mechanical characteristics

T. 4/12 Mechanical characteristics of the motor feedback cable. EEC-FM7S.

Type	Shielded and with shielded twisted pairs.
Approx. Dmax	8.5 mm.
Flexibility	High. Special for controlling servo drives, with a minimum bending radius, when working, of 12 times its diameter Dmax (102 mm).
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: 0 °C to +80 °C (+32 °F to +176 °F) Storage: -40 °C to +80 °C (-40 °F to +176 °F)
Rated voltage	U: 250 V.



Mounting the EEC-FM7 / EEC-FM7S cable

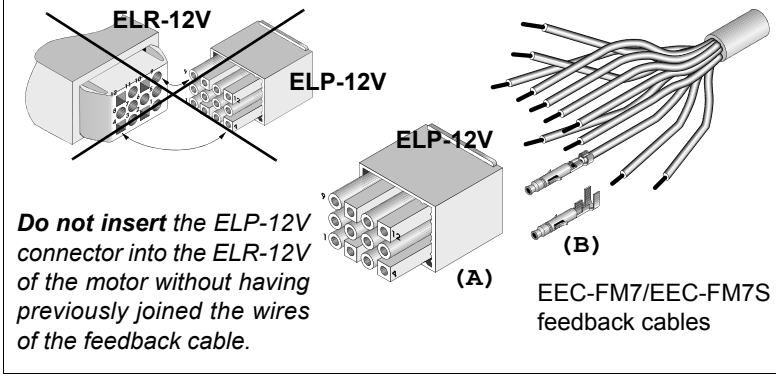
MANDATORY. Please read this section very carefully!

The feedback cable has unconnected wires at the motor end. The user must mount the connector following the indicated procedure:

- Remove the four M5x12 bolts located at the 4 corners of the top of the terminal box of the motor and open the lid to access to the accessories bag.

- Unpack the bag supplied by FAGOR containing 11 pins SLF-01T and the body of connector ELP-12V.

NOTE. Do not insert the body of the connector ELP-12V supplied as accessory into connector ERL-12V of the terminal box without previously making the connection cable.



***Do not insert** the ELP-12V connector into the ELR-12V of the motor without having previously joined the wires of the feedback cable.*

EEC-FM7/EEC-FM7S feedback cables

F. 4/17

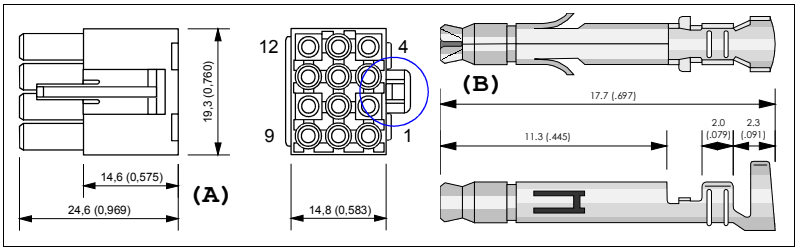
Mounting the EEC-FM7 or EEC-FM7S cable.
Accessories: **A.** Body of connector ELP-12V. **B.** SLF-01T pins.

- Crimp the end of each wire with each SLF-01T pin.

NOTE. Be careful with the wires being crimped with each terminal because there are 11 pins and 12 wires. One of them must not be connected and therefore will not have a pin to be crimped. See the cable diagram to know which wire it is and be careful with the colors.

- Insert each wire end already crimped into its corresponding pin of the body of connector ELP-12V supplied as accessory.

NOTE. Make sure that each pin is inserted into the corresponding pin of connector ELP-12V. If the user makes a mistake, it is difficult to recover the pin in its best shape. Carefully follow the connection diagram and the numbering of pins of connector ELP-12V. The tab marked with a circle in figure **F. 4/18** must be at the bottom when making the connection.



F. 4/18

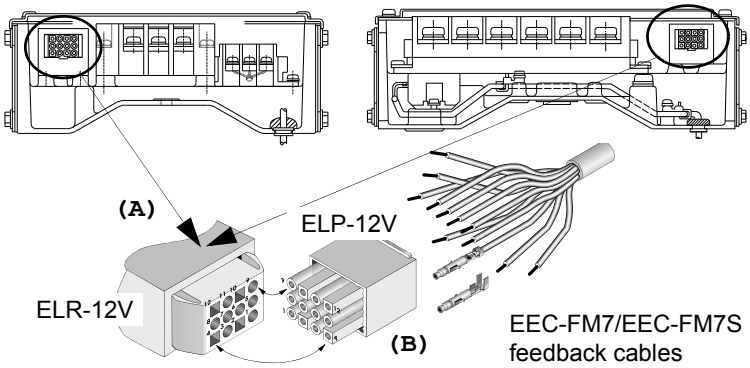
Accessories: **A.** Body of connector ELP-12V. **B.** SLF-01T pins.

- Insert the body of the connector ELP-12V already attached to the feedback cable into the socket of connector ERL-12V of the terminal box to make the connection with the feedback device.

NOTE. Make sure that the tab at the bottom of the body of the connector ELP-12V clicks when connecting it. This click ensures that it has been inserted properly.

Location of connector ELR-12V for the E01/E02 series of the FM7 family.

Location of connector ELR-12V for the E03/HS3 series of the FM7 family.



Before making this connection, the body of the connector ELP-12V (B) must be attached to the feedback cable !

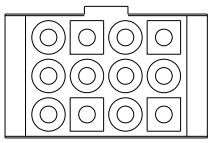
F. 4/19

A. Connector ELR-12V. **B.** Body of connector ELP-12V.

WARNING. When having to extract the body of the connector ELP-12V from the socket of the connector of the encoder ELR-12V, make sure that the motor is not powered, push the tab at the bottom (not visible) up and pull it. Never pull the cable because it could damage it!

Pinout of the C axis encoder connector

Motor feedback base connector



1	2	3	4
5	6	7	8
9	10	11	12

Connector ELR-12V

Any motor series of the FM7 family from Fagor Automation having an integrated C axis SinCos™ encoder (optional feedback) carries an ELR-12V connector in its terminal box. Looking at this connector from the fan side, the pinout is:

1	+ 8 Volt
2	0 Volts
3	SIN
4	REFSIN
5	COS
6	REFCOS

7	+ 485
8	- 485
9	SS (shield)
10	Not connected
11	THSA (thermistor NTC)
12	THSB (thermistor NTC)

NOTE. The ELR-12V connector comes already in the terminal box of the motor and it is rotated 180° with respect to that of the magnetic TTL encoder (standard). It will be used to connect the feedback cable.

C axis SinCos™ encoder connecting cables

The connection between the C axis SinCos™ encoder and the drive module must be made using one of the following cables:

T. 4/13 Range of motor feedback cables when using a C axis encoder.

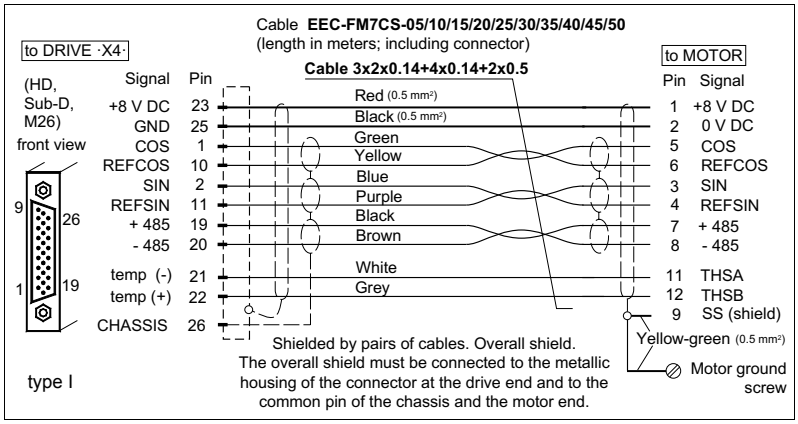
References	Description
EEC-FM7CS (type I)	Cable with overall shield & shielded twisted pairs.
EEC-FM7CS (type II)	Same as type I. Their wire colors are different.

EEC-FM7CS cable diagram

When having an EEC-FM7CS cable to connect the motor feedback to the drive, it must be borne in mind that for the same sales reference there are two cables hoses with identical characteristics but with different color wires depending on the manufacturer of the cable. Hence, we will refer to type I and type II to point out this difference.

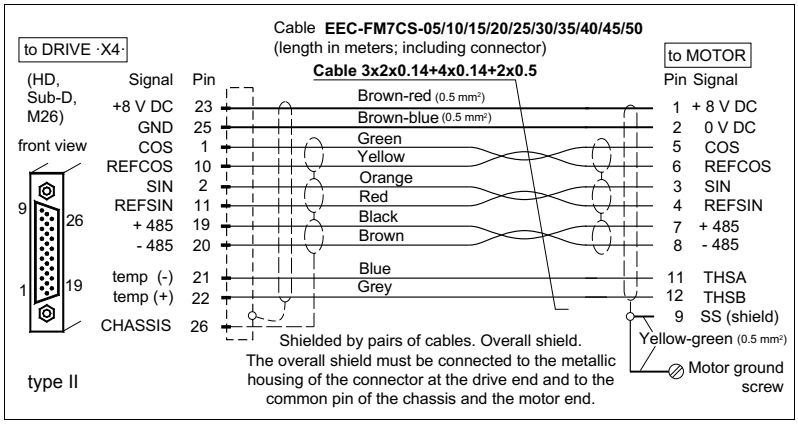
NOTE. When using an EEC-FM7CS cable, first verify whether it is a type I or a type II. A quick way to check this is to see **if it has an orange wire**. If so, it is a **type II** cable; otherwise, it is a type I. Once it has been identified as type I or type II, mount the motor end of the cable according to the diagram for the type that has been identified.

INFORMATION. Note that both cable hose types I and II mentioned next are the same in terms of pin-to-pin connection. Their only difference is the color of some of their wires because they are supplied by different manufacturers. The name of “cable hose” refers to a cable without connectors shown in the connection diagrams. According to these diagrams, the user must check which type matches the colors of the cable he is about to install.



F. 4/20

EEC-FM7CS-X ·type I· connection cable between the motor with C axis encoder and the drive.



F. 4/21

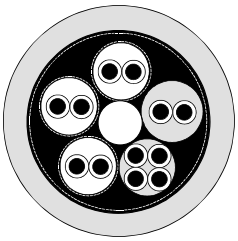
EEC-FM7CS-X ·type II· connection cable between the motor with C axis encoder and the drive.

NOTE. Pin 10 of connector ELP-12V does not receive any wire; i.e. the wire will not be crimped at this pin.

NOTE. There is no connector at the motor end of this cable. The user must insert the pins and mount the connector at this end before connecting it. All these elements are supplied by FAGOR packed in a bag inside the terminal box.

Mechanical characteristics

T. 4/14 Mechanical characteristics of the motor feedback cable. EEC-FM7CS.



Type	Shielded and with shielded twisted pairs.
Approx. Dmax	8.5 mm
Flexibility	High. Special for controlling servo drives, with a minimum bending radius, when working, of 12 times its diameter Dmax (102 mm).
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: 0 °C to +80 °C (+32 °F to +176 °F) Storage: -40 °C to +80 °C (-40 °F to +176 °F)
Rated voltage	U: 250 V.

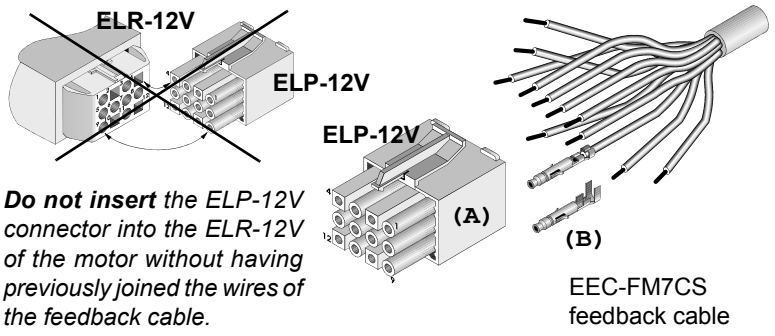
Assembling the EEC-FM7CS cable

MANDATORY. Please read this section very carefully!

The feedback cable has unconnected wires at the motor end. The user must mount the connector following the indicated procedure:

- Remove the four M5x12 bolts located at the 4 corners of the top of the terminal box of the motor and open the lid to access to the accessories bag.
- Unpack the bag supplied by FAGOR containing 11 pins SLF-01T and the body of connector ELP-12V.

NOTE. Do not insert the body of the connector ELP-12V supplied as accessory into connector ERL-12V of the terminal box without previously making the connection cable.



F- 4.22

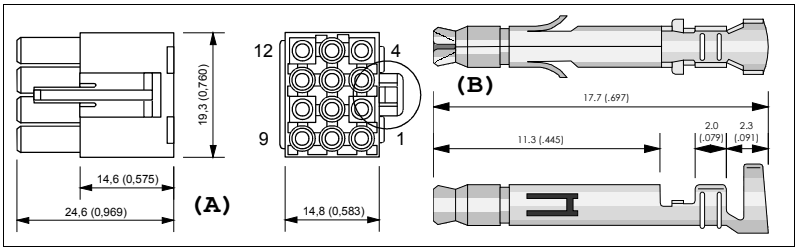
Assembling the EEC-FM7CS cable.
Accessories: **A.** Body of connector ELP-12V. **B.** SLF-01T pins.

- Crimp the end of each wire with each SLF-01T pin.

  NOTE. Be careful with the wires being crimped with each terminal because there are 11 pins and 12 wires. One of them must not be connected and therefore will not have a pin to be crimped. See the cable diagram to know which wire it is and be careful with the colors.

- Insert each wire end already crimped into its corresponding pin of the body of connector ELP-12V supplied as accessory.

  NOTE. Make sure that each pin is inserted into the corresponding pin of connector ELP-12V. If the user makes a mistake, it is difficult to recover the pin in its best shape.
  Carefully follow the connection diagram and the numbering of pins of connector ELP-12V. The tab marked with a circle in figure **F. 4/23** must be at the top when making the connection.



F. 4/23

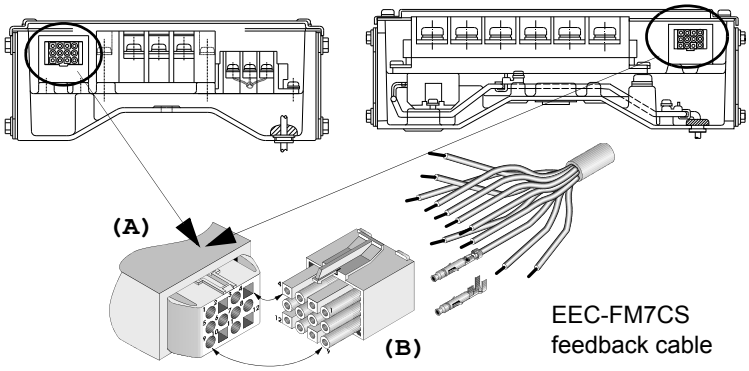
Accessories: **A.** Body of connector ELP-12V. **B.** SLF-01T pins.

- Insert the body of the connector ELP-12V already attached to the feedback cable into the socket of connector ERL-12V of the terminal box to make the connection with the feedback device.

NOTE. Make sure that the tab at the top of the body of the connector ELP-12V clicks when connecting it. This click ensures that it has been inserted properly.

Location of connector ELR-12V for the E01/E02 series of the FM7 family.

Location of connector ELR-12V for the E03/HS3 series of the FM7 family.



Before making this connection, the body of the connector ELP-12V (B) must be attached to the feedback cable!

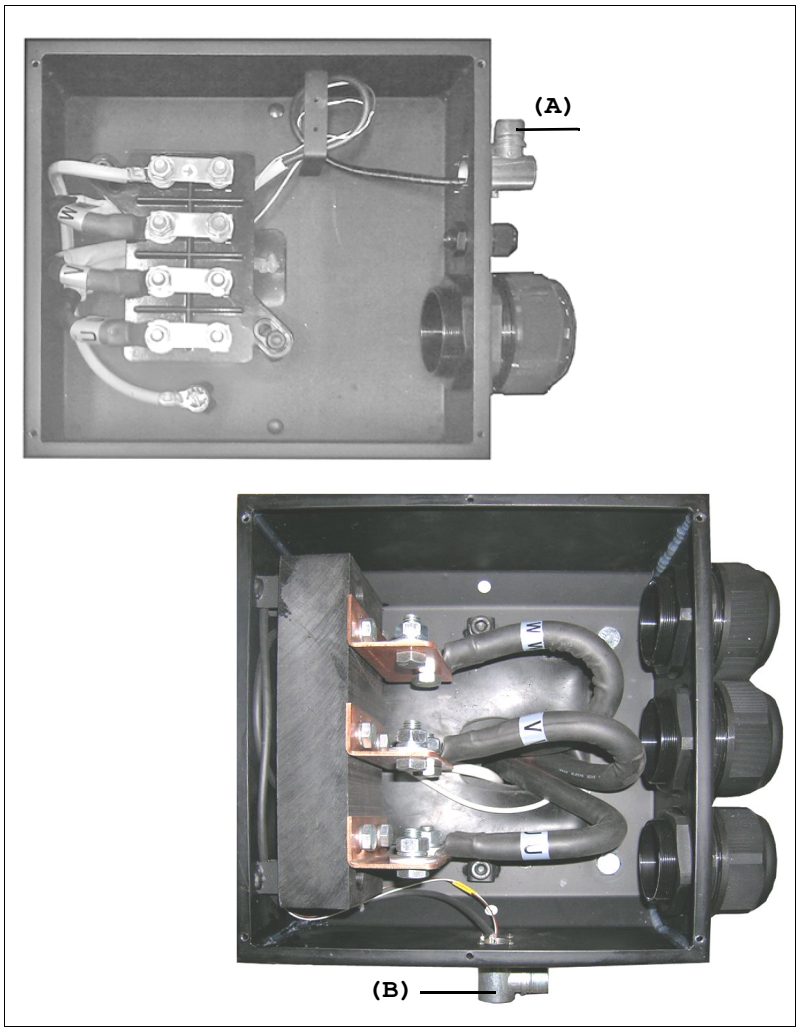
F. 4/24

A. Connector ELR-12V. **B.** Body of connector ELP-12V.

WARNING. When having to extract the body of connector ELP-12V from the housing of the connector of the ELR-12V encoder, make sure that the motor is without power. Press the tab on the top (not visible) down and pull at it. Never pull the cable because it could damage it.

Connecting the feedback to the drive on FM9 models

The connection between the motor feedback and its associated drive module must always be done using the connector located outside the terminal box and the connector of the motor feedback at the drive. See figure **F. 4/25** that shows the location of the feedback connector on the motor depending on model.



F. 4/25

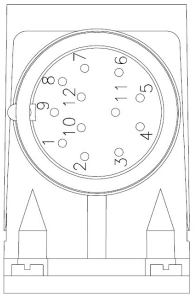
Motor feedback connector of the FM9 family motors.
A. Motor feedback connector on B037, B055 models.
B. Motor feedback connector on B071, A100, B113, A130 models.

Available encoders

T. 4/15 Encoders available for FM9 motors.

Motor series	Type of encoder
	Estándar, ● = C
FM9-□□□□-●□□□-E01	C axis. 1 Vpp sinusoidal SinCos™ encoder. 1024 ppt

Motor feedback base connector



EOC 12 connector

Pinout of the connector of the C axis SinCos™ encoder

Any motor series of the FM9 family from Fagor Automation having an integrated C axis SinCos™ encoder (optional feedback) carries an EOC-12 base connector in its terminal box. Looking at this connector, the pinout is:

1	REFCOS
2	+ 485
3	KTY84 -
4	KTY84 +
5	SIN
6	REFSIN

7	- 485
8	COS
9	SS (shield) + CHASSIS
10	GND
11	N C (**N**ot **C**onnected)
12	+ 8 V DC

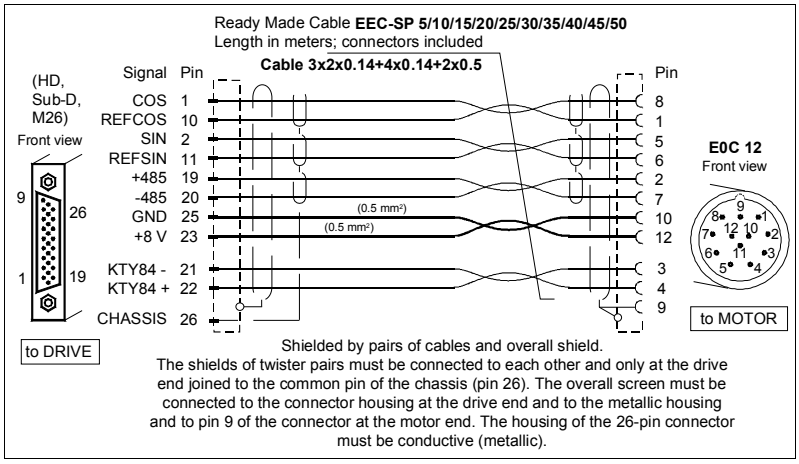
C axis SinCos™ encoder connecting cables

The connection between the C axis SinCos™ encoder and the drive module must be made using one of the following cables. Note that the motor feedback will be wired differently depending on the drive model it will be connected to.

T. 4/16 Range of motor feedback cables when using a C axis SinCos™ encoder.

Drive model	Cable reference	Description
SPD series	EEC-SP	Cable with overall shield and shielded twisted pairs
CT series	EEC-SP + CA-EEC-CT	Cable with overall shield and shielded twisted pairs + adapter cable

EEC-SP cable diagram



F. 4/26

EEC-SP motor connection cable with a C axis SinCos™ encoder directly to the drive (SPD series) or indirectly to the drive (through a CA-EEC-CT adapter).

Sales reference and code

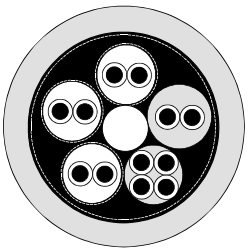
T. 4/17 Sales references and codes of the EEC-SP cable.

Reference	Service
EEC-SP-5	04080020
EEC-SP-10	04080021
EEC-SP-15	04080022
EEC-SP-20	04080023
EEC-SP-25	04080024

Reference	Service
EEC-SP-30	04080060
EEC-SP-35	04080061
EEC-SP-40	04080062
EEC-SP-45	04080063
EEC-SP-50	04080064

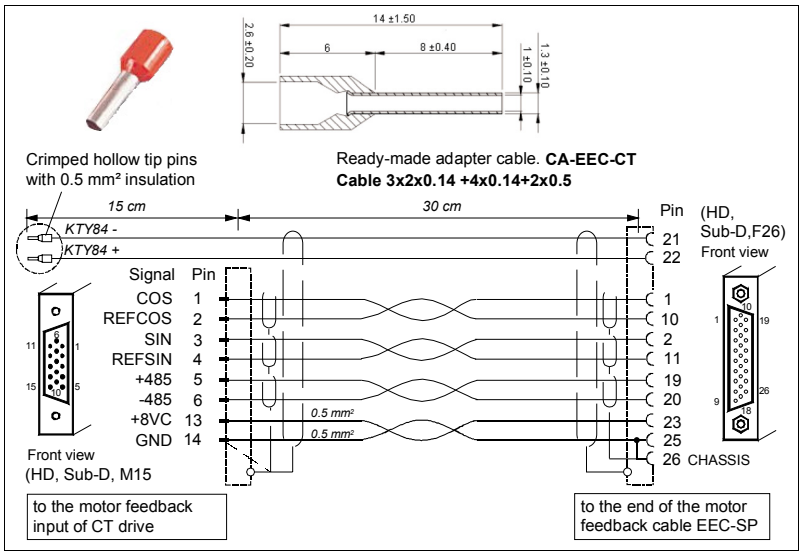
Mechanical characteristics

T. 4/18 Mechanical characteristics of the motor feedback cable. EEC-SP.



Type	Overall shield. Shielded twisted pairs.
Approx. Dmax	8.5 mm.
Flexibility	High. Special for controlling servo drives, with a minimum bending radius under dynamic conditions (when flexed) of 12 times the Dmax. (= 102 mm).
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: 0 °C to +80 °C (+32 °F to +176 °F). Storage: -40 °C to +80 °C (-40 °F to +176 °F).
Work voltage	U: 250 V.

CA-EEC-CT adapter cable diagram



F. 4/27

CA-EEC-CT adapter cable to be used with the EEC-SP cable to connect the SinCosTM encoder of the C axis of an FM9 motor and a CT series drive.

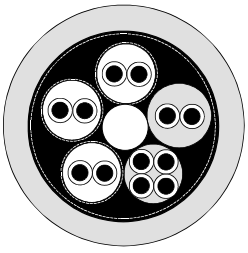
Sales reference and code

T. 4/19 Sales references and code of the CA-EEC-CT cable.

Reference	Service
CA-EEC-CT	04080070

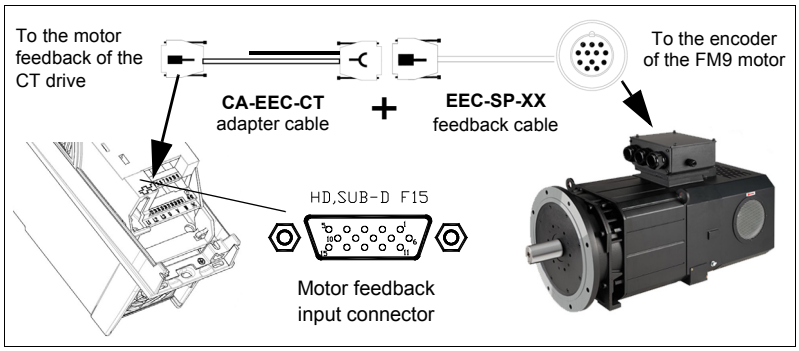
Mechanical characteristics

T. 4/20 Mechanical characteristics of the CA-EEC-CT adapter cable.



Type	Overall shield. Shielded twisted pairs.
Approx. Dmax	8.5 mm.
Flexibility	High. Special for controlling servo drives, with a minimum bending radius under dynamic conditions (when flexed) of 12 times the Dmax. (= 102 mm).
Covering	PUR. Polyurethane immune to the chemical agents used in machine tools.
Temperature	Work: 0 °C to +80 °C (+32 °F to +176 °F). Storage: -40 °C to +80 °C (-40 °F to +176 °F).
Work voltage	U: 250 V.

Connection of the motor feedback with CT series drives



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Connection of the feedback of an FM9 spindle with a CT series drive.

The motor feedback of FM9 spindles to be governed by CT servo drives is a sinusoidal encoder. The connection must be made between the connector of the motor feedback and the 15-pin HD Sub-D, F15 female connector of the drive through the EEC-SP feedback cable together with a CA-EEC-CT adapter cable. See figure.

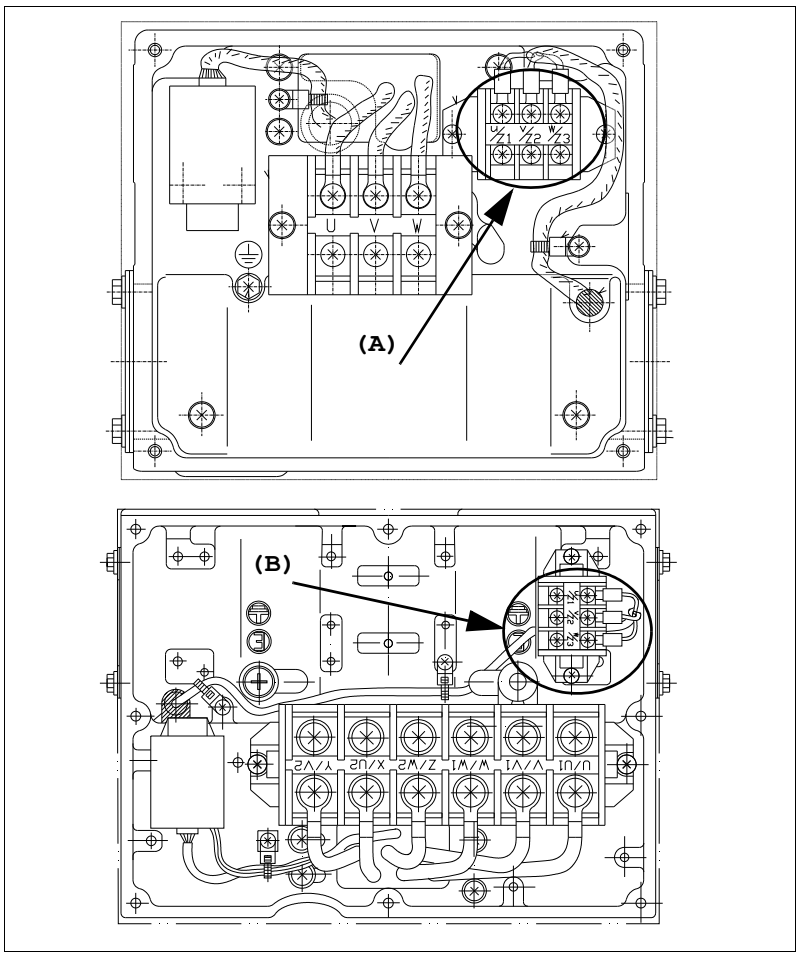
4.2.3 Fan

Fan connection on FM7 models

The fan integrated into the motors of the FM7 family is supplied with three-phase 400 V AC voltage at 50/60 Hz.

NOTE. Note that the fan can also be connected to three-phase 460 V AC at 60 Hz.

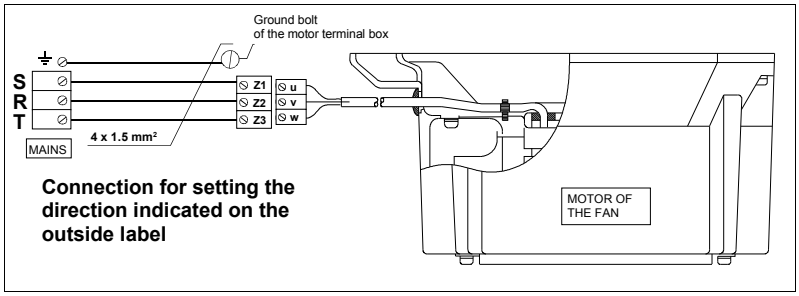
It must be connected between the three mains phases and pins u/Z1, v/Z2 and w/Z3 located inside the terminal box. Observe that depending on whether it is an E01/E02 series motor or an E03/HS3 series motor, the location of the terminals to connect the fan inside the terminal box is different. See figure **F. 4/29**.



F. 4/29

Terminals in the terminal box for connecting the fan. **A.** Terminals u/Z1, v/Z2 and w/Z3 in E01/E02 series. **B.** Terminals u/Z1, v/Z2 and w/Z3 in E03/HS3 series.

NOTE. Layouts other than the one shown in figure **F. 4/29** are also possible but the terminals may be easily located because they're identified in the same way u/Z1, v/Z2 and w/Z3.



F. 4/30

Fan connection to mains.

MANDATORY. To set the direction of the air flow and the turning direction shown on the outside plate of the fan, the fan must be connected at the corresponding terminal strip inside the terminal box in this order: Terminal Z1 with mains phase S, terminal Z2 with phase R and terminal Z3 with phase T. The ground cable must be connected to the motor's ground bolt. Therefore, note that two of the phases are swapped.

NOTE. When connecting Z1- phase R, Z2- phase S and Z3- phase T, the fan will turn in the opposite direction to the one shown on the label.

The fan will evacuate the heat towards the back of the motor (opposite direction to the machine) according to any of the two connections. However, one must always verify that the fan turns in the direction indicated on its outside label.

The following table offers the electrical data on voltage, frequency, power consumption and current absorbed by the fan.

T. 4/21 Electrical data of the integrated fan depending on motor model.

FM7-□□□□-□□□□-E01/E02				
Motor model	Voltage	Frequency	Power	Current
	V	Hz	W	A
FM7-A037-□□□□-E01/E02	400	50/60	37/51	0.11/0.14
	460	60	60	0.16
FM7-A055-□□□□-E01/E02	400	50/60	64/85	0.11/0.16
	460	60	96	0.17
FM7-A075-□□□□-E01/E02	400	50/60	41/62	0.07/0.10
	460	60	63	0.09
FM7-A090-□□□□-E01/E02	400	50/60	45/58	0.11/0.10
	460	60	63	0.10
FM7-A110-□□□□-E01/E02	400	50/60	59/83	0.11/0.14
	460	60	88	0.13
FM7-A150-□□□□-E01/E02	400	50/60	59/83	0.11/0.14
	460	60	88	0.13
FM7-A185-□□□□-E01/E02	400	50/60	58/82	0.11/0.14
	460	60	88	0.13
FM7-A220-□□□□-E01/E02	400	50/60	57/82	0.11/0.13
	460	60	87	0.13
FM7-B120-□□□□-E01/E02	400	50/60	58/82	0.11/0.14
	460	60	88	0.13
FM7-B170-□□□□-E01/E02	400	50/60	57/82	0.11/0.13
	460	60	87	0.13
FM7-A300-□□□□-E01	400	50/60	152/205	0.38/0.38
	460	60	226	0.40
FM7-B220-□□□□-E01	400	50/60	163/218	0.39/0.39
	460	60	238	0.41
FM7-A370-□□□□-E01	400	50/60	152/205	0.38/0.38
	460	60	226	0.40
FM7-B280-□□□□-E01	400	50/60	152/205	0.38/0.38
	460	60	226	0.40
FM7-A510-□□□□-E01/E02	400	50/60	86/117	0.22/0.23
	460	60	128	0.24
FM7-C215-□□□□-E01/E02	400	50/60	86/117	0.22/0.23
	460	60	128	0.24
FM7-C270-□□□□-E01/E02	400	50/60	103/140	0.18/0.23
	460	60	159	0.22
FM7-E600-C□B□-E01	400	50/60	94/132	0.22/0.25
	460	60	143	0.25

T. 4/22 Electrical data of the integrated fan depending on motor model.

FM7-D□□□-S1D0-E03				
Motor model	Voltage	Frequency	Power	Current
	V	Hz	W	A
FM7-D055-S1D0-E03	400	50/60	64/85	0.11/0.16
	460	60	96	0.17
FM7-D075-S1D0-E03	400	50/60	41/62	0.07/0.10
	460	60	63	0.09
FM7-D110-S1D0-E03	400	50/60	59/83	0.11/0.14
	460	60	88	0.13
FM7-D150-S1D0-E03	400	50/60	59/83	0.11/0.14
	460	60	88	0.13
FM7-D185-S1D0-E03	400	50/60	58/82	0.11/0.14
	460	60	88	0.13
FM7-D220-S1D0-E03	400	50/60	57/82	0.11/0.13
	460	60	87	0.13

T. 4/23 Electrical data of the integrated fan depending on motor model.

FM7-D□□□-S1D0-HS3				
Motor model	Voltage	Frequency	Power	Current
	V	Hz	W	A
FM7-D075-S1D0-HS3	400	50/60	41/62	0.07/0.10
	460	60	63	0.09
FM7-D110-S1D0-HS3	400	50/60	59/83	0.11/0.14
	460	60	88	0.13
FM7-D185-S1D0-HS3	400	50/60	58/82	0.11/0.13
	460	60	88	0.13
FM7-D220-S1D0-HS3	400	50/60	57/82	0.11/0.13
	460	60	87	0.13

Fan connection on FM9 models

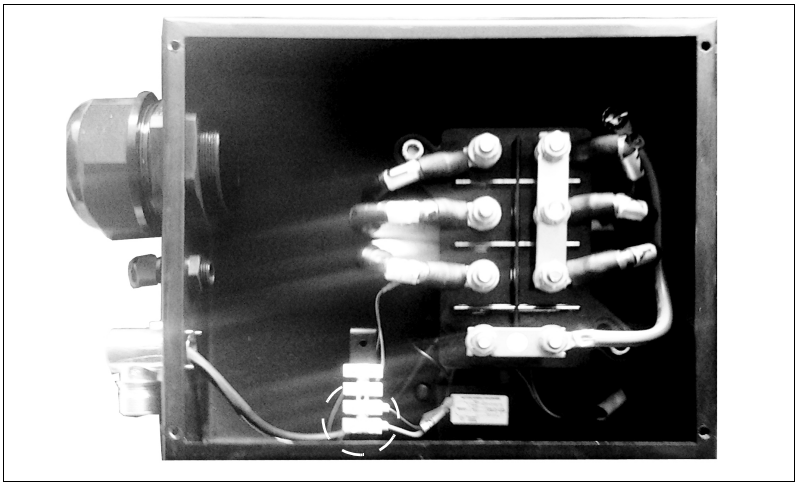
FM9-B037-C5CX-E01

FM9-B037-C5C1-E01 is a single-phase 220 V AC supply at a frequency 50 Hz. Note that the fan can also be connected to single-phase 220 V AC at 60 Hz.

NOTE. The user must manually connect those two terminals of the strip located inside the terminal box of the motor. Therefore, first open the terminal box of the motor.

WARNING. Before removing the lid of the terminal box, make sure that the motor has no voltage. Ignoring this warning may cause serious personal injury and even death.

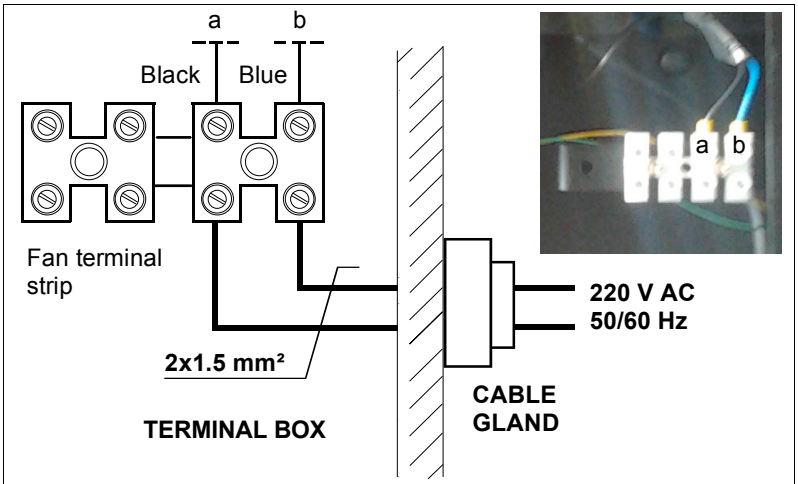
To connect the fan to mains, use the two pins (a and b) of the terminal strip located inside the terminal box. See figure **F. 4/31**. Use the cable gland with the smallest section to take the wires to the terminal box.



F. 4/31

Terminals inside the terminal box for connecting the fan of the FM9-B037-C5CX-E01 motor.

Get two 1.5 mm² wires and connect them to the a and b terminals indicated in the figure to 220 V AC mains after feeding them through the cable gland located inside the terminal box and closing it.



WARNING. *Close the lid of the terminal box before connecting the fan to 220 V AC mains .*

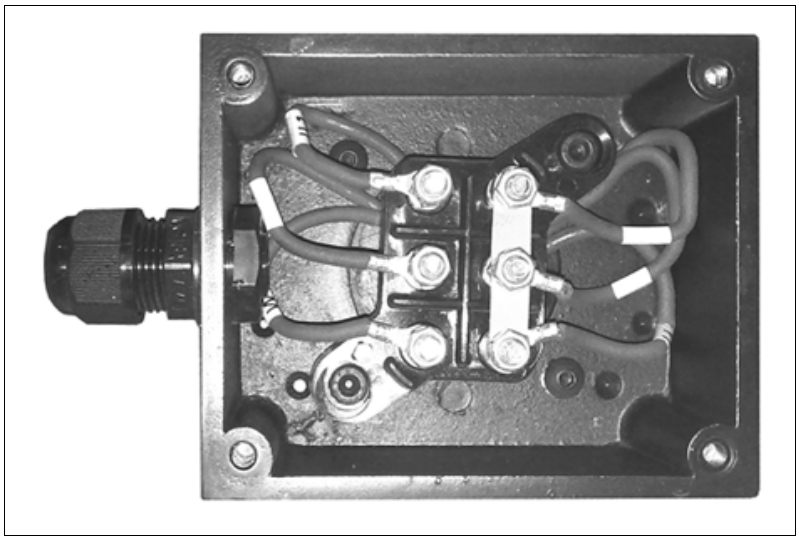
F. 4/32

Fan connection to mains from the terminal box at motor model FM9-B037-C5CX-E01.

FM9-B055-C5CX-E01-A, FM9-B071-C5CX-E01, FM9-A100-C5CX-E01, FM9-B113-C5CX-E01 and FM9-A130-C5CX-E01

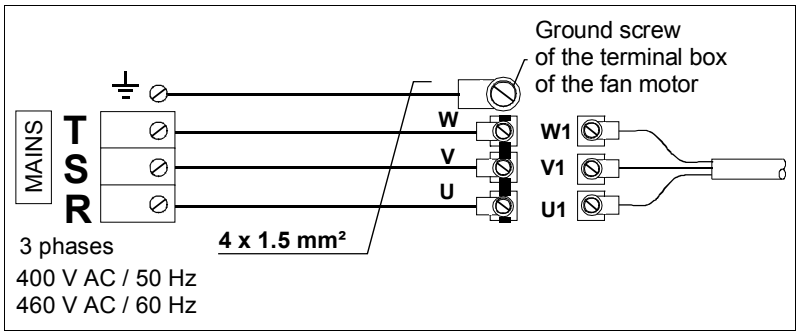
The supply of the integrated fan is three-phase 400 V AC at a frequency of 50 Hz. The fan can also be connected to three-phase 460 V AC at 60 Hz.

It must be connected between the three mains phases and pins U, V and W located inside the terminal box of the fan. See figure **F. 4/33**. Use a cable gland to insert the wires into the terminal box of the fan.



F. 4/33

Terminals inside the terminal box for connecting the fan . Terminals U, V and W at the FM9-B055 models E01 series and models of higher power.



F. 4/34

Fan connection to mains.

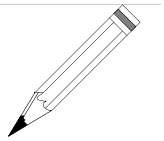
The fan will evacuate the heat towards the back of the motor (opposite direction to the machine).

Electrical characteristics

The following table offers the electrical data on voltage, frequency, power consumption and current absorbed by the fan.

T. 4/24 Electrical data of the integrated fan depending on motor model.

FM9-□□□□-C5C□-E01-□				
Motor model	Voltage	Frequency	Power	Current
	V AC	Hz	W	A
FM9-B037-C5C□-E01	220	50	195	0.92
	220	60	250	1.15
FM9-B□□□-C5C□-E01	400	50	1500	3.25
	460	60	1750	3.20
FM9-A□□□-C5C□-E01	400	50	1500	3.25
	460	60	1750	3.20



5.1 Overview

5.1.1 Daily inspections

Check:

- For too much vibration or unusual noise.

T. 5/1 Normal noise level.

	Noise dB(A)		Noise dB(A)
FM7-A037-□□□□-E01/E02	≤ 75	FM7-D055-S1D0-E03	≤ 75
FM7-A055-□□□□-E01/E02	≤ 75	FM7-D075-S1D0-E03	≤ 75
FM7-A075-□□□□-E01/E02	≤ 75	FM7-D110-S1D0-E03	≤ 75
FM7-A090-□□□□-E01/E02	≤ 75	FM7-D150-S1D0-E03	≤ 75
FM7-A110-□□□□-E01/E02	≤ 75	FM7-D185-S1D0-E03	≤ 75
FM7-A150-□□□□-E01/E02	≤ 75	FM7-D220-S1D0-E03	≤ 75
FM7-A185-□□□□-E01/E02	≤ 75		
FM7-A220-□□□□-E01/E02	≤ 80	FM7-D075-S1D0-HS3	≤ 75
FM7-B120-□□□□-E01/E02	≤ 75	FM7-D110-S1D0-HS3	≤ 75
FM7-B170-□□□□-E01/E02	≤ 80	FM7-D185-S1D0-HS3	≤ 75
FM7-A300-□□□□-E01	≤ 80	FM7-D220-S1D0-HS3	≤ 75
FM7-B220-□□□□-E01	≤ 80		
FM7-A370-□□□□-E01	≤ 80	FM9-B037-C5C□-E01	–
FM7-B280-□□□□-E01	≤ 80	FM9-B055-C5C□-E01-A	–
FM7-A510-□□□□-E01/E02	≤ 80	FM9-B071-C5C□-E01	–
FM7-C215-□□□□-E01/E02	≤ 80	FM9-A100-C5C□-E01	–
FM7-C270-□□□□-E01/E02	≤ 80	FM9-B113-C5C□-E01	–
FM7-E600-C□B□-E01	≤ 80	FM9-A130-C5C□-E01	–

NOTE. Remember that the data given in the table corresponds to sound pressure levels according to EN 21680 (tolerance +3 dB).

- For ambient temperature too high.

5.1.2 Periodic inspections

T. 5/2 Periodic inspections.

Area	Effect	Test	Corrective action
Bearings	Noise	Unusual noise or more noise	Replace the bearing
Bearings	Vibration	Unusual vibration	Replace the bearing
Bearings	Temperature	Unusual temperature increase	Replace the bearing
Bearings	Grease	Leaks	Eliminate the cause
Fan	Running status	Anomalous operation or not running	Eliminate the cause of the fan stop or replace the fan in case of a failure

5.1.3 Element replacement periods

If the running conditions were normal, i.e.

- Yearly average ambient temperature: 30 °C (86 °F).
- Load factor: 80 % or lower
- Operating range: Maximum 12 hours a day.

T. 5/3 Element replacement periods on FM7 motors.

Area	Element	Test	Corrective action
Motor	Bearings	12000 hours or two years	Remove and replace the defective bearings or perform their required maintenance
Motor	Fan	15000 hours or two years	Replace the fan
Motor	Revisions	20000 hours or five years	Contact Fagor Automation S.Coop

5.2 Bearings

First inspection

The first inspection must be done after running for 500 hours for motors that have been running in normal conditions or before one year since they were installed.

Periodic inspections

The period for maintenance and inspections will depend on the type of bearing, dimensions, average speed and temperature conditions. In any case, It must be done within two years.

NOTE. It will not be necessary to lubricate the bearings.

5.3 Fan

5.3.1 Fan replacement

FM7 MOTOR

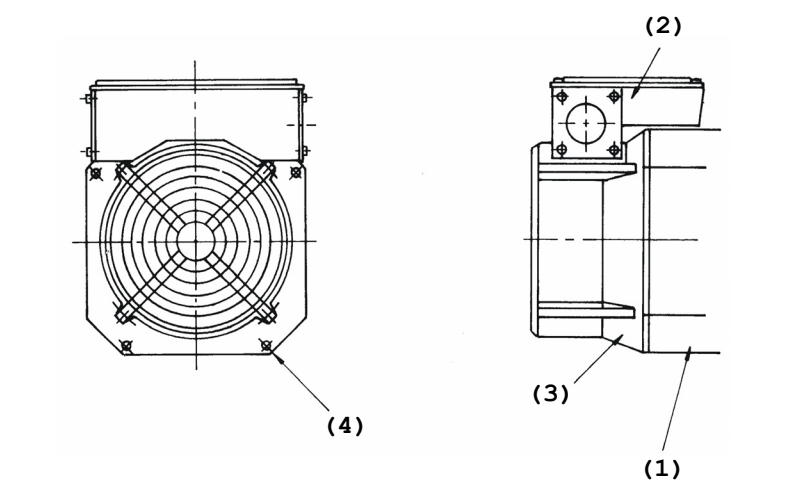
The motor is cooled by an integrated fan located on top. If due to dust, dirt or for other reasons, it starts working poorly, it must be replaced immediately. See the relevant tables in the **5.4 Spare parts** section of this chapter.

WARNING. The fan must not be replaced nor the connection terminals of its electrical cables manipulated while the motor is connected to the power supply and/or the fan is connected to the three-phase line.

WARNING. When replacing the fan, make sure that neither screws nor small items fall inside the motor.

It is recommended to proceed as follows when replacing the fan.

- Disconnect the motor from the power supply.
- Disconnect the fan from the three-phase line.
- Remove the fan cables from the terminal strip located in the terminal box. Take these cables out of the terminal box through the hole.
  To do that, remove the silicone in it and the fastener that secures it in order to make it easier to take it out. See the section, **4.2.3 Fan** of chapter 4 in this manual.
- Remove the 4 screws used to attach the fan housing to the motor block. See attached figure **F. 5/1**.

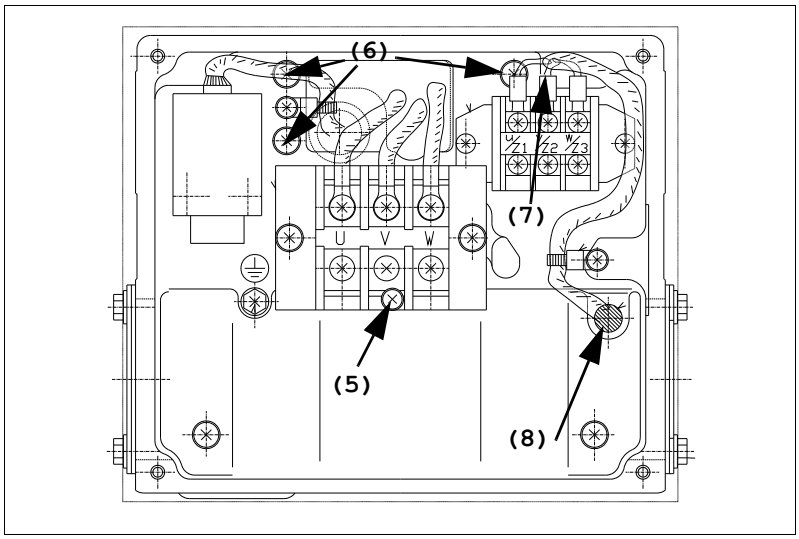


F. 5/1

Items attached to the fan housing.

1	Motor
2	Terminal box
3	Fan housing
4	Fan housing mounting screws (x4)

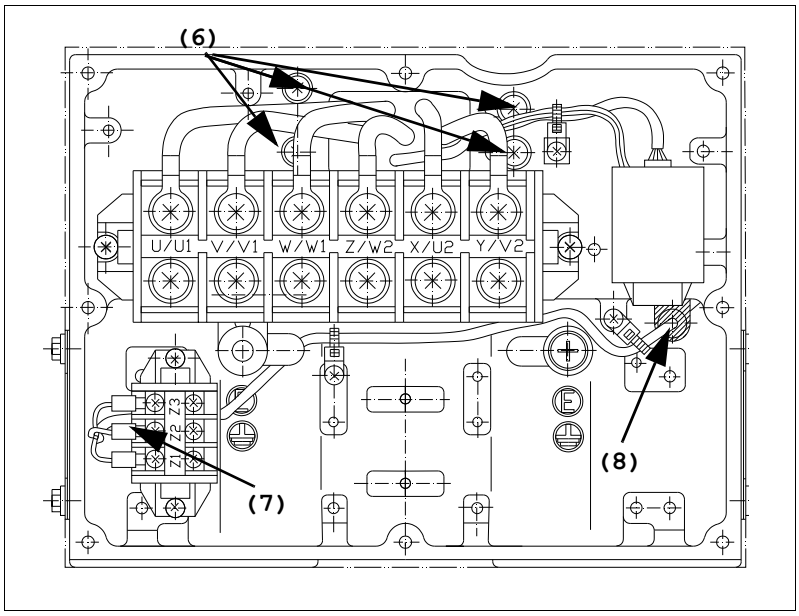
- Remove the screw used to attach the terminal box to the fan housing. See attached figure **F. 5/2**.



F. 5/2

Links between the fan housing, the terminal box and the motor block on FM7 (E01/E02 series) motors.

5	Screw to attach the terminal box to the fan housing
6	Screws to attach the terminal box to the motor block
7	Cables with terminals of the three-phase fan
8	Hole to feed the hose of the fan cables.



F. 5/3

Links between the fan housing, the terminal box and the motor block on FM7 (E03/HS3 series) motors.

- Take the fan assembly (housing + motor) out as a single (whole) unit.

INFORMATION. If when taking the fan assembly out gets in the way of the terminal box making it hard to take it out, loosen the screws that attach the terminal box to the motor block.

- Follow these steps backwards to install the replacement fan.

INFORMATION. Once the new fan has been installed, do not forget to cover the hole for feeding the cable from the fan to the terminal box and fasten the cable again like it was originally. The E03 or HS3 series models have this cable fastened in two points of the terminal box they both must be tightened with a screw. See figure **F. 5/3**.

NOTE. Remember that all these accessories are also supplied by FAGOR. They come in a bag inside the terminal box of the motor. It has fasteners, screws and a rubber seal to cover the hole that is now empty after removing the silicone to free the fan connection cable when it has been replaced.

FM9 MOTOR

Contact Fagor Automation S. Coop.

5.4 Spare parts

The following tables show the models for the spare parts of the motor.

5.4.1 FM7. E01/E02 series

T. 5/4 Spare parts for motors whose base speed is 1500 rpm.

	FM7- A● ● ● - □□□□ - E01/E02			
● ● ●	037	055	075	090
Encoder	TTL (UTMSI -10AAGAZA), C axis (SinCos® SRS50)			
Fan	B935P5653-1	B032P0426-1		

T. 5/5 Spare parts for motors whose base speed is 1500 rpm.

	FM7- A ● ● ● - □□□□ - E01/E02			
● ● ●	110	150	185	220
Encoder	TTL (UTMS -10AAGAZE), C axis (SinCos® SRS50)			
Fan	B032P0427-1			

T. 5/6 Spare parts for motors whose base speed is 1500 rpm.

	FM7- A ● ● ● - □□□□ - E01/E02		
● ● ●	300	370	510
Encoder	TTL (UTMSI -10AAGBZA), C axis (SinCos® SRS50)		
Fan	B935P5659-1		B935P6496-1

T. 5/7 Spare parts for motors whose base speed is 1250 rpm.

	FM7- E ● ● ● -C□B□ - E01	
● ● ●	600	
Encoder	C axis (SinCos® SRS50)	
Fan	B935P6496-1	

T. 5/8 Spare parts for motors whose base speed is 1000 rpm.

	FM7- B ● ● ● - □□□□ - E01/E02			
● ● ●	120	170	220	280
Encoder	TTL (UTMSI -10AAGAZE) C axis (SinCos® SRS50)		TTL (UTMSI -10AAGBZA) C axis (SinCos® SRS50)	
Fan	B032P0427-1		B935P5659-1	

T. 5/9 Spare parts for motors whose base speed is 500 rpm.

	FM7- C ● ● ● - □□□□ - E01/E02	
● ● ●	215	270
Encoder	TTL (UTMSI -10AAGBZA), C axis (SinCos® SRS50)	
Fan	B935P6496-1	

5.4.2 FM7. E03 series

T. 5/10 Spare parts for motors whose base speed is 1500/4000 rpm. (Y/Delta, star/triangle). Winding-selectable motor.

	FM7- D ●●● - S1D0 - E03	
●●●	055	075
Encoder	TTL (UTMSI -10AAGAZA)	
Fan	B032P0426-1	

T. 5/11 Spare parts for motors whose base speed is 1500/4000 rpm. (Y/Delta, star/triangle). Winding-selectable motor.

	FM7- D ●●● - S1D0 - E03			
●●●	110	150	185	220
Encoder	TTL (UTMSI -10AAGAZA)			
Fan	B032P0427-1			

5.4.3 FM7. HS3 series

T. 5/12 Spare parts for motors whose base speed is 1500/4000 rpm. (Y/Delta, star/triangle). Winding-selectable motor.

	FM7- D ●●● - S1D0 - HS3			
●●●	075	110	185	220
Encoder	TTL (UTMSI -10AAGAZB)			
Fan	B032P0426-2	B032P0427-2		

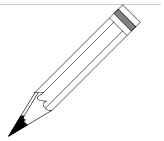
5.4.4 FM9. E01 series

T. 5/13 Spare parts for motors whose base speed is 1500 rpm (star -Y-).

	FM9 - A ●●● - C5Cx - E01			
●●●	100	130		
Encoder	SinCos® Stegmann® SRS64			
Fan	Contact FAGOR			

T. 5/14 Spare parts for motors whose base speed is 1000 rpm (star -Y-).

	FM9 - B ●●● - C5Cx - E01 - x			
●●●	037	055	071	113
Encoder	SinCos® Stegmann® SRS64			
Fan	Contact FAGOR			



Any motor selection process must consider five basic aspects that condition the performance characteristics of the motor-machine assembly:

- The characteristics of the motor
- The load requirements
- The service conditions
- The ambient conditions
- The supply voltage

6.1 Spindle motor selection

On the spindles of machine tools, it is important to maintain a constant turning speed of the spindle. To control this speed, the drive applies torque to the load according to the characteristics of this load as well as to the adjusted accelerations and decelerations.

Procedure to calculated the needed motor power:

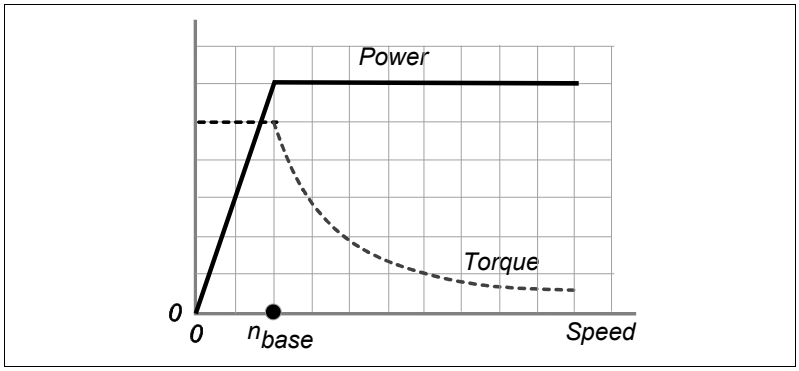
- Determine the required rated power values (in continuous duty cycle, instantaneous and periodically) depending on the characteristics of the load.
- Increase the value of that required power considering the power transmission efficiency and load dispersion.
- Select the drive that supplies the necessary current to govern the motor in all the duty cycles that the machine will work in).

6.1.1 Power demanded from a motor for a particular load

To determine the needed motor power, use the following formula:

$$P_{MOTOR} > P_{LOAD} + P_{ACCEL/DECEL}$$

The power of the motor must be greater than the sum of the power required by the load and the power required by the machine's accelerations and decelerations.



F. 6/1

Constant power required from the motor for a load regardless of the load.

T. 6/1 Constant motor power demanded by a load.

Constant motor power	
Load type	Constant power, regardless of speed
Examples	Winding machines at constant tenstion Milling spindle Lathe spindle
Torque/Speed characteristics	The torque decreases from base speed on
Motor power	The rated power of the drive will be the one demanded by the load.

6.1.2 Power required by the load

The power demanded from a spindle motor in a turning or machining center is determined by the cutting power.

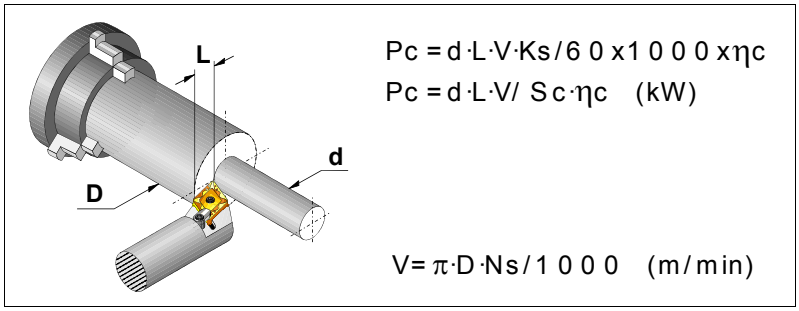
A good cutting process required the spindle motor to be working at constant power and with a power range between 1:3 and 1:5.

The powers used in cutting on a lathe, on a milling machine or on machining center with drilling are calculated using these formulae.

For a more accurate calculation of the power required, one must bear in mind different factors such as cutting oil, material, shape of the tools, hardness of the material machined, etc.

For lathe work, a cutting blade forces against the part to be machined, while this is turning. See figure **F. 6/2**.

The power required in this case **Pc** is calculated as follows:



F. 6/2

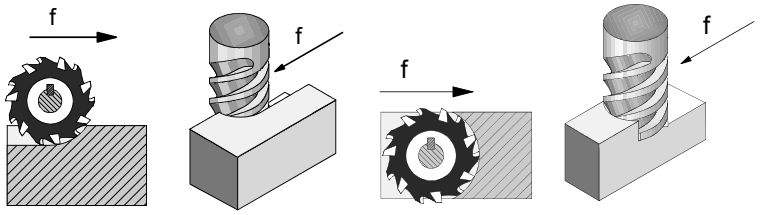
Machining for lathe. Cutting power.

where:

Symb.	**Description**	**Units**
Ks	Relative cutting resistance	N·mm²
d	Cutting depth	mm
L	Cutter length or feed per full rotation	mm
D	Diameter of the machine part	mm
Ns	Spindle turning speed	1/min
ηc	Mechanical efficiency (varies from 0.7 to 0.85)	non-dimensional
Sc	Cutting efficiency. Cutting volume per kilowatt every minute	(cm³/kW)/min

In the case of a milling machine, the cutter is mounted on the spindle itself and turns with this to cut the material. See figure **F. 6/3**.

The power required in this case **Pf** is calculated as follows:



$$Pf = d \cdot W \cdot f \cdot Ks / 60 \times 10002 \times \eta f$$

$$Pf = d \cdot W \cdot f / 10002 \cdot Sf \cdot \eta f \quad (kW)$$

F. 6/3

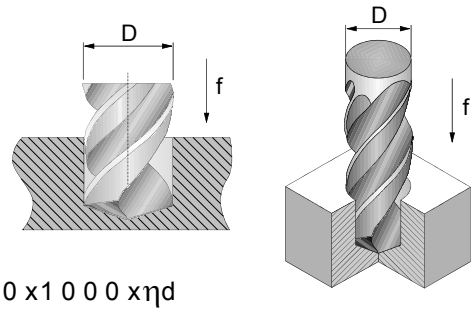
Machining for mill. Cutting power.

where:

Symb.	Description	Units
Ks	Relative cutting resistance	N·mm²
d	Cutting depth	mm
W	Cutting width	mm
f	Feedrate	mm/min
Ns	Spindle turning speed	rpm
ηf	Mechanical efficiency (varies from 0.7 to 0.8)	non-dimensional
Sf	Cutting efficiency. Cutting volume per kilowatt every minute	(cm³/kW)/min

In the case of a drill, the bit is mounted on the spindle itself and turns with this to drill the material. See figure **F. 6/4**.

Te power required in this case **Pd** is calculated as below:



$$Pd = 2\pi n \cdot M / 60 \times 100 \times 1000 \times \eta d$$

$$Pd = \pi D^2 f / 4 \times 1000 \cdot Sd \cdot \eta d \quad (kW)$$

F. 6/4

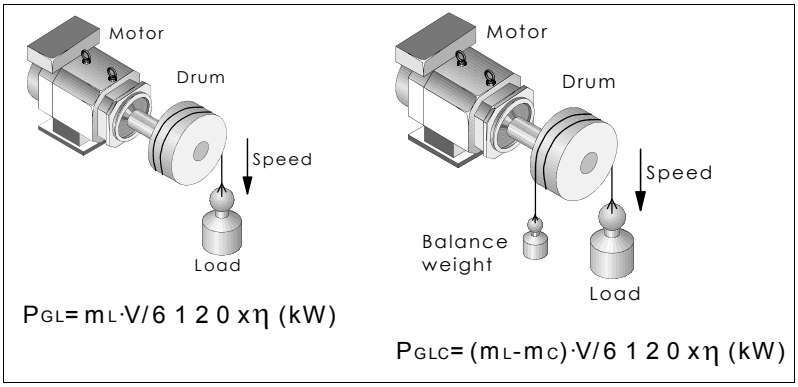
Drilling. Required power.

where:

Symb.	Description	Units
M	Drilling load torque	N·cm
n	Spindle turning speed	rpm
D	Hole diameter	mm
f	Feedrate	mm/min
ηd	Mechanical efficiency (varies from 0.7 to 0.85)	non-dimensional
Sd	Cutting efficiency. Cutting volume per kilowatt every minute	(cm³/kW)/min

In the event of governing a **gravitational load**, the power required depends very much on the presence on absence of balance weights. (crane or elevator). See figure **F. 6/5**.

The power required in this case, P_{GL} and P_{GLC} is calculated in the following way:



F. 6/5

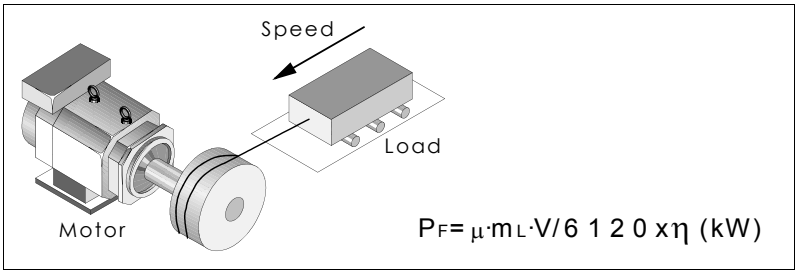
Gravitational load. Required power.

where:

Symb.	Description	Units
V	Linear speed	m/min
m_L	Load mass	kg
η	Mechanical efficiency	non-dimensional
m_C	Cutting efficiency	(cm³/kW)/min

Governing a **frictional load**, this is the case of horizontal movements such as a conveyor belt or a movable table, the required power depends on the friction coefficient μ. See figure **F. 6/6**.

The power required in this case P_F, is calculated as follows.



F. 6/6

Frictional load. Required power.

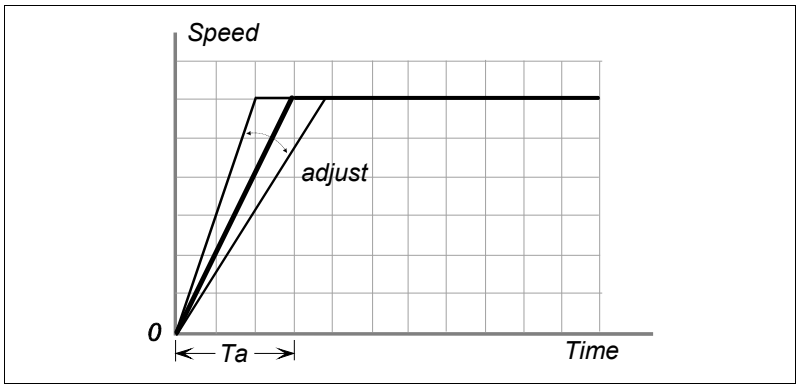
where:

Symb.	Description	Units
μ	Friction coefficiente	non-dimensional
m_L	Load mass	kg
η	Mechanical efficiency	non-dimensional
V	Linear speed	m/min

6.1.3 Power needed to accelerate or decelerate the spindle motor

There are three methods to control the acceleration and deceleration process of the machine spindle:

- Acceleration limited by time.



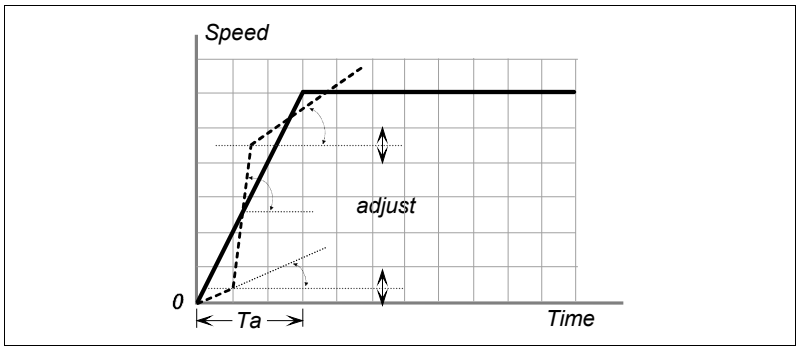
F. 6/7

Acceleration limited by time.

T. 6/2 Acceleration limited by time.

Method	Acceleration limited by time.
Control	Speed increases linearly in time until the command speed is reached.
Comment	The acceleration torque is constant.

- Different acceleration ramps depending on the speed reached.



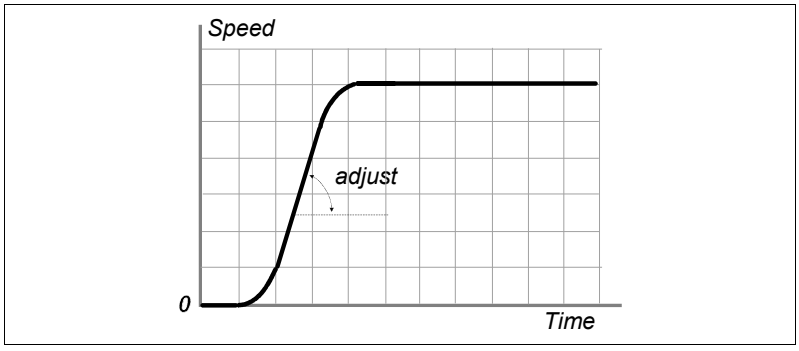
F. 6/8

Different accelerations depending on reached speed.

T. 6/3 Different accelerations depending on reached speed.

Method	Different accelerations depending on speed.
Control	Linear acceleration avoiding abrupt variations in transmitted torque.
Comment	Emulation of the square sine function for speed by using ramps.

- Limited acceleration and choke. Choke = (Δ acceleration / Δ t).



F. 6/9

Acceleration and choke limit.

T. 6/4 Acceleration and choke limit.

Method	Acceleration and choke limit.
Control	Progressive linear acceleration, avoiding abrupt variations of transmitted torque.
Comment	Approach square sine function (bell shape) for the speed.

The capability demanded from the motor is determined by the following formulas:

Capacity required by the motor in the constant torque area:
($0 < N_M < N_B$)

$$P_N = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M \cdot N_M^2}{1000 \cdot t} \quad (kW)$$

Capacity required by the motor in the constant torque and constant power area:
($0 < N_M < N_{max}$)

$$P_N = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M \cdot (N_M^2 + N_B^2)}{2000 \cdot t} \quad (kW)$$

where:

Symb.	Description	Units
J_M	Load inertia viewed from the motor shaft	kg·m²
P_N	Rated power at base speed	kW
N_{max}	Maximum motor speed	rpm
N_B	Motor base speed	rpm
N_M	Motor speed reached after a time period t	rpm
t	Duration of the acceleration until reaching N_M.	s

We will now give several examples of calculations using a mechanical specifications and for a standard motor. The results could vary from real ones through mechanical losses, fluctuations in mains voltage, or inaccuracies of mechanical data.

Example.

Data:

Acceleration time:

[1] Between 0 and 1500 rpm in 0.5 s

[2] Between 0 and 6000 rpm in 2.5 s

Motor inertia:

J motor= 0.13 kg·m²

Motor base speed:

N_B = 1500 rpm

Calculations:

[1] With speed between 0 and 1500 rpm.

$$P_N = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{J_M \cdot N_M^2}{1000 \cdot t}\ [kW] = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{0.13 \cdot 1500^2}{1000 \cdot 0.5} = 6.41\ [kW] \quad [1]$$

[2] With speed between 0 and 6000 rpm.

$$P_N = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{J_M\left[N_M^2 + N_B^2\right]}{2000 \cdot t}\ [kW] = \left[\frac{2\pi}{60}\right]^2 \cdot \frac{0.13[6000^2 + 1500^2]}{2000 \cdot 2.5} = 10.89\ [kW] \quad [2]$$

Calculation of acceleration and braking time

After selecting the mechanical characteristics and the power of the drive, the acceleration and braking time is calculated as follows:

Constant torque area:
($0 < N_M < N_B$)

$$t_1 = \frac{2\pi \cdot J_M \cdot N_M}{60 \cdot T_M} \quad (s)$$

Constant power area:
($N_B < N_M < N_{max}$)

$$t_2 = \frac{2\pi \cdot J_M \cdot (N_M^2 - N_B^2)}{120 \cdot T_M \cdot N_B} \quad (s)$$

Constant torque & power area:
($N_B < N_M < N_{max}$)

$$t_3 = (t_1 + t_2) = \frac{2\pi \cdot J_M \cdot (N_M^2 + N_B^2)}{120 \cdot T_M \cdot N_B} \quad (s)$$

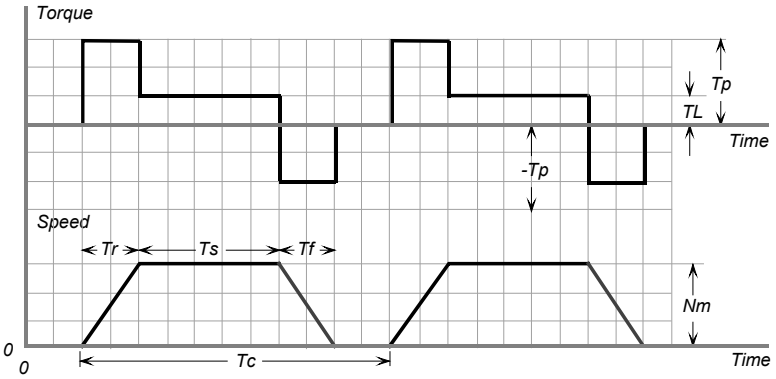
where:

Symb.	Description	Units
J_M	Load inertia viewed from the motor shaft.	kg·m²
T_M	Rated torque at base speed.	N·m
N_{max}	Maximum motor speed.	rpm
N_B	Motor base speed.	rpm
N_M	Motor speed reached after a time period t.	rpm

Calculation of power with intermittent load

Forming the drive to the right dimensions has to be done with the greatest care when the application involves a periodical starting and stopping operation, frequently repeated as in the case of threading with a miller.

For a cycle like the one shown in the **F. 6/10** which includes acceleration and stopping, the equivalent effective torque T_R of equation must be within the S1 dimension given for the drive torque.



$$T_R = \sqrt{\frac{T_P^2 \cdot (t_r + t_f) + T_L^2 \cdot t_s}{t_c}} \quad (Nm)$$

F. 6/10

Periodic start-stop operation

6.2 Technical characteristics

6.2.1 FM7-XXXX-XXXX-E01/E02 series

T. 6/5 Technical data. Assigning the drive to the corresponding motor model.

	Rated torque	Rated power		Spindle drive	
	Mn (S1)	Pn (S1)	Pn (S6-40%)	References	
	N·m	kW	kW	Modular	Compact
FM7-A037-□□□□-E01/E02	23.5	3.7	5.5	SPD 1.25	SCD 1.25A
FM7-A055-□□□□-E01/E02	35.0	5.5	7.7	SPD 1.25	SCD 1.25A
FM7-A075-□□□□-E01/E02	47.7	7.5	11.0	SPD 1.35	SCD 2.35
FM7-A090-□□□□-E01/E02	57.4	9.0	13.0	SPD 2.50	SCD 2.50
FM7-A110-□□□□-E01/E02	70.0	11.0	15.5	SPD 2.50	SCD 2.50
FM7-A150-□□□□-E01/E02	95.5	15.0	22.0	SPD 2.75	SCD 2.75
FM7-A185-□□□□-E01/E02	117.8	18.5	26.0	SPD 2.85	-
FM7-A220-□□□□-E01/E02	140.0	22.0	33.0	SPD 3.100	-
FM7-B120-□□□□-E01/E02	114.6	12.0	18.5	SPD 2.75	-
FM7-B170-□□□□-E01/E02	162.3	17.0	25.0	SPD 2.85	-
FM7-A300-□□□□-E01	191.0	30.0	45.0	SPD 3.150	-
FM7-B220-□□□□-E01	210.0	22.0	33.0	SPD 3.100	-
FM7-A370-□□□□-E01	235.0	37.0	56.0	SPD 3.200	-
FM7-B280-□□□□-E01	267.4	28.0	42.0	SPD 3.150	-
FM7-A510-□□□□-E01/E02	325.0	51.0	71.0	SPD 3.200	-
FM7-C215-□□□□-E01/E02	410.6	21.5	29.0	SPD 3.150	-
FM7-C270-□□□□-E01/E02	515.7	27.0	37.0	SPD 3.200	-
FM7-E600-C□B□-E01	458.4	60.0	80.0	SPD 3.200	-

T. 6/6 Technical data.

	Vbase	Rated current	Inertia	Max. speed		Current without	Rated voltage	Mass
	n_N	In (S1)	J	nmax		Io	Un	P
				E01	E02			B/P
	1/min	A	kg·cm²	1/min		A	V	kg
FM7-A037-□□□□-E01/E02	1500	12.4	140	9000	12000	8.45	288.6	47/49
FM7-A055-□□□□-E01/E02	1500	14.6	210	9000	10000	7.34	304.1	52/56
FM7-A075-□□□□-E01/E02	1500	19.8	260	9000	10000	9.47	301.7	59/64
FM7-A090-□□□□-E01/E02	1500	25.0	330	9000	10000	12.04	282.1	68/73
FM7-A110-□□□□-E01/E02	1500	28.0	690	9000	10000	13.54	302.9	94/110
FM7-A150-□□□□-E01/E02	1500	39.4	690	8000	9000	19.51	297.6	94/110
FM7-A185-□□□□-E01/E02	1000	35.0	890	8000	9000	20.96	286.6	120/130
FM7-A220-□□□□-E01/E02	1500	47.5	890	8000	9000	24.98	305.0	120/130
FM7-B120-□□□□-E01/E02	1000	61.4	1080	8000	9000	36.07	291.1	135/145
FM7-B170-□□□□-E01/E02	1000	47.3	1080	8000	9000	24.92	284.7	135/145
FM7-A300-□□□□-E01	1500	82.1	2310	6500	-	43.20	279.7	220/230
FM7-B220-□□□□-E01	1000	64.9	2310	6500	-	35.46	267.3	220/230
FM7-A370-□□□□-E01	1500	90.0	2660	6500	-	35.26	293.1	250/260
FM7-B280-□□□□-E01	1000	78.2	2660	6500	-	38.16	269.0	250/260
FM7-A510-□□□□-E01/E02	1500	115.2	4730	5000	6000	43.83	314.3	340/350
FM7-C215-□□□□-E01/E02	500	87.9	4730	5000	6000	36.73	190.3	340/350
FM7-C270-□□□□-E01/E02	500	117.0	5840	5000	6000	48.18	177.5	380/390
FM7-E600-C□B□-E01	1250	117.4	8720	5000	-	53.49	370.4	525/540

6.2.2 FM9-XXXX-C5CX-E01-X series

T. 6/7 Technical data. Assigning the drive to the corresponding motor model.

	Rated torque	Rated power	Spindle drive	Power supply
	Mn (S1/S6-40%)	Pn (S1/S6-40%)	References	References
	N·m	kW		
FM9-B037-C5C☐-E01	350.0/426.0	37/45	SPD 3.150	RPS-45
FM9-B055-C5C☐-E01-A	525.2/687.5	55/72	SPD 3.200	RPS-75
FM9-B071-C5C☐-E01	678.0/ -	71/-	SPD 3.250	RPS-80
FM9-A100-C5C☐-E01	636.6/ -	100/-	*	
FM9-B113-C5C☐-E01	1079.0/ -	113/-	*	
FM9-A130-C5C☐-E01	827.6/ -	130/-	*	

* See the drive associated with the motor in the **"man_drive_ct"** manual.

T. 6/8 Technical data.

	Vbase	Rated current	Inertia	Vmax	Current without	Voltage without	Mass
	n_N	In (S1)	J	nmax	Io	Vo	P
				E01			B+P
	1/min	A	kg·cm²	1/min	A	V	kg
FM9-B037-C5C☐-E01	1000	74.7	3000	5000	42.0	275	265
FM9-B055-C5C☐-E01-A	1000	104.4	6900	5000	39.4	350	440
FM9-B071-C5C☐-E01	1000	134.8	14790	4500	38.6	350	680
FM9-A100-C5C☐-E01	1500	189.9	14790	4500	75.2	350	635
FM9-B113-C5C☐-E01	1000	214.6	23260	4500	81.1	350	860
FM9-A130-C5C☐-E01	1500	246.9	19300	4500	106.0	350	745

6.2.3 FM7-DXXX-S1D0-E03 series

T. 6/9 Technical data. Assigning the drive to the corresponding motor model.

	Rated torque		Rated power				Drive
	Mn (S1)		Pn (S1)		Pn (S6-40%)		Modular
	⅄	Δ	⅄	Δ	⅄	Δ	
	N·m		kW		kW		
FM7-D055-S1D0-E03	35.0	13.1	5.5	5.5	7.7	10.0	SPD 1.35
FM7-D075-S1D0-E03	47.7	17.9	7.5	7.5	11.0	13.0	SPD 2.50
FM7-D110-S1D0-E03	70.0	26.3	11.0	11.0	15.5	20.0	SPD 2.75
FM7-D150-S1D0-E03	95.5	35.8	15.0	15.0	22.0	26.0	SPD 2.85
FM7-D185-S1D0-E03	117.8	44.2	18.5	18.5	26.0	32.0	SPD 2.85
FM7-D220-S1D0-E03	140.1	52.5	22.0	22.0	33.0	40.0	SPD 3.100

T. 6/10 Technical data.

	Vbase		Rated current				Inertia	Vmax	Mass
	n_N		In (S1)		In (S6-40%)		J	nmax	P
	⅄	Δ	⅄	Δ	⅄	Δ			B
	1/min	1/min	A	A	A	A	kg·cm²	1/min	kg
FM7-D055-S1D0-E03	1500	4000	20.3	20.7	26.2	27.6	210	15000	67
FM7-D075-S1D0-E03	1500	4000	26.5	25.8	35.7	34.5	260	15000	74
FM7-D110-S1D0-E03	1500	4000	38.0	40.0	50.0	51.9	690	12000	110
FM7-D150-S1D0-E03	1500	4000	46.4	45.7	63.3	62.3	690	12000	110
FM7-D185-S1D0-E03	1500	4000	49.2	49.2	63.0	70.5	890	12000	135
FM7-D220-S1D0-E03	1500	4000	62.3	61.7	82.5	86.4	1080	12000	150

6.2.4 FM7-DXXX-S1D0-HS3 series

T. 6/11 Technical data. Assigning the drive to the corresponding motor model.

	Rated torque		Rated power				Drive
	Mn (S1)		Pn (S1)		Pn (S6-40%)		Modular
	⅄	Δ	⅄	Δ	⅄	Δ	
	N·m		kW		kW		
FM7-D075-S1D0-HS3	47.7	17.9	7.5	7.5	11.0	13.0	SPD 2.50
FM7-D110 -S1D0 HS3	70.0	26.3	11.0	11.0	15.5	20.0	SPD 2.75
FM7-D185-S1D0-HS3	117.8	44.2	18.5	18.5	26.0	32.0	SPD 2.85
FM7-D220-S1D0-HS3	140.1	52.5	22.0	22.0	33.0	40.0	SPD 3.100

T. 6/12 Technical data.

	Vbase		Rated current				Inertia	Max. speed	Mass
	n_N		In (S1)		In (S6-40%)		J	nmax	P
	⅄	Δ	⅄	Δ	⅄	Δ			B
	1/min	1/min	A	A	A	A	kg·cm²	1/min	kg
FM7-D075-S1D0-HS3	1500	4000	26.5	25.8	35.7	34.5	260	15000	77
FM7-D110-S1D0-HS3	1500	4000	38.0	40.0	50.0	51.9	690	12000	115
FM7-D185-S1D0-HS3	1500	4000	49.2	49.2	63.0	70.5	890	12000	140
FM7-D220-S1D0-HS3	1500	4000	62.3	61.7	82.5	86.4	1080	12000	155

⅄ Y (star) connection of the stator winding.
Δ Delta (triangle) connection of the stator winding.

6.3 Spindle drive selection

Once the necessary motor model has been selected following the selection criteria, one must determine the reference of the modular spindle drive SPD associated with the motor. Check the technical characteristics table of the motor, given in the previous section that shows the drive associated with the motor in its last columns for modular SPD drives and for compact SCD drives.

The data to be checked when selecting a modular SPD drive for FM7 motor series (E01, E02, E03 and HS3) or FM9 motor series (E01) are:

- The value 0.7 x In (S1) of the drive must be higher than or equal to the magnetizing current (or without load) of the motor.
- The current In (S1) of the drive must be higher than or equal to the rated current of the motor.
- The current I (S6-40%) of the drive must be higher than or equal to the current I (S6-40%) of the motor.

  NOTE. This condition may not be required depending on the application.
- The Imax current supplied by the drive must be enough for the spindle to accelerate to its maximum work speed in the required amount of time.

T. 6/13 Technical data. FM7. E01/E02 series.

Motor	Current (A)			Drive	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	0.7x In	In (S1)	IS6-40%
FM7-A037-□□□□-E01/E02	8.45	12.4	15.8	SPD 1.25	11.2	16.0	20.8
FM7-A055-□□□□-E01/E02	7.34	14.6	18.9	SPD 1.25	11.2	16.0	20.8
FM7-A075-□□□□-E01/E02	9.47	19.8	27.0	SPD 1.35	16.2	23.1	30.0
FM7-A090-□□□□-E01/E02	12.04	25.1	33.6	SPD 2.50	21.7	31.0	40.3
FM7-A110-□□□□-E01/E02	13.54	27.9	36.5	SPD 2.50	21.7	31.0	40.3
FM7-A150-□□□□-E01/E02	19.51	39.3	52.8	SPD 2.75	29.0	42.0	54.6
FM7-A185-□□□□-E01/E02	24.98	47.4	61.5	SPD 2.85	35.0	50.0	65.0
FM7-A220-□□□□-E01/E02	36.07	61.4	81.3	SPD 3.100	49.0	70.0	91.0
FM7-B120-□□□□-E01/E02	20.96	35.0	47.5	SPD 2.75	29.0	42.0	54.6
FM7-B170-□□□□-E01/E02	24.92	47.2	64.1	SPD 2.85	35.0	50.0	65.0
FM7-A300-□□□□-E01	43.20	82.1	113.2	SPD 3.150	63.0	90.0	117.0
FM7-B220-□□□□-E01	35.46	64.9	89.5	SPD 3.100	49.0	70.0	91.0
FM7-A370-□□□□-E01	35.26	89.9	127.9	SPD 3.200	84.7	121.0	157.3
FM7-B280-□□□□-E01	38.16	78.2	109.0	SPD 3.150	63.0	90.0	117.0
FM7-A510-□□□□-E01/E02	43.83	115.1	153.2	SPD 3.200	84.7	121.0	157.3
FM7-C215-□□□□-E01/E02	36.73	87.8	114.7	SPD 3.150	63.0	90.0	117.0
FM7-C270-□□□□-E01/E02	48.18	116.9	153.2	SPD 3.200	84.7	121.0	157.3
FM7-E600-C□□□-E01	53.49	117.4	150.4	SPD 3.200	84.7	121.0	157.3

NOTE. In many applications, it is possible to associate the FM7-A370-□□□□-E01 motor with an SPD 3.150 drive.

T. 6/14 Technical data. FM9. E01 series. Y (star) connection.

Motor	Current (A)			Drive	Power supply	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	Ref.	0.7xIn	In (S1)	IS6-40%
FM9-B037-C5C□-E01	42.0	74.7	89.7	SPD 3.150	RPS-45	63.0	90.0	117.0
FM9-B055-C5C□-E01-A	39.4	104.4	146.2	SPD 3.200	RPS-75	84.7	121.0	157.3
FM9-B071-C5C□-E01	38.6	134.8	-	SPD 3.250	RPS-80	94.5	135.0	*
FM9-A100-C5C□-E01	75.2	189.9	-	*	*	*	*	*
FM9-B113-C5C□-E01	81.1	214.6	-	*	*	*	*	*
FM9-A130-C5C□-E01	106.0	246.9	-	*	*	*	*	*

* See the drive associated with the motor in the “man_drive_ct” manual.

Note that, with FM9 motors larger than the B055:

- the «FM9 motor + associated drive» combination is designed to work in duty cycle S1.
- a torque overload at high speed is allowed depending on the maximum current allowed for the combination (power supply+drive). To estimate its value, use the smallest rated power of the drive and that of the power supplied minus 7 %.

Also keep in mind that, with FM9 motors larger than the B037, the DC BUS must be configured at 675 V DC (for RPS power supplies) in order to obtain the graph of rated power at high speed.

T. 6/15 Technical data. FM7. E03 series. Y (star) connection.

	Current (A)			Drive	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	0.7x In	In (S1)	IS6-40%
FM7-D055-S1D0-E03	9.8	20.3	26.2	SPD 1.35	16.1	23.1	30.0
FM7-D075-S1D0-E03	12.7	26.5	35.7	SPD 2.50	21.7	31.0	40.3
FM7-D110-S1D0-E03	18.7	38.0	50.0	SPD 2.75	29.0	42.0	54.6
FM7-D150-S1D0-E03	22.6	46.4	63.3	SPD 2.85	35.0	50.0	65.0
FM7-D185-S1D0-E03	28.5	49.2	63.0	SPD 2.85	35.0	50.0	65.0
FM7-D220-S1D0-E03	37.4	62.3	82.5	SPD 3.100	49.0	70.0	91.0

T. 6/16 Technical data. FM7. E03 series. Delta (triangle) connection.

	Current (A)			Drive	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	0.7x In	In (S1)	IS6-40%
FM7-D055-S1D0-E03	15.5	20.7	27.6	SPD 1.35	16.1	23.1	30.0
FM7-D075-S1D0-E03	19.2	25.8	34.5	SPD 2.50	21.7	31.0	40.3
FM7-D110-S1D0-E03	32.7	40.0	52.0	SPD 2.75	29.0	42.0	54.6
FM7-D150-S1D0-E03	32.7	45.7	62.3	SPD 2.85	35.0	50.0	65.0
FM7-D185-S1D0-E03	32.0	49.2	70.5	SPD 2.85	35.0	50.0	65.0
FM7-D220-S1D0-E03	44.5	61.7	86.4	SPD 3.100	49.0	70.0	91.0

T. 6/17 Technical data. FM7. HS3 series. Y (star) connection.

	Current (A)			Drive	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	0.7x In	In (S1)	IS6-40%
FM7-D075-S1D0-HS3	12.7	26.5	35.7	SPD 2.50	21.7	31.0	40.3
FM7-D110-S1D0-HS3	18.7	38.0	50.0	SPD 2.75	29.0	42.0	54.6
FM7-D185-S1D0-HS3	28.5	49.2	63.0	SPD 2.85	35.0	50.0	65.0
FM7-D220-S1D0-HS3	37.4	62.3	82.5	SPD 3.100	49.0	70.0	91.0

T. 6/18 Technical data. FM7. HS3 series. Delta (triangle) connection.

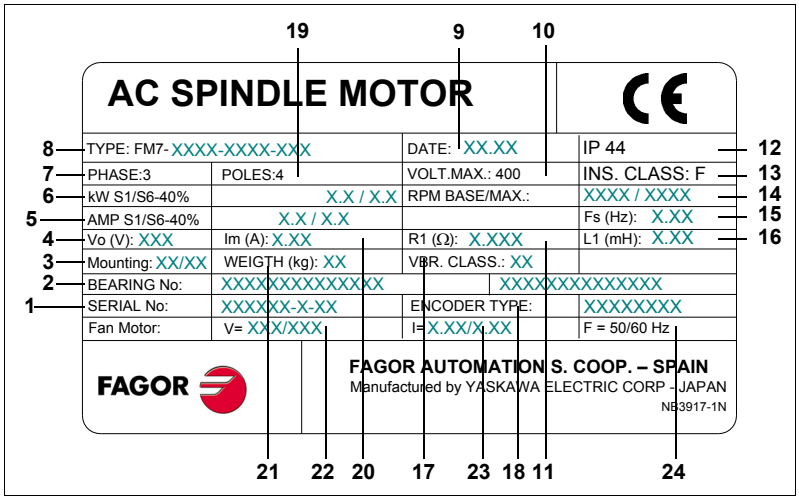
	Current (A)			Drive	Current (A)		
	Io	In (S1)	IS6-40%	Ref.	0.7x In	In (S1)	IS6-40%
FM7-D075-S1D0-HS3	19.2	25.8	34.5	SPD 2.50	21.7	31.0	40.3
FM7-D110-S1D0-HS3	32.7	40.0	52.0	SPD 2.75	29.0	42.0	54.6
FM7-D185-S1D0-HS3	32.0	49.2	70.5	SPD 2.85	35.0	50.0	65.0
FM7-D220-S1D0-HS3	44.5	61.7	86.4	SPD 3.100	49.0	70.0	91.0

For further information on the currents of the modular SPD spindle drives and their duty cycles, see chapter **3. DRIVES** of the “man_dds_hard_pdf” servo manual.

6.4 Characteristics plate

FM7 MOTOR

The FM7 spindle motor series carry the following characteristics plate:



F. 6/11

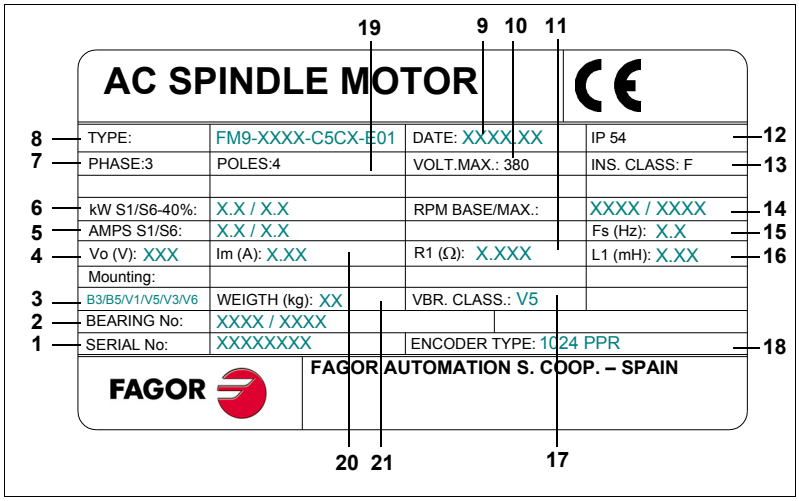
Characteristics plate of the FM7 motors.

This characteristics plate of the motor is located on the left side of the motor viewed from its shaft. The items shown on this plate are:

1	Serial Nr.
2	Bearing number: Load side / fan side
3	Mounting type
4	Voltage without load
5	Rated currents in S1/S6-40%
6	Rated powers in S1/S6-40%
7	Nr of phases
8	Motor model reference
9	Manufacturing year/month
10	Maximum voltage
11	Stator winding resistance per phase
12	Protection degree
13	Insulation class
14	Base speed / maximum speed
15	Slip frequency
16	Stator dispersion inductance per phase
17	Level of vibration
18	Type of encoder
19	Nr of poles
20	Magnetizing current
21	Mass
22	Fan supply voltage at 50/60 Hz
23	Fan supply current at 50/60 Hz
24	Frequency of the fan supply voltage

FM9 MOTOR

The corresponding series of FM9 spindle motors carry the following characteristics plate:



F. 6/12

Characteristics plate of the FM9 motors.

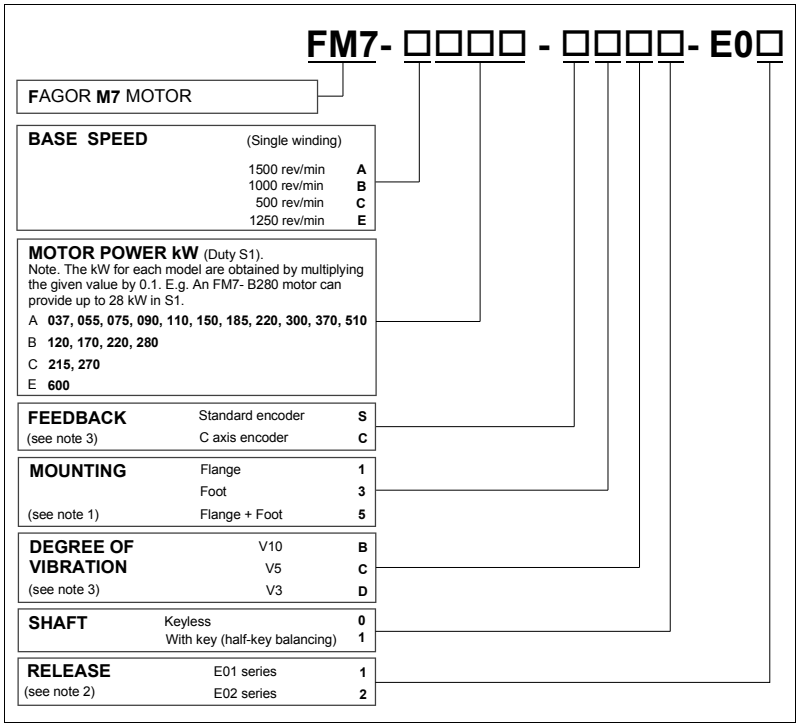
This characteristics plate of the motor is located on the right side of the motor viewed from its shaft. The items shown on this plate are:

1	Serial Nr.
2	Bearing number: Load side / fan side
3	Mounting type
4	Voltage without load
5	Rated currents in S1/S6-40%
6	Rated powers in S1/S6-40%
7	Nr of phases
8	Motor model reference
9	Manufacturing year/month
10	Maximum voltage
11	Stator winding resistance per phase
12	Protection degree
13	Insulation class
14	Base speed / maximum speed
15	Slip frequency
16	Stator dispersion inductance per phase
17	Level of vibration
18	Encoder pulses per turn
19	Nr of poles
20	Magnetizing current
21	Mass

6.5 Sales reference

FM7 MOTOR

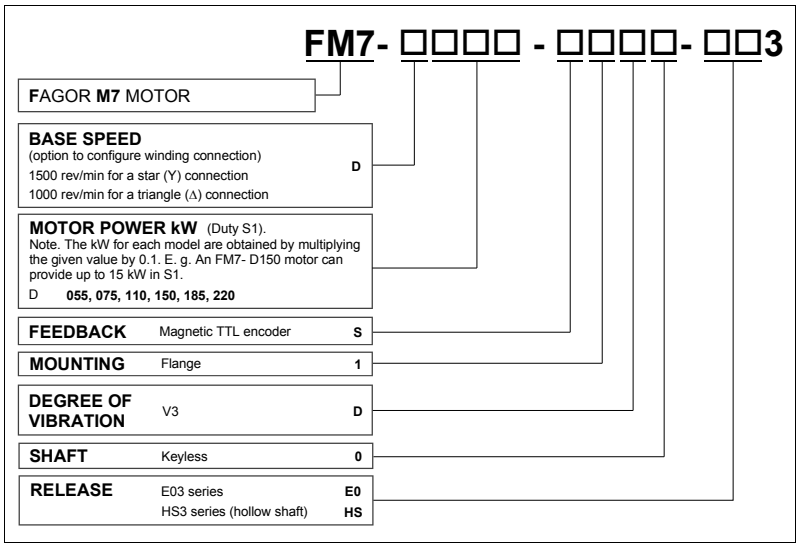
The sales reference of each motor model is determined in a set of blocks showing letters and numbers whose meaning is:



F. 6/13

FM7 motor model name. E01/E02 series.

NOTE 1. The “flange+foot” mount type comes in all models except A037, A055, A075 and A090. **NOTE 2.** Models A300, A370, B220, B280 and E600 are not available for the E02 series. **NOTE 3.** E600 models can only have the C axis option for feedback and V10 vibration degree.



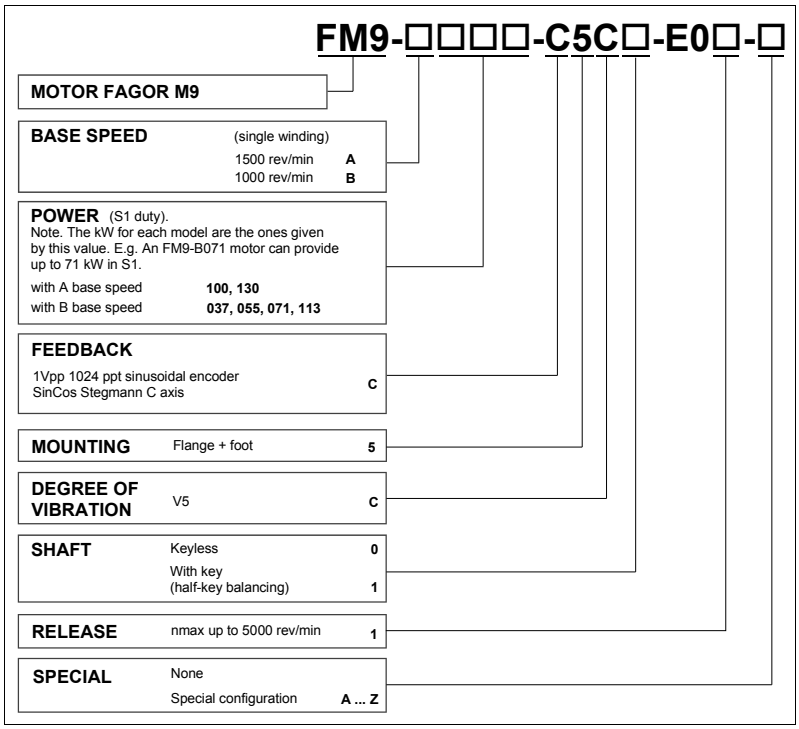
F. 6/14

FM7 motor model name. Series E03/HS3.

NOTE. The D055 and D150 models will not be available in the HS3 series.

FM9 MOTOR

The sales reference of each motor model is determined in a set of blocks showing letters and numbers whose meaning is:



F. 6/15

FM9 motor model name. E01 series.

Special configurations.
Motor model FM9-B055-C5C□-E01-A. Smaller shaft extension diameter, 65 mm.

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