SIEMENS

SIMODRIVE
1FN1- and 1FN3-SL-type linear motors

Configuration Manual

Valid for

Motor	*Drive Converters*
1FN1	SIMODRIVE 611digital/611universal
1FN3-SL	SIMODRIVE 611digital/611universal

Edition 01.06

SIMODRIVE® Documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each version is indicated by the code in the "Remarks" columns.

Status code in the "Remarks" column:

A .... New documentation.

B .... Unrevised reprint with new order number

C .... Revised edition with new version.

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Starting in April 2006, this manual will be included in the documentation on CD ROM (DocOnCD)

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www.siemens.com/motioncontrol

This publication was produced with MS Word 2000.

The controller may support functions that are not described in this documentation. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

Although we have checked the contents of this publication for agreement with the hardware and software described, differences cannot be totally ruled out. Since deviations cannot be precluded entirely, we cannot guarantee complete conformance. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. We welcome any suggestions for improvement.

We reserve the right to make technical changes.

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Preface

This document is part of the Technical Customer Documentation which has been developed for the SIMODRIVE system. All of the documents are available individually. The documentation list, which includes all Advertising Brochures, Catalogs, Overviews, Short Descriptions, Operating Instructions and Technical Descriptions with Order No., ordering address and price can be obtained from your local Siemens office.

This document does not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

We would also like to point out that the contents of this document are neither part of nor modify any prior or existing agreement, commitment or contractual relationship. The sales contract contains the entire obligation of Siemens. The warranty conditions specified in the contract between the parties is the sole warranty of Siemens. Any statements contained herein neither create new warranties nor modify the existing warranty.

Objectives

This Planning Guide provides

- Basic information about the implementation of linear motors in machine tools and automation systems
- Information about planning and designing systems including linear motors
- 1FN1 product specifications
- 1FN3-type (1FN3-SL) peak-load motors specifications

It is thus intended for planning engineers designing linear motor based drives, electricians, technicians, and service personnel.

Guidelines for Use

This manual is divided into several sections whose main topics are listed immediately following the cover sheet:

- Safety Guidelines (!)
- General Information about 1FN1 and 1FN3 (ALL) Linear Motors
- 1FN1-type (1FN1) Motors
- 1FN3-type (1FN3) Peak-Load Motors
- General Information about Connection Systems (CON)
- Appendix (ABC)

Each of the indicated sections begins with a table of contents listing the individual chapters of each section.

The header on every page indicates the version, the section title, and the number and title of the respective chapter. The footer contains consecutive page numbers.

For better orientation this document also includes an index and bibliography.

Special Notes

Besides the Danger and Warning Concept explained in chapter 1, this documentation also contains additional notes:

Important

!

This symbol is used in the documentation if reference is made to important information and data.

Note

in this document indicates important information about the product or the respective part of the documentation that is essential to highlight.

Manufacturer recommendations

This section contains third-party product recommendations whose general suitability we know. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or dictates. We cannot accept any liability for the quality and properties/features of third-party products.

For contact information of the listed manufacturers see the Appendix B.

Dimensions

All dimensions are subject to production-related effects. This is the reason why they cannot be guaranteed or only within the specified tolerances.

Information about this Printed Edition

This Planning Guide is designed for double-sided printing. It can be printed in black and white without the risk of data loss.

Contact Addresses in Case of Questions

If you have any questions, please contact the following Hotline:

- Phone.: +49 (0) 180 50 50–222
- Fax: +49 (0) 180 50 50–223
- Internet: http://www.siemens.com/automation/support-request

Please send any questions about the documentation (e g. suggestions for improvement, corrections) to the following fax number or e-mail address:

- Fax: +49 (0) 9131 98–63315
- Fax form: Refer to the correction sheet at the end of the document
- E-mail: motioncontrol.docu@siemens.com

Additional support

We also offer introductory courses to help you familiarize yourself with the implementation and commissioning of linear motors. For additional information, contact your regional training center or the central training center in D-90027 Nuremberg, phone +49 (0)911/895-3202.

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Notes

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Safety Guidelines

! Notes

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Notes

1 Danger and Warning Concept

The following signs are used in this documentation to alert you to dangers.

Danger

This symbol appears whenever death, serious bodily injury or property damage **will occur** if you fail to take the necessary precautions.

Warning

This symbol appears whenever death, serious bodily injury or property damage **may occur** if you fail to take the necessary precautions.

Caution

This symbol appears whenever minor bodily injury or property damage **may occur** if you fail to take the necessary precautions.

Caution

This warning (without the warning triangle) means that property damage **may occur** if you fail to take the necessary precautions.

Attention

This warning means that failure to heed the instructions **can** lead to an undesirable result or condition.

■

2 General Safety Guidelines

!

These safety guidelines apply for handling linear motors and their components. Please read this chapter carefully in order to avoid accidents and/or property damage.

Danger

⚠ **There is a danger of death, serious bodily injury, and/or property damage if the safety guidelines and instructions are not heeded and complied with.**

It is imperative to observe the safety guidelines in this Planning Guide – also the very specific safety guidelines in the individual chapters!

Observe all warning and instruction signs!

Make sure that your end product satisfies all the pertinent standards and legal specifications! The relevant applicable national, local, and machine-specific safety regulations and requirements must also be taken into account!

In addition to the safety guidelines included in this Planning Guide, the detailed specifications in the catalogs and offers also apply to the special motor versions.

When working with the converter system, be sure to follow the respective operating instructions!

2.1 Personnel Requirements

Qualified personnel in the sense of this publication and the warnings on the product refers to persons familiar with the installation, assembly, commissioning, and operation of the product and appropriately qualified to perform the tasks assigned to them through:

- training or instruction and authorization to switch circuits and devices on and off, earth and label them according to safety standards
- training or instruction according to safety standards in the care and use of appropriate safety equipment
- training in first aid measures

Danger

⚠ **There is danger of death, serious bodily injury, and/or property damage when untrained personnel is allowed to handle linear motors and/or their components.**

Only personnel familiar with and observing the safety guidelines are allowed to handle linear motors and their components.

Installation, commissioning, operation, and maintenance may only be performed by qualified, trained and instructed personnel. The personnel must be thoroughly familiar with the content of this Guide.

In case of danger of crushing due to strong magnetic fields (see chapter 2.3), all work must be performed by at least two persons.

Important

!

Make sure that the information about the sources of danger and the safety measures is available at all times! Keep all the descriptions and safety guidelines concerning three-phase linear motors and their components if possible!

All descriptions and safety guidelines can also be requested from the motor manufacturer.

!

2.2 Use for the Intended Purpose

Danger

⚠

There is a danger of death, serious bodily injury, and/or serious property damage when linear motors or their components are used for a purpose for which they were not intended.

Linear motors are designed for industrial or commercial machines. They comply with the norms stated in the Declaration of Conformity. It is prohibited to use these products in areas where there is a risk of explosion (Ex-zone) unless they are designed expressly for this purpose (observe the separately enclosed additional instructions where applicable). If increased demands (e.g. touch protection) are made in special cases – for use in non-commercial systems – these conditions must be ensured on the machine side during installation.

Linear motors and their components may only be used for the applications specified by the manufacturer. Please contact your Siemens branch if you have any questions on this matter.

Special versions and design variants whose specifications vary from the linear motors described herein are subject to consultation with the manufacturer.

The motors are designed for an ambient temperature range of -5° C to +40° C. Any alternative requirements specified on the rating plate must be noted! The on-site conditions must comply with the rating plate specifications and the condition specifications contained in this Planning Guide.

Note

The recommendations given in this Planning Guide are for third-party products which we know to be generally suitable. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or dictates. We cannot accept any liability for the quality and properties/features of third-party products.

Following the results of a risk analysis, additional protection equipment on the machine or the system is necessary to avoid endangering persons. With this, especially the programming, configuration, and wiring of the inserted I/O modules have to be executed, in accordance with the necessary risk analysis identified safety performance. It must be ensured that the device is correctly used.

The proper use of the device has to be verified with a function test on the system. With this, programming, configuration, and wiring errors can be identified. The test results must be documented, and, if required, entered into the relevant documents that prove safety.

2.3 Danger from Strong Magnetic Fields

!

Strong magnetic fields occur in the secondary sections of linear motors due to the permanent magnets they contain. The magnetic field strength of linear motors results exclusively from the magnetic fields of the secondary sections in the de-energized state. In addition, primary sections will produce electromagnetic fields during operation.

⚠ Danger

Strong magnetic fields can directly affect persons and cause damage.

The BGR B11 "Electromagnetic Fields" must be observed in the Federal Republic of Germany! In other countries the relevant applicable national and local regulations and requirements must be taken into account.

The handling of linear motors or secondary sections is generally prohibited for all persons with pacemakers, metallic implants, and foreign objects that conduct electricity or magnetism. A medical report is required for any exceptions to this ruling. Unique access controls must be put in place according to the magnetic fields at the place of work, and the boundaries of the permissible areas must be clearly identified.

Attraction Forces on Magnetizable Materials

Humans have no sensory organs for picking up strong magnetic fields and have no experience with them as a rule. Therefore, the magnetic attraction forces emanating from strong magnetic fields are often underestimated.

The magnetic attraction forces may be several kN in the vicinity of secondary sections (within a distance of less than 100 mm). – That is equivalent to crushing your foot with a weight of several 100 kg.

⚠ Danger

Strong attraction forces on magnetizable materials lead to a great danger of crushing in the vicinity of secondary sections (distance less than 100 mm).

Do not underestimate the strength of the attraction forces!

Do not carry any objects made of magnetizable materials (e. g. watches, steel or iron tools) and/or permanent magnets (e. g. another secondary section) close to a secondary section.

For the event of accidents when working with permanent magnets, the following objects must be on hand to free pinched body parts (hands, fingers, feet etc.):

- a hammer (about 3 kg) made of solid, non-magnetizable material
- two pointed wedges (wedge angle approx. 10° - 15°) made of solid, non-magnetizable material (e. g. hard wood)

⚠ Danger

Any movement of primary sections in relation to permanent magnets leads to induced voltages on the motor connectors. Electrical shock hazard!

Movement of primary sections in relation to secondary sections (and vice versa) must be avoided.

Caution

Magnetic fields can lead to loss of data on magnetic or electronic data media.

Do not carry any magnetic or electronic data media with you!

!

2.3.1 First Aid in the Case of Accidents Involving Permanent Magnets

- Stay calm!
- Press the EMERGENCY STOP if the machine is still on
- Administer/call for FIRST AID
- To free pinched parts of the body (hands, fingers, feet...) separate attracted parts!
  - Drive a wedge into the separating rift with the hammer
  - Free part of body (hand, finger, foot)...
- Call DOCTOR if necessary

2.4 Posting of Warning Signs

All danger areas must be identified by well-visible warning and prohibiting signs (pictograms) in the immediate vicinity of the danger. The associated texts must be available in the language of the country in which the product is used.

For all 1FN1- and 1 FN3-type secondary sections, warning and prohibiting signs are enclosed in the packaging in the form of permanent adhesive stickers. Be sure to attach them visibly on the sides of the secondary section track as close as possible to the motor.

Note

Do not attach the stickers on a secondary section or the secondary section cover! Stickers do not adhere well to these surfaces.

Table 2-1 and Table 2-2 list the enclosed warning and prohibiting signs and their meanings.

Table 2-1 Enclosed warning signs in compliance with BGV A8 and DIN 4844-2 and their meanings

Sign	Meaning	Sign	Meaning
	Warning strong magnetic field (D-W013)		Warning hand injuries (D-W027)

!

Table 2-2 Enclosed prohibiting signs according to BGV A8 and DIN 4844-2 and their meanings

Sign	Meaning	Sign	Meaning
	No pacemakers (D-P011)		No metal implants (D-P016)
	No metal objects or watches (D-P020)		No magnetic or electronic data media (D-P021)

■

3 Special Safety Guidelines

The perfect and safe operation of linear motors is dependent on proper transport, storage, installation, assembly, and maintenance as well as protection against soiling and contact with aggressive materials.

3.1 Guidelines for Storage and Transport

Danger

Improper storage and/or transport can cause death, serious bodily injury, and/or property damage.

Never store or transport unpacked linear motor components! Only use undamaged original packaging!

When transporting machines or machine parts with pre-assembled motors, protect the components from moving!

Follow the IATA regulations when transporting components in airplanes. In particular, secondary sections must always be transported in pairs.

The storage locations for secondary sections must be marked with pictograms, see Table 2-1 and Table 2-2.

Keep storage areas dry and protected from heat and cold.

Comply with the warning instructions on the packaging!

Wear safety shoes and work gloves!

The packaging of the direct drives and their components provides reliable protection during transport and storage especially against the strong magnetic forces of secondary sections.

!

Important

Keep the packaging of linear motors and their components where possible!

Original packaging can also be requested from the motor manufacturer.

3.2 Guidelines for Installation

Danger

You may have to work close by unpacked secondary sections when installing linear motors. The danger from strong magnetic fields is particularly high in this case.

Only remove the packaging from the motor components immediately prior to installation.

Never place metals on magnetic surfaces and vice versa!

Never use magnetizable tools. If such tools are required, they must be held firmly with both hands and moved slowly toward the three-phase linear motor.

Prevent unintentional movement of pre-assembled linear motors.

Only perform installation work in a disconnected, de-energized state. Electrical shock hazard!!

Caution

Sharp edges can cause cuts.

Wear work gloves!

Caution

Falling objects can injure feet.

Wear safety shoes!

Warning

Defective connection cables can cause electrical shock and/or property damage, e.g. by fire.

When installing, make sure the connection cables are:

- not damaged
- not under tension
- cannot be caught up in moving part,
- and that the minimum bending radius is adhered to.

3.3 Guidelines for Electrical Connection

!

Danger

Parts of electrical equipment and devices can be at hazardous voltages. There is an electrical shock hazard!

Observe the regulations for working on electrical installations! In particular, the following safety rules for working on electrical installations in accordance with DIN VDE-0105-100 must be observed:

- only work on de-energized installations
- switch off
- secure against switching back on
- make sure there is no current and voltage
- earth and short-circuit
- cover or cordon off adjacent live parts
- release for work
- connect PE conductor first and disconnect last!

All installations should be performed by a qualified electrician.

All circuits must meet the requirements of *safe electrical disconnection* in accordance with VDE 0160/EN 50178.

Danger

There is a danger of death, serious bodily injury (electrical shock) and/or property damage if linear motors are connected incorrectly.

Linear motors may only be connected according to the instructions. Direct connection of the motors to the three-phase current network is not permissible.

See the documentation of the converter system used!

3.4 Guidelines for Commissioning

Danger

There is a danger of death, serious bodily injury, and/or property damage if a machine is commissioned which does not meet the acknowledged safety requirements.

Commissioning is prohibited until such time as it is ensured that the machine installed in the three-phase linear motor satisfies the regulations of the Machine Directive 98/37/EC.

!

Danger
In case of unforeseeable movements of the motor, there is a danger of death, serious bodily injury (crushing), and/or property damage.

Never reach into the moving parts of the machine when it is switched on!

Keep persons away from moving parts and areas where there is a danger of crushing!

Ensure free axial travel!

Check the commutation before switching the unit on! Also observe the instructions of the used converter system!

Limit the motor currents!

Set the speed limit to low values!

Monitor the end positions of the motor!

Warning
The surface temperature of the motors may exceed 100 °C (212 °F). Danger of burns!

Make sure the cooling system is working properly (if applicable)!

Do not touch the motor directly during/after use!

Temperature-sensitive parts (electric cables, electronic components) must not be placed on hot surfaces.

Attention
The motor may overheat without temperature protection.

Before switching the unit on for the first time (for testing), check whether the temperature protection is effective!

3.5 Guidelines for Operation

Danger
Machine parts driven by linear motors pose a considerable danger of injury – e. g. crushing – due to the very high speed and acceleration and the low friction and self-locking characteristics.

Keep persons clear of all moving parts and areas of the axles where there is danger of crushing!

Caution
Improper operation can lead to serious property damage.

Check continuously whether the temperature protection is effective!

Keep the motor area free from foreign objects (chips, particles, liquids, oils, screws, tools, etc.)!

Listen for noise!

If there are accuracy problems with the work piece, check the freedom of movement and the current consumption of the motor. Accuracy problems may also have other causes, e.g. the machine design.

Make sure the cooling system is working properly (if applicable)!

3.6 Guidelines for Maintenance, Service, and Repair

3.6.1 Maintenance

!

Linear motors are almost maintenance-free. Observing the following instructions will prolong the life of your motor:

- Check for freedom of movement regularly.
- Clear foreign objects (e. g. chips) regularly from the motor area.
- Check the general condition of the motor components regularly.
- Check the current consumption in the defined test cycle

Since operating conditions differ greatly, no intervals for inspection and maintenance work can be specified.

⚠ Danger

There is a danger of death, serious bodily injury, and/or property damage when maintenance work is performed with the machine switched on.

Always switch off power to the machine before working on areas with moving parts!

All work on the electrical system may only be performed with the power disconnected!

⚠ Warning

The coolant and motor need some time to cool down. There is a danger of burns when working on the motor shortly after operation!

Do not work on the motor until you have made sure there is no danger of burns!

3.6.2 Service and Repair

⚠ Danger

There is a danger of death, serious bodily injury, and/or property damage when service and repair work is performed by inexperienced personnel.

All service and repair work on the motor must be performed by the SIEMENS Service Centers. For addresses of SIEMENS Service Centers see http://www.automation.siemens.com/partner/index.asp.

!

3.6.3 Guidelines for Inspecting the Insulation Resistance (High Voltage Test)

Warning
An insulation resistance inspection under high voltage conditions can damage the motor insulation!

For an insulation resistance inspection on a machine/system with 1FN1- and 1FN3-type motors or directly on the motors (such as installation inspection, preventative maintenance, troubleshooting) use only IEC 61557-1, IEC 61557-2, and IEC 61010-1 compliant inspection devices.

The inspection may only be carried out with a maximum direct current of 1000 V for a maximum time of 60 s! If a higher direct or alternating current is necessary for the machine/system inspection, all motor terminals must be disconnected before the inspection!

Please follow the operating instructions for the inspection device!

Inspections of the insulation resistance on individual motors must always be carried out as follows:

(1) Connect all high-voltage and temperature sensor connectors with each other; inspection current not to exceed DC 1000 V, 60 s against PE connection.

(2) Connect all temperature sensor connectors to the PE connector and all high-voltage connectors with each other; the inspection current must not exceed DC 1000 V, 60 s, high voltage against PE connector.

Each insulation resistance must be at least 10 MΩ, otherwise the motor insulation is defective.

3.7 Guidelines for Disposal

Danger
Death, serious bodily injury, and/or property damage may result from improper disposal of linear motors or their components (especially secondary sections).

Linear motors and their components must be disposed of properly, see chapter . Make particularly sure that secondary sections are completely demagnetized!

Direct drives and their components will be taken back by the manufacturer in the original packaging for proper disposal. Costs for transport and disposal will be charged to the sender.

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! Notes

General Information Regarding the 1FN1- and 1FN3-Type Linear Motors

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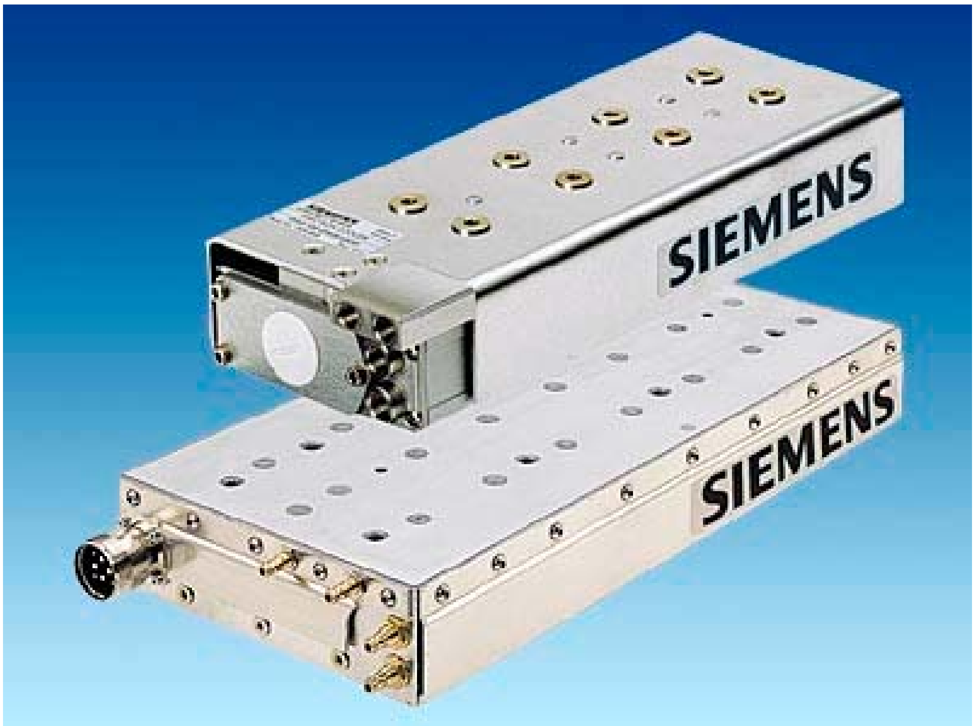

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4 System technology

4.1 System requirements

Linear motors of the product families 1FN1 and 1FN3 can be operated with converters of SIMODRIVE 611digital and SIMODRIVE 611universal series together with control systems according to Table 4-1.
The following conditions apply:

- The selection of the power unit depends on the rated current or maximum current of the motor.
- The linear motors are to be set up as feed drives.
- The encoder system depends on the application.

For the connection to these systems, see the CON section from page 347.

Table 4-1 possible control systems for the SIMODRIVE 611 digital and SIMODRIVE 611 universal HR converter series

	SIMODRIVE 611 digital	SIMODRIVE 611 universal HR
No control system	--	x
SINUMERIK 810D	x (with CCU 3)	--
SINUMERIK 840D	x	--
SINUMERIK 840Di	--	x
SIMATIC	--	x

The SIMODRIVE 611 converter system is dimensioned for direct operation on TN networks. For 1FN1- and 1FN3-type motors, the permissible rated voltages of TN networks according to Table 4-2 apply. Preferably, the motors should be operated at U_{ZK} = 600 V.

Table 4-2 Permissible rated voltages of TN networks for motors of the 1FN1 and 1FN3 product families and the resulting DC link and converter output voltages

Permitted mains voltage	Resulting DC link voltage U_{ZK}	Converter output voltage (effective value) U_{amax}
400 V	600 V (regulated) 540 V (unregulated)	425 V (regulated) 380 V (unregulated)
480 V	648 V (unregulated)	460 V (unregulated)

During operation on IT or TT networks, adaptation transformers that have been tailored to the system are available.

ALL

4.2 Configuration

Figure 4-1 shows a typical installation situation for linear motors.

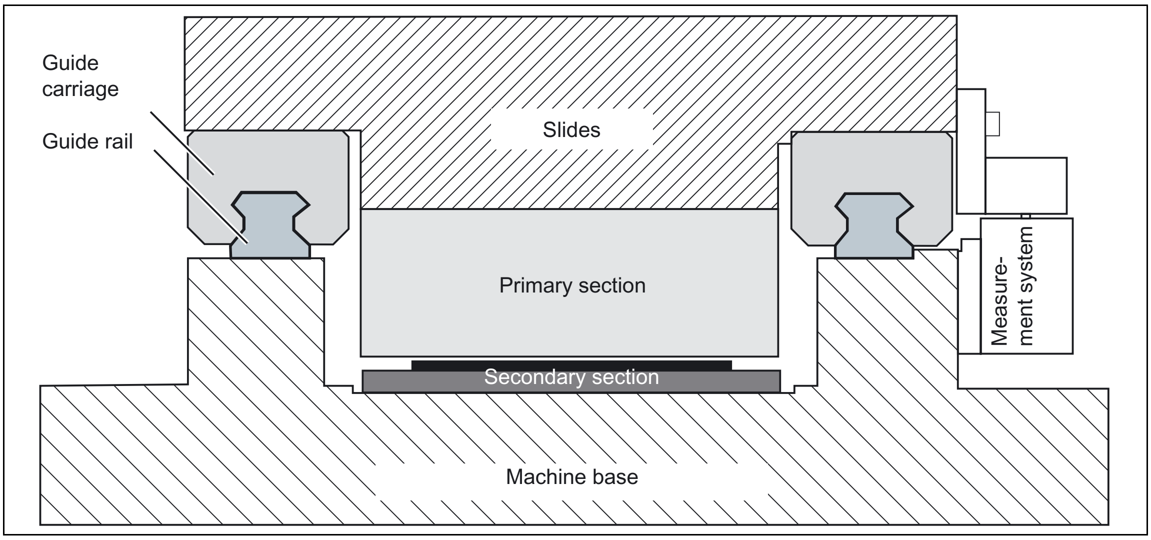

Figure 4-1 Typical installation situation of a single-sided motor with moving primary section

During commissioning, the motor must be adjusted in such a way that the positive voltage zero of the EMF $U_{U\text{-}Y}$ (Phase U against the start point) in the positive direction of movement coincides with the falling edge of the electrical pole angle Φ_{EL}. Figure 4-2 shows an example of this. The positive direction of movement (movement in case of the U-V-W phase sequence) results from the position of the connecting side of the primary section (see Figure 4-3).

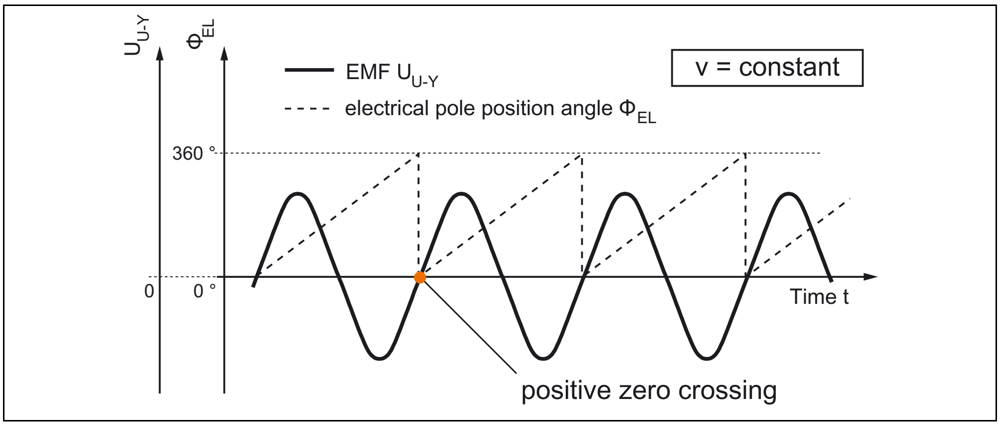

Figure 4-2 Example for the correct position of the electrical pole position angle Φ_{EL} in comparison with the EMF $U_{U\text{-}Y}$ curve

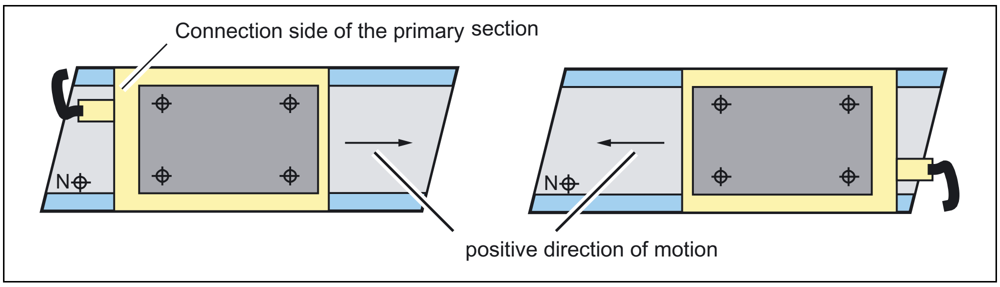

Figure 4-3 Positive direction of motion of the primary sections

To simplify the adjustment, the connection side of the primary section should point in the direction of the N-marking of the secondary section on which the primary section is currently located (see Figure 4-4). For this case, the RPU indicates the position for the correct adjustment.

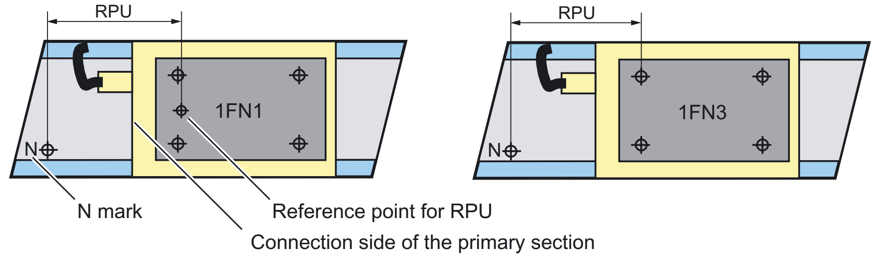

Figure 4-4 Standard position of the primary section in comparison with the secondary section track and RPU[1]

Figure 4-3 contains RPU for FN1-type motors and for peak-load motors of the 1FN3 product family.

Table 4-3 RPU for (peak-load) motors of the 1FN1 and 1FN3 product families

	RPU
1FN1072…076 standard winding	(53.5 + n·112.8) mm; n = 0,1,2…
1FN1072…076 inverse winding	(25.3 + n·112.8) mm; n = 0,1,2…
1FN1122…246	(80.5 + n·72) mm; n = 0,1,2…
1FN3050…150	(10 + n·30) mm; n = 0,1,2…
1FN3300…600	(13 + n·46) mm; n = 0,1,2…
1FN3900	(36 + n·46) mm; n = 0,1,2…

4.3 Temperature Monitoring

4.3.1 Temperature Monitoring Circuits

Two temperature monitoring circuits, Temp-F and Temp-S, are available for protecting the primary sections against impermissibly high thermal load and for monitoring the temperature. Both circuits are independent of each other. They are generally evaluated via the converter system. For exceptions, see chapter CON in the CON section.

Temp-F

The *temperature monitoring circuit* is used for monitoring the temperature and for a possible warning before a pending shutdown of the drive by Temp-S. It consists of temperature sensor KTY 84, which is located between two of three phase windings.

Temp-S

The *over temperature shutdown circuit* allows the temperature monitoring of each individual motor phase winding. This guarantees overload protection, even in case of an uneven current sourcing of the individual phases of a primary section or in case of the different loading of several primary sections. Temp-S consists of either temperature switches or PTC elements.

[1] For the precise position of the reference points for RPU, also see the dimensional drawings in Chapter 12 or Chapter 16.

Caution
Excessive thermal load leads to a destruction of the motor!

Use only Temp-S for motor protection! The use of Temp-F for motor protection is not permissible since not all phase windings of the motor are monitored.

Connection

ALL

⚠ Danger
The temperature monitoring circuits constitute a risk of electrical shock!

The circuits of Temp-F and Temp-S neither have "protective separation" between each other nor to the power circuits in accordance with VDE 0160/EN 50178.

The circuitry and connection technology of the temperature monitoring circuits is described in detail in chapter CON in the CON section.

4.3.2 Description of the temperature sensors used

KTY 84

KTY 84 is used as Temp-F for almost all primary sections of the 1FN1 and 1FN3 product families.[2] It has a progressive, approximately linear resistance-temperature characteristic curve (see 18.1). In addition, KTY 84 has a low thermal capacity and good thermal contact to the motor winding.

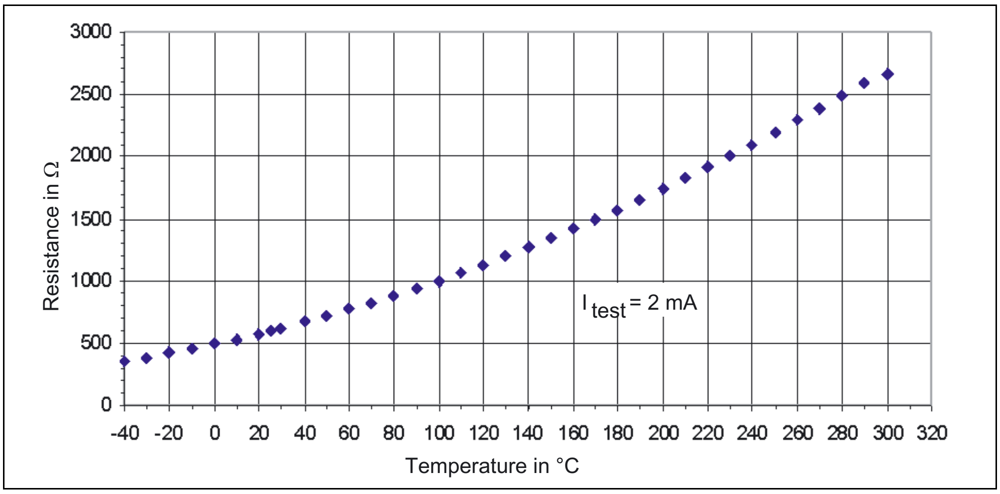

Figure 4-5 Characteristics of KTY 84

Technical data:

- Resistance when cold (20° C) approx. 580 Ω
- Resistance when hot (100° C) approx. 1000 Ω

Temperature switch

The temperature switches are used as Temp-S for primary sections of the 1FN1 product family (see chapter 9.4.1). They open if the temperature is too high and are series-connected.

[2] Exceptions: 1FN3xxx-…-0AA0

Technical data:

- Minimum current: 10 mA
- Maximum current: 1.6 A
- Rated voltage (AC): $U_{N,eff}$ = 250 V
- Resistance when closed: < 2 Ω

PTC elements

ALL

PTC elements are used as Temp-S for primary sections of the 1FN3 product family as triplets (see chapter 13.4.1). Every PTC element shows a sudden increase in the resistance in the area of the nominal response temperature ϑ_{NAT} (see Figure 4-6). It thus has a quasi-switching characteristic. Due to the low thermal capacity and the good thermal contact of the PTC element to the motor winding, a fast sensor and thus system reaction to impermissibly high primary section temperatures is possible.

The PTC elements of the triplet are connected in series. The characteristics correspond with DIN EN 60947-8, DIN 44081, and DIN 44082.

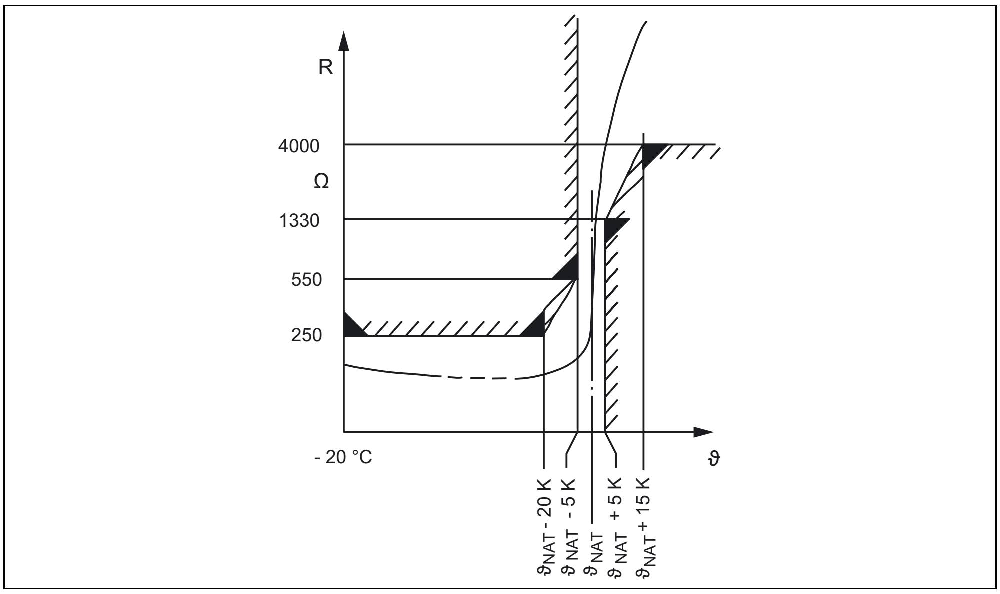

Figure 4-6 Typical characteristics of a PTC element; source: DIN 44081/DIN 44082

ALL

Technical data:

The technical data refers to ϑ_{NAT} = 120 °C as the nominal response temperature of the PTC elements when they are used in the 1FN3 motor.

- Triplet resistance when cold
  - – at T < ϑ_{NAT} - 20 K   min. 60 (3x20) Ω; max. 750 Ω
- Minimum triplet resistance when hot
  - – at T < ϑ_{NAT} - 5 K   min. 590 Ω (550 Ω + 2x20 Ω) max. 1650 (3x550) Ω
  - – at T < ϑ_{NAT} + 5 K   min. 1370 Ω (1330 Ω + 2x20 Ω) max. 3990 (3x1330) Ω
  - – at T < ϑ_{NAT} + 15 K   min. 4040 Ω (4000 Ω + 2x20 Ω) max. 12000 (3x4000) Ω

Note

The PTC elements do not switch automatically! To protect the motor effectively, an evaluation is required (see also chapter 18.2).

4.4 Cooling system

During operation, the motor heats up. The temperature increase in the primary section causes high electrical resistances in the coils and thus reduced motor thrust. To maintain the highest power density possible, cooling is necessary.

4.4.1 The constructive design of the cooling system

The cooling system of the 1FN1- and 1FN3-type motors can consist of various components:

- Primary section main cooler
- Primary section precision cooler
- Secondary section cooling

The components are structurally separated the motors of the 1FN3 product family. In the case of 1FN1-type motors, the primary section main cooler and the primary section precision cooler form a structural unit.

If several components are used, they are separated from each other by an insulating layer. Figure 4-7 shows a diagram of the cooling system of the 1FN1- and 1FN3-type motors.

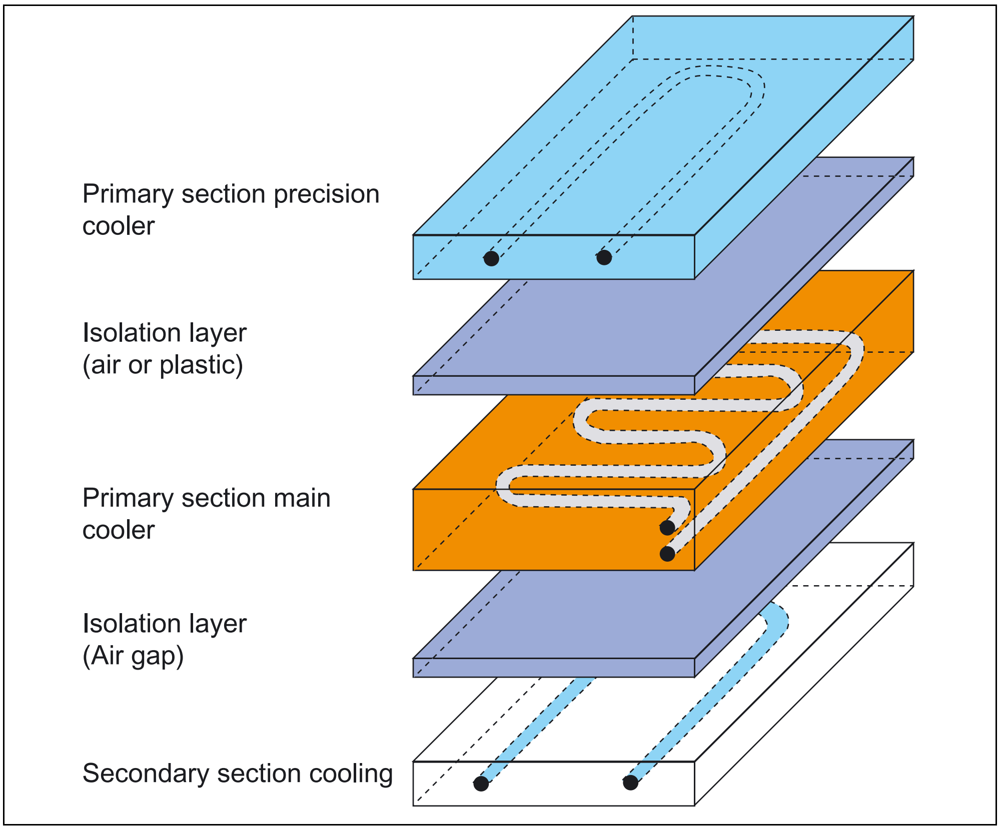

Figure 4-7 Diagram of the cooling system of the motors of the 1FN1 and 1FN3 product families

Primary section main cooler

The primary section main cooler is directly installed into the primary section and cools it. Under rated conditions, it removes between 85% and 90% of the arising heat. This suffices to achieve the rating data listed in the data sheets.

The primary section main cooler has no influence on the heat insulation of the motor from the machine.

Primary section precision cooler

Together with the secondary section cooling system, the primary section precision cooler determines the quality of the heat insulation of the motor from the machine. The primary section precision cooler removes residual heat (2 – 10% of the entire power loss under rated conditions) from the primary section. The temperature increase of the outer surface of the primary section precision cooler is thus maintained at a maximum of 2 K (1FN1) or 4 K (1FN3) in comparison with the intake temperature of the primary section precision cooler. The primary section precision cooler thus protects the environment – e.g. the machine structure – from a heat transfer from the primary section.

Secondary section cooling

The secondary section cooling system consists of parallel V2A steel pipes (1FN1) or aluminum cooling sections (1FN3). They also remove the residual heat of the motor. The heat removed by the secondary section cooling system amounts to about 5-8% of the entire power loss of the motor under rated conditions.

ALL

The Thermo-Sandwich® principle

If only the primary section main cooler is used during the operation of the motor, the motor achieves the rated data listed in the data sheets. To protect the machine against the heat input of the motor, the Thermo-Sandwich® principle can be applied.

In the case of the Thermo-Sandwich® principle, components of the cooling system are layered on top of each other. The components are each separated by an insulating layer (see Figure 4-8). The heat arising in the primary section must run through the individual layers before it is input into the machine. In the process, heat is again removed in each component of the cooling system. For this reason, the residual amount of heat that ultimately arrives in the machine is very low.

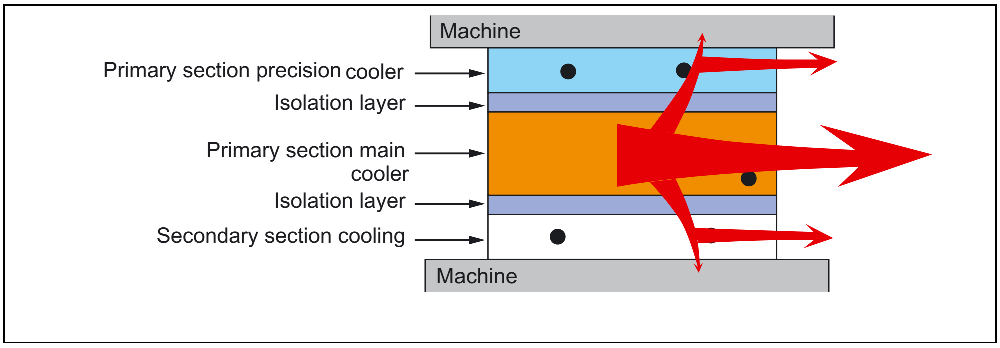

Figure 4-8 Diagram of the Thermo-Sandwich® principle

On principle, the following must be taken into consideration for the selection of the components used:

- If no special requirements are placed on the heat input of the motor into the machine structure, the use of the main cooler alone suffices.
- If increased requirements are placed on the precision of the machine, the use of the primary section precision cooler and secondary section cooling system via the Thermo-Sandwich® principle are necessary.

Note

According to the thermal conductivity of the fastening screws, the temperature at the interface to the machine base increases slightly. In the case of secondary section, this influence is negligible under normal circumstances. All concrete data that can be provided in regard to the temperature at the interfaces to the machine base in this document – e.g. the temperature increase on the surface of the precision cooler – refers to stainless steel screws.

4.4.2 Cooling circuits

Just like the use of the individual cooling components, the design of the individual cooling circuits depends on the requirements of the motor.

Interconnection of cooling circuits

To simplify the connection technology and pipework, cooling circuits of the individual components of the cooling system can be interconnected. In particular, they can be connected in series due to the lower temperature and pressure differences between the intake and return lines.

ALL

Notice

In the case of the interconnection of cooling circuits, only flexible connections (hoses) may be used!

Figure 4-9 shows two examples for the series connection of various cooling circuits: At the left, all cooling circuits of the motor are connected in series. In the right image, the cooling circuits of the primary section precision cooler and the primary section main cooler of a motor form a series circuit. The cooling circuits arising in this way are connected in parallel. The secondary section cooling systems of both motors are also connected in series.

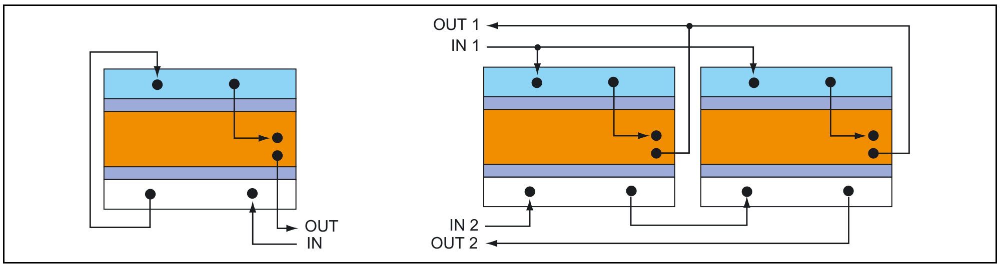

Figure 4-9 Examples for the interconnection of various cooling circuits (diagram)

Note

In the case of a series connection, cooling medium should first flow through the secondary section cooling system and the primary section precision cooler and then through the main cooler. Otherwise, the heat from the main cooler is actively input into the machine via the secondary section cooling system and the primary section precision cooler.

Use of cold water units

When using cold water units, you can choose between the use of

- one cold water unit OR several cold water units
- unregulated cold water units OR regulated cold water units

A comparably affordable system is the use of an unregulated cold water unit that can be connected to all coolers used, e.g. in series connection. In this case, the disadvantage is that the intake temperature can fluctuate. The maximum power density of the motor and its heat insulation to the machine cannot be considered to be constant, which must be taken into consideration in the design.

In contrast, it is of course also possible to assign each cooler its own regulated cold water unit. In regard to the cooling system, this permits the complete control of the power density of the motor and its heat insulation to the machine since the intake temperature is always kept constant.

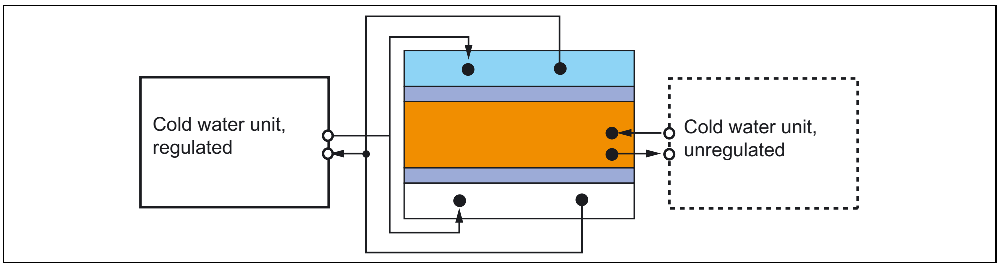

Figure 4-10 Example for the use of cold water units

ALL

The temperature control of the main cooler intake line is not necessarily required, even if the Thermo-Sandwich® principle is utilized. This makes a good compromise possible: the main cooler is operated with an unregulated cold water unit, while the primary section precision cooler and the secondary section cooling system are connected to a regulated cold water unit at the same time. Figure 4-10 shows a diagram of this structure. In this case, the regulated cold water unit must be designed for only about 20% of the total power loss. The parallel connection of the cooling circuits of the primary section precision cooler and the secondary section cooling system guarantee that the intake temperature of the primary section precision cooler and the secondary section cooling system are the same.

Cooling circuit requirements

We recommend that the cooling circuits be designed as closed system to prevent corrosion-promoting oxidation. The maximum permissible pressure is 10 bar.

Note

We advise against using the cooling circuits of machines to cool the motors as well: Due to soiling and long-term deposits, blockage may result!

The cooling medium requirements are described in Chapter 4.4.3. The maximum downtimes of cooling circuits should be observed according to the information provided by the cooling medium manufacturer.

Connection of cooling circuits

For the connection technology of the cooling circuits, see Chapter 9.3.4 in the 1FN1 section and Chapter 13.3 in the 1FN3 section.

4.4.3 Cooling media

The customer must provide the cooling medium. Only water with anti-corrosion agent should be used as the cooling medium.

The use of untreated water may lead to considerable damage and malfunctions due to water hardness deposits, the formation of algae and slime, as well as corrosion, for example:

- Worsening of the heat transfer
- Higher pressure losses due to reductions in cross-sectional area
- Blockage of nozzles, valves, heat exchangers, and cooling ducts

For this reason, water as a cooling medium must contain an anti-corrosion agent that reliably prevents deposits and corrosion even under extreme conditions. In addition, a closed cooling circuit (equalization vessel) to prevent the growth of algae reliably is recommended.

The cooling medium must be pre-cleaned or filtered in order to prevent the cooling circuit from becoming blocked. The formation of ice is not permitted!

Note

The maximum permissible size for particles in the cooling medium amounts to 100 µm.

Cooling system requirements

The water used as the basis of the cooling medium must fulfill the following minimum requirements:

- Concentration of chloride: c < 100 mg/l
- Concentration of sulfate: c < 100 mg/l
- 6.5 ≤ pH value ≤ 9.5

Please check further requirements with the manufacturer of the anti-corrosion agent!

Anti-corrosion agent requirements

The anti-corrosion agent must fulfill the following requirements:

- The basis is ethylene glycol (also called ethanediol)
- The water and anti-corrosion agent do not segregate.
- The point of freezing of the water used is reduced to at least –5°C.
- The anti-corrosion agent used must be compatible with the fittings and cooling medium hoses use, as well as the materials of the motor cooler listed in Table 4-4.

Check these requirements, especially in regard to material compatibility, with the cooling unit manufacturer and the manufacturer of the anti-corrosion agent!

Table 4-4 Minimum of materials used for the cooling system

	Precision cooler	Main cooler	Secondary section cooling unit
Materials used in 1FN1	AlMgSi0.5, CuZn40Pb2/ CuZn39Pb2/ CuZn38Pb2	SF-Cu, CuZn40Pb2/ CuZn39Pb2/ CuZn38Pb2, silver solder	1.4541
Materials used in 1FN3	1.4301/1.4305, Viton	SF-Cu, 1.4301/1.4305, Viton	AlMgSi0.5, Viton

Manufacturer recommendation

The manufacturers of anti-corrosion agent are recommended in Appendix B.

Commissioning and maintenance

Before the cooling circuits are filled, they must be rinsed with the cooling medium to be used. The checking and change intervals for the cooling medium should be harmonized with the manufacturers of the anti-corrosion agent and the cooling system.

4.4.4 Intake temperature of the cooling circuits

Two variables play a role in the determination of the intake temperature of the coolers: the power density of the motor and damage due to condensation.

Power density

The lower the temperature of the motor is, the higher the power density of the motor (see the characteristic curves in Chapter 11.3.1 (1FN1) or Chapter 15.3.1.

ALL

Condensation

When the relative humidity in the direct vicinity of the motor reaches 100%, the excess water in the air condenses on the surface of the motor. The resulting water film is called *condensation*.

Notice

The motor itself is not sensitive to condensation. Condensation, however, can lead to damage to the encased machine (e.g. rust).

Condensation must be avoided!

Select the intake temperatures, especially that of the primary section precision cooler, in such a way that no condensation can occur.

Generally, condensation arises when parts of the cooling circuit or outer parts are colder than the ambient air: The air in the vicinity of the colder surfaces is cooled. The relative humidity thus rises and possibly reaches the limit value of 100%.

To minimize the formation of condensation, the intake temperature of the cooling circuits may lie a maximum of 3K below the temperature of the ambient air. When the machines are used in regions with very high humidity, the intake temperature should even be higher than the temperature of the ambient air.

Conclusion

Figure 4-11 shows how the two rules:

- lowest intake temperature possible for the highest power density possible
- an intake temperature that is not too low to avoid condensation

lead to a solution for the regulation of the intake temperature of the cooling circuits.

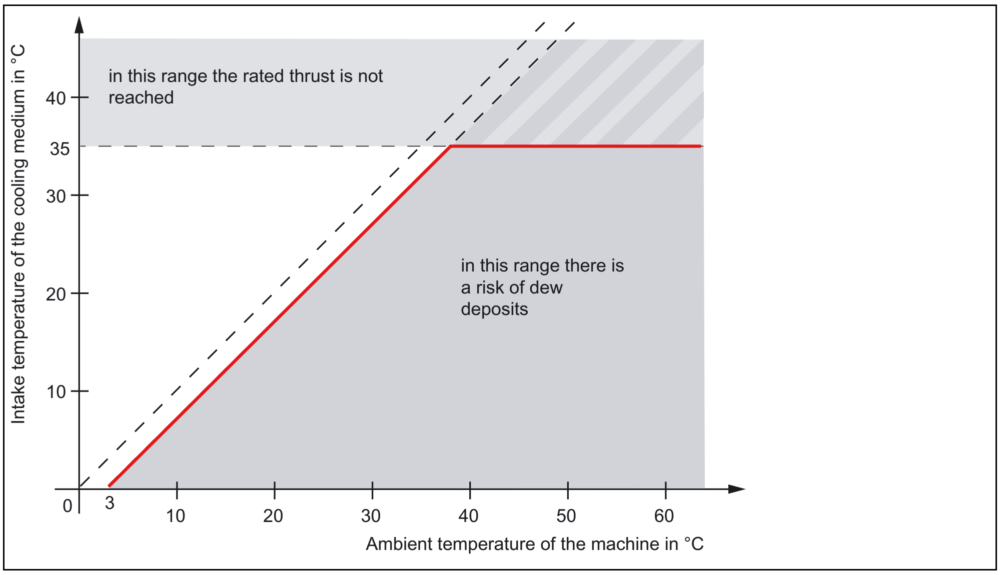

Figure 4-11 Characteristic curve of the intake temperature of the cooling circuits

The ambient temperature of the machine should be selected as a reference variable of the intake temperature: $T_{VORL} = T_{Umgebung} - 3$ K protects the areas near the motor from condensation.

If the intake temperature is regulated using a constant value controller, the temperature value depends on the maximum ambient temperature.

A sequence control for which the intake temperature is adapted to the current ambient temperature at the application site of the motor is more favorable than the regulation of the intake temperature using a constant value controller (see the characteristic curve in Figure 4-11). In this way, the motor can be kept cooler on average. The service life and power density of the motor thus increase.

If the constant feed force of the motor must be completely exhausted, the intake temperature must be limited to a maximum of 35°C (see Figure 4-11). In this case, condensation may appear in case of unfavorable weather conditions.

ALL

A further favorable possibility is the use of two separately regulatable cooling circuits. One cooling circuit supplies the precision cooler and has a cooling medium sequence control with a linear characteristic curve and no limitation of the intake temperature. The second cooling circuit supplies the main cooler and has a cooling medium sequence control according to the characteristic curve in Figure 4-11.

4.4.5 Dimensioning of the cooling system

Individual coolers

Starting from the required sustained power F_{eff} (see Chapter 5.1.3), the heat $Q_{K,i}$ that must be removed from the individual coolers can be calculated first. At the same time, this corresponds to the refrigerating capacity $P_{kühl,i}$ that a return cooling unit or heat exchanger must have for the cooling system under consideration.

$$P_{kühl,i} = Q_{K,i} \simeq Q_{K,MAX} \cdot \left(\frac{F_{eff}}{F_N}\right)^2 \qquad \text{Equation 4.1}$$

The values for the rated thrust F_N and the heat being removed under full load $Q_{K,MAX}$ can be found in the data sheets.

The volume flow is defined, whereby the value listed in the tables of the data sheets should be used.

The pressure drop belonging to the volume flow can be see on the characteristic curves for the primary section main cooler, the primary section precision cooler, and the secondary section cooling system.

The temperature increase $\Delta T_{K,i}$ between the intake and return lines of the individual cools can be determined from the following at the given volume flow

$$\Delta T_{K,i} = \frac{Q_{K,i}}{\rho \cdot c_p \cdot \dot{V}} \qquad \text{Equation 4.2}$$

In the process, the ρ and c_p variables characterize the density or the specific heating capacity of the cooling medium water: ρ = 998 kg/m^3, c_p = 4180 J/(kg · K).

Series connection of coolers

If cooling circuits are connected in series, the greatest volume flow for the individual coolers is decisive for the entire system:

$$\dot{V}_{gesamt} = \max(\dot{V}_1, \dot{V}_2, \dot{V}_3, \ldots) \qquad \text{Equation 4.3}$$

Pressure drops and temperature increases are determined and summed up for: $\dot{V}_{gesamt}$:

$$\Delta p_{gesamt} = \Delta p_{K,1} + \Delta p_{K,2} + \Delta p_{K,3} + \ldots$$
$$\Delta T_{gesamt} = \Delta T_{K,1} + \Delta T_{K,2} + \Delta T_{K,3} + \ldots \qquad \text{Equation 4.4}$$

ALL

If a return cooling unit or a heat exchanger is used for all cooling circuits together, the necessary refrigerating capacity $P_{kühl}$ is calculated from the individual refrigerating capacities $P_{kühl,i}$:

$$P_{kühl} = P_{kühl,1} + P_{kühl,2} + P_{kühl,3} + \ldots = Q_{K,1} + Q_{K,2} + Q_{K,3} + \ldots \qquad \text{Equation 4.5}$$

Example: Design of a cooling system for 1FN3300-2WC00

A motor with a primary section of the series 1FN3300-2WC00 should be operated at a constant force $F_{eff} = 0{,}8\ F_N$. For this purpose, the use of the primary section main cooler is necessary. To protect the machine from heat input, the primary section precision cooler and the secondary section cooling system should also be used.

The secondary section track has a length of 4 m. There is a coupling point for the cooling sections. The intake and return lines of the secondary section cooling system are connected via combi distributors.

The medium flows through the primary section precision cooler, secondary section cooling system, and primary section main cooler of the cooler in that order. To maintain the temperature difference of 4 K between the intake temperature and the surface of the primary section precision cooler, the recommended values from the corresponding data sheet in chapter 15.2 are used.

Data from data sheet: [3]

Flow rate:	$\dot{V}_{gesamt} = 4$ l/min	for all coolers
Pressure drop:	$\Delta p_{P,H} = 0{,}32$ bar	for main cooler
	$\Delta p_{P,P} = 0{,}33$ bar	for precision cooler
	$\Delta p_S = 0{,}09$ bar/m	for cooling sections
	$\Delta p_{KV} = 0{,}42$ bar	for each combi distributor
	$\Delta p_{KS} = 0{,}31$ bar	for each coupling point
Maximum heat dissipation:	$Q_{P,H,MAX} = 995$ W	for main cooler
	$Q_{P,P,MAX} = 35$ W	for precision cooler
	$Q_{S,MAX} = 93$ W	for secondary section cooling system

Calculating the refrigerating capacity

Individual cooling circuits

The following results for the individual cooling circuits according to Equation 4.1:

$$P_{kühl,P,H} = Q_{P,H} \simeq 995\ \text{W} \cdot 0{,}8^2 = 636{,}8\ \text{W}$$

$$P_{kühl,P,P} = Q_{P,P} \simeq 35\ \text{W} \cdot 0{,}8^2 = 22{,}4\ \text{W}$$

$$P_{kühl,S} = Q_S \simeq 93\ \text{W} \cdot 0{,}8^2 = 59{,}52\ \text{W}$$

Total cooling

For a cold water unit that has been designed for the entire series connection, Equation 4.5 must accordingly be assumed as the minimum refrigerating capacity:

$$P_{kühl,gesamt} = P_{kühl,P,P} + P_{kühl,P,H} + P_{kühl,S}$$

$$= 22{,}4\ \text{W} + 636{,}8\ \text{W} + 59{,}52\ \text{W}$$

$$\underline{P_{kühl,gesamt} = 718{,}72\ \text{W}}$$

ALL

[3] The data used here may deviate from the values listed in the data sheet. This changes nothing in the procedure during the dimensioning of the cooling system.

Calculation of the pressure drop

Pressure drop in the secondary section cooling system

The secondary section cooling system consists of a coupling point, two combi distributors, and two parallel cooling sections, each with a length of l_S = 4 m.

In total, the pressure drop of the secondary section cooling system amounts to:

$$\Delta p_{S,ges} = 2 \cdot \Delta p_S \cdot l_S + 2 \cdot \Delta p_{KV} + \Delta p_{KS}$$

The result is:

$$\Delta p_{S,ges} = 2 \cdot 0{,}09 \text{ bar/m} \cdot 4 \text{ m} + 2 \cdot 0{,}42 \text{ bar} + 0{,}31 \text{ bar}$$

$$\Delta p_{S,ges} = 1{,}87 \text{ bar}$$

Total cooling

For the total cooling, the following results accordingly Equation 4.4:

$$\Delta p_{gesamt} = \Delta p_{P,P} + \Delta p_{P,H} + \Delta p_{S,ges}$$

$$= 0{,}33 \text{ bar} + 0{,}32 \text{ bar} + 1{,}87 \text{ bar}$$

$$\underline{\Delta p_{gesamt} = 2{,}52 \text{ bar}}$$

Calculation of the temperature increase

Individual cooling circuits

The following results for the individual cooling circuits according to Equation 4.2:

$$\Delta T_{P,H} = \frac{636{,}8 \text{ W}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \text{ l/min}}$$

$$= \frac{636{,}8 \text{ J/s}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \cdot (10^{-3} \text{ m}^3/60 \text{ s})} = 2{,}3 \text{ K}$$

$$\Delta T_{P,P} = \frac{22{,}4 \text{ W}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \text{ l/min}}$$

$$= \frac{22{,}4 \text{ J/s}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \cdot (10^{-3} \text{ m}^3/60 \text{ s})} = 0{,}08 \text{ K}$$

$$\Delta T_S = \frac{59{,}52 \text{ W}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \text{ l/min}}$$

$$= \frac{59{,}52 \text{ J/s}}{998 \text{ kg/m}^3 \cdot 4180 \text{ J/(kg·K)} \cdot 4 \cdot (10^{-3} \text{ m}^3/60 \text{ s})} = 0{,}21 \text{ K}$$

Total cooling

For the total cooling, the following results accordingly Equation 4.4:

$$\Delta T_{gesamt} = \Delta T_{P,P} + \Delta T_{P,H} + \Delta T_S$$

$$= 0{,}08 \text{ K} + 2{,}3 \text{ K} + 0{,}21 \text{ K}$$

$$\underline{\Delta T_{gesamt} = 2{,}59 \text{ K}}$$

Conclusion

A cold water unit that should cool the motor under the described conditions must thus be designed for about 720 W. The pressure loss amounts to about 3 bar and the temperature difference between the intake and return lines of the cooling system to about 3 K.

ALL

Recommended manufacturers

The manufacturers of cold water units are recommended in Appendix B.

4.5 Notes on connection systems

Electrical and cooling system interfaces are described in chapter 9.2 in the 1FN1 section and in chapter 13.3 in the 1FN3 section. The connection to the converter system takes place according to the CON section from page 347.

When laying electrical cables, observe the following:

- The cables must fulfill the following requirements:
  - Sufficiently high dynamic-mechanical load capacity (due to high accelerations and speeds)
  - Temperature resistance up to 80° C (static) or 60° C (dynamic)
- The cables may not chafe anywhere.
- The cables must be clamped or fixed into place after a maximum of 200 mm.
- Manufacturer's information regarding mounting are to be observed.

Carefully note the following for the connection system of the cooler:

- All connections are to be designed flexibly (hoses)
- All material used must be resistant to the predominant surrounding conditions.
- Manufacturer's information regarding mounting are to be observed.

4.6 Motor component protection

4.6.1 Primary section

Primary sections of the 1FN1 and 1FN3 product families fulfill the requirements of IP 65 protection class according to DIN EN 60529. In case of proper use and the observance of the degrees of protection specified by the type of protection, no additional protective measures are required.

4.6.2 Secondary section

The secondary sections should be protected from corrosion the best way possible using structural measures.

Make sure that the secondary sections remain free of chips. Suitable covers should be provided for this purpose. It can be assumed that ferromagnetic particles are no longer attracted from a distance of 150 mm from the surface of the secondary section.

The use of abrasive or aggressive substances (such as acids) must be avoided.

4.6.3 Installed motor

The better the mounting space of the motor is protected from the penetration of mechanical foreign bodies (especially ferromagnetic particles) and aggressive chemical substances, the higher the service life of the motor. The air gap must be kept free of chips and other foreign bodies.

The protection class of the installed motor according to DIN EN 60529 results initially from the machine construction, but must be at least IP23.

ALL

4.7 Short-term duty S2 and intermittent duty S3

4.7.1 Short-term duty S2

In the case of short-term duty S2, the load time is so short that the final thermal state is not reached. The subsequent zero-current break is so long that the motor practically cools down completely.

Attention

An excessive load can lead to the destruction of the motor.

The load may not exceed the value I_{MAX} listed in the data sheets!

The motor may be operated with a current $t < t_{MAX}$ only for a limited time $I_N < I_M \leq I_{MAX}$. The time t_{MAX} can be calculated using the following logarithmic formula:

$$t_{MAX} = t_{TH} \, . \, \ln\left(\frac{\nu}{\nu - 1}\right) \qquad \text{Equation 4.6}$$

with $\nu = (I_M / I_N)^2$ and the thermal time constant t_{TH}.

The thermal time constants, the maximum currents, and the rated currents of the motors can be found in the data sheets in chapter 11.2 (1FN1) and chapter 15.2 (1FN3).

Note

Equation 4.6 applies under the prerequisite that the starting temperature of the motor corresponds with the intake temperature of the water cooling system T_{VORL}!

Example

The 1FN3300-2WC00-0AA1 motor should be operated from a cold state at maximum current.

- I_{MAX} = 39,2 A, I_N = 12,6 A; from this, ν = 9,679 results.
- t_{TH} = 120 s

$$t_{MAX} = 120 \text{ s} \, . \, \ln\left(\frac{9{,}679}{9{,}679 - 1}\right)$$

$$t_{MAX} \approx 13 \text{ s}$$

The motor may only be operated for a maximum of 13 s at maximum current.

4.7.2 Intermittent duty S3

In case of intermittent duty S3, load times t_B with constant current and downtimes t_S without current sourcing alternate in periodic sequence. During the load time, the motor heats up; in the downtime, it cools down again. After a sufficient number

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of load duty cycles with a cycle duration of $t_{Spiel} = t_B + t_S$, the temperature curve alternates between a constant maximum value T_O and a constant minimum value T_U (see Figure 4-12).

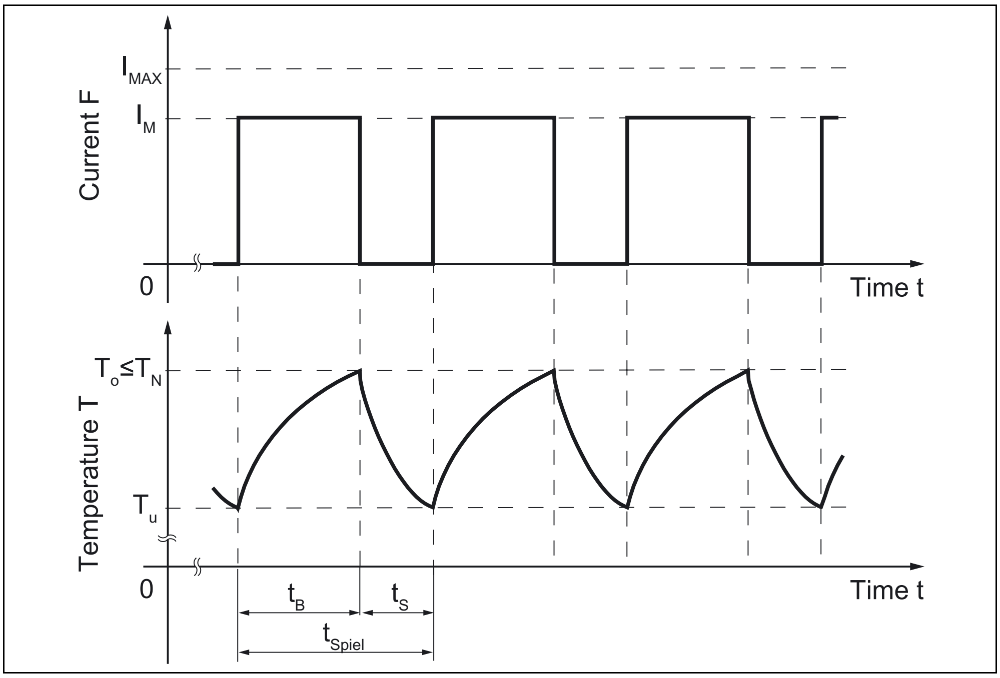

Figure 4-12 Current and temperature curve for intermittent duty S3

For currents $I_N < I_M \le I_{MAX}$, the effective constant current may not exceed the rated current (for more information, also see chapter 5.1.3):

$$I_{eff} = \left[\frac{1}{t_{Spiel}} \left(I_M^2 \cdot t_B \right) \right]^{\frac{1}{2}} = I_M \left(\frac{t_B}{t_{Spiel}} \right)^{\frac{1}{2}} < I_N \qquad \text{Equation 4.7}$$

In the process, the cycle duration should not be longer than 10% of the thermal time constants t_{TH} . If a longer cycle duration is necessary, please contact your local Siemens office.

4.8 Operation of linear motors in the area of reduced magnetic coverage

The independent movement of a primary section beyond the ends of the secondary section track is possible. In this case, the motor thrust is reduced.

The available motor thrust is proportional to the percentage of magnetically covered surface in the entire magnetically active surface of the primary section. Depending on the extent of the frictional forces in the guides, the motor thrust of the drive may be too low for the independent move back into the secondary section track if the degree of coverage is too low. A return to the track is then only possible via an external force.

Note

The degree of coverage should not be below 50% to guarantee an independent return of the drive to the secondary section track.

In the area of reduced magnetic coverage, an asymmetrical load of the phases results, especially in case of high speeds. This leads to additional heating.

Note

The speed in areas of reduced magnetic coverage should not exceed 25% of the rated speed v_N.

ALL

The area of reduced magnetic coverage should be used only for the approaching of parking or service positions, but not for processing. When a Hall sensor box (HSB) is used for the identification of the position, make sure that the HSB is located above the magnets of the secondary section track when the system is switched on and that the primary section can move on its own.

Normally, the drive is operated in a position-controlled manner. Since the loss of motor thrust changes the behavior of the control circuit, stable operation can be achieved only when the value of the positional controller amplification k_V is reduced.

The appropriate k_V value for each case depends on the structural properties of the respective machine. It can only be determined by tests within the scope of commissioning. The search for the suitable value of k_V should start with 5% of its value at full magnetic coverage.

4.9 Braking of the motor during malfunctions

Caution
Malfunctions at unfavorable slide positions can lead to uncontrolled spinning of the drive. Due to the high kinetic energy stored in the machine slides with large masses and high speeds, machine damage is very probable.

Take measures to stop the motor in case of a malfunction!

The design and calculation of brake systems depends on the maximum kinetic energy, that is, on the maximum mass of the machine slide and its maximum speed. It is thus not a part of this planning guide. This chapter, however, lists a number of possibilities how the machine slide can be stopped on the axis in case of malfunctions.

Malfunctions may appear in case of:

- Power mains failure
- Encoder failure, actuation of the encoder monitoring system
- Failure of the NCU, bus
- Failure of the control board
- Drive errors
- Error in the NC

The only reliable protective measure is to use sufficiently dimensioned damping and impact absorption elements at the ends of traversing paths. If several slides are on one axis, damping and impact absorption elements must be mounted between the slides.

To remove the kinetic energy of the slide before it runs into the damping elements, the following measures should be taken to support the brake system described above:

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(1) **Electrical braking via the energy of the intermediate circuit:**
The intermediate circuit must have pulse resistors and condenser modules that store enough energy to brake the machine slide safely when the power mains fails.
Disadvantage: This measure does not work if the encoder system fails.

(2) **Electrical braking by short-circuiting the primary section** (corresponds to an armature short circuit):
The motor terminals are disconnected from the converter system using a self-actuating contactor and short-circuited in case of a malfunction.
Disadvantage: The braking force depends on the speed and does not suffice to brake the slide completely.

(3) **Mechanical braking via brake elements**
The braking capacity must be dimensioned as highly as possible so that the slide can be safely braked at maximum kinetic energy.
Disadvantage: The relatively long response times of the brake control system leads to long, unbraked traversing distances.

We recommend that all three measures be planned in concert. Measures (2) and (3) are used as an additional security here in case Measure (1) fails: The short-circuiting of the primary section works at high speeds first and then the mechanical brake comes into play at lower speeds.

Recommended manufacturers

The manufacturers of brake elements are recommended in Appendix B.

4.10 Use of a holding brake

Due to cogging thrust, linear motors can be pulled into a preferable magnetic operating position if the motor is no longer supplied with power from the drive. In the process, if the drive is already at a standstill, unexpected movements may occur up to a half magnetic pole pitch in both directions. To prevent possible damage to the work piece and/or tool, the use of a holding brake may be a good idea.

Due to the missing mechanical self-locking, a holding brake should be provided in case of inclined or vertical drives without weight compensation so that the drive can be shut down and de-energized in any position.

A holding brake may be required if:

- The bearing friction does not compensate or exceed the cogging thrust and unexpected movements result.
- Unexpected movements of the drive lead to damage (e.g. a motor with a large mass also achieves a large kinetic energy).
- Weight-loaded drives must be shut down and de-energized in any position.

To prevent movements when the drive is turned on and shut off, the reaction of the holding brake must be synchronized with the drive. For commissioning, please observe the documentation of the converter system used.

■

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5 Selection of a linear motor

5.1 Drive configuration

The selection of a suitable linear motor depends on the following:

- The peak and sustained power required for the application
- The desired speed and acceleration
- The mounting space available
- The desired or possible drive arrangement (e.g. single-sided, parallel, or double-sided arrangement)
- The required cooling system

Usually, the process of the motor selection is an iterative procedure since the motor type in turn determines the required forces itself due to its intrinsic mass, especially in the case of highly dynamic direct drives. Figure 5-1 shows a flow chart of this process.

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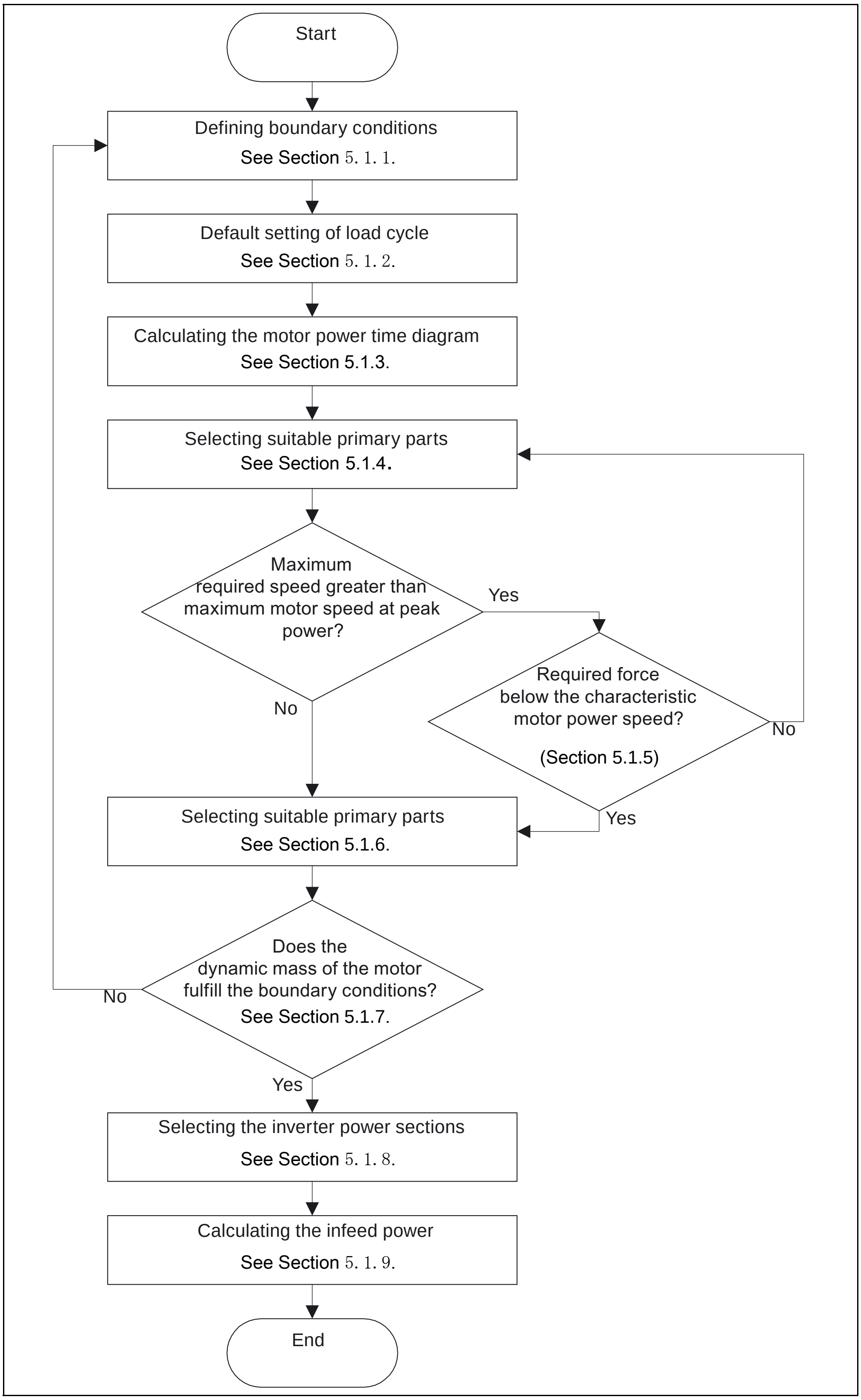

Figure 5-1 Sequence diagram for drive configuration

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5.1.1 Mechanical limitations

The limitations that influence the selection of the motor include the following:

- Dynamic mass (incl. motor mass)
- Gravitation
- Friction
- Processing powers
- Lengths of travel
- The drive configuration

In this chapter, the first three points are considered in more detail.

Dynamic masses

All machine parts, energy chain devices, covers, attachments, etc. used to move the motor must be included in the calculation of the dynamic mass. This includes the mass of the motor itself. Since this is not known initially – the motor still has to be selected – the mass of an approximately appropriate motor type should be used first. If the assumed mass turns out to be very incorrect within the further course of the calculation, a further iteration step in the motor selection will be subsequently required (see Figure 5-1).

In contrast to rotatory drives with a mechanical reduction, all load masses are included in the acceleration capacity of the drive in an unreduced manner in case of a direct drive.

Gravitation

Every mass is subject to gravitational force. The motor must thus compensate a part of the gravitational force F_G that has an effect on the dynamic mass. This part F_g depends on the dynamic mass M, the mounting position of the axis in relation to the earth's normal (angle α) and any weight compensation used. Figure 5-2 shows the power ratios of the motor due to gravitation in case of an inclined mounting position. $F_\perp$ is the part of the gravitational force at work vertically on the inclined axis.

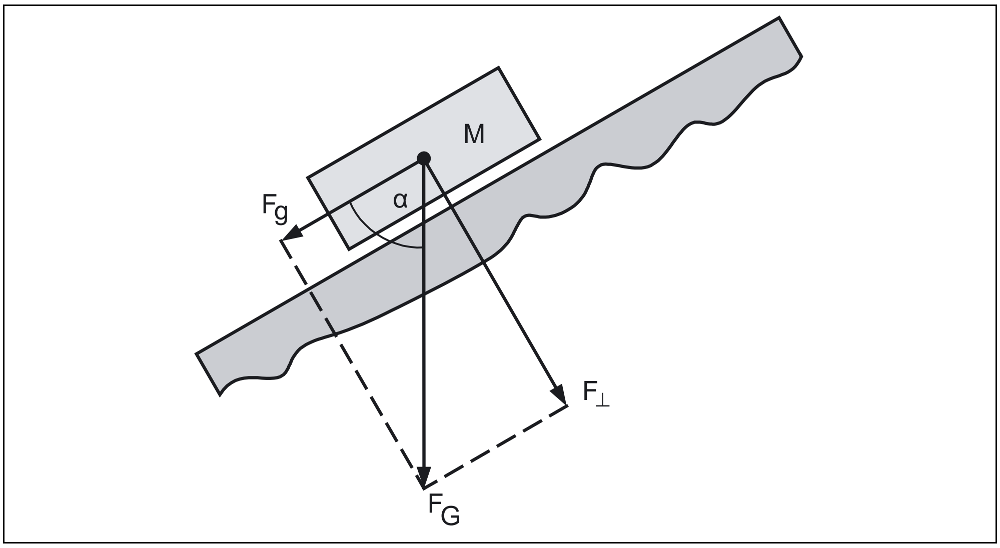

Figure 5-2 Power ratios of the motor in case of an inclined mounting position

According to the relations from Figure 5-2, the part of the gravitational force that must be compensated by the motor is calculated from:

$$F_g = M \cdot g \cdot \cos \alpha \qquad \text{Equation 5.8}$$

with a gravitational acceleration g.
When using a weight compensation, you must consider that the compensation does not automatically amount to 100% and is thus connected with additional frictions and inert masses.

ALL Friction

Friction that impedes the movement of a linear motor occurs between the guide carriage and the guide. The corresponding force F_r opposes the direction of motion of the slide.
Essentially, the frictional force F_r consists of a constant component F_{rc} and a component F_{rv} that is proportional to the speed v:

$$F_r = F_{rc} + F_{rv} \qquad \text{Equation 5.9}$$

Both components depend on the type of linear guide used and its load. According to the design of the mechanical structure, the loads mainly include forces due to gravitation ($F_\perp$ from Figure 5-2), magnetic attraction forces F_{magn} between the motor sections, and distortion forces F_{spann} between various guide elements. All of these forces result in a single force F_n that is vertical ("normal") to the axis:

$$F_n = F_\perp + F_{magn} + F_{spann} \qquad \text{Equation 5.10}$$

If you assume $F_{rc} = \mu_{rc} \cdot F_n$ and $F_{rv} = \mu_{rv} \cdot v \cdot F_n$, the following results from for the frictional force:

$$F_r = \mu_{rc} \cdot F_n + \mu_{rv} \cdot v \cdot F_n \qquad \text{Equation 5.11}$$

For the calculation of the friction forces, the data of the manufacturer of the linear guides should be consulted, especially in regard to the coefficients of friction μ_{rc} and μ_{rv} . Figure 5-3 shows a simplified example for the speed curve and the correspondingly occurring frictional forces in a motor.

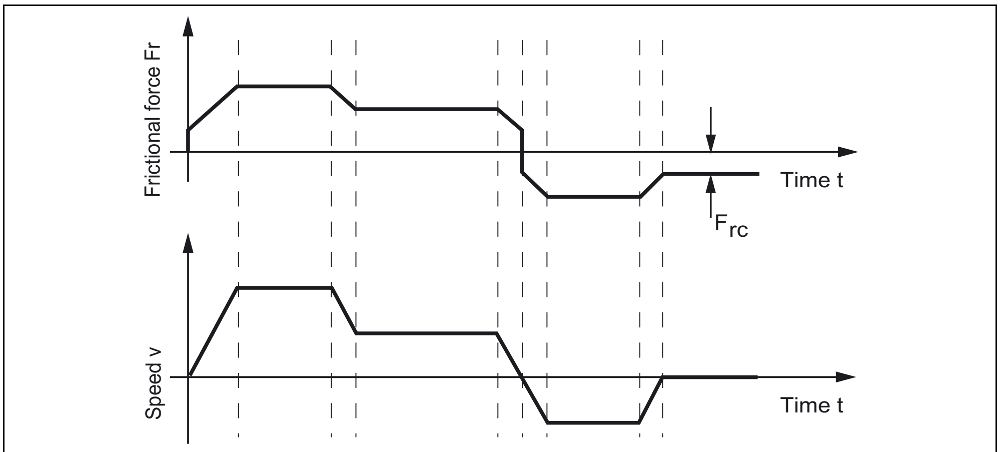

Figure 5-3 Example for frictional forces

Note

Due to the possible high speeds of the linear motors, the frictional forces may reach unexpectedly high values.

5.1.2 Requirements of the load cycle

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In addition to the frictional and gravitational forces, the load cycle is decisive for the selection of the motor. The load cycle contains information regarding the sequence of movements of the drive axis and the processing powers that occur in the process.

The *sequence of movements* can be defined using a distance/time chart, a speed/time chart, or an acceleration/time chart (see Figure 5-4).

In accordance with the following relations:

$$a(t) = \frac{dv}{dt} = \frac{d^2s}{dt^2} \qquad \text{Equation 5.12}$$

the relations can be converted into each other.

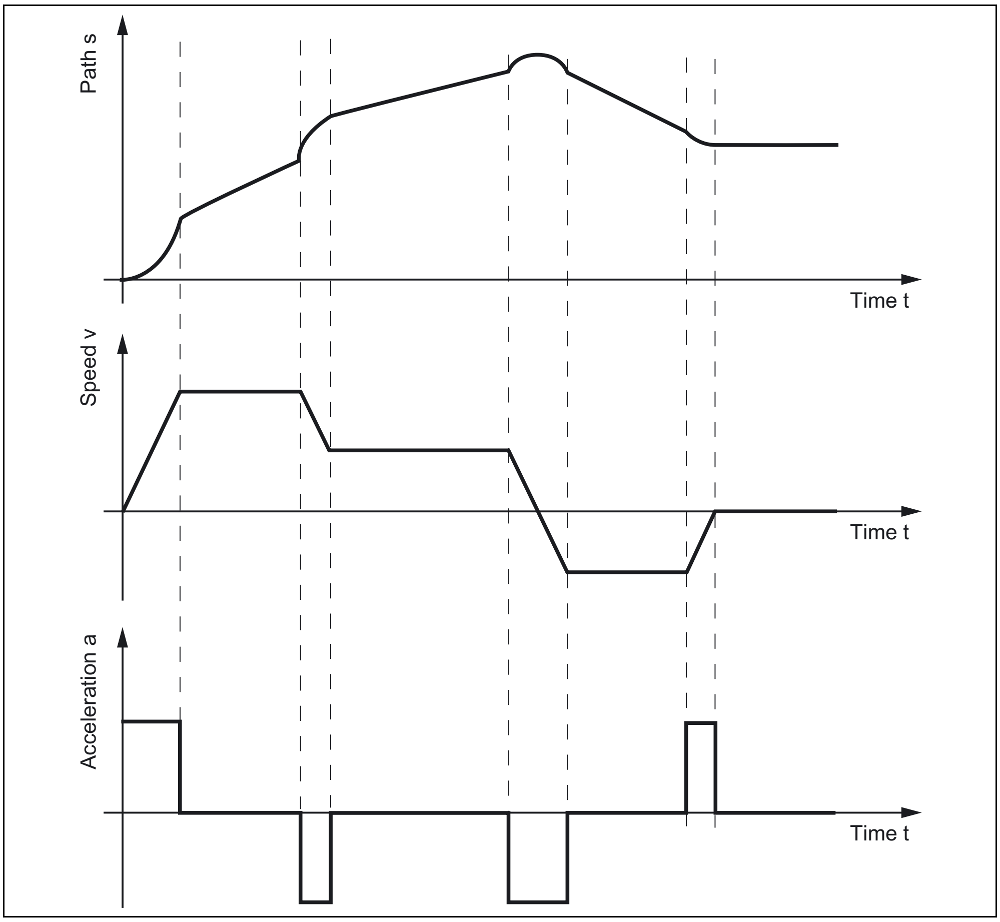

Figure 5-4 Example for the sequence of movement of a linear motor in diagrams

The inertia forces resulting from the sequence of movements that the motor must compensate are proportional to the acceleration a and the dynamic mass M:

$$F_a = M \cdot a \qquad \text{Equation 5.13}$$

They oppose the direction of acceleration.

A *processing power*/time chart for a motor can have the following appearance: Figure 5-5. The speed/time chart from Figure 5-4 is used for comparison.

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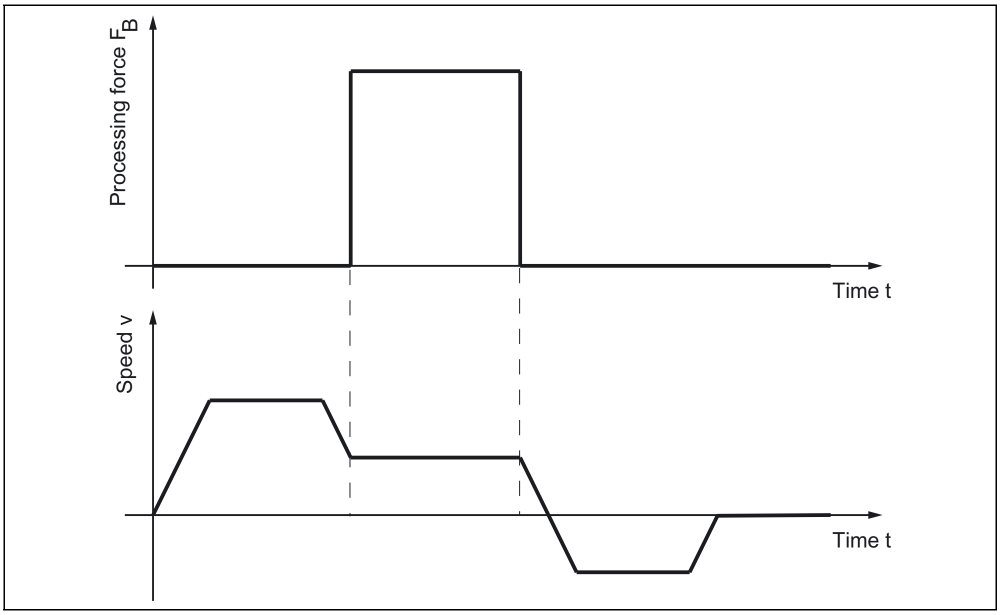

Figure 5-5 Example for a processing power/time chart

5.1.3 Motor thrust/time chart

The power that the motor has to raise consists of the sum of the individual forces at any time.

$$F_M = F_a + F_b + F_g + F_r \qquad \text{Equation 5.14}$$

In the process, the signs of the forces must be observed! The peak power F_{MAX} that the motor has to raise can be found very easily in a diagram, such as Figure 5-6.

In addition to the peak power, the required sustained power of the motor is decisive for its dimensioning. The *maximum* sustained power of the motor F_{eff} is calculated from the square mean of the motor thrust over the entire time of a sequence of movements and may not exceed the rated thrust F_N:

$$F_{eff} = \left[\frac{1}{t_{ges}} \int_0^{t_{ges}} F^2(t)\, dt \right]^{\frac{1}{2}} \leq F_N \qquad \text{Equation 5.15}$$

For the case that the motor thrust is constant in sections, such as in Figure 5-7, the integral from Equation 5.15 is simplified to the following sum:

$$F_{eff} = \left[\frac{1}{t_{ges}} \sum F_i^2 \cdot t_i \right]^{\frac{1}{2}} = \left[\frac{1}{t_{ges}} \left(F_1^2 \cdot t_1 + F_2^2 \cdot t_2 + F_3^2 \cdot t_3 + \ldots \right) \right]^{\frac{1}{2}} \qquad \text{Equation 5.16}$$

Equation 5.15 and Equation 5.16 apply only under the prerequisite that saturation effects can be ignored. For more exact calculations, the forces are replaced by the corresponding currents.

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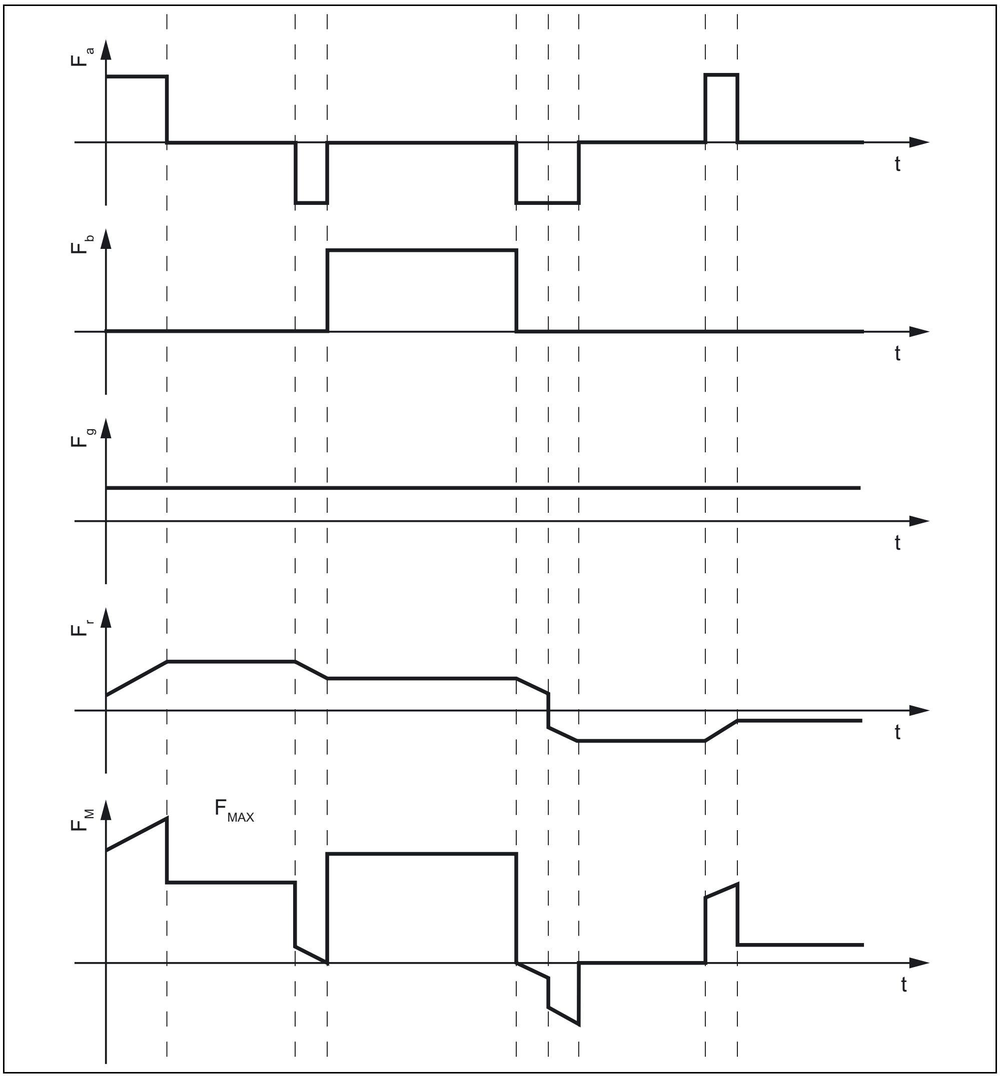

Figure 5-6 Example for individual forces of the linear motor and the resulting motor thrust

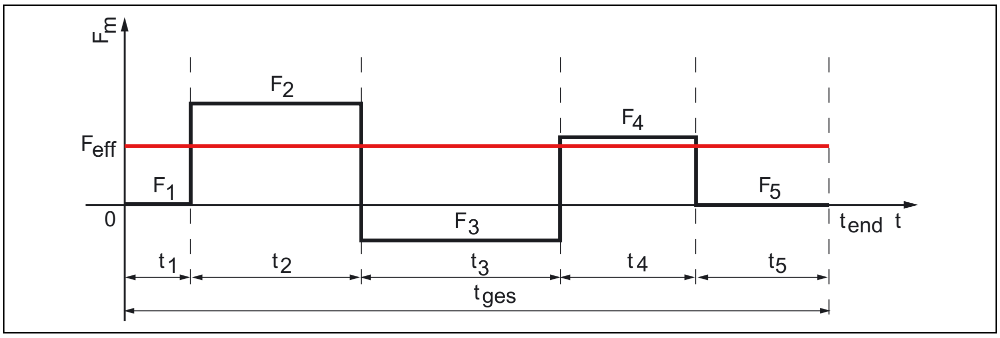

Figure 5-7 Sustained power in case of a motor thrust that is constant in sections

5.1.4 Selection of the primary sections

Using the determined values for the required peak and sustained power, a suitable primary section can be selected for the linear motor. The primary section should have about 10% control reserves in comparison with the required peak power

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F_{MAX}. This avoids undesired limitation effects in case of the overshooting of control circuits. The sustained power of the primary section (rated thrust F_N) must be greater than or equal to the determined sustained power value F_{eff} of the load cycle. In addition, overload phases of the load cycle must not lead to deactivation by the temperature monitoring (see chapter 4.7). If some limitations such as the processing powers and frictions are not known, it may be a good idea to plan for larger reserves.

In addition to the requirements from the load cycle, mechanical installation conditions may influence the choice of motor. The same motor thrust may often be generated by different types of primary sections.

Insofar as several primary sections are involved in the formation of forces on the axis, the values for the peak and sustained power of the individual motors must be summed up. If the distribution of power among the individual motors is not the same, such as in the case of the Gantry axis with an uneven distribution of weight, the power requirements on the individual motors must be taken into consideration separately (see the configuration example in chapter 5.2.2).

!

Important

Not in all motor operating states are all three phases are evenly loaded with current, for example:

- Standstill with current sourcing of motor, for example, in case of:
  - The compensation of a weight
  - Driving against a brake system (damping and impact absorption elements)
- Low speeds < 0.5 m/min
- Cyclic traversing distances below the pole width

In case of a lasting uneven load, the motor may be operated only at about 70% of the rated thrust (see F_0* in the data sheets).

For precise information, please contact your local Siemens office.

5.1.5 Thrust at high speeds

At high speeds, the maximum motor thrust is limited by the available intermediate circuit voltage. If speeds that are greater than the maximum speed at peak power $v_{MAX,FMAX}$ are required, check whether the power occurring is actually reached by the motor. For this purpose, the motor thrust/speed chart that results from the required sequence of movements and the motor thrust/time chart is required. In the process, only the amounts for motor thrust and speed are decisive, not the directions.

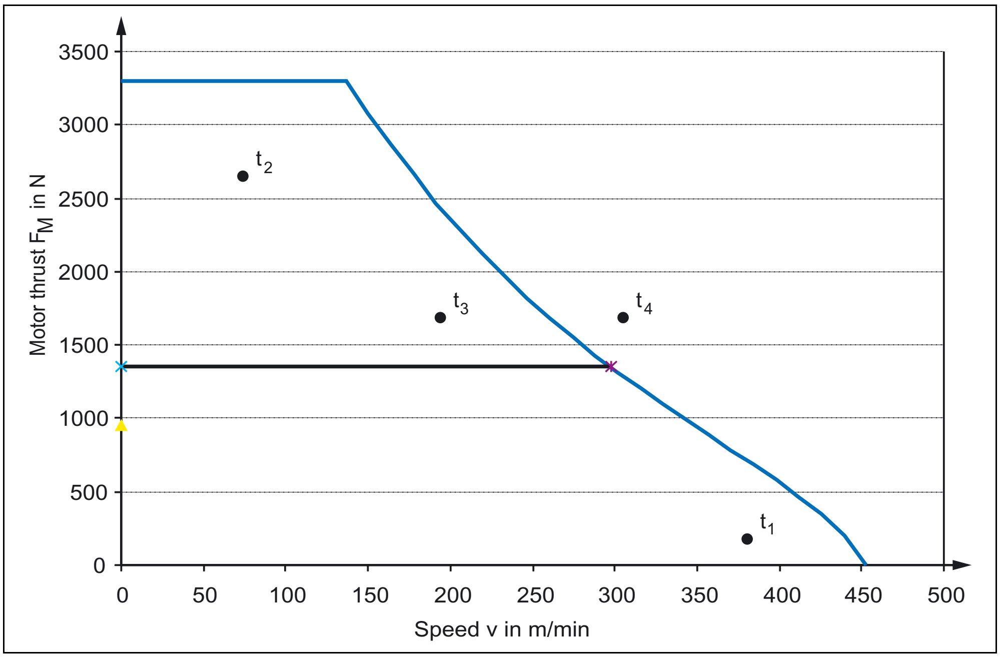

Figure 5-8 Example for the motor thrust/speed characteristic curve

All points on the resulting motor thrust/speed characteristic curve must lie before the power/speed characteristic curve of the motor, which can be found in the data sheets – chapter 11.2 in the 1FN1 section and chapter 15.2 in the 1FN3 section.

Figure 5-8 shows some points of the thrust/speed characteristic points at the times t_1 through t_4 , for example:

- t_1: This point is uncritical since it lies below the thrust/speed characteristic curve of the motor.
- t_2, t_3: These points are uncritical since they lie below the thrust/speed characteristic curve of the motor. It should be checked, however, whether the motor can be driven as long as intended at overload (see chapter 4.7).
- t_4: If such a point occurs, the required motor thrust cannot be achieved at this speed. In this case, you must select another primary section at which the point t_4 lies below the thrust/speed characteristic curve.

5.1.6 Selection of the secondary sections

The number and selection of the required secondary sections depends on the following.

- The selected primary section
- The desired length of travel
- The drive arrangement

Width of the secondary sections

Irrespectively of the lengths, the secondary sections must have the same magnetic track width as the selected primary section. This can be guaranteed through a selection using the MLFB (order numbers): in the MLFB of the primary and secondary sections, the following digits marked with □ must correspond:

- 1FN1: 1FN1□□x
- 1FN3: 1FN3□□□

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Total length of the secondary section track

The total length of a secondary section track determines the number of required secondary sections. It depends on the length of the desired traversing distance, the number of primary sections on this secondary section track, and, if applicable, the use of a Hall sensor box.

Note

The calculation of the total length of the secondary section track listed here guarantees the maximum motor thrust over the entire traversing distance.

A single primary section on the secondary section track

Insofar as only a single primary section is planned on the secondary section track, the length of the secondary section track is calculated from the length of the desired traversing distance and the magnetically active length of the primary section (see Figure 5-9).

Note

The magnetically active length of the primary section without the use of a Hall sensor box ($l_{P,AKT}$) is shorter than when a Hall sensor box is used ($l_{P,AKT,H}$).

The size $l_{P,AKT}$ is listed in the dimensional sheets – chapter 12 in the 1FN1 section and chapter 16 in the 1FN3 section. The length $l_{P,AKT,H}$ then results from the drawings for the attachment of the Hall sensor box.

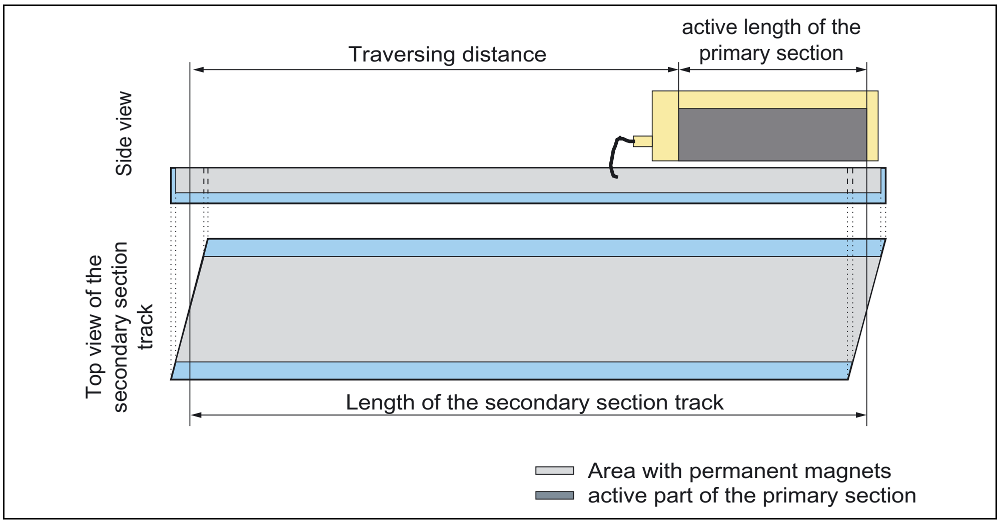

Figure 5-9 Determination of the length of the secondary section track for a primary section

Several primary sections on a secondary section track

If several primary sections are to be mounted on a secondary section track, the required length of the secondary section increases by the active length of the additional primary sections and the distances in between (see Figure 5-10).

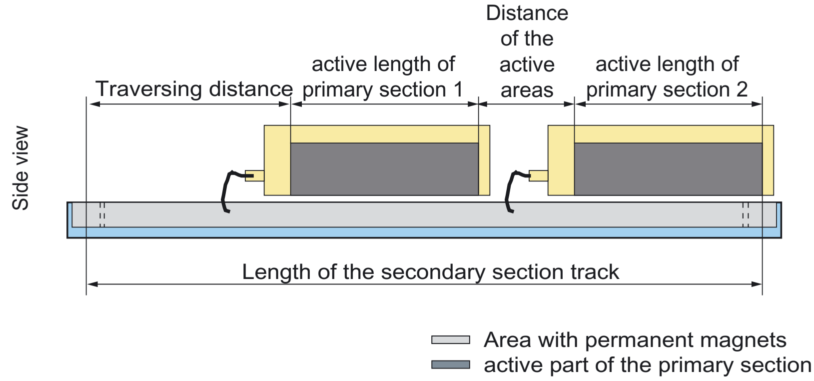

Figure 5-10 Determination of the length of the secondary section track for several primary sections

If the various primary sections are operated by separate converters with separate measuring systems, for example, in case of gantry or master/slave operation, the distance between the primary sections is limited only by mechanical limitations such as the length of the connecting plug and the bending radii of the cables. Insofar as the primary sections are operated electrically parallel to a converter, the distance may have only specific defined values according to the data in the motor installation drawings (see chapters 6.1.2 and Table 9-8 for 1FN1-type motors and chapter Table 13-6 for the peak-load motors of the 1FN3 product family.

Number of secondary sections

The required total length of the secondary section track can be composed of any number of secondary sections of various length. The available lengths are listed in the motor data. In regard to mounting, it is often more favorable to use a greater number of shorter secondary sections instead of a few longer secondary parts.

5.1.7 Checking the dynamic mass

The dynamic mass of the motor or the axis is determined after the secondary sections are selected at the latest. With this data, the assumptions made in chapter 5.1.1 can be checked. Insofar as the mass of the motor assumed there deviates considerably from the actual mass of the motor, a new calculation of the load cycle is required.

5.1.8 Selection of the power inverter power unit

The required power units are selected according to the peak and sustained currents that occur in the load cycle. If several primary sections are operated in parallel with one converter, then the summed values of the peak and sustained currents must be taken into account.

A selection of available power units can be found in the following literature:

- Catalog /NC60/
- SIMODRIVE 611 Planning Guide for Converters /PJU/

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Note

In systems where direct drives are used together with regulated (closed-loop control) infeed units, electrical oscillations can occur with respect to ground potential. These oscillations are, among other things, influenced by the following:

- The lengths of the cables
- The size of the infeed/regenerative feedback module
- The number of axes
- The size of the motor
- The winding design of the motor
- The type of network
- The place of installation

The oscillations lead to increased voltage loads and may damage the main insulation! We thus recommend using a HFD choke with damping resistance for damping the oscillations. For details, see the planning guide for converters /PJU/.

5.1.9 Calculation of the required infeed units

The electrical infeed power P_{EL} of the linear motors can be determined from the delivered mechanical power P_{MECH} and the occurring losses P_V.

$$P_{EL} = P_{MECH} + P_V$$
$$= F_M \cdot v + 3 \cdot R_{STR} \cdot I_{eff}^2$$
Equation 5.17

The effective current I_{eff} results from the motor thrust F_M and the power constant of the motor k_F :

$$I_{eff} = \frac{F_M}{k_F}$$
Equation 5.18

For the lane resistance R_{STR} of the primary sector of the motor, the value of the rated temperature T_N found in the data sheets in chapters 11.2 (1FN1) and 15.2 (1FN3) is assumed. The variable v from Equation 5.17 is the speed set in the load cycle (chapter 5.1.2).

The electrical power can be calculated for every point in time in the load cycle. For the selection of an infeed unit for the intermediate circuit, it generally suffices to determine the required maximum infeed power for the load cycle for highly dynamic direct drives: the constant input is generally considerably lower. The maximum infeed power is usually required when accelerating to the maximum speed. Since accelerating can take place only for a very brief period of time in the case of highly dynamic drives, the 200 ms value can generally be used as design criterion for the maximum infeed power of the infeed devices.

In the case of several axes, the infeed powers of the individual axes are to be added together with the corresponding simultaneity conditions for the selection of the infeed device.

5.2 Configuration examples

In the following chapters, two typical examples how a motor can be dimensioned according to the given limitations are presented.

The data used here may deviate from the values listed in the data sheets. This changes nothing in the procedure during the configuration procedure.

5.2.1 Positioning in the given time

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Limitations/secondary conditions

Given variables

During positioning in the given time, only the end points of the distance and the duration of the individual steps are set. For the example shown here, the motor should move on a horizontal axis to a certain point t_1 the time s_{MAX} . It should stay there for a while t_2 and then return to the home position. Figure 5-11shows these variables in a distance/time chart.

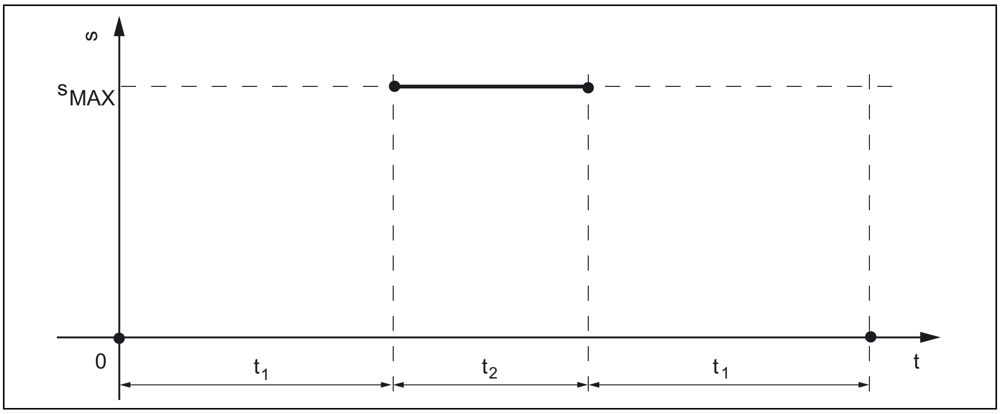

Figure 5-11 Example 1: Representation of the given variables in the distance/time chart

The individual given variables are:

- Traversing distance s_{MAX} = 260 mm = 0.26 m
- Traversing time t_1 = 0.21 s
- Dwell time t_2 = 0.18 s
- Mass to be moved (without motor mass) M = 50 kg
- Constant friction F_r = 100 N
- Horizontal axis F_g = 0

Required

is an appropriate primary segment of the 1FN1 product family, the appropriate secondary sections, and the number of required secondary sections. In addition, a power inverter power unit is selected and the maximum infeed power calculated.

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Traversing profile

The form of the traversing profile is not explicitly given for the time duration t_1 . For this reason, a suitable traversing profile must be defined first. Figure 5-12 shows some examples for possible traversing distances.

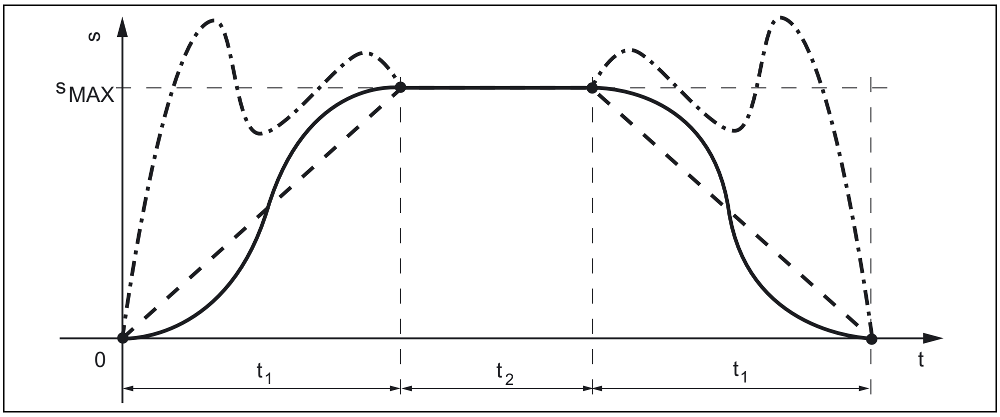

Figure 5-12 Example 1: Examples for traversing profiles

The traced line characterizes the traversing profile that can be realized most easily: It takes only one constant acceleration procedure and one constant braking procedure to reach the position s_{MAX} (see Figure 5-13). Such a traversing profile makes very short positioning times possible.

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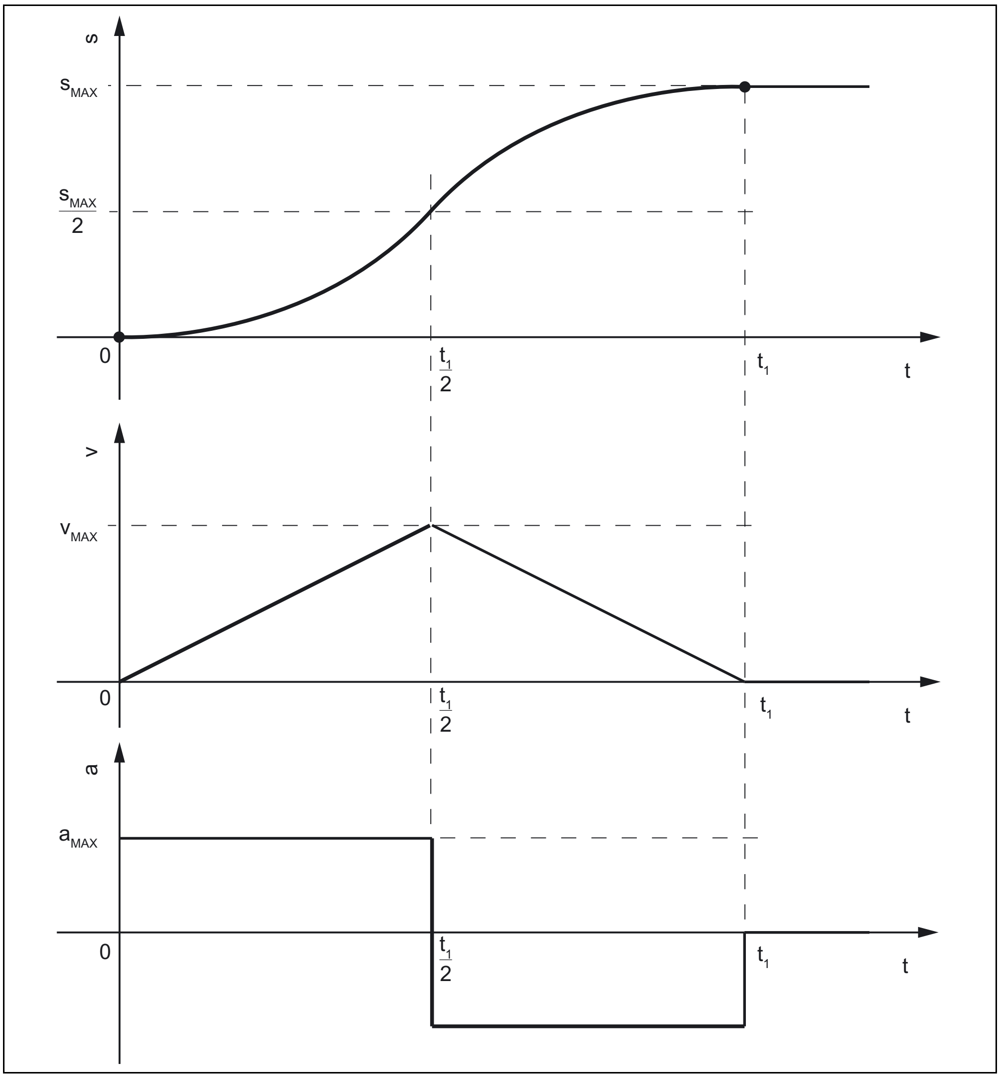

Figure 5-13 Example 1: Sequence of movements for the most simple traversing profile

From the given values, you can calculate how great the maximum speed and maximum acceleration (delay) of the motor must be:

$$\frac{s_{MAX}}{2} = \frac{a_{MAX}}{2} \cdot \left(\frac{t_1}{2}\right)^2 \rightarrow a_{MAX} = s_{MAX} \cdot \left(\frac{2}{t_1}\right)^2 \qquad \text{Equation 5.19}$$

$$a_{MAX} = 0{,}26\ \text{m} \cdot \left(\frac{2}{0{,}21\ \text{s}}\right)^2 = 23{,}6\ \text{m/s}^2$$

$$v_{MAX} = a_{MAX} \cdot \frac{t_1}{2} = s_{MAX} \cdot \frac{2}{t_1}$$

$$v_{MAX} = 0{,}26\ \text{m} \cdot \left(\frac{2}{0{,}21\ \text{s}}\right) = 2{,}48\ \text{m/s}$$

Since the required force for this is not yet known, F_{MAX} should be assumed. The value for the maximum speed v_{MAX} then corresponds with the values listed for $v_{MAX,FMAX}$ in the data sheets in chapter 11.2. One speed v_{MAX} = 2,48 m/s =149 m/min lies above the maximum permissible values $v_{MAX,FMAX}$ for the 1FN1-type motors. For this reason, the traversing profile must be modified.

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A further simple traversing profile that should be checked contains, in addition to the phases of constant acceleration and constant delay, a phase in which the motor should run at maximum speed (see Figure 5-14).

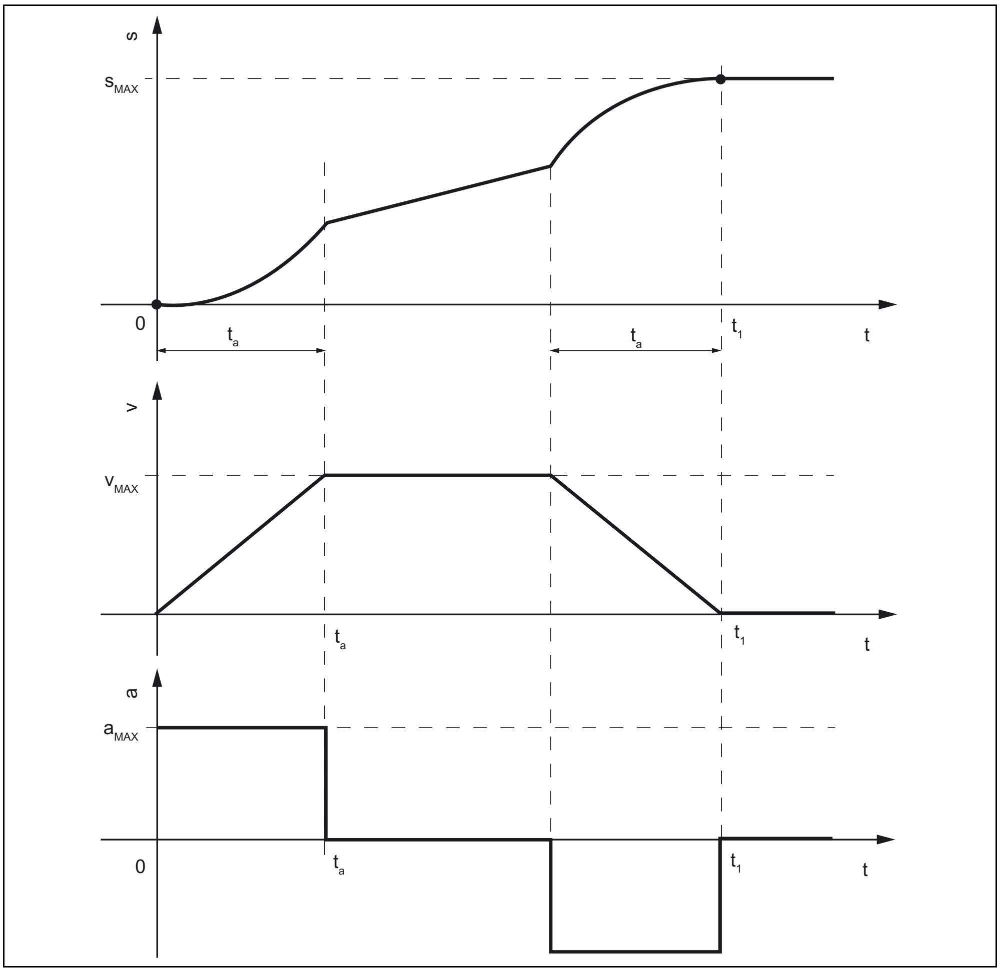

Figure 5-14 Example 1: Modified traversing profile

For the maximum speed that the motor should achieve, the following should apply:

$$s_{MAX} \geq v_{MAX} \cdot t_1 \qquad \text{Equation 5.20}$$

Otherwise, the time t_1 does not suffice to position the motor at s_{MAX}. In the current example, the following must apply for the maximum speed of the motor:

$$v_{MAX} \geq 1{,}24 \text{ m/s} = 74{,}3 \text{ m/min} \qquad \text{Equation 5.21}$$

In comparison with the previous profile a higher acceleration a_{MAX} must be assumed so that the motor can be positioned in the same time t_1 . At the defined maximum speed, this acceleration can be calculated:

$$s_{MAX} = 2 \cdot \left(\frac{a_{MAX}}{2} t_a^2\right) + (t_1 - 2t_a)v_{MAX} \text{ with } t_a = \frac{v_{MAX}}{a_{MAX}}$$

$$a_{MAX} = \frac{v_{MAX}^2}{v_{MAX}\, t_1 - s_{MAX}} \qquad \text{Equation 5.22}$$

A primary section can be selected using this data.

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Selection of the primary section:

With the condition from Equation 5.20 or Equation 5.21, some of the primary sections are no longer under consideration for selection (see the data sheet in chapter 11.2). For the rest of the motors, speeds up to a maximum of 105 m/min = 1.75 m/s apply. If you assume a maximum speed v_{MAX} = 1,5 m/s = 90 m/min – which further reduces the selection of motors – you will obtain an acceleration a_{MAX} = 41 m/s^2 from . For the maximum power F_{MAX} that the motor must raise, the following results:

$$F_{MAX} = M \cdot a + F_r$$

$$F_{MAX} = 50\ \text{kg} \cdot 41\ \text{m/s}_2 + 100\ \text{N} \qquad \text{Equation 5.23}$$

$$\underline{= 2150\ \text{N}}$$

The smallest motor that reaches this power is the 1FN1076. Even the previously assumed 90 m/min does not exceed the given maximum speed at peak power v_{MAX}, F_{MAX} .

Now, two other points must be checked:

- Does the reserve power of the selected primary section also suffice for the previously unconsidered mass of the primary section?
- Does the sustained power lie below the permissible sustained power?

Reserve power

The mass of the primary section amounts to 17.5 kg for the 1FN1076; the entire dynamic mass M to be moved thus amounts to (50+17.5) kg = 67.5 kg. The maximum power that the motor must raise accordingly amounts to Equation 5.23.

$$F_{MAX} = 67{,}5\ \text{kg} \cdot 41\ \text{m/s}_2 + 100\ \text{N}$$

$$\underline{= 2868\ \text{N}} \qquad \text{Equation 5.24}$$

The reserve power is thus sufficient.

Sustained power

Figure 5-15 shows the power/time chart for the entire sequence of movements of the example shown here. To calculate the sustained power, the summation formula from Equation 5.16 can be used here since the motor thrust F_m is constant in sections:

$$F_{eff} = \sqrt{\frac{1}{2t_1 + t_2}\left[F_1^2 t_a + F_2^2 (t_1 - 2t_a) + F_3^2 t_a + F_4^2 t_2 + F_5^2 t_a + F_6^2 (t_1 - 2t_a) + F_7^2 t_a\right]}$$

With F_1 = 2868 N, F_2 = 100 N, F_3 = -2668 N (Travel to position s_{MAX})

F_4 = 0 (Dwell time)

F_5 = -2868 N, F_6 = -100 N, (Travel to position s_{MAX})

F_7 = 2668 N

$$t_a = \frac{v_{MAX}}{a_{MAX}} = \frac{1{,}5\ \text{m/s}}{41\ \text{m/s}^2} = 0{,}0366\ \text{s} \qquad \text{(See Equation 5.22)}$$

F_{eff} = 1370 N

The sustained power thus lies below the permissible value of 1580 N (see chapter 12.1.2).

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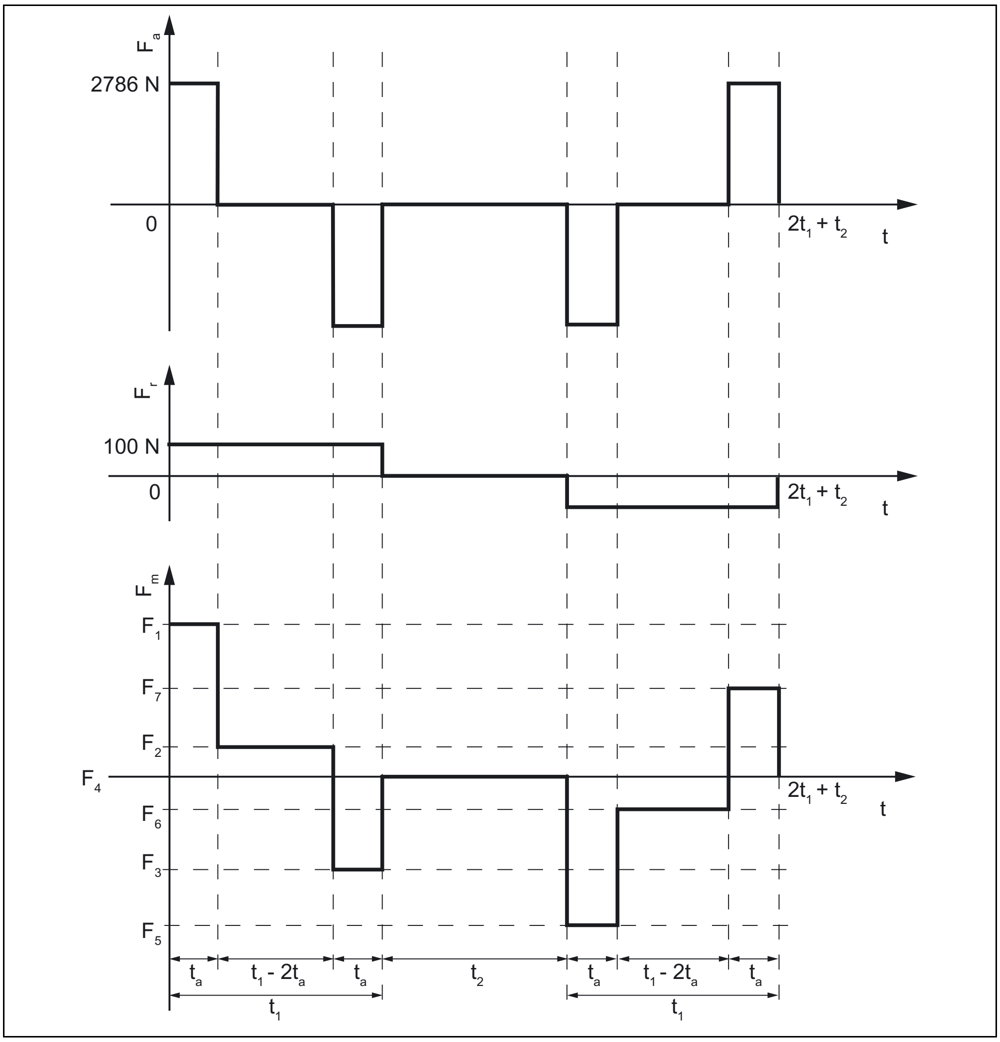

Figure 5-15 Example 1: Power/time chart and sustained power of the observed load cycle

Interim result

For the example shown here, the primary section of the 1FN1076 is suitable.

Selection of the secondary sections

Type of secondary section:

According to chapter 5.1.6, only secondary section 1FN1070 is suited for this motor.

Length of the secondary section track

The magnetically active length of the primary section $l_{P,AKT}$ amounts to 517.6 mm. Together with the traversing distance s_{max} , the length of the secondary section track l_{Spur} results according to Figure 5-9 as

$$l_{Spur} = l_{P,AKT} + s_{MAX}$$

$$= (517 + 260)\ \text{mm} \qquad \text{Equation 5.25}$$

$$= 777\ \text{mm}$$

Number of secondary sections

The 1FN1070 secondary sections are available in two versions:

- l_S = 225 mm (1FN1070-0AA00-0AA0)
- l_S = 563,4 mm (1FN1070-0AA00-1AA0)

The combination of a long and a short secondary section results in a length of the secondary section track of (225 + 563.4) mm = 788.4 mm. This length is sufficient.

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Selection of the power inverter power unit

The selected motor has the following data:

- Maximum power F_{MAX} = 3450 N
- Rated thrust F_N = 1580 N
- Maximum current I_{MAX} = 28 A
- Rated current I_N = 11,1 A

A power unit that matches this data, for example, is the 18 A/36 A power unit from the catalog /NC60/.

Calculation of the maximum infeed voltage:

The electrical infeed power results from the mechanical power P_{MECH} and the power loss P_V (see Equation 5.17). Both values in this example are maximum if the motor works at maximum speed and power according to the necessary load cycle. In the example shown here, these values are as follows:

- v_{MAX} = 1,5 m/s
- F_{MAX} = 2868 N (Equation 5.24)

For the maximum infeed power, the following results from Equation 5.17, Equation 5.18, and the data sheet from chapter 12.1.2

$$P_{EL,MAX} = F_{MAX} \cdot v_{MAX} + 3 \cdot R_{STR} \cdot \left(\frac{F_{MAX}}{k_F}\right)^2$$

$$= 2868\ \text{N} \cdot 1{,}5\ \text{m/s} + 3 \cdot 4{,}3\ \Omega \cdot \left(\frac{2868\ \text{N}}{142\ \text{N/A}}\right)^2 = 9564\ \text{W}$$

$$\text{Units: } [P_{EL}] = \frac{\text{N}\cdot\text{m}}{\text{s}} + \frac{\Omega\cdot\text{N}^2\cdot\text{A}^2}{\text{N}^2}$$ Equation 5.26

$$= \frac{\text{N}\cdot\text{m}}{\text{s}} + \frac{\text{V}\cdot\text{A}^2}{\text{A}} \quad (1\ \text{W} = 1\ \text{Nm/s} = 1\text{VA})$$

$$= \text{W}$$

The value of 9564 W must be added to the infeed cables of other consumers that are also operated on the intermediate circuit. A corresponding infeed/regenerative feedback module can thus be selected.

5.2.2 Processing center with Gantry axis

In processing centers, arrangements with three linear motor axes riding on top of each other as shown in Figure 5-16 are frequently used. In the design of the linear drives, it must be observed that underlaid axes must move the masses of the riding axes as well. In the case of the arrangement from Figure 5-16, the y-axis thus also bears the mass of the z-axis. For the x-axis, which lies at the bottom (on the very

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outside), the mass of both the y-axis and the z-axis must be taken into consideration.

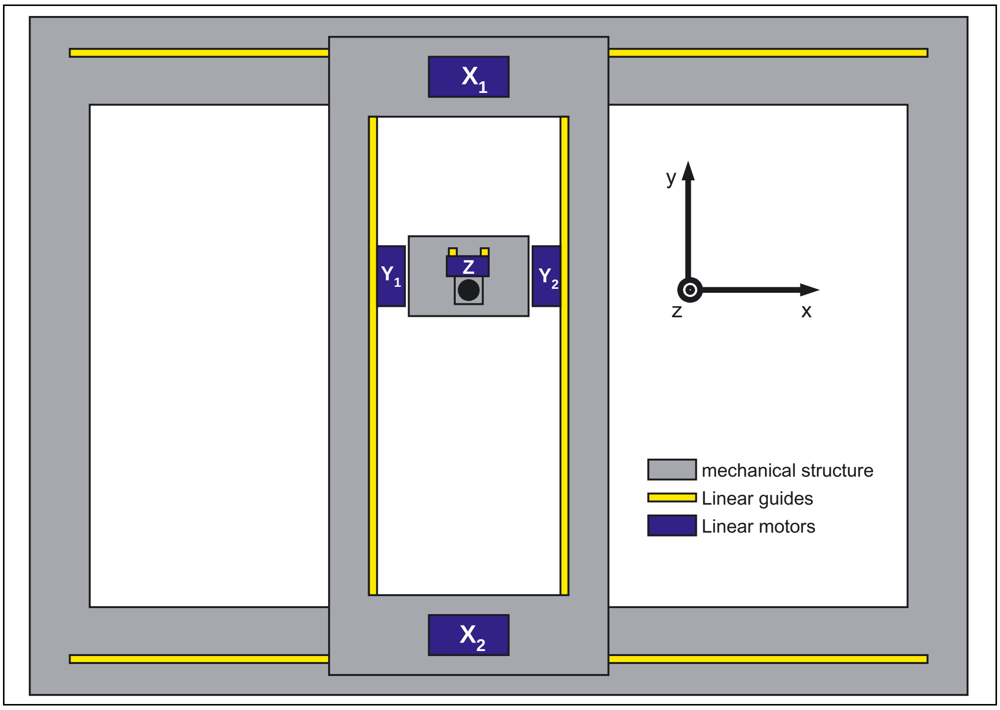

Figure 5-16 Three linear motor axes lying on top of each other in the x, y, and z directions

The x-axis is designed as a gantry[4] in the arrangement from Figure 5-16: Motor X_1 and motor X_2 have their own linear measurement system and converter, but move synchronously. In the following, both motors X_1 and X_2, which should belong to the 1FN1 product family, will be designed.

Limitations/secondary conditions

Speed/time chart

The required speed/time chart consists of phases of constant speed and phases of constant acceleration (see Figure 5-17). The acceleration should respectively take on the value a = 2g (g: gravitational force; g = 9,81 m/s²). At the end of the movement cycle, the motor should have a standstill phase.

[4] Definition: In "gantry operation" mode, two rigidly coupled machine axes are traversed synchronously via mutually independent axis drives. The sequence of movements of both drives follows the same program and is thus synchronous.

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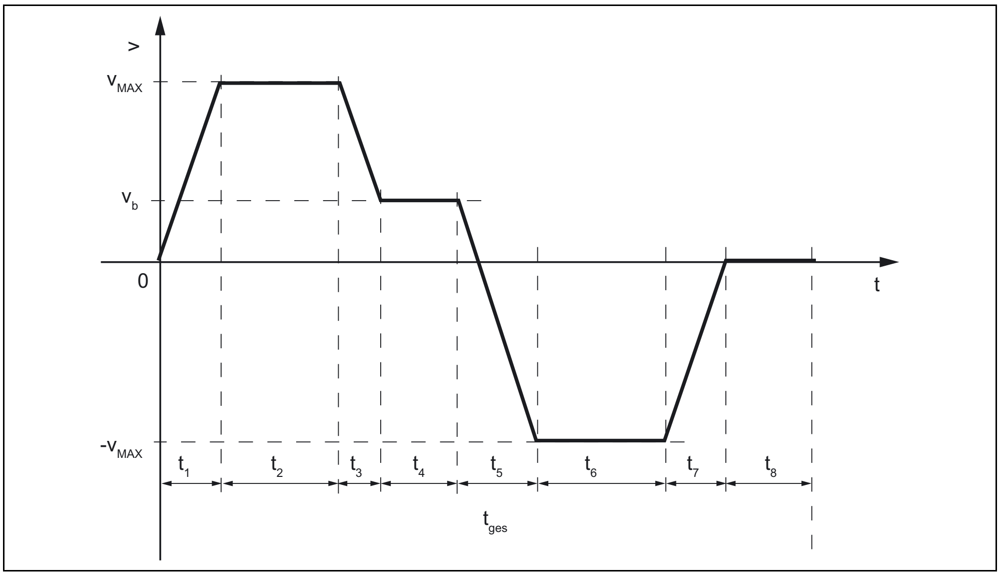

Figure 5-17 Example 2: Speed/time chart for the gantry

During the time t_6, the processing of a work piece should take place at the speed v_b and the constant power F_b. A general friction of F_r = 300 N should be assumed per side.

The individual variables until now have been:

Speeds: v_{MAX} = 1,5 m/s = 90 m/min

v_b = 0,5 m/s = 30 m/min

Times:

t_1 = 76,5 ms

t_2 = 180 ms

t_3 = 51,0 ms

t_4 = 100 ms

t_5 = 102 ms

t_6 = 200 ms

t_7 = 76,5 ms

t_8 = 80 ms

$$t_{ges} = \sum_{i=1}^{8} t_i = 866 \text{ ms}$$

Note:
The times during the acceleration phases result from

$$v = a \cdot t + v_0 \rightarrow t = \frac{v - v_0}{a}$$

Example:

$$t_5 = \frac{- v_{MAX} - v_b}{- 2g} = \frac{v_{MAX} + v_b}{2g}$$

$$= \frac{1{,}5 \text{ m/s} + 0{,}5 \text{ m/s}}{2 \cdot 9{,}81 \text{ m/s}^2}$$

t_5 = 0,102 s = 102 ms

Forces:

F_b = 1000 N

F_r = 300 N

Mass to be moved

The mass to be moved is composed of the mass of the primary sections, which are unknown up to now, and the mass of the y-axis. In the process, note that the mass distribution of the y-axis to both motors X_1 and X_2 is generally not even: it depends on the position of the center of gravity of the frame and the slide of the y-axis (see Figure 5-18).

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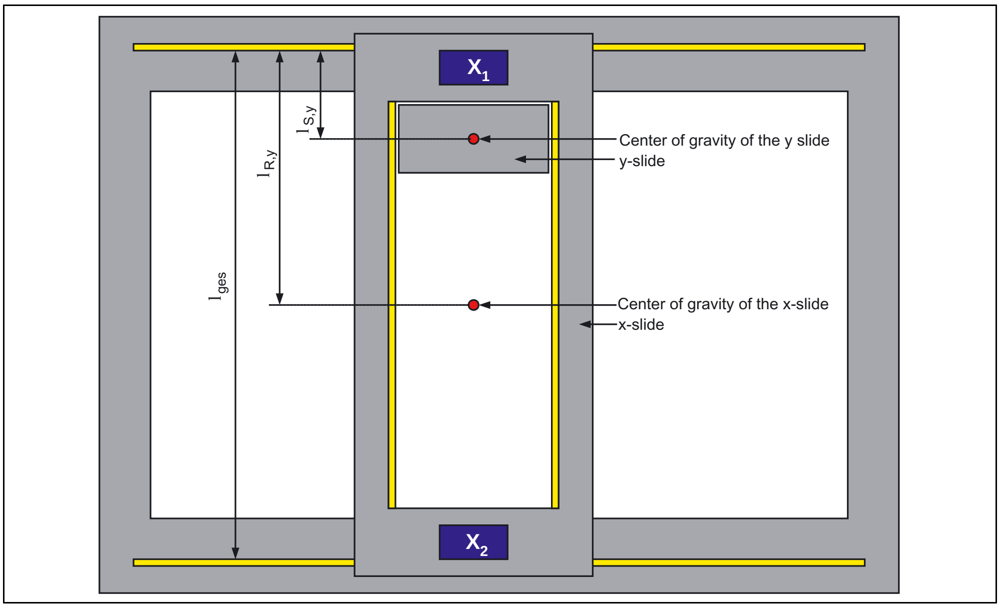

Figure 5-18 Example 2: Mass distribution of the y-axis to both motors: relevant lengths

The following lengths and masses are given for the example shown below:

Lengths: l_{ges} = 1200 mm = 1,2 m
$l_{S,y,X1,MIN}$ = 300 mm = 0,3 m
$l_{S,y,X1}$ = 600 mm = 0,6 m

Masses: $m_{S,y}$ = 180 kg
$m_{R,y}$ = 280 kg

The mass $m_{R,y,X1}$ that the motor X_1 must support from the frame of the y-axis results from the following:

$$\frac{m_{R,y,X1}}{m_{R,y}} = \frac{l_{ges} - l_{R,y}}{l_{ges}} \rightarrow m_{R,y,X1} = \left(1 - \frac{l_{R,y}}{l_{ges}}\right) m_{R,y} \qquad \text{Equation 5.27}$$

Analogous to this, the mass $m_{S,y,X1}$ results as a part of the mass of the slide of the y-axis ($m_{S,y}$):

$$m_{S,y,X1} = \left(1 - \frac{l_{S,y}}{l_{ges}}\right) m_{S,y} \qquad \text{Equation 5.28}$$

The following results as the total mass to be moved of the motor X_1:

$$M_{X1} = m_{X1} + \left(1 - \frac{l_{R,y}}{l_{ges}}\right) m_{R,y} + \left(1 - \frac{l_{S,y}}{l_{ges}}\right) m_{S,y} \qquad \text{Equation 5.29}$$

At the same time, the motor X_2 must accelerate a mass that consists of a primary section mass m_{X2} and the mass of the y-axis that is not accelerated by the motor X_1:

$$M_{X2} = m_{X2} + (m_{R,y} - m_{R,y,X1}) + (m_{S,y} - m_{S,y,X1})$$

$$M_{X2} = m_{X2} + \frac{l_{R,y}}{l_{ges}} m_{R,y} + \frac{l_{S,y}}{l_{ges}} m_{S,y} \qquad \text{Equation 5.30}$$

The center of gravity of the frame does not shift during the movement. M_{X1} thus only changes due to the movement of the slide of the y-axis: The mass that the motor X_1 must move is maximum if $l_{S,y}$ is minimum:

$$M_{X1,MAX} = m_{X1} + \left(1-\frac{l_{R,y}}{l_{ges}}\right) m_{R,y} + \left(1-\frac{l_{S,y,MIN}}{l_{ges}}\right) m_{S,y}$$ Equation 5.31

For the variables shown here in the example, the following maximum mass M_{X1} results:

$$M_{X1,MAX} = m_{X1} + \left(1-\frac{0{,}6\ m}{1{,}2\ m}\right) \cdot 280\ kg + \left(1-\frac{0{,}3\ m}{1{,}2\ m}\right) \cdot 180\ kg$$

$$= m_{X1} + 275\ kg$$

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Since the center of gravity of the frame is precisely between both motors X_1 and X_2 in the current example, $M_{X1,MAX} = M_{X2,MAX}$ applies so that all following observations can be made only for the motor X_1 .

Selection of the primary sections

Power/time chart and sustained power

If you initially ignore the mass of the primary section of the motor X_1, the maximum power that the motor requires for the acceleration results from the maximum mass to be moved M_{X1}:

$$F_{a,MAX} = M_{X1,MAX} \cdot 2g$$

$$= 275\ kg \cdot 2 \cdot 9{,}81\ m/s^2$$

$$= 5395{,}5\ N$$

Added to this is the friction F_r = 300 N so that the maximum power that the motor X_1 must raise amounts to about 5700 N without taking the mass of the primary section into consideration.[5]

From the 1FN1-type motors, the 1FN1126-5xF71 motor thus comes into question. This motor fulfills all previous requirements with a maximum force of 6500 N and a maximum speed of 103 m/s. Together with the mass of the primary section of 40.7 kg, however, a maximum force of about 6500 N results. The recommended control reserves of 10% (see chapter 5.1.4) would otherwise not exist in this form. We accordingly recommend that you select primary section 1FN1184-5xF71. This primary section has a mass of 44.5 kg, and the maximum force that the motor must move amounts to about 6570 N. This lies considerably below the given maximum of 7920 N (see chapter 12.3.1).

It now must be checked whether the sustained power lies below the rated thrust F_N of the selected primary section. The calculation takes place analogously to the first example (see page 5-57): Here, too, there are only sections with constant force (see Figure 5-19).

[5] The processing power is much lower than the power the motor needs to accelerate (see Figure 5-19). For this reason, the maximum power of the load cycle is also needed during acceleration.

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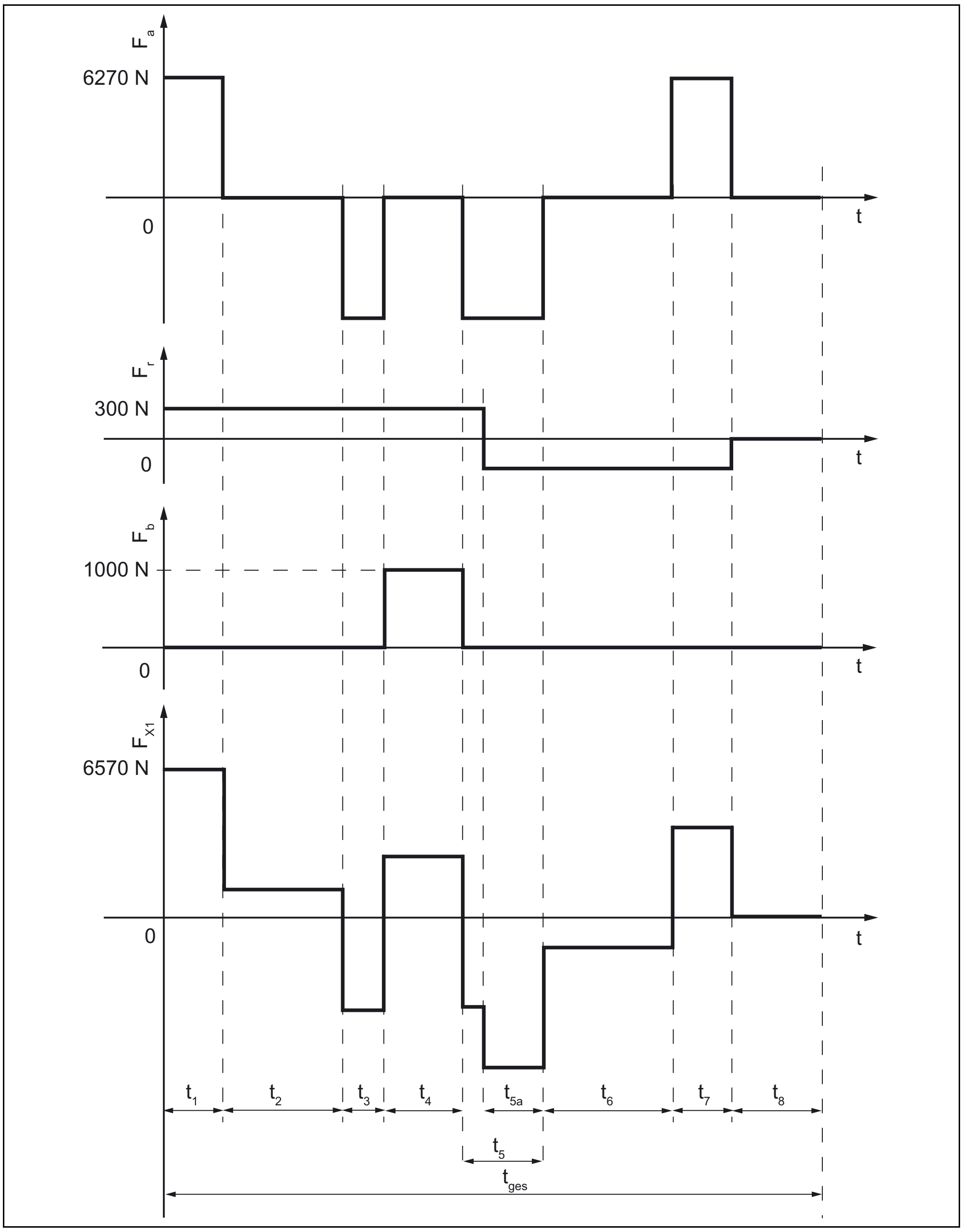

Figure 5-19 Example 2: Power/time chart of the observed load cycle

The times listed in Figure 5-19 correspond to those from the speed/time chart in Figure 5-17. The only thing that must be considered is that the direction of motion of the motor reverses during this time t_5 and the frictional force F_r thus changes its sign accordingly. Using a ray equation, the time t_{5a} in Figure 5-19 can be calculated according to Figure 5-17 from:

$$\frac{t_{5a}}{t_5} = \frac{v_{MAX}}{v_{MAX}+v_b} \rightarrow t_{5a} = \frac{v_{MAX}}{v_{MAX}+v_b} t_5$$

Equation 5.32

$$t_{5a} = \frac{1{,}5 \text{ m/s}}{(1{,}5+0{,}5) \text{ m/s}} \cdot 102 \text{ ms} = 76{,}5 \text{ ms}$$

For the sustained power F_{eff} , a value of about 3848 N results. This lies above the rated thrust F_N = 3600 N of the selected primary section! There are two alternatives now:

- The extension of the standstill phase at the end of the movement cycle: A time t_8 = 950 ms instead of t_8 = 866 ms results in a value F_{eff} = 3592 N < 3600 N.
- The selection of the next largest primary section: This primary section 1FN1186-5xF71 fulfills all requirements on maximum force ($F_{X1,MAX}$ = 6830 N < 10600 N), maximum speed (v_{MAX} = 90 m/min < 102 m/min), and sustained power (F_{eff} = 3920 N < 4800 N).

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In the following, the first variant is used.

Result

Both for the motor X_1 and the motor X_2 , the primary section 1FN1184-5xF71 is selected.

Selection of the secondary sections

According to chapter 5.1.6, only secondary section 1FN1180 is suited for this motor. This secondary section is available in two versions:

- l_S = 215,4 mm (1FN1180-0AA00-0AA0)
- l_S = 503,4 mm (1FN1180-0AA00-1AA0)

Together with the magnetically active length of the primary section 1FN1184-5xF71 of $l_{P,AKT}$ = 518 mm, the necessary length of the magnet system is composed of individual secondary sections according to chapter 5.1.6 or Equation 5.25.

Selection of the power inverter power unit

The selected motors have the following data:

- Maximum power F_{MAX} = 7920 N
- Rated thrust F_N = 3600 N
- Maximum current I_{MAX} = 65,5 A
- Rated current I_N = 26,1 A

A power unit that matches this data, for example, is the 56 A/112 A power unit from the catalog . If no power increase is planned in the long term, power unit 28 A/56 A also suffices since the maximum current I_{MAX} = 65,5 A according to the load cycle is not reached. The actual current used results according to Equation 5.18 from:

$$I_{MAX} = \frac{F_{MAX}}{k_F} = \frac{6570\ \text{N}}{138\ \text{N/A}} = 47{,}6\ \text{A}$$

Calculation of the maximum infeed voltage:

The mechanical power P_{MECH} and power loss P_V of *one* motor become maximum when this motor is running at maximum speed and maximum power according to the required load cycle. In the example shown here, these values are as follows:

- v_{MAX} = 1,5 m/s
- F_{MAX} = 6570 N (see page 5-63)

In case of *gantry axes*, the infeed powers of both motors X_1 and X_2 are added up. In case of an uneven weight distribution, the sum becomes maximum since the power loss of the motors increases quadratically with the power that the motor

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must raise. This means that the maximum infeed power is necessary if the motor X_1 should actually have to raise the maximum force F_{MAX}. For the motor X_2 , the following mass to be accelerated results according to Equation 5.30:

$$M_{X2} = m_{X2} + (m_{R,y} + m_{S,y}) - (m_{R,y,X1} + m_{S,y,X1})$$

$$M_{X2} = 44{,}5\ \text{kg} + (280\ \text{kg} + 180\ \text{kg}) - 275\ \text{kg}$$

$$M_{X2} = 229{,}5\ \text{kg}$$

The following power to be raised F_{X2} results as well:

$$F_{X2} = M_{X2} \cdot 2g + F_r$$

$$F_{X2} = 229{,}5\ \text{kg} \cdot 2 \cdot 9{,}81\ \text{m/s}^2 + 300\ \text{N}$$

$$F_{X2} = 4803\ \text{N}$$

For the infeed power, the following results from Equation 5.17, Equation 5.18, and the data sheet from chapter 12.3.1 at maximum speed:

$$P_{EL} = P_{EL,X1} + P_{EL,X2}$$

$$P_{EL} = F_{X1} \cdot v_{MAX} + 3R_{STR} \cdot \left(\frac{F_{X1}}{k_F}\right)^2 + F_{X2} \cdot v_{MAX} + 3R_{STR} \cdot \left(\frac{F_{X2}}{k_F}\right)^2$$

$$= (F_{X1} + F_{X2}) \cdot v_{MAX} + 3R_{STR} \frac{F_{X1}^2 + F_{X2}^2}{k_F^2}$$

The maximum infeed power is thus:

$$P_{EL,MAX} = (6570\ \text{N} + 4803\ \text{N}) \cdot 1{,}5\ \text{m/s} + 3 \cdot 15{,}7\ \Omega \cdot \frac{(6570\ \text{N})^2 + (4803\ \text{N})^2}{(138\ \text{N/A})^2}$$

$$= 180870\ \text{W}$$

The value of 181 kW must be added to the infeed cables of other consumers that are also operated on the intermediate circuit. A corresponding infeed/regenerative feedback module can thus be selected.

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6 Parallel and double-sided arrangement

6.1 Parallel connection of motor primary sections

In contrast to the gantry drive (see chapter 5.2.2), the parallel-connected motors are supplied with power by a single converter.

Note

Only linear motors with identical order designations should be connected in parallel. This means that the motors have:

- The same forces
- The same winding type
- The same secondary section type
- The same air gap

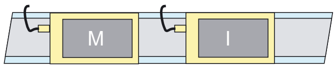
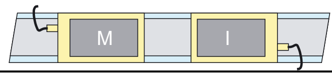
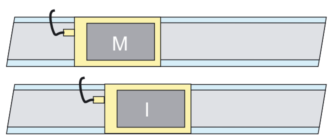
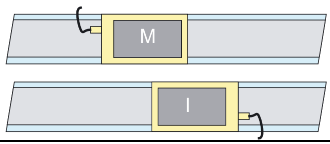
Insofar as you want to connect different types of motors in parallel, the necessary data can be provided for the possible pairings if desired.

The prerequisite for an electrical parallel connection of motors is a sufficiently rigid coupling. The position of the primary sections that must fulfill certain prerequisites thus remain constant in relation to each other.

6.1.1 Motor arrangements

Primary sections can both be arranged on one secondary section track or use one secondary track each. The cable outlet direction can be the same or different. For motors connected electrically in parallel (Master M and Stoker S), four basic mechanical arrangements thus result (see Table 6-1).

Table 6-1 Basic mechanical arrangements of parallel-connected motors

	Same cable outlet direction	Different cable outlet direction
One secondary section track	TANDEM arrangement 	JANUS arrangement 
Two secondary section tracks	PARALLEL arrangement 	ANTIPARALLEL arrangement 

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6.1.2 Position of the primary sections and phase sequence

Note

If linear motors on a secondary section track are connected in parallel, the position of the primary sections with respect to one another must exhibit a specific grid to achieve a matching electrical phase position. In case of separate secondary section tracks, the position of the tracks in relation to each other must be taken into consideration.

The reference points for the determination of the correct position of the parallel-connected linear motors are as follows:

- For the primary section: The bore hole that is located farthest from the cable outlet of the primary section.
- For the secondary section: The mounting hole closest to the N-marking.

Same cable outlet direction

The phase sequence of Master and Stoker is identical for the same cable outlet (see Table 6-2).

Table 6-2 Phase sequence for PARALLEL and TANDEM arrangement

	Phase		
Master	U	V	W
Stoker	U	V	W

The position of Master and Stoker must accordingly be identical in comparison with the position of the permanent magnets of the secondary section track(s) (see Figure 6-1).

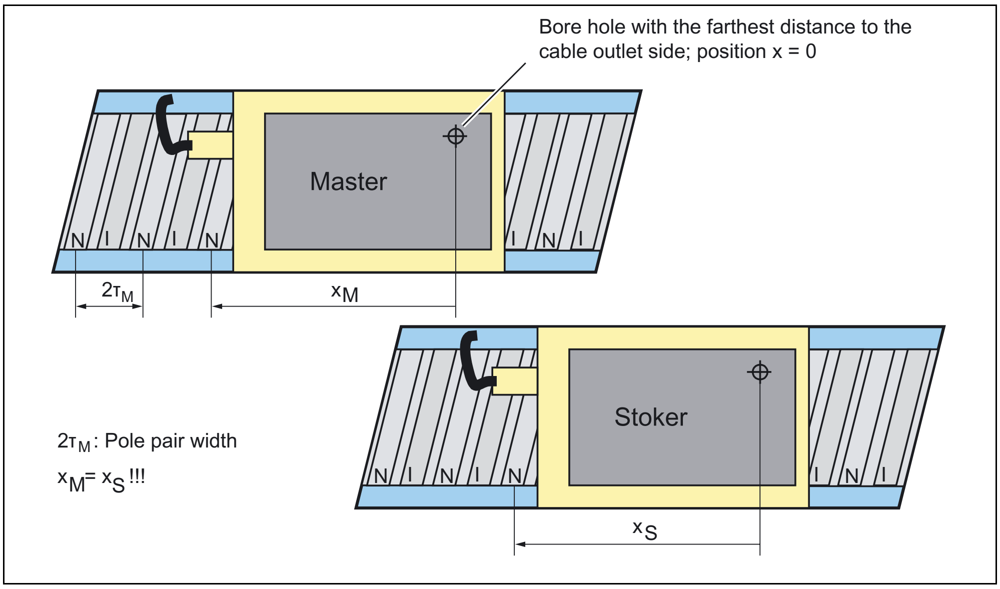

Figure 6-1 Position of Master and Stoker in the same cable outlet direction

In the case of the *TANDEM arrangement*, the bore hole distance Δs_b must accordingly be a whole-number multiple of the pole pair width $2\tau_M$ (see Table 6-2 (a)):

$$\Delta s_b = n \cdot 2\tau_M \quad \text{with } n = 0, 1, 2, \ldots \qquad \text{Equation 6.33}$$

In the case of the *PARALLEL arrangement*, you also have the possibility of shifting the second secondary section track by Δx (see Table 6-2 (b)). For the bore hole distance Δs_b , the following thus results:

$\Delta s_b = \Delta x + n \cdot 2\tau_M$ with n = 0, 1, 2, ... Equation 6.34

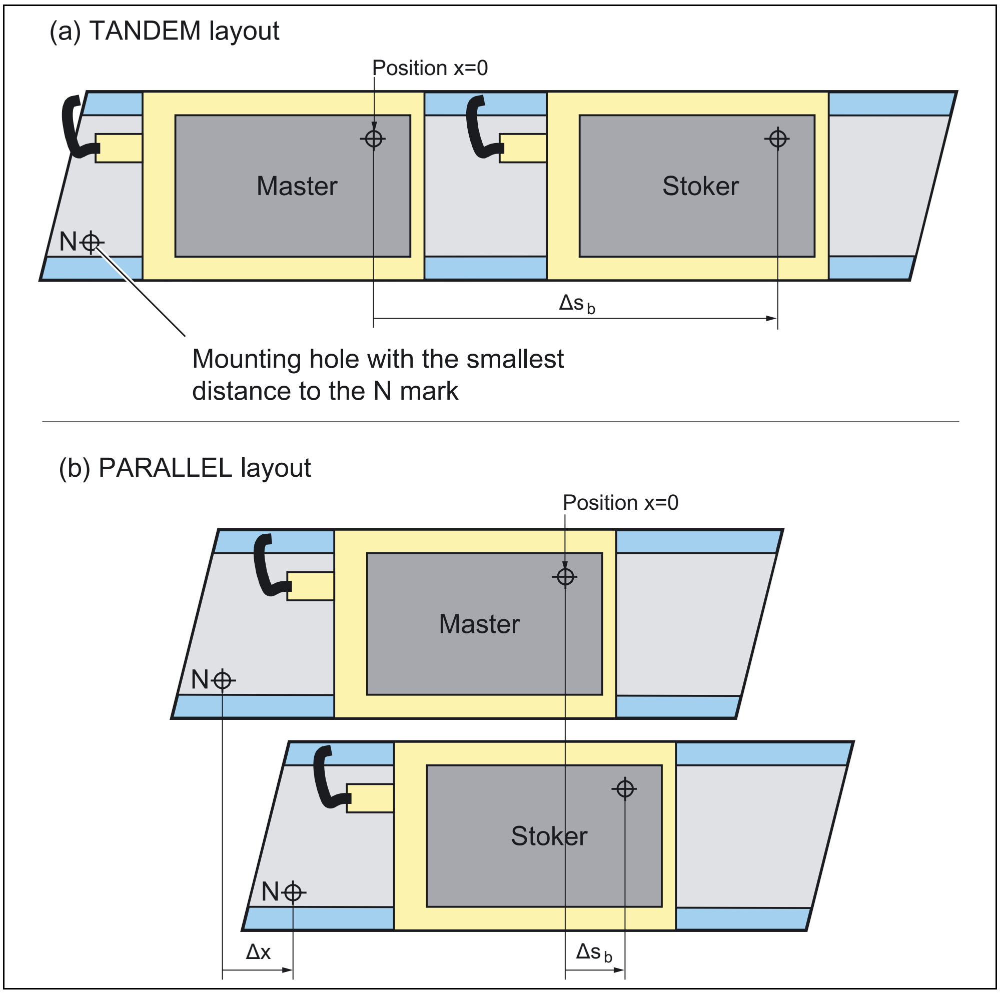

Figure 6-2 Position of Master and Stoker in case of PARALLEL and TANDEM arrangement

Different cable outlet direction

The phase sequence of Master and Stoker results according to Table 6-3 in case of a different cable outlet direction. One phase is assigned as in the case of Master, the other two are switched.

Table 6-3 Phase sequence for ANTIPARALLEL and JANUS arrangement

	Phase		
Master	U	V	W
Stoker (1FN1)	V	U	W
Stoker (1FN3)	U	W	V

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The position of the primary sections in relation to the permanent magnets of the secondary section track is no longer identical: The Stoker must be shifted by a distance $\Delta s_0 \mp 2\tau_M$ so that the formation of forces in both motors is the same. Such a distance is easiest to define in the JANUS arrangement: Δs_0 is the smallest possible bore hole distance (see Figure 6-3). [6]

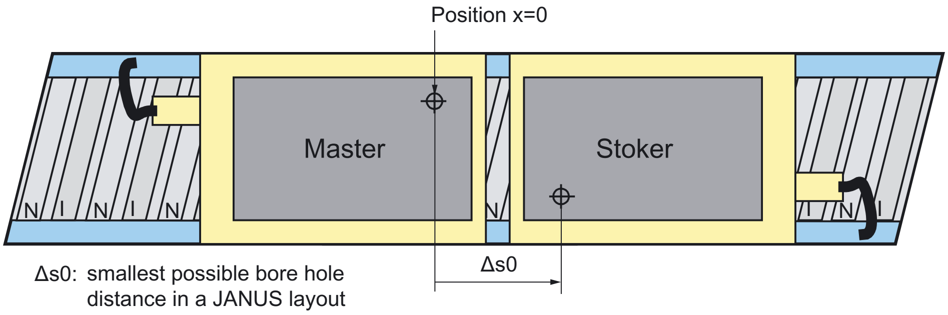

Figure 6-3 Position of the Master and Stoker in the case of different cable outlet directions

Accordingly, borehole distances Δs_b that result from the following are possible in the *JANUS arrangement*:

$$\Delta s_b = \Delta s_0 + n \cdot 2\tau_M \quad \text{with } n = 0; 1; 2; \ldots \qquad \text{Equation 6.35}$$

In the case of the *ANTIPARALLEL arrangement*, you can shift the second secondary section track by Δx as in the case of the PARALLEL arrangement. For the bore hole distance Δs_b , the following thus results:

$$\Delta s_b = \Delta s_0 + \Delta x + n \cdot 2\tau_M \quad \text{with } n = 0; 1; 2; \ldots \qquad \text{Equation 6.36}$$

Example: Calculation of the bore hole distance in case of the ANTIPARALLEL arrangement

Prerequisites:

- Motor type: 1FN3300–1W (data from Table 13-6)
  - Δs_0 = 111,2 mm
  - $2\tau_M$ = 46 mm
- Both motors should be next to each other if possible (see Figure 6-4).
- $|\Delta x|$ should be as small as possible.

[6] The differences between 1FN1 and 1FN3 in the phase assignment of the Stoker with a different cable outlet direction also result from the definition of s_0 as the smallest possible bore hole distance of the JANUS arrangement.

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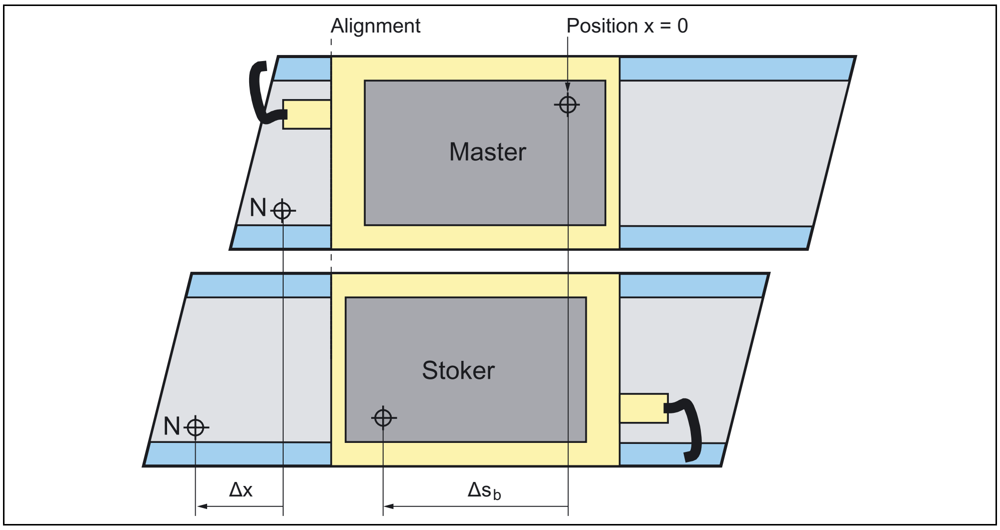

Figure 6-4 Targeted sample position of the Master and Stoker

Steps:

First, imagine the JANUS arrangement (see Figure 6-5) for Step 1. The shift s_V that would be necessary to bring the Stoker into the desired position in this arrangement depends on the length of the primary section l_P, the distance of the bore hole to the front of the primary section $l_{P,B}$, and the minimum bore hole distance of the JANUS arrangement Δs_0:

$|s_V| = l_P + (\Delta s_0 - 2l_{P,B})$

with l_P = 221 mm (see chapter 16.2.2)

with $l_{P,B}$ = 50,5 mm (see chapter 16.2.2)

$|s_V|$ = 221 mm + (111,2 - 2· 50,5) mm

s_V = -231,2 mm (negative since the shift is to the left)

Since the secondary section tracks should be pushed against each other as little as possible, the shift s_V should be realized from a multiple of the pole pair width $2\tau_M$ if possible. The optimum case ($\Delta x = 0$) would be $\Delta s = s_V = -n \cdot 2\tau_M$. The n for which $|s_V - \Delta s|$ becomes minimum is determined via:

$$\frac{|s_V|}{2\tau_M} = \frac{231{,}2\text{ mm}}{46\text{ mm}} = 5{,}02 \approx 5$$

In this example, the Stoker must be shifted five pole pair widths to the left in Step 2. Thus, the following applies for Δs :

$\Delta s = -5 \cdot 2\tau_M = -5 \cdot 46$ mm = -230 mm

The difference $s_V - \Delta s$ must be compensated by shifting the secondary section track:

Δx = -231,2 mm -(-230 mm) = -1,2 mm

In this case, the secondary section track with the Stoker must be shifted 1.2 mm to the left.

The bore hole distance can now be defined:

$\Delta s_b = \Delta s_0 + \Delta s + \Delta x$

Δs_b = 111,2 mm - 230 mm - 1,2 mm = -120 mm

The reference bore hole of the Stoker is thus 120 mm to the left of the reference bore hole of the Master.

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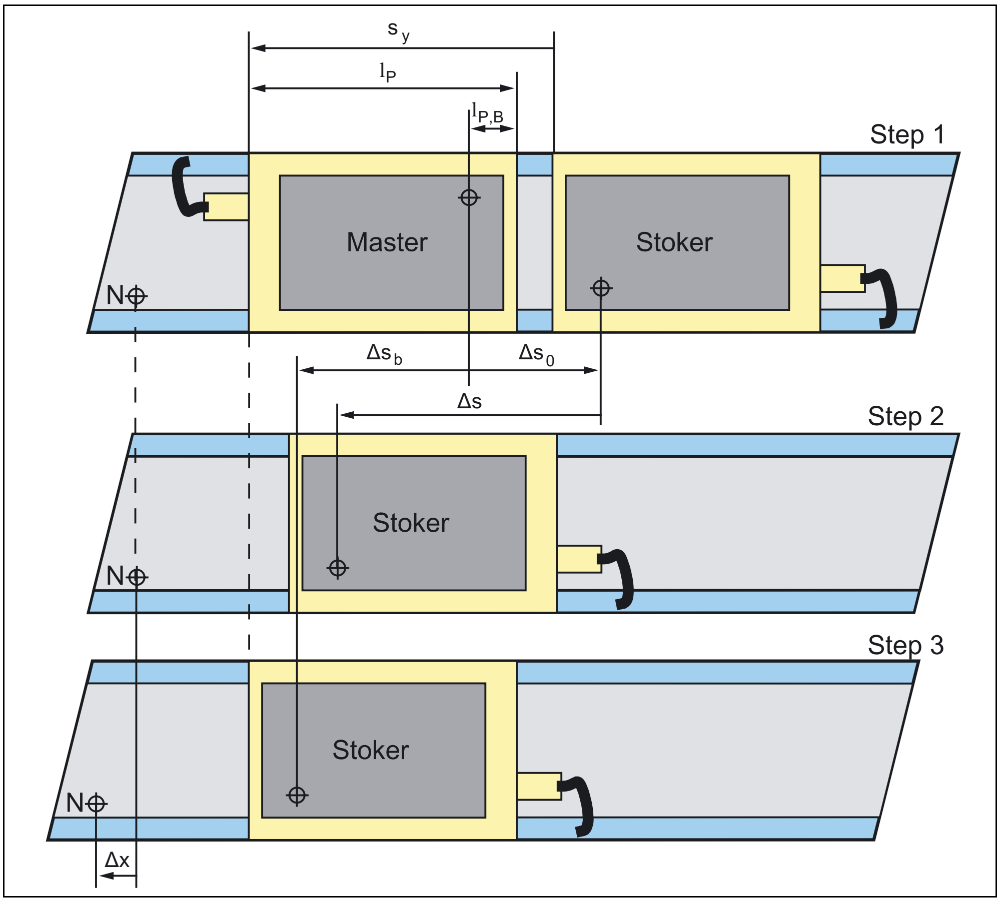

Figure 6-5 Dimensions (with counting direction) in the case of the specified example

6.2 Double-sided motors

Double-sided motors are suited for drives with high power density and short traversing distances. Since the primary sections are usually known and the structure is moved together with the secondary section, no power cable that must be moved is expected.

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6.2.1 Basic design

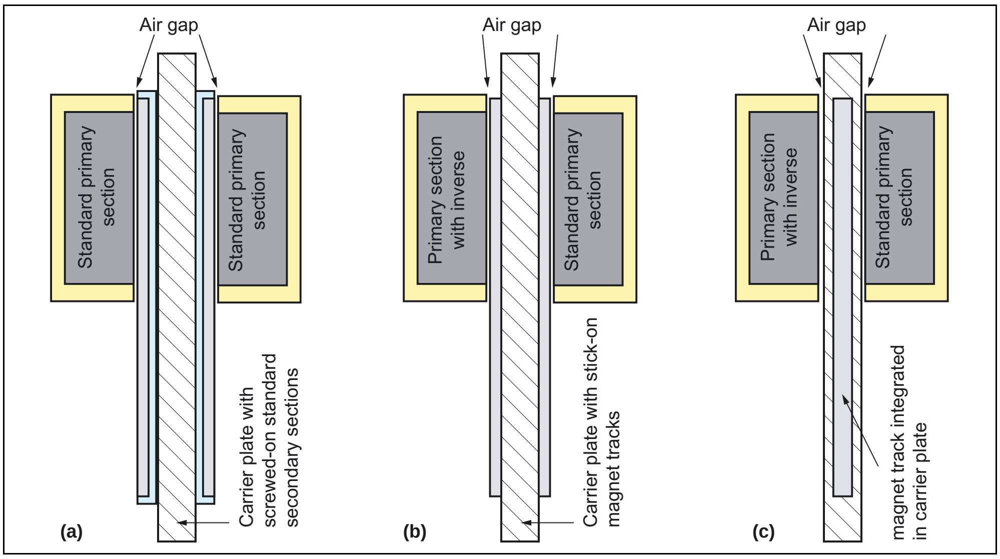

Figure 6-6 Principle design of a double-sided motor

Figure 6-6 shows the variants in which a double-sided motor can be realized:

a) Two standard secondary section tracks are mounted on a carrier plate – the incline of the permanent magnets is not parallel.

b) Two magnetic tracks are glued onto a carrier plate with a parallel incline

c) One magnetic track is integrated into the carrier plate.

In the case of Variant (a), two standard primary sections can be used since both primary sections work with the usual incline of the permanent magnets. For this reason, this variant can be realized with all motors of the 1FN1 and 1FN3 product families.

Due to the lower dynamic mass for Variants (b) and (c), these double-sided motors are suited for the maximum dynamic requirements. Since a primary section must work with the opposite incline, an inverse winding is needed here. This can be obtained only for certain motor types of the 1FN1 and 1FN3 product families or upon request. For the corresponding data, see chapter 9.5.2 in the 1FN1 section and chapter 13.5.2 in the 1FN3 section.

6.2.2 Connection of the primary sections

For both variants, the primary sections are connected in parallel according to Table 6-2.

6.2.3 Structure of the carrier plate

The carrier plate for the application-specific secondary section track is to be manufactured in consultation with the Siemens office responsible for the customer.

The minimum thickness of the carrier plate only depends on the motor thrust to be transferred. For reasons of stiffness, this dimension – according to the structure of the application-specific secondary section – should be increased since uneven air gaps on the left and right lead to various attraction forces. The difference of the attraction forces of the motors must be transferred to the guide via the carrier plate and its connecting structure. In case the stiffness of the carrier plate is too low, impermissibly high deformation may result. Even though the attraction forces are compensated in the case of double-sided motors, forces of up to about 25% of the attraction forces of a motor have an effect on the carrier plate.

ALL

6.2.4 Configuration of the motors

The configuration essentially takes place according to chapter 5.1. Only difference: in this case, the dynamic mass is the mass of the secondary section plant. This means that the following must be taken into consideration:

- The mass of the secondary sections or the mass of the magnetic material
- The mass of the (special) secondary section covers
- The mass of the mount of the carrier plate
- The mass of the guide elements
- The mass of the length measurement system

For specific data, see chapter 9.5.2 in the 1FN1 section, chapter 13.5.2 in the 1FN3 section, and the corresponding data sheets in chapters 11.2 (1FN1) and 15.2 (1FN3).

■

7 Motor mounting

7.1 Mounting instructions

Danger

⚠ For mounting and dismantling tasks, there is a special danger of injury!

You must observe the safety instructions in chapter 3.2!

7.2 Proceed as follows

The mounting of a linear motor is divided into the following steps:

(1)Checking the mounting dimensions before the installation of the motors

(2)Cleaning of the attachment surfaces of motor parts and the machine

(3)Installation of primary sections, secondary sections, and components

(4)Connection of the electrical and cooling systems

(5)Checking of the smooth running of the motor slide

7.3 Checking the mounting dimensions

For the observance of the electrical and system-technical properties of the motor, only the mounting dimensions and not the measurable air gap are decisive. The mounting dimensions can be checked before mounting the motor, e.g. using final dimensions and feeler gauges. For precise dimensions, see chapter 9.6.1 in the 1FN1 section and chapter 13.6.1 in the 1FN3 section. The mounting dimensions must lie within the given tolerances over the complete traversing distance.

7.4 Attraction forces

The attraction forces between the primary section and the secondary section track can amount to several 10 kN.

Note

In order not to impair the function of the motor, the air gap may not be reduced by the attraction force between the primary section and the secondary section track when installed. For this reason, a corresponding stiffness of the mechanical structure should be provided.

With decreasing air gap, the attraction forces between the primary section and the secondary section track increase; see the characteristic curves in chapter 11.3.2 for 1FN1-type motors and chapter 15.3.2 for the peak-load motors of the 1FN3 product family.

7.5 Mounting system

When fastening the motor to the machine structure, the following must be considered:

- Use only new, unused screws oiled with MoS2.
- Observe the maximum length of thread engagement into the primary sections (see the respective mounting drawing)
- Observe the minimum length of thread engagement.
  - Primary section: 1.0 x d
  - Secondary section: 1.0 x d (steel), 1.1 x d (aluminum alloy)
  - Partially specified in drawings!
- Tighten screws using a calibrated torque wrench while observing the tightening torques from Table 7-1.
- To secure screws, choose long clamp lengths l_K, l_K/d > 5 if possible; alternatively (in case l_K/d > 5 is not possible), secure the screws additionally (e.g. Loctite, loosenable) or check the pretensioning of the screws at regular intervals (tighten with calibrated torque wrench).

Table 7-1 Maximum permissible tightening torques $M_{A,MAX}$ *

	M5	M6	M8	M10	M12
$M_{A,MAX}$ in Nm	4.8	8.3	20	40	69

* Based on the coefficient of friction: μ_{ges} = 0,1 (oiled, lubricating pressure MoS_2)

Note

Please observe the maximum tightening torques of the screws used as well! These may be lower than the values from Table 7-1!

7.6 Motor mounting procedure

There are three different procedures for mounting a linear motor:

- Motor mounting with divided secondary section track
- Motor mounting through the insertion of the slide
- Motor mounting through the placement of the motor parts

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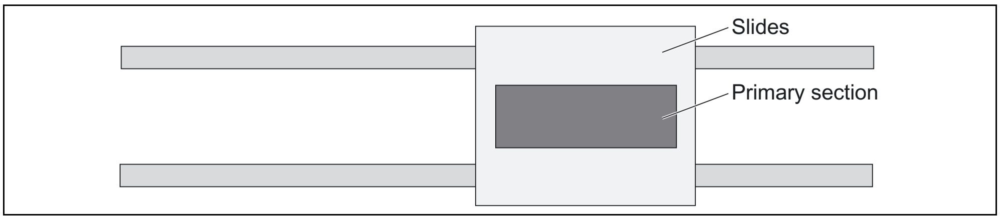
7.6.1 Motor mounting with divided secondary section track

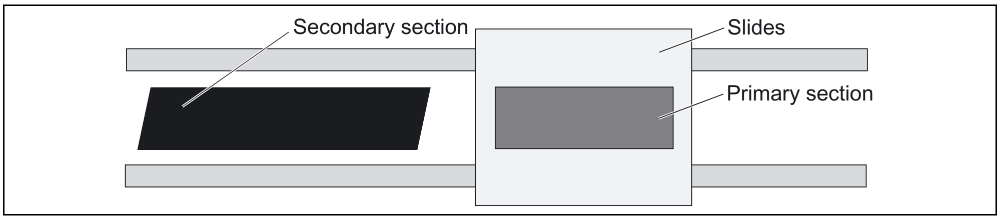
The easiest way is to mount the motor with a divided secondary section track. The prerequisite is that the entire secondary section track can be divided into two sections, of which each has at least the length of the slide. During mounting, you must work against the attraction force of the secondary sections.

Proceed as follows

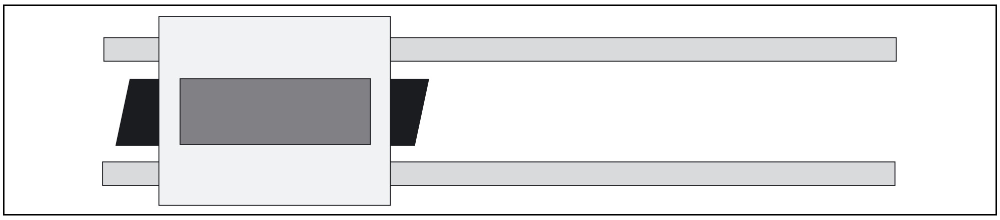
1. Mounting of the slide including the linear guide and the primary section



2. Move the slide to one side and mount the secondary section on the other side.



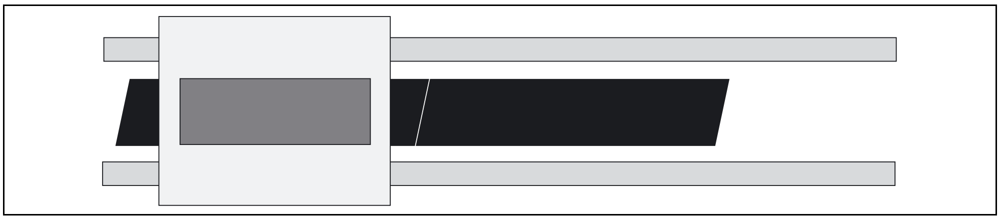
3. Move the slide over the secondary section. The attraction forces are taken up by the linear guides.



Warning
When moving the primary section onto the secondary section (Step 3), drawing forces towards the secondary section will occur for a short time. Danger of crushing injuries!

Make sure that your fingers do not reach into the danger zone!

4. Mounting of the second secondary section.



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7.6.2 Motor mounting through the insertion of the slide

If the secondary section track cannot be divided into several sections, for example, because the entire length of the secondary section track is too small, or, in the case of the double-sided motor, the moving part of the motor (slide) can be pushed into the stationary housing with the previously mounted motor parts (see Figure 4-1). A special insertion mechanism is usually used for this purpose.

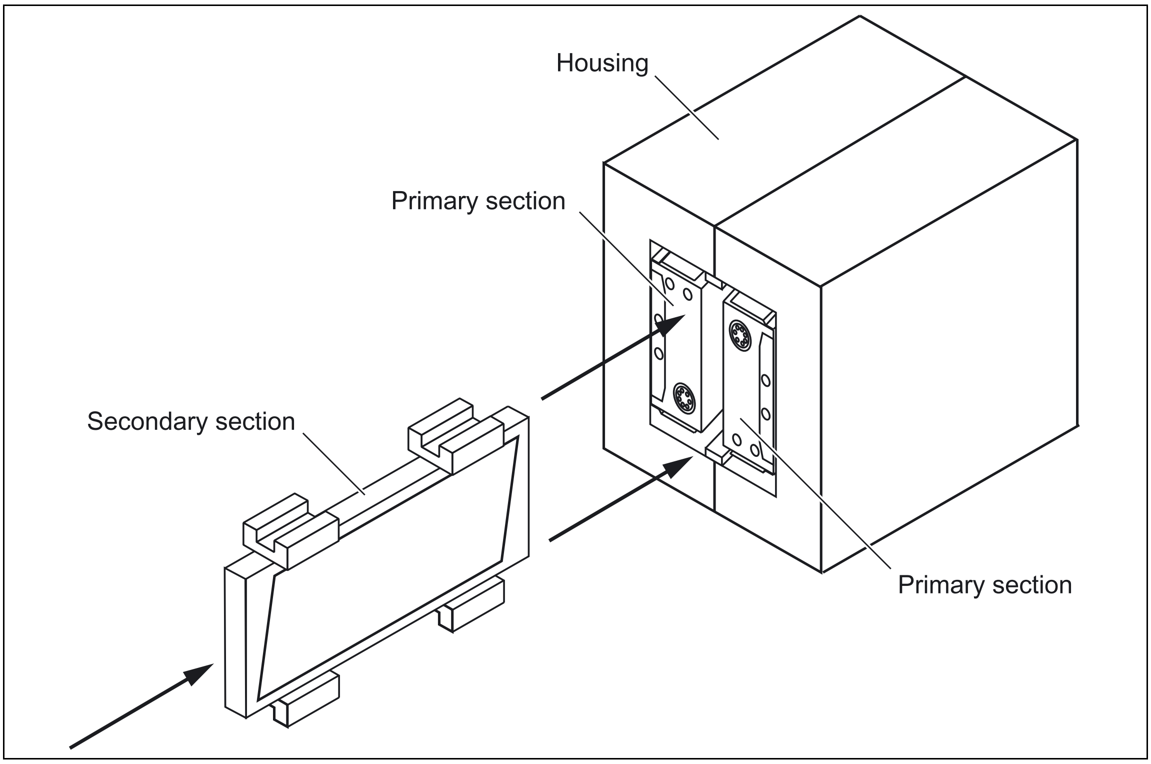


Figure 7-1 Insertion of the secondary section in the case of a double-sided motor

Warning
In the case of this procedure, drawing forces towards the stationary motor component occur. Danger of crushing injuries!

Before inserting ferromagnetic components of the linear motor into the active zone of the stationary motor component, remember that guiding or supporting elements (motor bearing) must already be effective!

7.6.3 Motor mounting through the placement of the motor parts

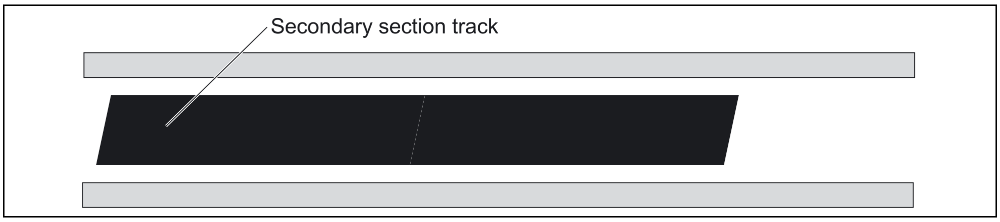
In the case of the third procedure for motor mounting, the primary section is placed on the secondary section track before mounting into the slide using the spacer and the extractor. After that, the primary section is mounted to the slide pushed above

ALL

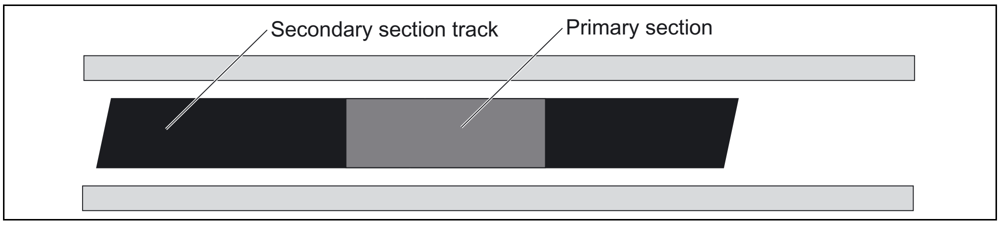
it. This procedure is the most difficult of the described procedures. It should be used only if the other procedures are not possible. The spacer and the extractor must be provided by the customer.

Proceed as follows

1. Mounting of the secondary section track



2. Placement of the primary section
Using the spacer and the extractor (see Figure 7-2 and Figure 7-3) the primary section is centered above the secondary section track.



Warning
Danger of crushing injuries during the placement of the primary section onto the secondary section!

Never set the primary section directly onto the secondary section, but rather use a spacer made of non-magnetizable material (e.g. a board made of hard wood).

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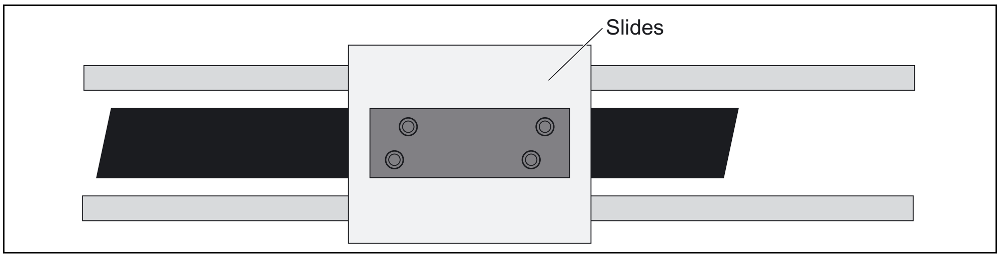
3. Mounting of the slide.
The primary section lifts into its desired position when the slide is evenly screwed into place. After that, the spacers are removed.



The Extractor

The extractor to be provided by the customer must consists of a sufficiently thick steel sheet with holes for fastening the primary section and threaded holes for the accommodation of the forcing screws. Figure 7-2 and Figure 7-3 show the principle structure. To guide the forcing screws, two thrust bearing blocks are used.

ALL

Notice
When the primary section is being placed, attraction forces work towards the secondary section track. Danger of crushing injuries!

The forcing screws must be at least long enough that the primary section is located outside of the immediate vicinity of the secondary sections
(distance greater than 100 mm) when it is placed.

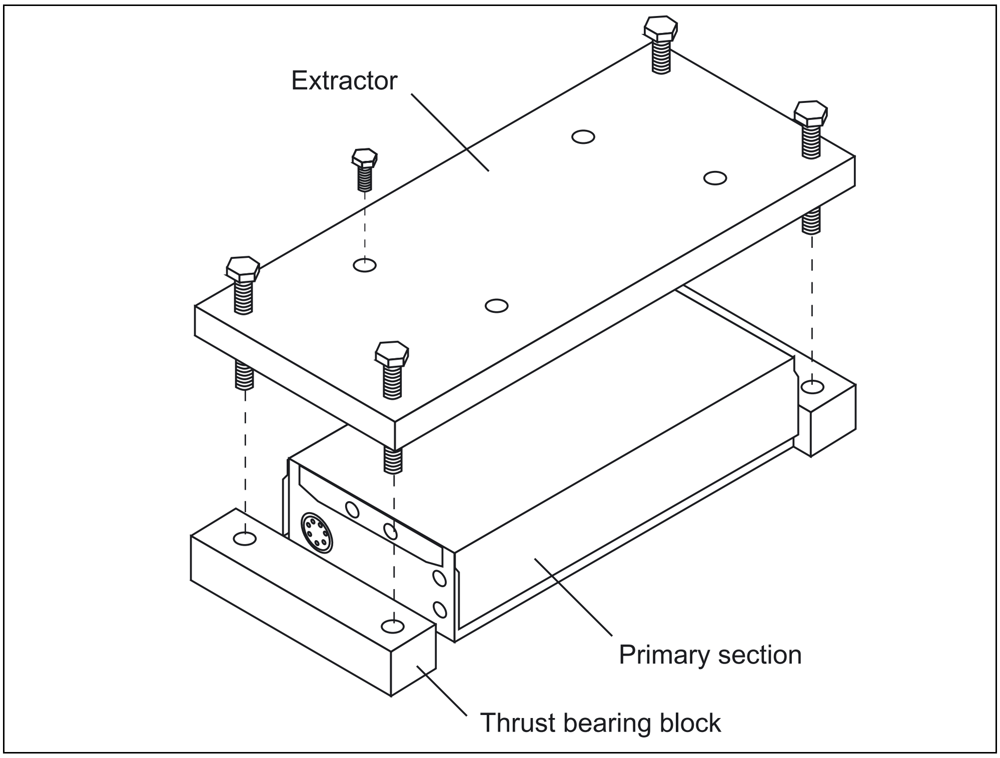


Figure 7-2 Principle structure of an extractor

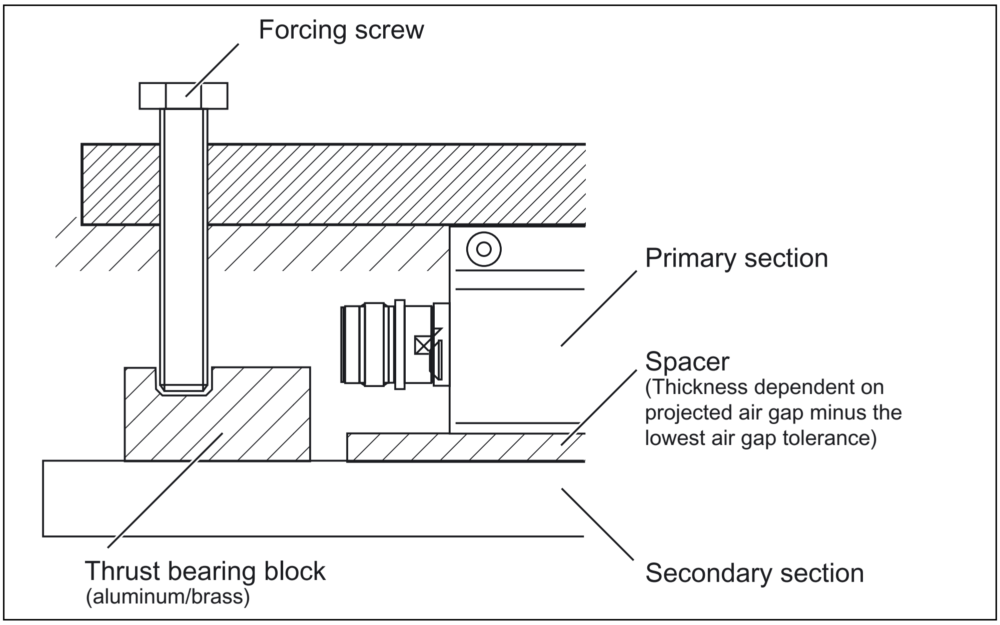


Figure 7-3 Principle structure of an extractor (longitudinal section)

7.7 Checking the air gap

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After mounting the motor components, the air gap can be subjected to an optional, approximate, spot check. A non-magnetic strip (e.g. of aluminum, plastic, cardboard, etc.) with a thickness of 0.5 mm must be able to be pushed through the air gap between the primary section and the secondary section track without a considerable amount of force.

Generally, this test is not necessary. If the mounting dimensions are correct, the correct air gap is automatically obtained. If the tolerances of the air gap (see chapter 9.6.1 (1FN1) and chapter 13.6.1 (1FN3) are exceeded, the mounting is generally faulty.

Note

This air gap check is valid only when performed when the engine is cold (T < 30 °C).

7.8 Checking the motor mounting

After the mounting procedure has been completed, the smooth running of the slide should be checked. Before moving the slide, remove all tools and objects from the traversing range and clean the magnetic surface with a cloth.

The slide of the linear motor must be able to be moved over the entire traversing range with even, minimum friction. The slide may not jam! If you suspect a jam, check the air gap on the corresponding side!

Danger

⚠ **Each movement of primary sections against secondary sections leads to induced voltages at the motor connections. Electrical shock hazard!**

Motor power connections must be properly connected or insulated.

Note

When the motor is shifted evenly, increased resistances ("power waves") may be noticeable at regular intervals, especially in case of short circuits of the phases. These are connected with the motor type and do not indicate faulty mounting.

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8 Disposal of linear motors

ALL

An independent disposal of three-phase linear motors or components is permitted only when proper disposal can be guaranteed. In particular, this includes:

- Demagnetization of the secondary sections
- Reuse of components (if possible)
- Proper disposal of electrical waste

Three-phase linear motors and components are accepted for proper disposal by the manufacturer only in original packaging. The sender must pay the shipping and disposal costs.

Demagnetization of the secondary sections

Disposal companies specialized in demagnetization use special disposal furnaces. The insides of the disposal furnace consist of non-magnetic material.

The secondary sections are put in the furnace in a solid, heat-resistant container (such as a skeleton container) made of non-magnetic material and left in the furnace during the entire demagnetization procedure. The temperature in the furnace must be at least 300° C during a holding time of at least 30 minutes.

Escaping exhaust must be collected and made risk-free without damaging the environment.

Disposal of electronic components

Electronic components (primary sections, converters, cables, etc.) must be properly disposed of as electrical waste.

Disposal of packaging

The packaging and packing aids we use contain no problematic materials. With the exception of wood material, they can and should be recycled. Wood materials should be burned.

Only recyclable plastics are used as packing aids:

- Code 02 PE-HD (polyethylene)
- Code 04 PE-LD (polyethylene)
- Code 05 PP (polypropylene)
- Code 04 PS (polystyrene)

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Notes

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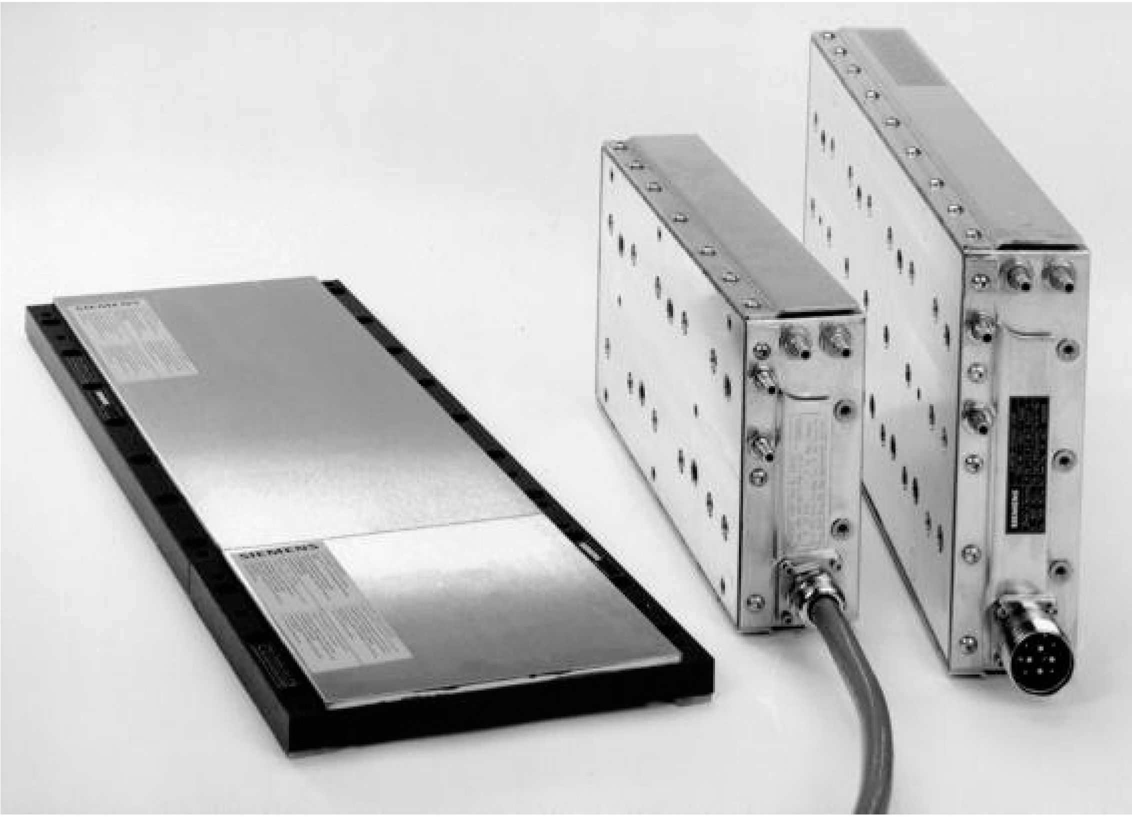
1FN1-type motors



Notes

Table of contents

9 1FN1 motors

9.1 Features and technical data

Fields of application

The 1FN1 product family was especially developed for use with maximum requirements on dynamics and contour precision. Especially the 1FN1 product family fulfills high requirements in regard to aggressive ambient conditions and thermal neutrality insofar as the instructions in this manual – especially the safety guidelines – are observed.

1FN1

In conjunction with a converter system with a digital control system (e.g. SIMODRIVE 611), the motors are admirably suited for

- Loops
- Ultra-precision machining

The development of double-sided motors is also possible.

Warning

The motors are not designed to be connected directly to the line supply.

Characteristics

1FN1-type motors are liquid-cooled synchronous linear motors. The drive is delivered in components (primary and secondary sections) and directly installed into the machine. Due to the series connection of primary and secondary sections, any motor power or traversing distances can be reached. Special features:

- Double cooling circuit with thermal insulation (Thermo-Sandwich®) for the complete thermal isolation of the motor from the machine
- Full metal encapsulation of the motor components for extensive insensitivity to aggressive liquids and particles in the air gap
- Service-friendly due to simple mounting and pluggable connection technology
- The motors are especially optimized for minimum force waves and good overload behavior.

Standards and regulations

The appropriate standards and regulations are directly assigned to the functional requirements.

1FN1

Technical features

Table 9-1 Standard motor of the 1FN1 product family: Technical features

Technical feature	Version
Machine type	Permanent-magnetic, synchronous linear motor:
Construction type	Individual components (IM 5110 acc. to IEC 60034-7)
Mounting dimensions	Tolerance ±0.3 mm
Rated air gap	1.1 mm
Cooler	• Liquid cooling system (see chapter 4.4). • Maximum pressure in cooling circuit: 10 bar = 1 MPa • Connection: Quick-snap coupling for main and precision coolers
Thermal motor protection	PTC thermistor (according to IEC 60034-11) and overtemperature switch in primary section
Rating plate	A second rating plate has been included in the delivery of every motor (see chapter 9.2).
Winding insulation	• Thermal class F (according to DIN EN 60034-1)
Permanent magnets	• Material: Rare-earth connections • Aging: At operating temperatures and magnetic operating points, aging losses lie below 1%. Magnetization reserves of 1-2% exist for the compensation of long-term losses (10-100 years).
Electrical connection	Plug for the power outlet and for temperature sensors/switches (see chapter 9.3.3).
Contact and foreign body protection/motor protection	• Primary section: IP 65 (according to DIN EN 60529) • Secondary section: As electrical components, the secondary sections should have IP 65. • Mounted motor: The protection class depends on the machine design and must thus be determined by the machine builder. Minimum requirement: IP 23

Options and supplements

Table 9-2 Special motor designs: additional possible technical features

Technical feature	Version
Previously mounted, ready-made cable	Length: 3 m
Winding direction	Inverse winding for double-sided motors

9.2 Data on the rating plate

A rating plate according to Figure 9-1 is attached to each primary section of the 1FN1-type motors.

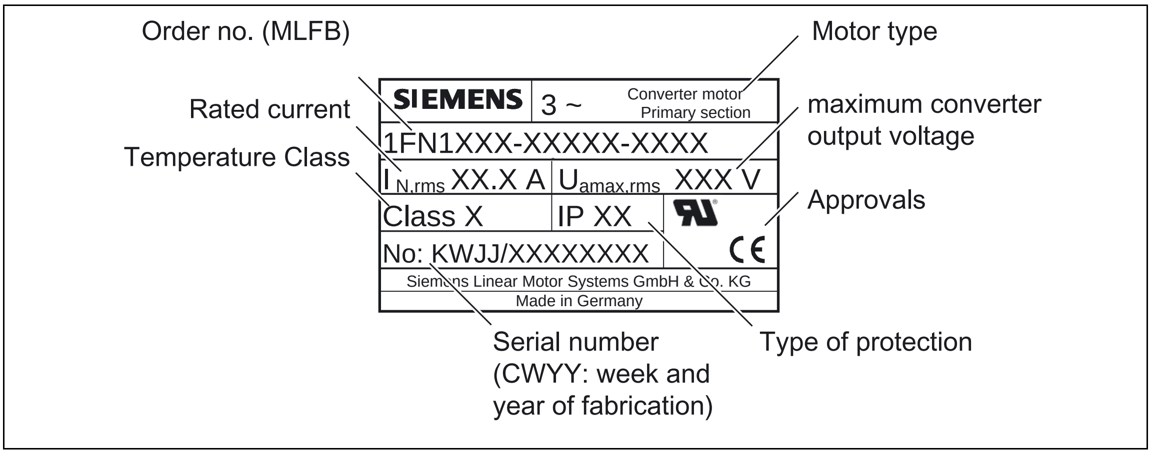


Figure 9-1 Data on the rating plate (diagram)

Additionally, a second rating plate that the customer can attach to the machine in which the motor is installed is included in delivery. This rating plate may not be abused! When it is removed, it must be made unusable.

9.3 Interfaces for the electrical and cooling systems

9.3.1 Position of terminals

The connections for the electrical and cooling systems are on the front of one of the primary sections. They are thus easily accessible for installation and servicing.

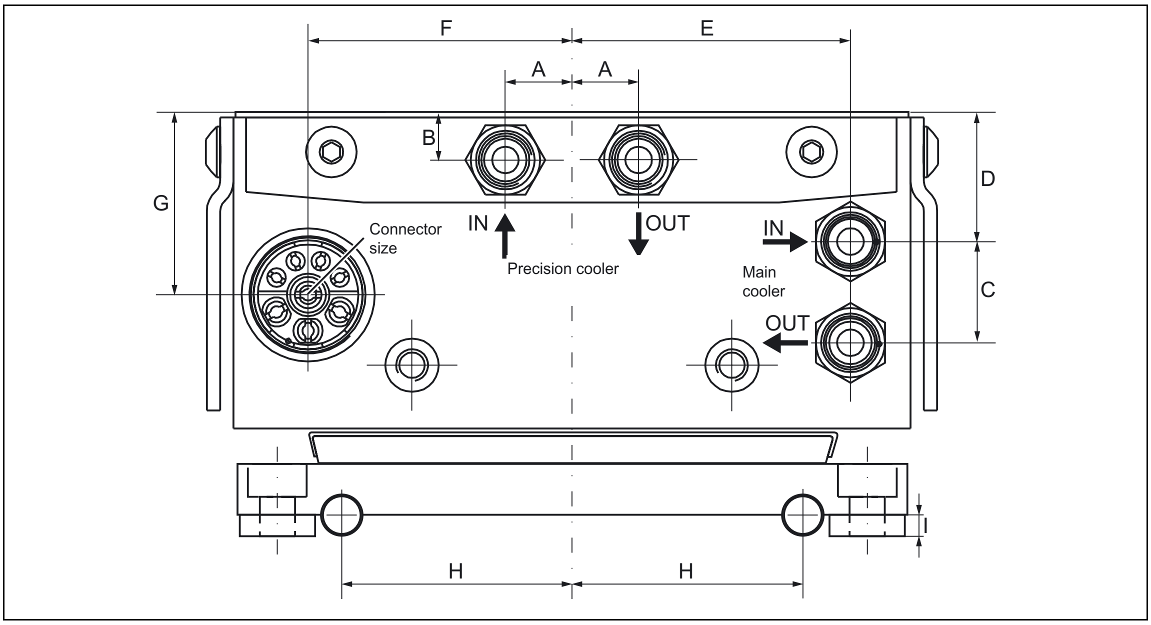


Figure 9-2 Position of the connecting elements for the 1FN1 (top view, front side)

Table 9-3 Dimensions for the position of the connecting elements (see Figure 9-2)

Motor type	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	G [mm]	H [mm]	I [mm]
1FN107x	12.5	9	19	24.3	52.2	49.5	34.3	43	4
1FN112x	20/60*	10	25	31.2	79	70.5	43.5	61	5
1FN118x	27/80*	10	25	31.2	109	100.4	43.5	94	5
1FN124x	60/110*	10	25	31.2	139	130.5	43.5	124	5

* Terminals lie at the right of the center line (as seen from the front)

1FN1

9.3.2 Mounting space for the connection system

Depending on the connection system, cables, and hoses used, corresponding mounting space should be provided in the longitudinal direction of the primary section.

Motors with plugs

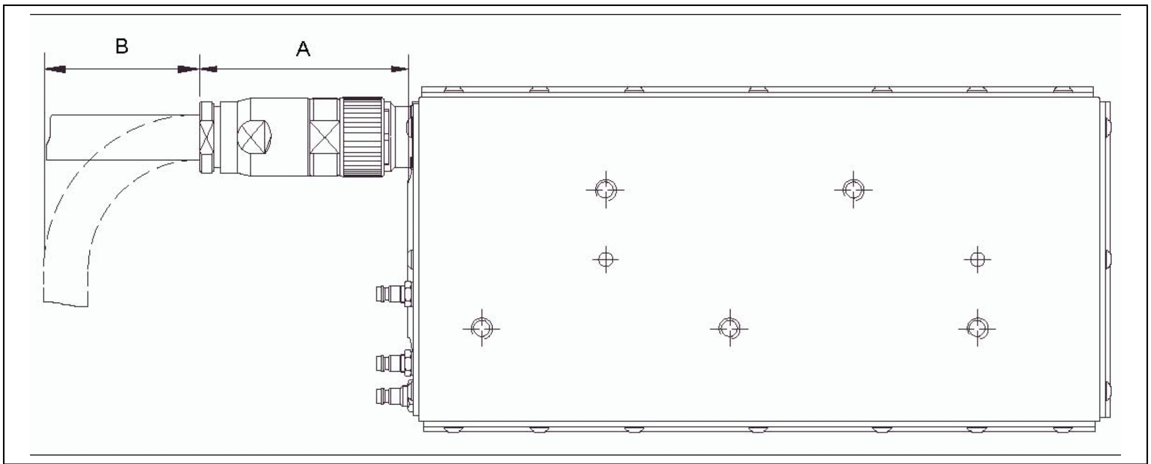


Figure 9-3 Mounting space for the connection system of the 1FN1xxx-xAxxx motors (with plug, top view)

For assembled cables of the 6FX7002 (see Catalog /NC60/, Section 10) series, the bending radius B is approximately derived from the outer diameter $d_{außen}$ of the cable:

$$B_{min,stat} \approx 4 \cdot d_{außen}$$
$$B_{min,dyn} \approx 7.5 \cdot d_{außen}$$ Equation 9.1

Precise values can be found in Catalog /NC60/.

Table 9-4 Dimensions of the mounting space for the connection system of the 1FN1xxx-xAxxx motors (see Figure 9-3)

Motor type	Connector size	A* [mm]
1FN107x	1	90
1FN112x	1.5	128
1FN118x	1.5	128
1FN124x	1.5	128

* Dimensions from the radiating plate

Motors with previously mounted, assembled cables

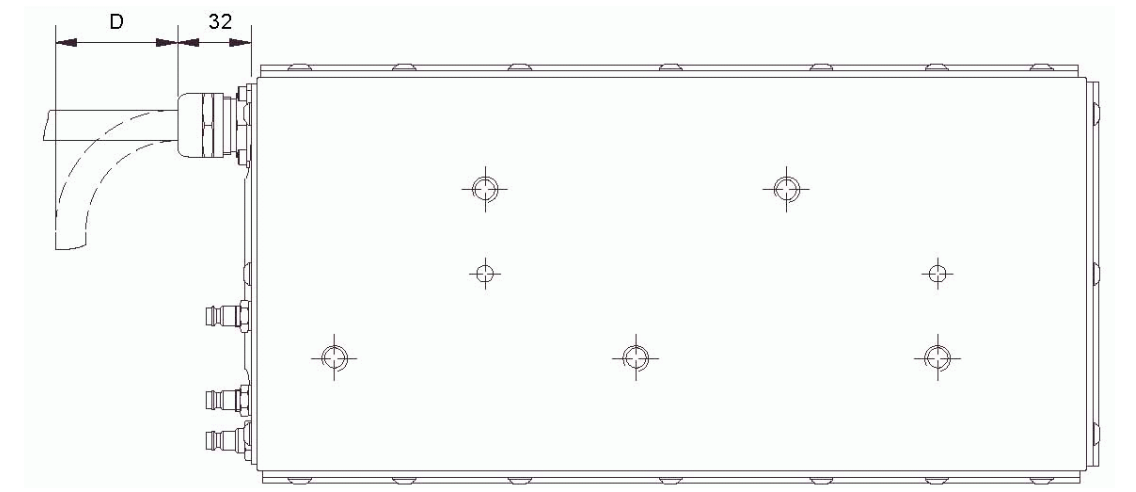


Figure 9-4 Mounting space for the connection technology of the 1FN1xxx-xKxxx motors (with previously mounted, assembled cable, top view)

Table 9-5 Dimensions of the mounting space for the connection system of the 1FN1xxx-xKxxx motors (see Figure 9-4)

Motor type	Core cross-section, cable outlet [mm²]		$d_{außen}$ [mm]	$D_{min,stat}$ [mm]	$D_{min,dyn}$ * [mm]
	Power wire	Control wire			
1FN1122	2.5	1	14.6	51	90
1FN1124	2.5	1	14.6	51	128
1FN1126	4	1	16.1	56	128

* Not recommended since the entire primary section must be exchanged in case of cable breakage

9.3.3 Electrical connection

Internal interconnection of the primary section

Figure 9-5 shows the internal circuitry of the primary section.

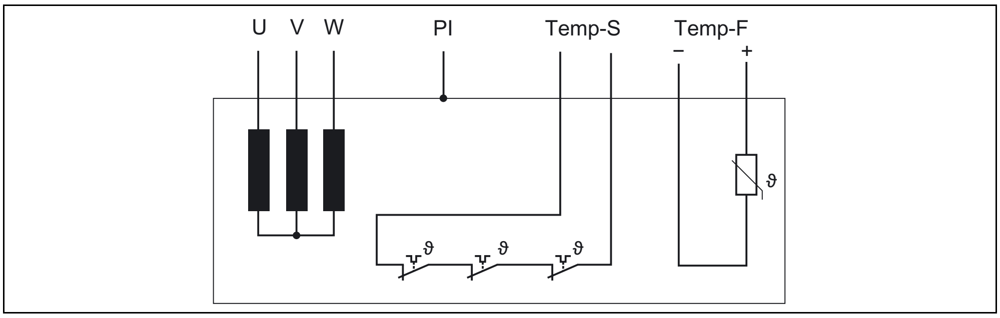


Figure 9-5 Internal circuitry of the primary section

Connecting the cables

The 1FN1xxx-xAxxx motors are equipped with a plug for assembled cables. The order numbers of the appropriate power cables can be found in Catalog /NC60/. The technical data for these cables can also be found in Catalog /NC60/.

Figure 9-6 shows the plug assignment for the 1FN1xxx-xAxxx motors. The labeling of the wires and the plug contacts and the screening concept refer to the 6FX7002-5Exxx assembled cable.

1FN1

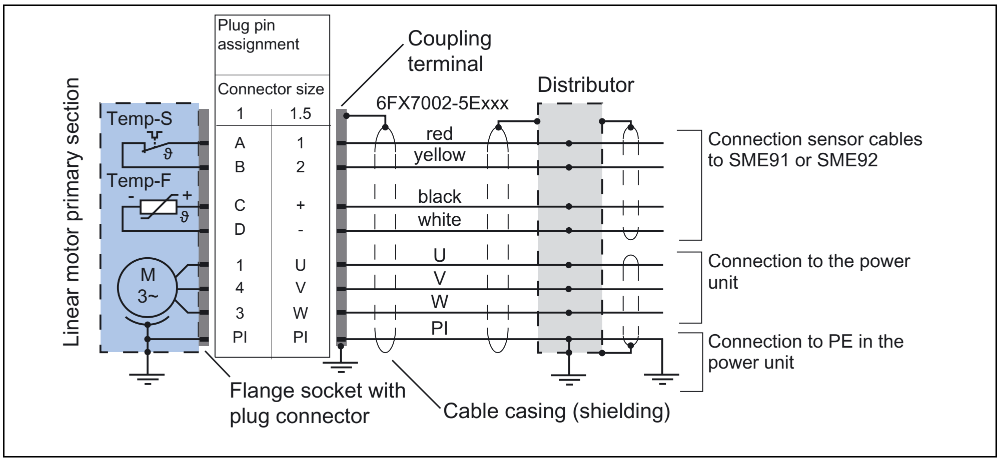


Figure 9-6 Terminal assignment of the plugs for the 1FN1xxx-xAxxx primary sections

Caution!
Vibrations can loosen the power connections!

When connecting the power plug, make sure the union ring on the bushing flange is completely screwed on and tightened! The plug must have an O-ring!

For 1FN1xxx-xKxxx motors, cables sold by the meter can be ordered in case previously mounted assembled cables (length of 3 m) must be extended (see Catalog /NC60/. Figure 9-7 shows the terminal assignment of the previously mounted assembled cable.

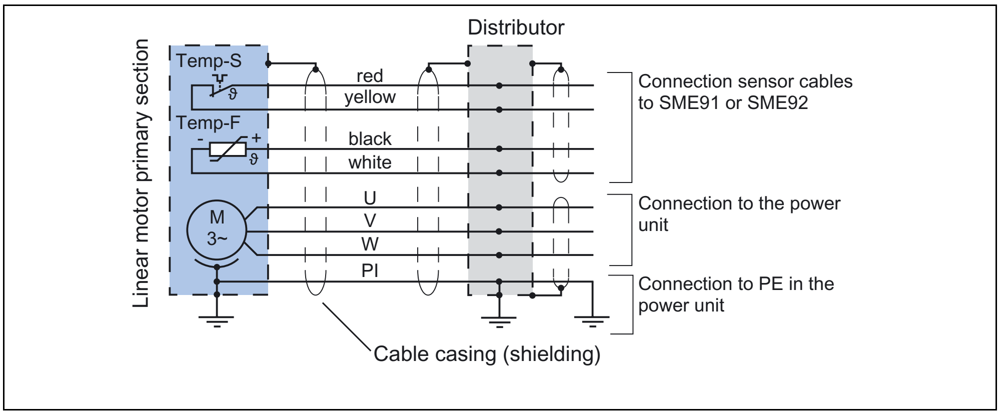


Figure 9-7 Terminal assignment of the previously assembled cable for 1FN1xxx-xKxxx primary sections

9.3.4 Cooler connection

Attention!

The connecting pieces of the primary section cooler are permanently connected with the primary section. They may not be unscrewed.

The primary section cooler can be connected using quick-snap couplings, size NW 5. Use coupling pieces without a non-return valve!

Recommended manufacturers

The manufacturers of coupling pieces without non-return valves are recommended in Appendix B.

9.4 Protecting the motor from overheating

9.4.1 Temperature monitoring

Temp-F

The temperature monitoring circuit consists of temperature sensor KTY 84, which is located between two of three phase windings. This could possibly – especially in case of varying current sourcing of the individual phases – lead to the maximum temperature of the three phase windings not being measured. An evaluation of Temp-F for motor protection is thus not permissible. Temp-F is mainly used for temperature monitoring and possibly for warning that the drive is about to be shut down by Temp-S.

Temp-S

One switch is used for each motor phase winding.

Response temperatures:

Table 9-6 Response temperatures of the switches

	1FN107x, 1FN112x	1FN118x, 1FN124x
Shutdown temperature	130°C ± 5°C	140°C ± 5°C
Switch-in temperature	70°C ± 20°C	70°C ± 20°C

Reaction time

The reaction time of the drive system from the time the switch is turned off to the disconnection of the current (pulse inhibitor in the converter) may not exceed one second!

Attention!

During commissioning, make sure Temp-S is working before the first (test) activation!

1FN1

9.4.2 Cooler

The function of the cooling system was already described in chapter 4.4. Figure 9-8 shows details of the thermal encapsulation of the 1FN1-type motors.

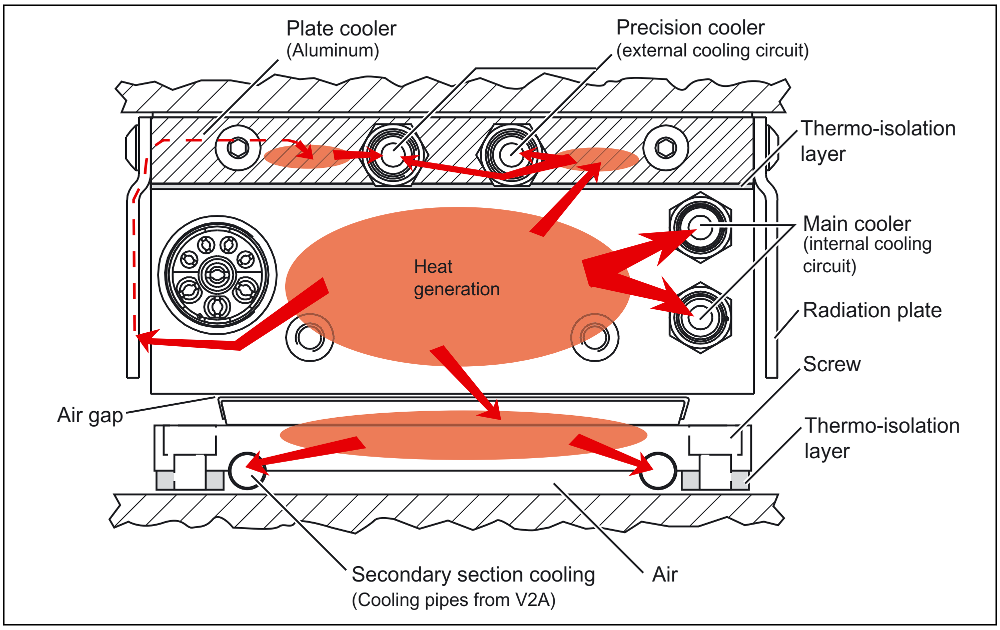


Figure 9-8 Thermal encapsulation of the 1FN1-type motors

Primary section main cooler

Water cooling at an intake temperature of T_{VORL} = 35 °C is standard. If this temperature is changed, the value F_N for the continuous motor thrust specified in chapter 11.2 of the data sheets changes. The corresponding characteristic curve is in chapter 11.3.1.

Thermal insulation of the primary sections/primary section precision cooler

The primary section is insulated by the air gap on the bottom and the insulation layer on top. Radiating plates have been attached to the sides. In turn, these plates are insulated from the primary section by an air space (see Figure 9-8).

In addition, a precision cooling system has been provided. For this purpose, a plate cooler has been integrated into the bolting surface of the primary section. This cooler also removes the heat from the radiating plates.

For the general function of the primary section precision cooler, see chapter 4.4.1.

Thermal insulation of the secondary section/secondary section cooling system

Insulating strips have been attached to the back of the secondary sections. These strips insulate the secondary section plate from the machine.

For use at high lost heat input, the secondary sections must be cooled.

Caution!
High temperatures can lead to the demagnetization of the permanent magnets!

The temperature of the secondary sections may not exceed 90° C! In case of motors manufactured before August 2, 2002, this limit temperature amounts to 75° C.

Cooling is possible due to a direct, flat screwing of the secondary sections onto the cooler machine body. The insulating strips must be removed for this purpose, e.g., using a scraper or by lightly hitting them with a hammer. Optionally, cooling pipes can be inserted into the ventilating slots of the secondary sections. The cooling pipes extend over the entire length of the secondary section track to prevent leak tightness problems. The dimensions of the pipe material to be used is specified in Table 9-7.

Note

Pipes must be used in a seamless design with the dimensions specified in Table 9-7. Otherwise, they cannot be compressed as strongly as required.

Table 9-7 Dimensions of the used pipe material of the 1FN1 secondary sections

	1FN1070	1FN1120 1FN1180 1FN1240
Diameter [mm] x wall thickness [mm]	8 x 0.4	10 x 0.5

9.5 Parallel and double-sided motor – technical data

9.5.1 Parallel circuit configuration

The pole pair widths $2\tau_M$ and, for the opposite cable outlet direction, the minimum distance Δs_0 is decisive for the position of parallel-connected primary sections (see chapter 6.1). Both variables are specified in Table 9-8.

Table 9-8 Pole pair width and minimum distance of parallel-connected 1FN1 motors

	1FN107x	1FN112x 1FN118x 1FN124x
Pole pair width $2\tau_M$ [mm]	56.4	72.0
Minimum clearance Δs_0 [mm]	128.0	175.0

9.5.2 Double-sided motors

The primary sections of size 1FN107x are available both with the standard and the inverse winding. They are thus suited for the mounting of a double-sided motor with an application-specific secondary section (see chapter 6.2). The data required for the configuration can be found in Figure 9-9 and Table 9-9.

1FN1

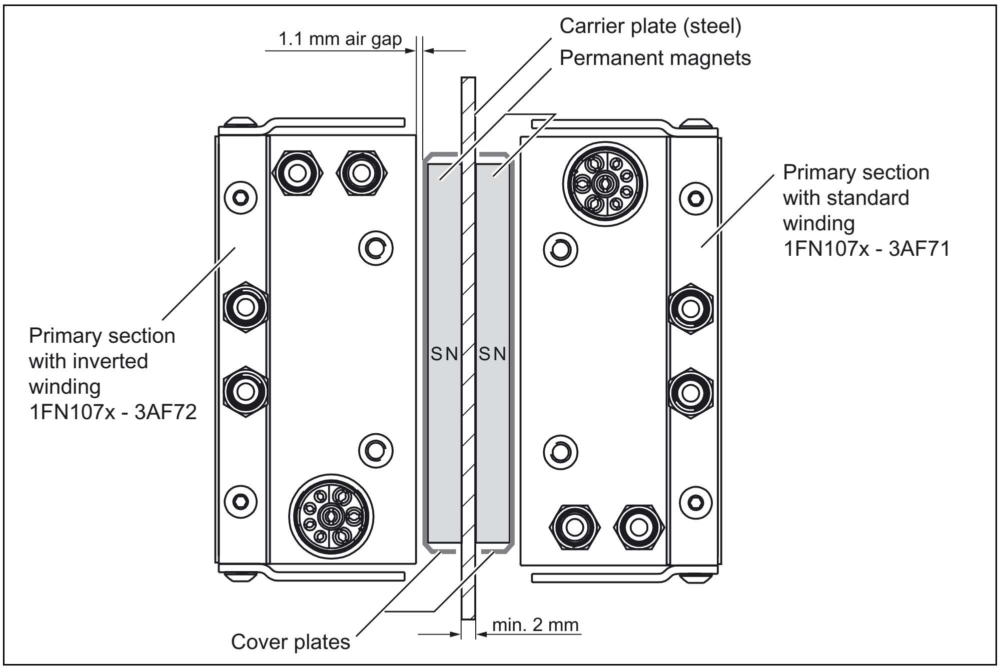


Figure 9-9 Double-sided motor with motors of the size 1FN107x

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Note

The specified dimensions for the steel carrier plate is the minimum thickness! Attraction forces between the secondary sections do not cancel each other out.

Table 9-9 Masses of the secondary section components for the 1FN1 double-sided motor

	Mass [kg/m]
Magnets (both sides)	5.6
Adhesive, small parts	0.5
Cover plates	1.1

In addition to the specified masses in Table 9-9, the masses of the mount of the support plate, the guide system, and the length measurement system must be taken into consideration for the total dynamic mass.

9.6 Motor mounting – details

The motor mounting procedure is explained in general in chapter 7. In this chapter, you will find special information regarding the motors of the 1FN1 product family.

9.6.1 Control dimensions for the mounting dimensions and air gap

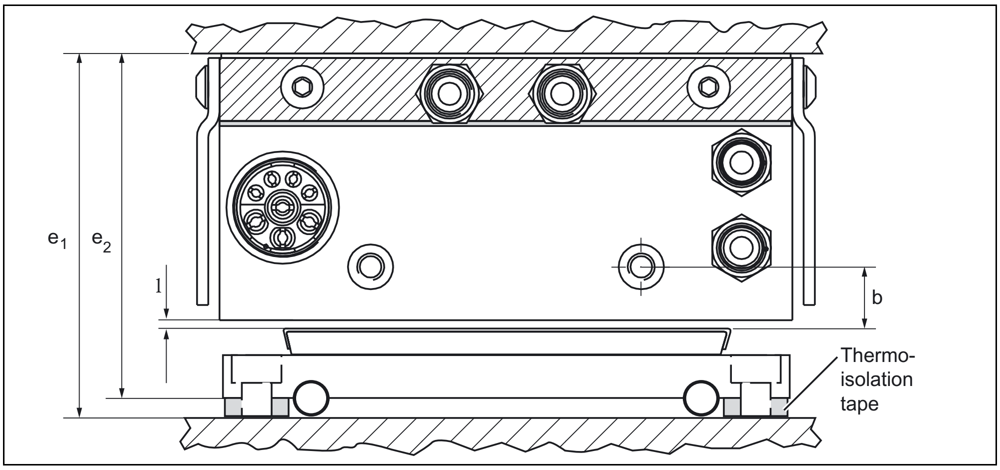


Figure 9-10 Control dimensions during motor mounting

Table 9-10 Control dimensions for the mounting dimensions and air gap according to Figure 9-10

	1FN107x	1FN112x, 1FN118x, 1FN124x
Mounting dimensions e_1 in mm	80.7 ± 0.3	106.7 ± 0.3
Mounting dimensions without thermal insulation strips e_2 in mm	76.7 ± 0.3	101.7 ± 0.3
Air gap l in mm (without tolerance of the mounting dimension)	$1.1^{+0.3}_{-0.45}$	$1.1^{+0.3}_{-0.45}$
Air gap b in mm (without tolerance of the mounting dimension)	13 ± 1	13 ± 1

9.6.2 Mounting of individual motor components

Positioning the motor parts

For the precise positioning of the primary and secondary sections, dowel holes have been provided on the bolting surfaces of the respective motor parts. The use of dowel pins thus enabled permits an exact and reproducible positioning of the primary and secondary sections in regard to the machine and the measurement system. This is necessary to safely avoid a readjustment of the commutation angle in the control system during the installation and removal of motor parts.

The use of dowel pins is optional. If they are used, as few dowel pins as possible should be used – if possible, only one.

Note

Any holes provided for the dowel pins might be closed with paint and must be drilled open.

Mounting of the secondary sections

The secondary sections are pegged out with a dowel pin and fixed into place with the fastening screws. The optionally mountable cooling pipes are clamped between the secondary sections and the machine base. The insulation strips on the back side of the secondary sections are removed if necessary. In this case, the mounting dimensions are reduced by the thickness of the insulation strip (see Figure 9-10 and Table 9-10).

The letter N, which has been imprinted into the carrier plate of the secondary sections, must show in the same direction for all series-connected secondary sections (see Figure 9-11).

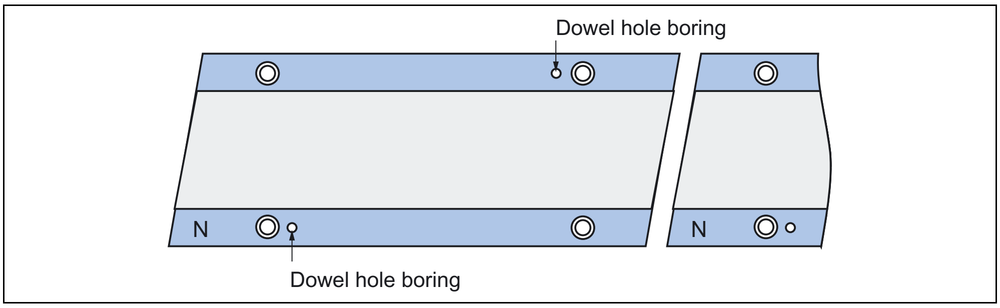


Figure 9-11 Position of the dowel holes and the N-marking

Danger!
There is an increased danger of crushing injuries when handling unpacked secondary sections!

You must observe the instructions in chapter 2.3!

Mounting the primary section

The primary section is positioned using the dowel pin and fixed into place with the fastening screws.

Caution!
Observe the maximum length of thread engagement of the fastening screws!

Screws that are too long could damage the motor part or lead to disadvantageous properties due to an insufficiently rigid connection of the motor parts to the machine structure.

Mounting of the Hall sensor box

For 1FN1-type motors, the use of a Hall sensor box is not absolutely necessary since the pole position can be determined using software.

The optional Hall sensor box is to be mounted according to the dimension drawing for the respective motor type (chapter 12). Your Siemens office can provide you with further information regarding Hall sensor boxes.

Other information

Two threaded blind holes are located on the front of the linear motor primary sections (see the dimension drawings in chapter 12.

Attention!
The threaded holes are not suited for the accommodation of greater forces!

Strippers should be directly attached to the primary section.

Independently of the use of strippers, the working area and especially the air gap must be kept free of chips: Blockage of the air gap can lead to the damage of primary and secondary sections.

■

10 Order designations

The order designation comprises a combination of digits and letters, the machine-readable model designation (MLFB). The MLFB consists of three blocks that are separated by hyphens.

10.1 Primary and secondary sections

1FN1

The first block of the MLFB comprises seven digits. It designates the product family, size, and motor components, and, in the case of the primary section, the length. Additional features are coded in the second block. The third block is provided for additional data.

1FN1xxx - xxx7x - xAA0

- Electrical machine
- Synchronous motor
- Linear motor
- Type series
- Size (width of the magnetic track)
  - 07 ≙ 76 mm
  - 12 ≙ 120 mm
  - 18 ≙ 180 mm
  - 24 ≙ 240 mm
- Motor component/primary section length
  - 0 ≙ secondary section
  - 2 ≙ primary section, short
  - 4 ≙ primary section, medium
  - 6 ≙ primary section, long
- Pole pair width
  - 3 ≙ 56.6 mm
  - 5 ≙ 72.0 mm
- Line connection
  - A ≙ plug or no connector
  - K ≙ tail end of cable
- $v_{MAX, FN}$ range [1]
  - C ≙ 150 m/min ≤ $v_{MAX, FN}$ < 170 m/min
  - D ≙ 150 m/min ≤ $v_{MAX, FN}$ < 200 m/min
  - F ≙ 150 m/min ≤ $v_{MAX, FN}$ < 220 m/min
  - A ≙ secondary section
- DC link voltage
  - 7 ≙ 600 V
- Type of construction
  - 0 ≙ secondary section
  - 1 ≙ primary section, standard
  - 2 ≙ primary section, inverse winding
- Length of the secondary section
  - 0 ≙ short
  - 1 ≙ long

1 exception: 1FN1124-5xC71. The order number was assigned before the speed ranges were specified.

10.2 Accessories

The first block of the MLFB for accessories comprises seven digits. It designates the product family and says that the part in question is an accessory. Features are coded in the second block. The third block is provided for additional data.

10.2.1 Hall sensor box

1FN1910 - 0Axx0 - 0AA0

Accessories (91)

Module (xx)

B0 ≙ Hall sensor box for 1FN1070

B1 ≙ Hall sensor box except for 1FN1070

10.2.2 SME9x

1FN1910 - 0AA20 - xAA0

Accessories (91)

Module (A2)

A2 ≙ SME9x

Type (x)

1 ≙ SME91

2 ≙ SME92

3 ≙ SME93

4 ≙ SME94

10.2.3 Connector box

1FN1910 - 0AA00 - 0AA0

Accessories (91)

Module (A0)

A0 ≙ connector box to connect to a Hall sensor box

■

1FN1

11 Technical data and characteristics

This chapter specifies the technical data and characteristics of 1FN1-type motors. This data collection provides the motor data required for configuration and contains a number of additional data for more detailed calculations within the scope of detailed considerations and problem analyses. Data subject to change without notice.

Note

Insofar as nothing else is specified, the following limitations apply for the data:

- The DC link voltage U_{ZK} amounts to 600 V, while the converter output voltage U_{amax} amounts to 425 V.
- The motor is water-cooled with an intake temperature T_{VORL} of 35° C and a specified volume flow of $\dot{V}_{P,H,MIN}$
- Voltage and currents are specified in effective values.

11.1 Description

11.1.1 Definitions of the 1FN1 motor data

Limitations/secondary conditions

U_{ZK}

DC link voltage of the converter

Note: For converter output voltage U_{amax} , see chapter 4.1 .

T_{VORL}

Maximum intake temperature of the water cooling if the motor is to be utilized to its rated power F_N .

T_N

Rated temperature.

Note: The rated temperature corresponds to the shutdown temperature of the Temp-S temperature monitoring circuit (see chapter 9.4.1).

Rating data

F_N

Rated motor thrust.

I_N

Rated motor current at rated thrust F_N.

$v_{MAX,FN}$

Maximum speed up to which the drive can deliver the rated thrust F_N.

$P_{V,N}$

Power loss of the motor at the rating point (F_N,$v_{MAX,FN}$) at rated temperature T_N. Losses due to friction and eddy currents are negligible.

Note: The power loss results from the line resistance $R_{STR}(T)$ (see there) and the applied current: $P_V = 3 \cdot R_{STR}(T) \cdot I^2$. Accordingly, $P_{V,N}$ is calculated using

$P_{V,N} = 3 \cdot R_{STR}(T_N) \cdot I_N^2$

Limiting data

F_{MAX}

Maximum motor thrust.

I_{MAX}

Maximum motor current at maximum thrust F_{MAX}.

$v_{MAX,FMAX}$

Maximum speed up to which the drive can deliver the maximum thrust F_{MAX}.

$P_{EL,MAX}$

Electrical input of the motor at point (F_{MAX},$v_{MAX,FMAX}$) at rated temperature T_N. Losses due to friction and eddy currents are negligible.

Note: The sum of the mechanical output P_{MECH} and the power loss P_V result in the electrical input of the motor P_{EL}:

$P_{EL} = P_{MECH} + P_V = F \cdot v + 3 \cdot R_{STR}(T) \cdot I^2$

Accordingly, $P_{EL,MAX}$ can be calculated:
$P_{EL,MAX} = P_{MECH,MAX} + P_{V,MAX} = F_{MAX} \cdot v_{MAX,FMAX} + 3 \cdot R_{STR}(T_N) \cdot I_{MAX}^2$

F_0*

Stall thrust: Motor thrust that can be permanently reached if only one of the three phases is loaded (maximum uneven load of the phases).

Note: F_0* can be approximately calculated from the rated thrust F_N while ignoring the influence of the saturation of the motor:

$F_0^* \approx \frac{1}{\sqrt{2}} F_N$.

I_0*

Stall current of the motor at stall thrust F_0* .

Note: I_0* can be calculated from the rated current I_N:

$I_0^* = \frac{1}{\sqrt{2}} I_N$.

Physical constants

$k_{F,20}$

Power constant of the motor in case of a rated air gap and a temperature of the secondary sections of 20° C.

Note: The power constant refers to the linear (lower) part of the motor thrust/current characteristic curve.

k_E

Voltage constant for the calculation of the mutually induced voltage between the phase and the start point in case of a rated air gap.

$k_{M,20}$

Motor constant at a winding temperature of 20° C.

Note: The motor constant k_M can be calculated for other temperatures:
$k_M(T) = k_{M,20}$ [1 + α(T – 20 °C)] with the temperature coefficient α = – 0.001 1/K for the magnets used.

$R_{STR,20}$

Line resistance of the winding at a winding temperature of 20° C.

Note: The line resistance R_{STR} can be calculated for other temperatures:
$R_{STR}(T) = R_{STR,20}$ [1 + α(T – 20 °C)] with the temperature coefficient
α = 0.00393 1/K for copper.

L_{STR}

Phase inductance of the winding in case of a rated air gap.

F_A

Attraction force between the primary section and the secondary section in case of a rated air gap.

t_{TH}

Thermal time constant of the winding.

Note: The thermal time constant results from the time curve in the winding in case of a sudden load with constant current at time t = 0 (see Figure 11-1). When the time is up t_{TH}, the motor winding achieves about 63% of its end temperature T_{GRENZ} if the temperature protection is not effective beforehand.

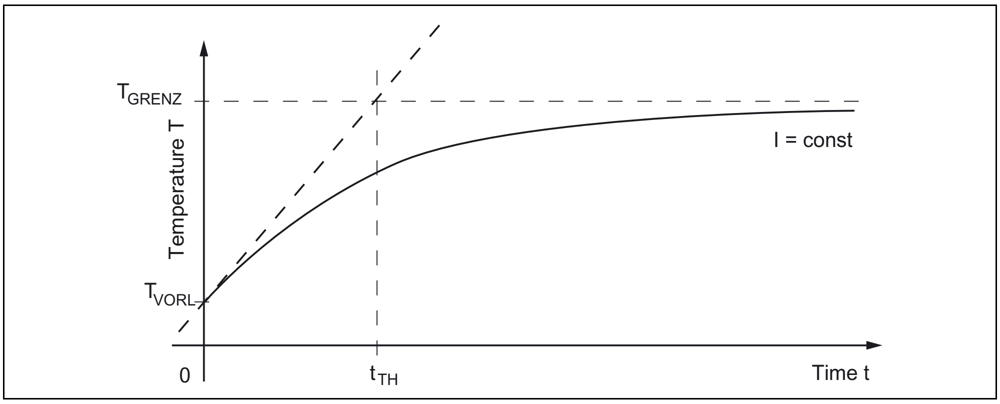


Figure 11-1 Definition of the thermal time constants

τ_M

Pole width of the motor, corresponds to the distance between the respective centers of the north and south poles of neighboring magnets on a secondary section.

m_P

Mass of the primary section with precision cooler (permanently mounted), but without fastening screws, plugs, connecting cables, and cooling medium

m_S

Mass of a secondary section without fastening screws and optional cooling pipes.

Note: Since there are short and long secondary sections, two values are specified.

Primary section main cooler data

$Q_{P,H,MAX}$

Maximum removed heat input via the main cooler with utilization of the rated thrust F_N and the rated temperature T_N.

$\dot{V}_{P,H,MIN}$

Recommended minimum volume flow in the main cooler to achieve the rated thrust F_N .

$\Delta T_{P,H}$

Temperature increase of the cooling medium between the intake and return lines of the main cooler at the operating point ($Q_{P,H,MAX}$;$\dot{V}_{P,H,MIN}$)

$\Delta p_{P,H}$

Pressure drop of the cooling medium between the intake and return lines of the main cooler at the operating point $\dot{V}_{P,H,MIN}$.

Primary section precision cooler data

$Q_{P,P,MAX}$

Maximum removed heat input via the primary section precision cooler with utilization of the rated thrust F_N and the rated temperature T_N.

$\dot{V}_{P,P,MIN}$

Recommended minimum volume flow in the primary section precision cooler to achieve a maximum surface temperature T_{VORL} + 2 K .

$\Delta p_{P,H}$

Pressure drop of the cooling medium between the intake and return lines of the primary section precision cooler at the operating point $\dot{V}_{P,P,MIN}$.

Secondary section cooling data

$Q_{S,MAX}$

Maximum removed heat input via the secondary section cooling system with utilization of the rated thrust F_N and the rated temperature T_N.

$\dot{V}_{S,MIN}$

Recommended minimum volume flow in the secondary section cooling.

Δp_S

Pressure drop of the cooling medium between the intake and return lines of the secondary section cooling system at volume flow $\dot{V}_{S,MIN}$ and a reference length of a meter.

11.1.2 Description of the characteristic curves

Motor thrust vs. speed

Every diagram that shows the motor thrust F_M depending on the speed of the respective motor has three characteristic curves:

- For DC link voltage U_{ZK} = 540 V (U_{amax} = 380 V)
- For DC link voltage U_{ZK} = 600 V (U_{amax} = 425 V)
- For DC link voltage U_{ZK} = 648 V (U_{amax} = 460 V)

1FN1

One of these characteristic curves is shown with descriptions of the most important points Figure 11-2.

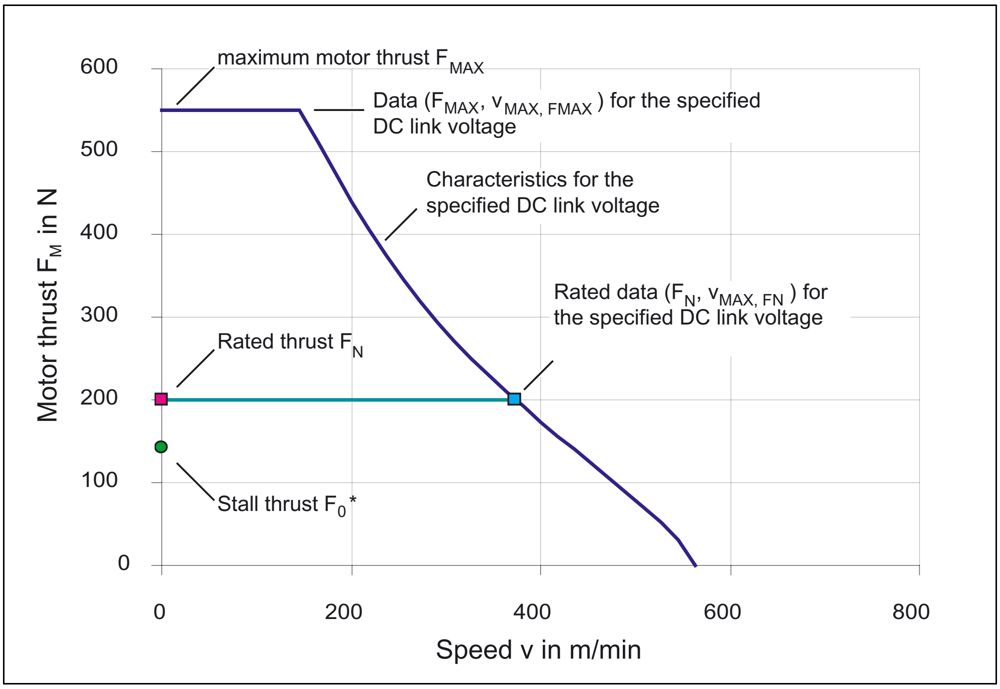


Figure 11-2 Motor thrust/speed characteristics diagram

Braking force vs. speed

The characteristic curve shows the braking force of the short-circuited motor depending on the speed. In the process, the occurring friction is negligible. Figure 11-3 shows the approximation of such a characteristic curve.

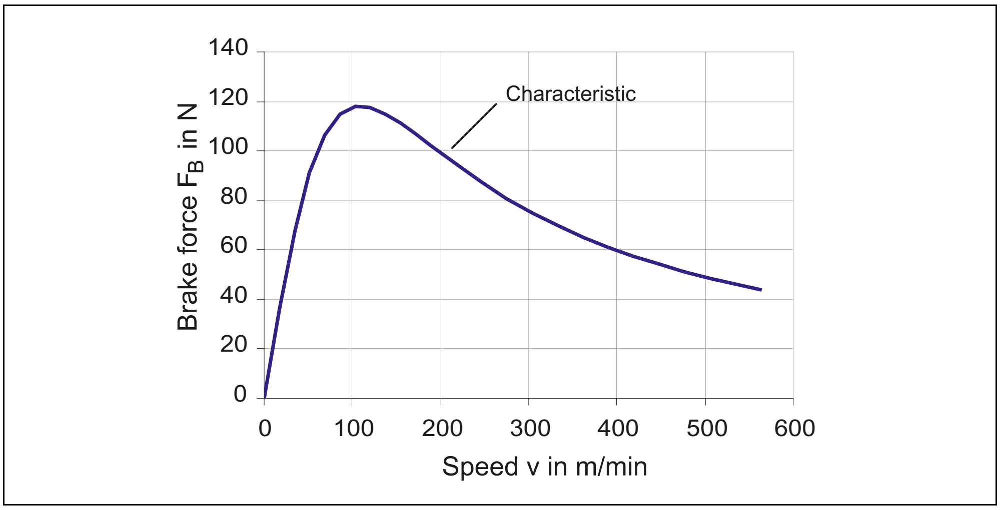


Figure 11-3 Braking force/speed characteristic curve when motor is short-circuited, diagram

Temperature increase of the primary section main cooler vs. the volume flow

This characteristic curve shows the temperature increase between the intake and return lines of the primary section main cooler depending on the volume flow (see Figure 11-4).

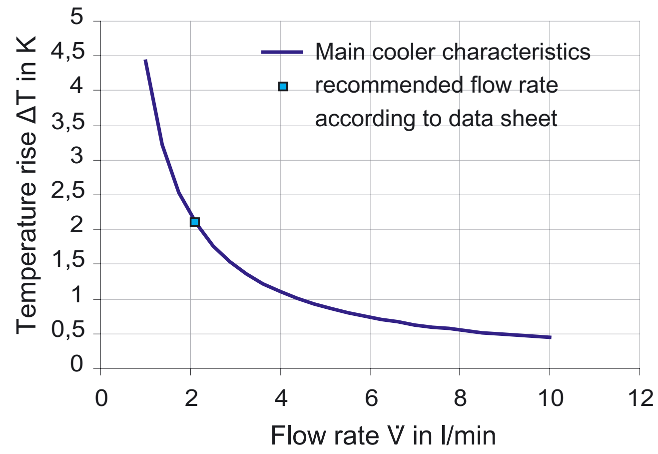


Figure 11-4 Temperature increase/volume flow in main cooler characteristics diagram

Pressure drop of the cooler vs. the volume flow

This characteristic curve shows the temperature increase between the intake and return lines of the respective cooler depending on the volume flow (see Figure 11-5). One diagram shows the characteristic curve of the primary section main cooler, the other the characteristic curve of the primary section precision cooler. The third diagram shows the characteristic curve for the standard secondary section cooling system.

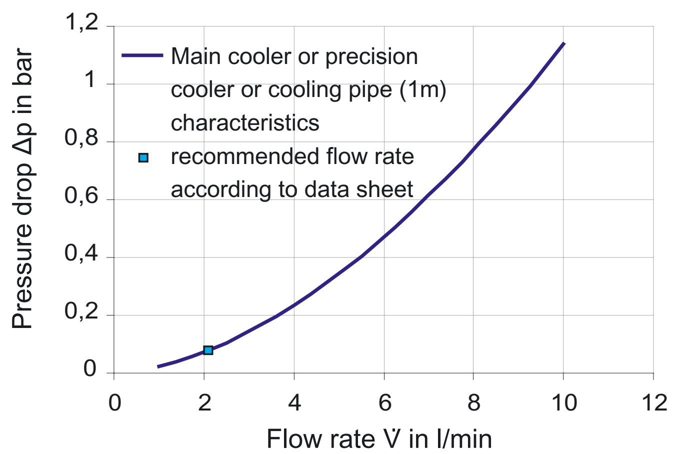


Figure 11-5 Pressure drop/volume flow characteristics diagram

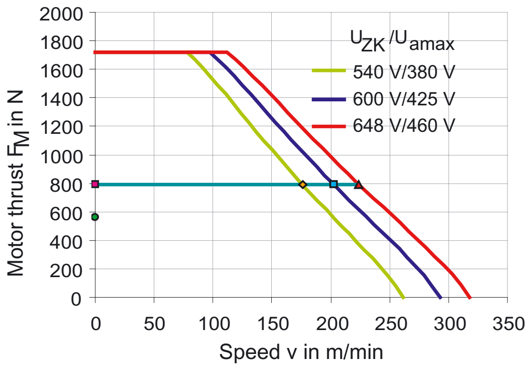
1FN1

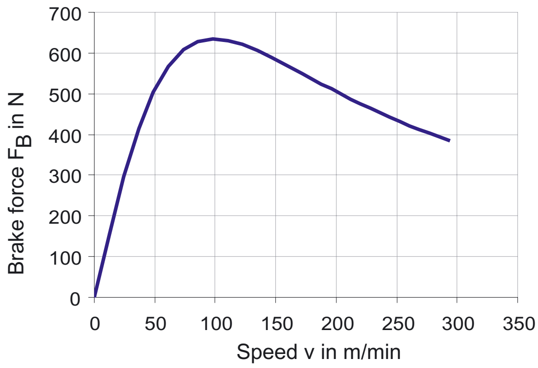
11.2 Motor data

1FN1072-3AF7x-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	790
Rated current	I_N	A	5.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	203
Rated power loss	$P_{V,N}$	W	810
Limiting data			
Maximum thrust	F_{MAX}	N	1720
Maximum current	I_{MAX}	A	14
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	97
Maximum electric power input	$P_{EL,MAX}$	W	7850
Stall thrust	F_0*	N	559
Stall current	I_0*	A	4
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	141
Voltage constant	k_E	Vs/m	47.1
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	32.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	6.2
Phase inductance	L_{STR}	mH	47.1
Attraction force	F_A	N	4600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	28.2
Mass primary section	m_P	kg	10.1
Mass of a secondary section (short/long)	m_S	kg/m	3/7.5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	810
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	1.4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	8.3
Pressure drop	$\Delta p_{P,H}$	bar	0.19
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	80
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	3.8
Pressure drop	$\Delta p_{P,P}$	bar	0.14
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	48
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	3
Pressure drop per meter secondary section cooling	Δp_S	bar	0.07

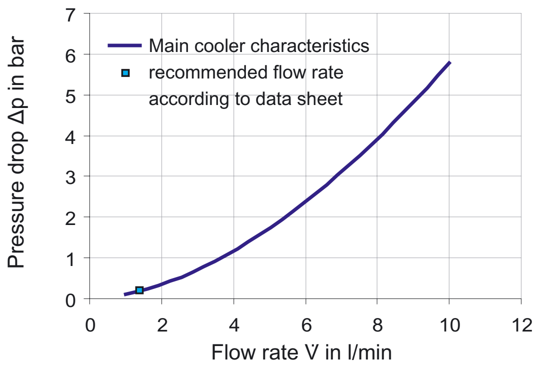
1FN1072-3AF7x-0AA0 characteristics

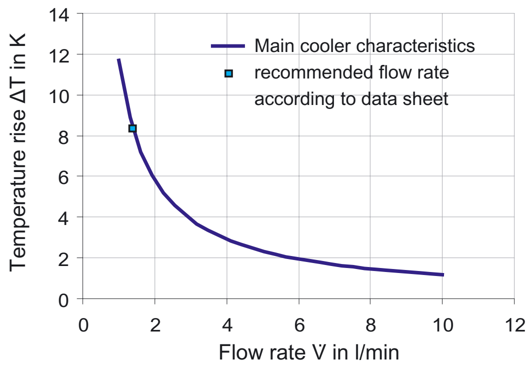
Thrust characteristics



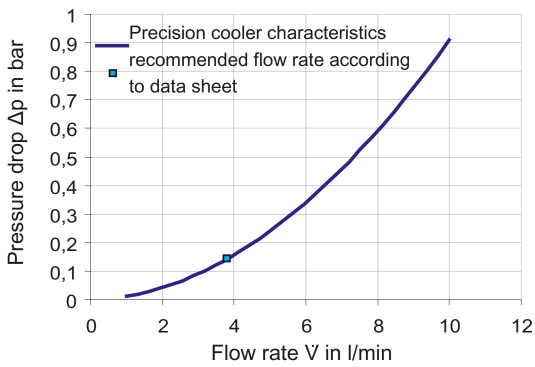


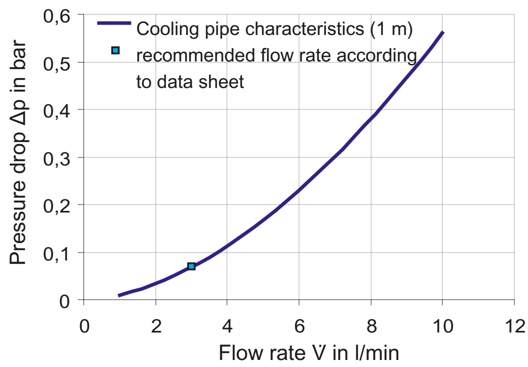
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



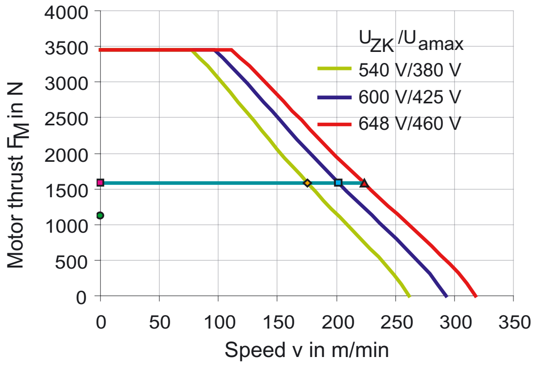


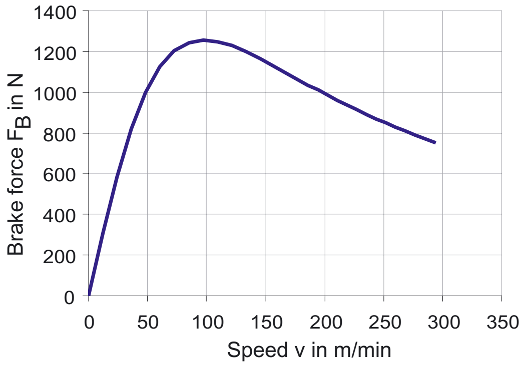
1FN1

1FN1076-3AF7x-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1580
Rated current	I_N	A	11.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	202
Rated power loss	$P_{V,N}$	W	1620
Limiting data			
Maximum thrust	F_{MAX}	N	3450
Maximum current	I_{MAX}	A	27.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	96
Maximum electric power input	$P_{EL,MAX}$	W	15690
Stall thrust	F_0*	N	1117
Stall current	I_0*	A	7.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	141
Voltage constant	k_E	Vs/m	47.1
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	46.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.1
Phase inductance	L_{STR}	mH	23.8
Attraction force	F_A	N	8300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	28.2
Mass primary section	m_P	kg	17.5
Mass of a secondary section (short/long)	m_S	kg/m	3/7.5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1625
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.3
Cooling medium temperature increase	$\Delta T_{P,H}$	K	10.2
Pressure drop	$\Delta p_{P,H}$	bar	0.79
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	145
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.6
Pressure drop	$\Delta p_{P,P}$	bar	0.24
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	84
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	3
Pressure drop per meter secondary section cooling	Δp_S	bar	0.07

1FN1076-3AF7x-0AA0 characteristics

Thrust characteristics





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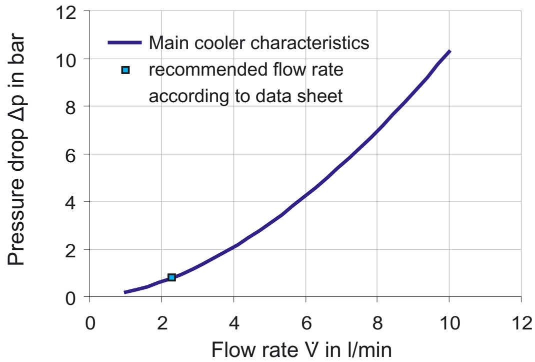
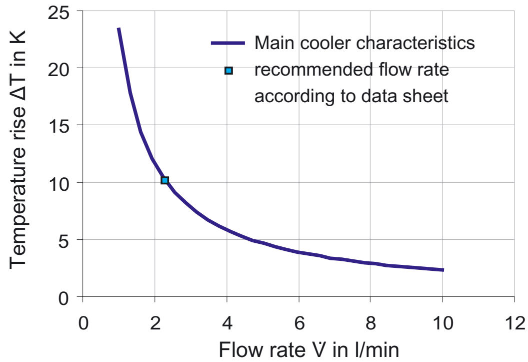
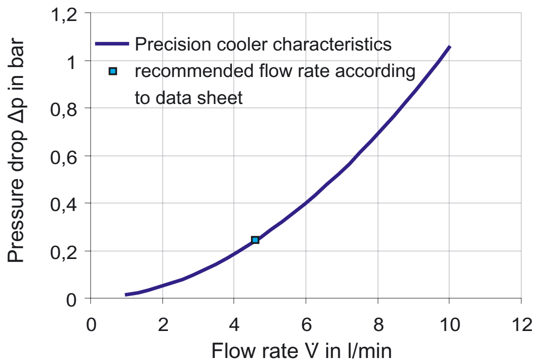
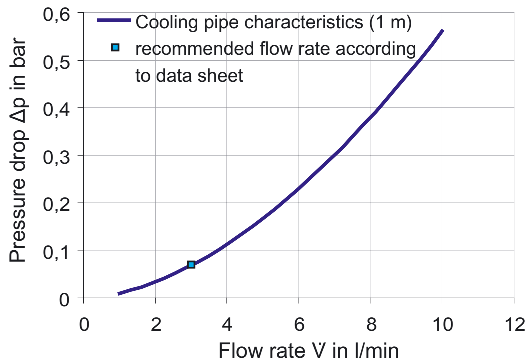
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



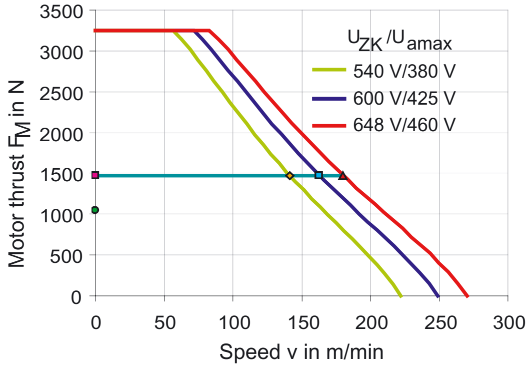


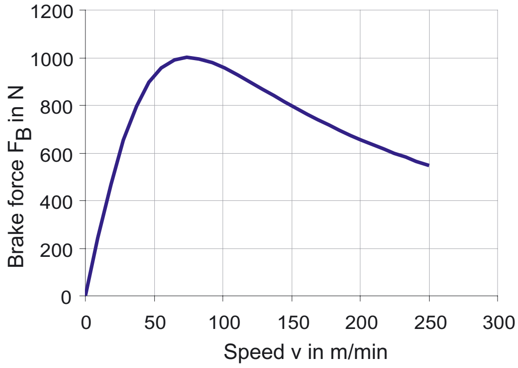
1FN1

1FN1122-5xC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1475
Rated current	I_N	A	8.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	163
Rated power loss	$P_{V,N}$	W	1350
Limiting data			
Maximum thrust	F_{MAX}	N	3250
Maximum current	I_{MAX}	A	22.4
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	72
Maximum electric power input	$P_{EL,MAX}$	W	12480
Stall thrust	F_0*	N	1043
Stall current	I_0*	A	6.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	166
Voltage constant	k_E	Vs/m	55.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	47.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	4.1
Phase inductance	L_{STR}	mH	52.8
Attraction force	F_A	N	8000
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	23.2
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1350
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.2
Pressure drop	$\Delta p_{P,H}$	bar	0.39
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	160
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	3.8
Pressure drop	$\Delta p_{P,P}$	bar	0.17
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	93
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

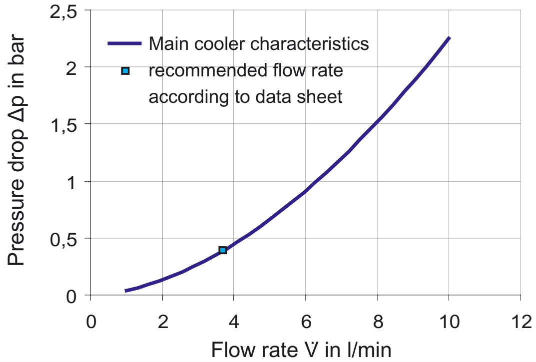
1FN1122-5xC71-0AA0 characteristics

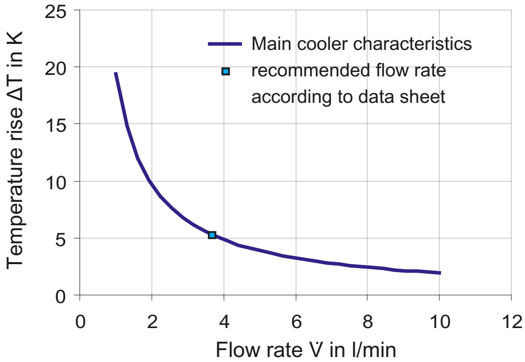
Thrust characteristics



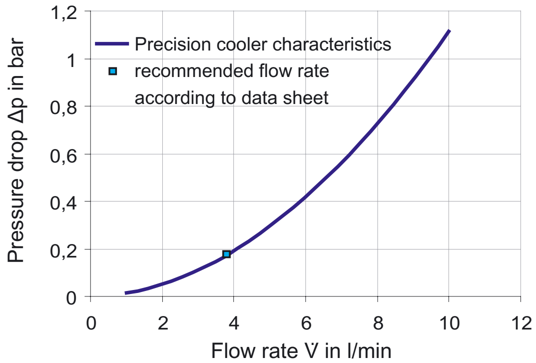


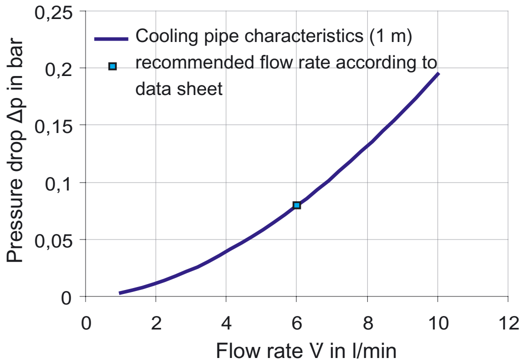
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



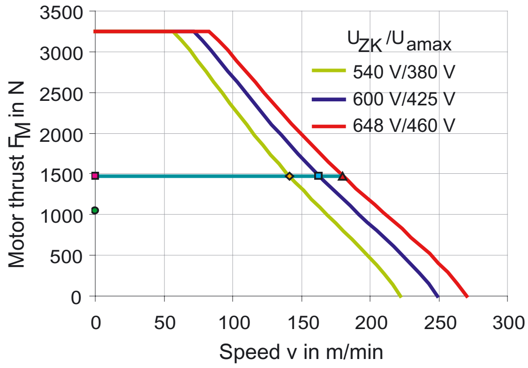


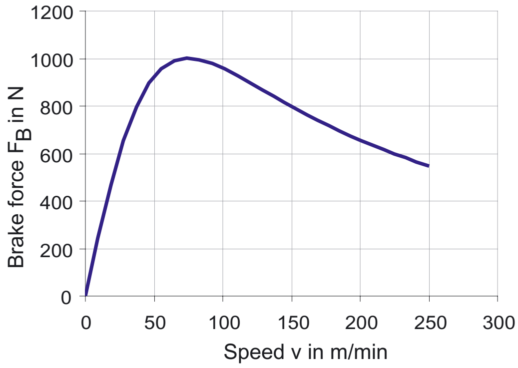
1FN1

1FN1122-5xF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1475
Rated current	I_N	A	11.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	214
Rated power loss	$P_{V,N}$	W	1350
Limiting data			
Maximum thrust	F_{MAX}	N	3250
Maximum current	I_{MAX}	A	28
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	105
Maximum electric power input	$P_{EL,MAX}$	W	14250
Stall thrust	F_0*	N	1043
Stall current	I_0*	A	7.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	133
Voltage constant	k_E	Vs/m	44.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	47.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.6
Phase inductance	L_{STR}	mH	33.8
Attraction force	F_A	N	8000
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	23.2
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1345
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.2
Pressure drop	$\Delta p_{P,H}$	bar	0.39
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	160
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	3.8
Pressure drop	$\Delta p_{P,P}$	bar	0.17
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	93
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

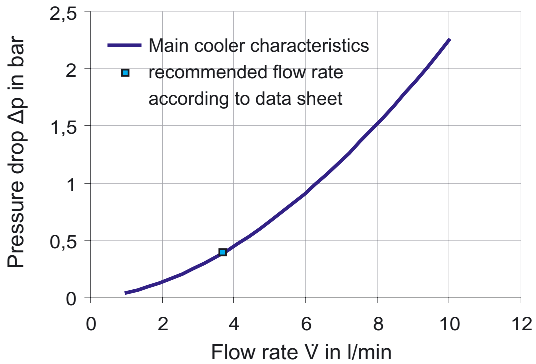
1FN1122-5xF71-0AA0 characteristics

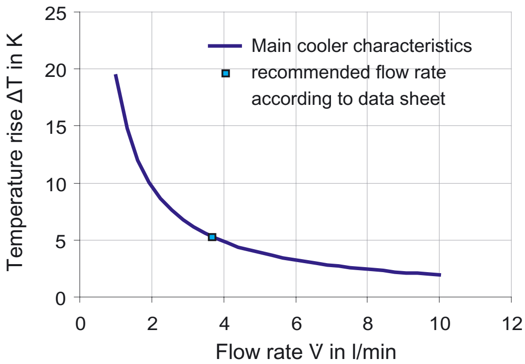
Thrust characteristics



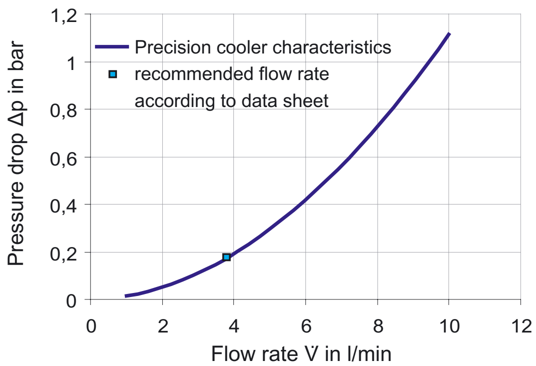


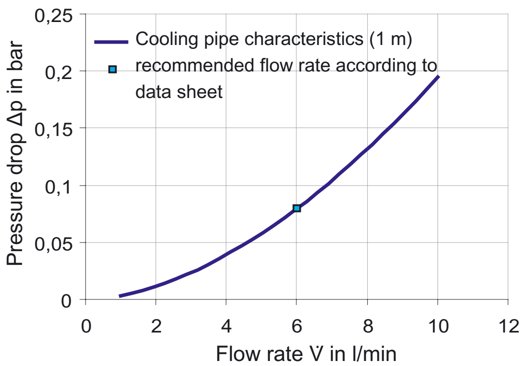
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



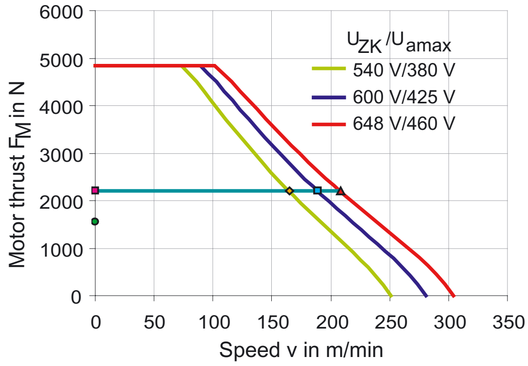


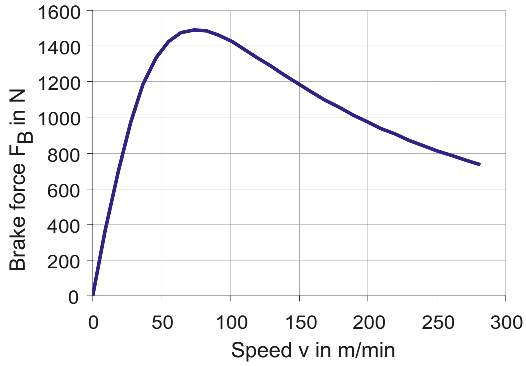
1FN1

1FN1124-5xC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2200
Rated current	I_N	A	14.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	189
Rated power loss	$P_{V,N}$	W	2010
Limiting data			
Maximum thrust	F_{MAX}	N	4850
Maximum current	I_{MAX}	A	37.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	89
Maximum electric power input	$P_{EL,MAX}$	W	19900
Stall thrust	F_0*	N	1556
Stall current	I_0*	A	10.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	148
Voltage constant	k_E	Vs/m	49.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	58.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.2
Phase inductance	L_{STR}	mH	27.9
Attraction force	F_A	N	11300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	31.9
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2010
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.8
Pressure drop	$\Delta p_{P,H}$	bar	0.53
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	225
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	0.39
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	129
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

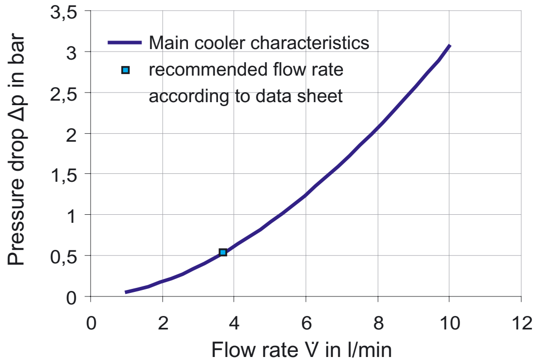
1FN1124-5xC71-0AA0 characteristics

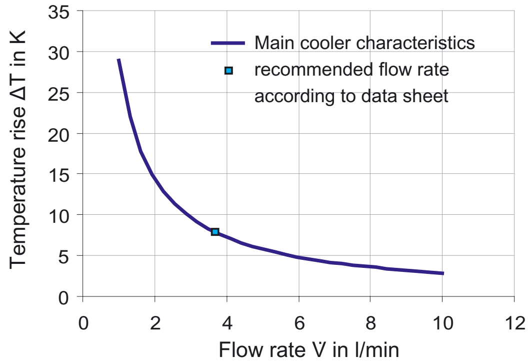
Thrust characteristics



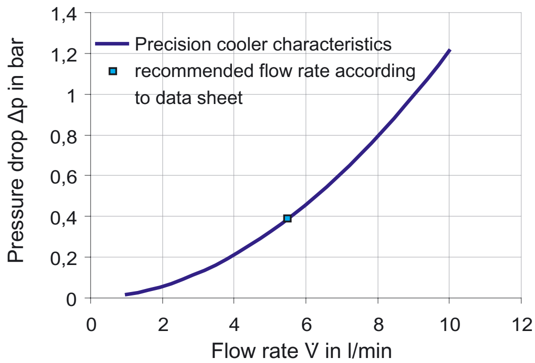


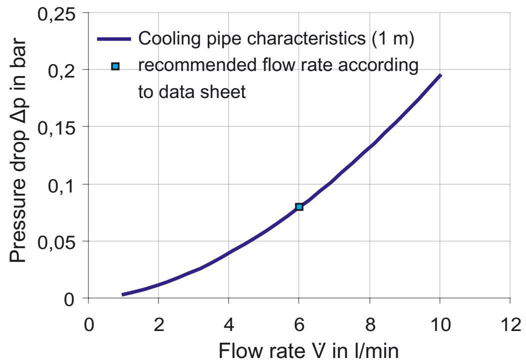
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



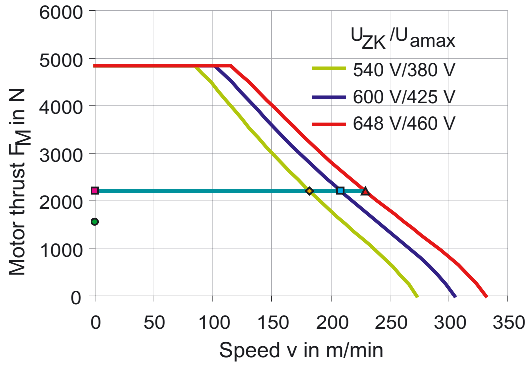


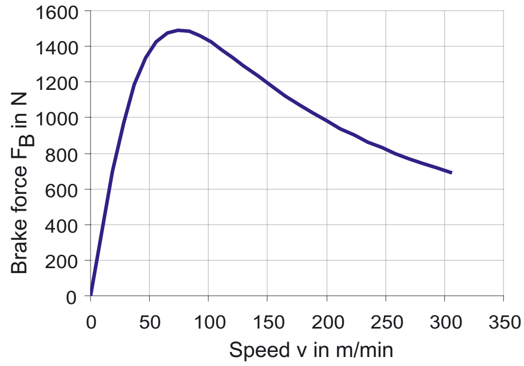
1FN1

1FN1124-5xF71-0AA0			
Technical data	Brief designation	Units	Value
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2200
Rated current	I_N	A	16.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	208
Rated power loss	$P_{V,N}$	W	2030
Limiting data			
Maximum thrust	F_{MAX}	N	4850
Maximum current	I_{MAX}	A	40.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	101
Maximum electric power input	$P_{EL,MAX}$	W	21020
Stall thrust	F_0*	N	1556
Stall current	I_0*	A	11.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	136
Voltage constant	k_E	Vs/m	45.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	57.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.8
Phase inductance	L_{STR}	mH	23.6
Attraction force	F_A	N	11300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	31.9
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2030
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.9
Pressure drop	$\Delta p_{P,H}$	bar	0.53
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	225
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	0.39
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	130
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

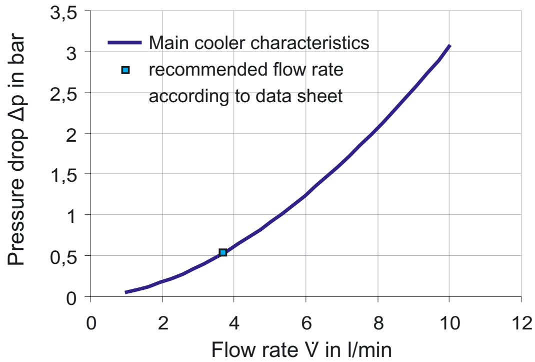
1FN1124-5xF71-0AA0 characteristics

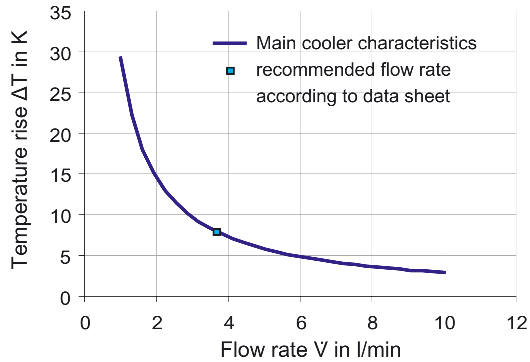
Thrust characteristics



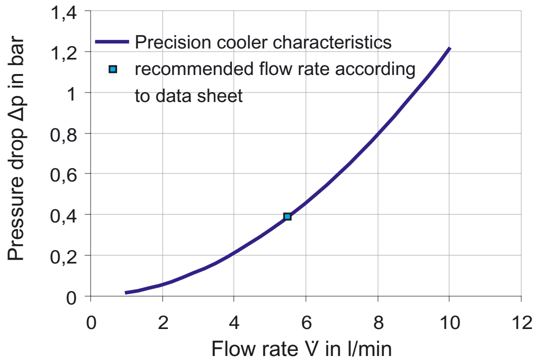


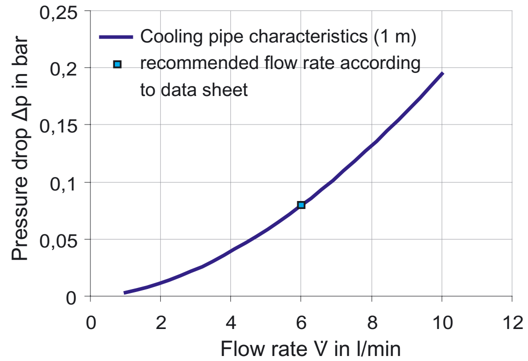
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



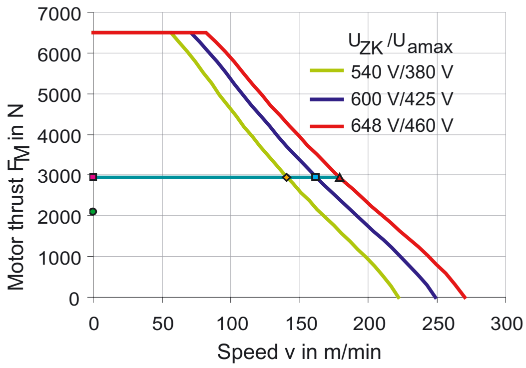


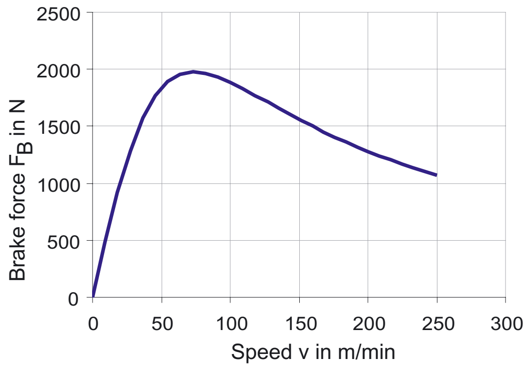
1FN1

1FN1126-5xC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2950
Rated current	I_N	A	17.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	162
Rated power loss	$P_{V,N}$	W	2700
Limiting data			
Maximum thrust	F_{MAX}	N	6500
Maximum current	I_{MAX}	A	44.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	71
Maximum electric power input	$P_{EL,MAX}$	W	24910
Stall thrust	F_0*	N	2086
Stall current	I_0*	A	12.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	166
Voltage constant	k_E	Vs/m	55.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	67.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2
Phase inductance	L_{STR}	mH	26.8
Attraction force	F_A	N	14500
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	40.7
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2700
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	10.5
Pressure drop	$\Delta p_{P,H}$	bar	0.67
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	290
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	7
Pressure drop	$\Delta p_{P,P}$	bar	0.67
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	166
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

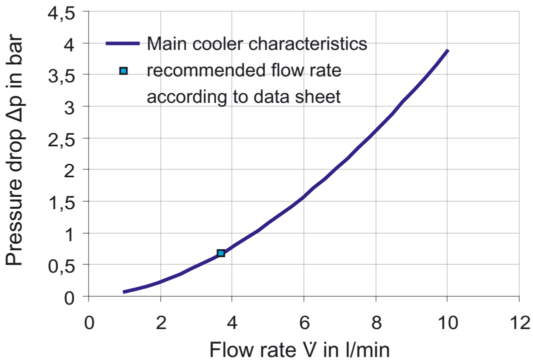
1FN1126-5xC71-0AA0 characteristics

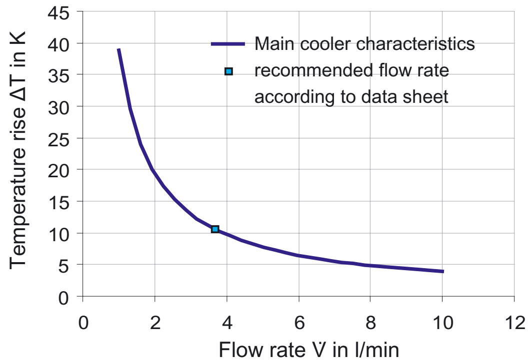
Thrust characteristics



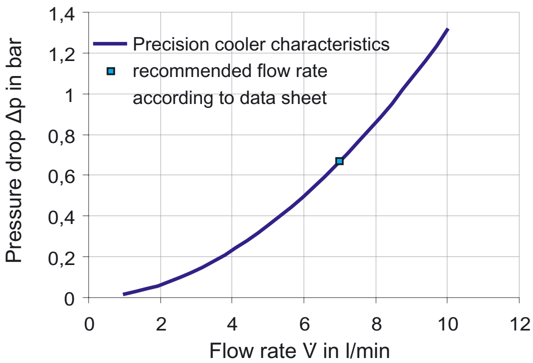


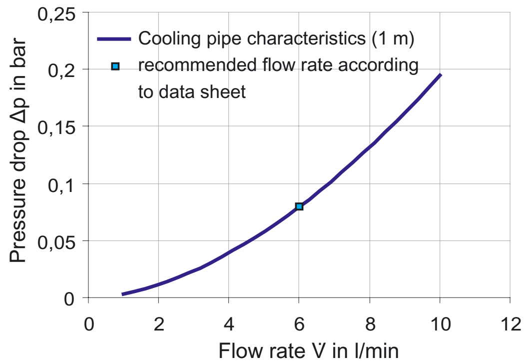
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





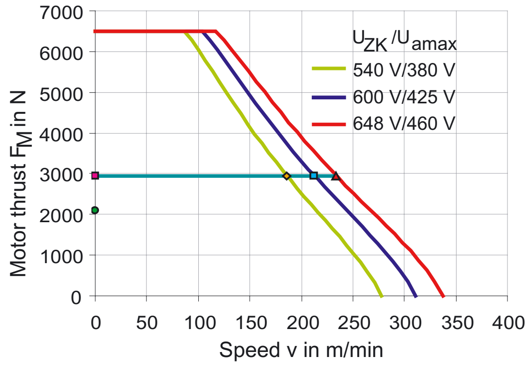
1FN1

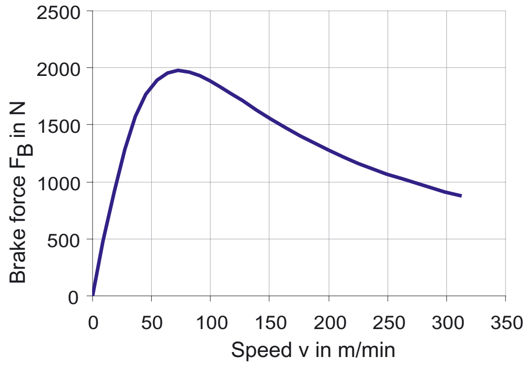
1FN1126-5xF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2950
Rated current	I_N	A	22.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	213
Rated power loss	$P_{V,N}$	W	2690
Limiting data			
Maximum thrust	F_{MAX}	N	6500
Maximum current	I_{MAX}	A	56
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	104
Maximum electric power input	$P_{EL,MAX}$	W	28400
Stall thrust	F_0*	N	2086
Stall current	I_0*	A	15.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	133
Voltage constant	k_E	Vs/m	44.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	67.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.3
Phase inductance	L_{STR}	mH	17.1
Attraction force	F_A	N	14500
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	40.7
Mass of a secondary section (short/long)	m_S	kg/m	6.8/15.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2695
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.7
Cooling medium temperature increase	$\Delta T_{P,H}$	K	10.5
Pressure drop	$\Delta p_{P,H}$	bar	0.67
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	290
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	7
Pressure drop	$\Delta p_{P,P}$	bar	0.67
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	166
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

1FN1

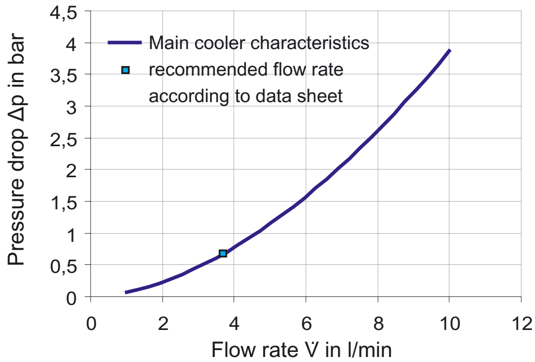
1FN1126-5xF71-0AA0 characteristics

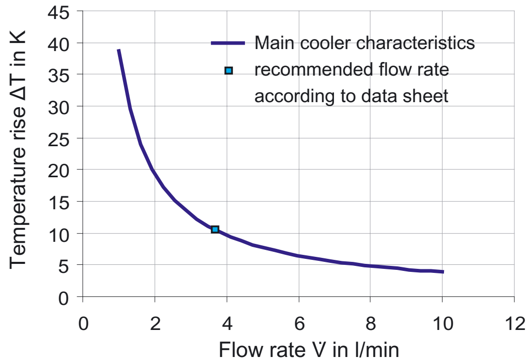
Thrust characteristics



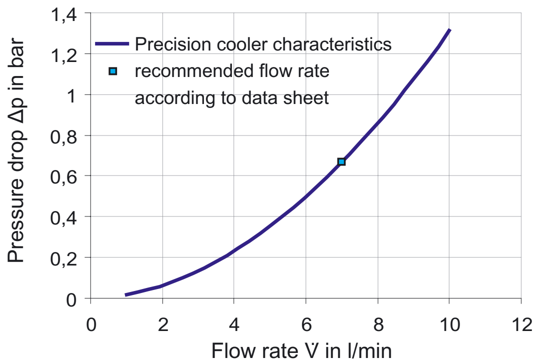


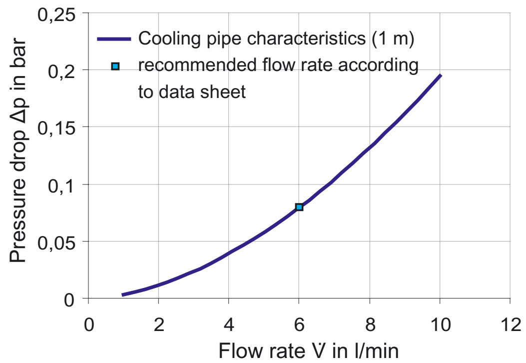
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



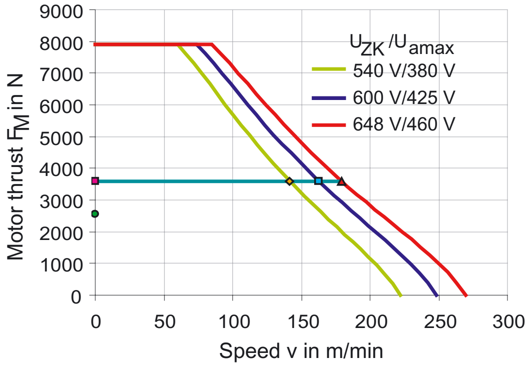


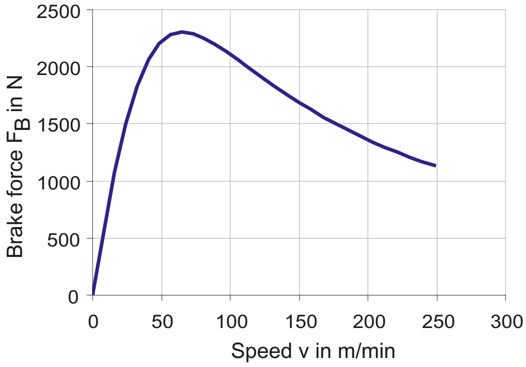
1FN1

1FN1184-5AC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3600
Rated current	I_N	A	21.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	162
Rated power loss	$P_{V,N}$	W	3070
Limiting data			
Maximum thrust	F_{MAX}	N	7920
Maximum current	I_{MAX}	A	54.2
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	74
Maximum electric power input	$P_{EL,MAX}$	W	29050
Stall thrust	F_0*	N	2546
Stall current	I_0*	A	15.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	167
Voltage constant	k_E	Vs/m	55.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	76.9
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.6
Phase inductance	L_{STR}	mH	23
Attraction force	F_A	N	16900
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	44.5
Mass of a secondary section (short/long)	m_S	kg/m	10/23.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	3070
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	9.2
Pressure drop	$\Delta p_{P,H}$	bar	1.03
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	335
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	7
Pressure drop	$\Delta p_{P,P}$	bar	0.62
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	194
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

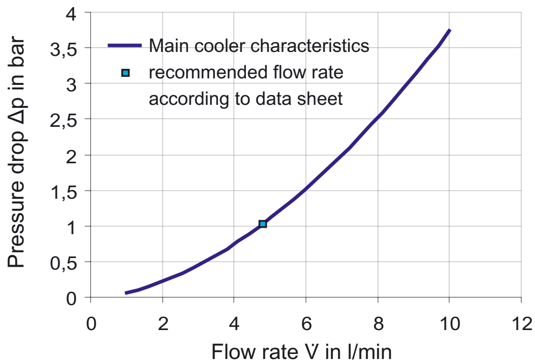
1FN1184-5AC71-0AA0 characteristics

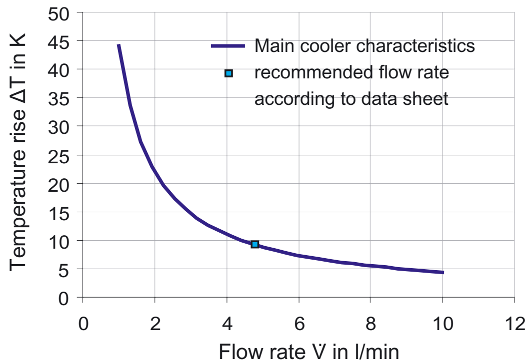
Thrust characteristics



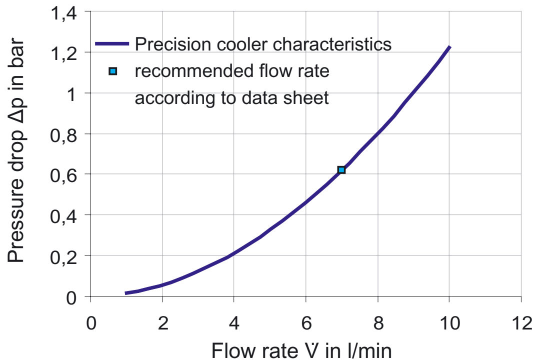


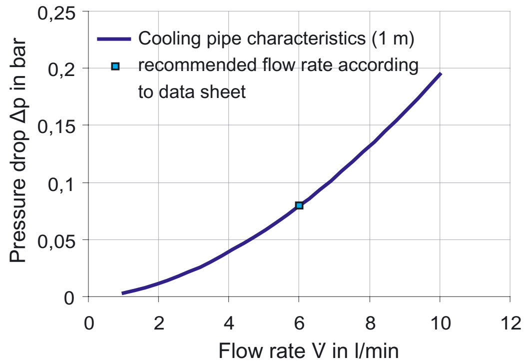
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





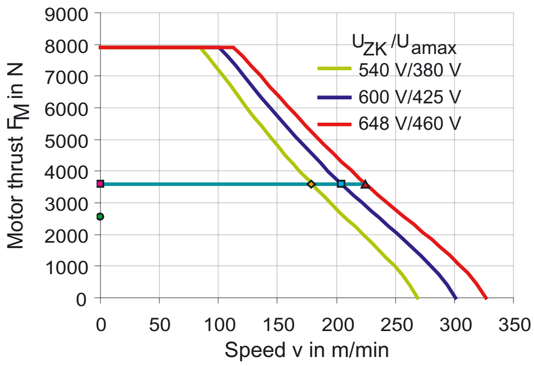
1FN1

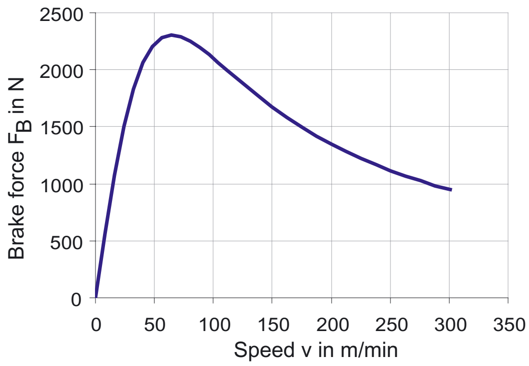
1FN1184-5AF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3600
Rated current	I_N	A	26.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	204
Rated power loss	$P_{V,N}$	W	3040
Limiting data			
Maximum thrust	F_{MAX}	N	7920
Maximum current	I_{MAX}	A	65.6
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	100
Maximum electric power input	$P_{EL,MAX}$	W	32380
Stall thrust	F_0*	N	2546
Stall current	I_0*	A	18.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	138
Voltage constant	k_E	Vs/m	45.9
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	77.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.1
Phase inductance	L_{STR}	mH	15.7
Attraction force	F_A	N	16900
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	44.5
Mass of a secondary section (short/long)	m_S	kg/m	10/23.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	3040
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	9.1
Pressure drop	$\Delta p_{P,H}$	bar	1.03
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	335
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	7
Pressure drop	$\Delta p_{P,P}$	bar	0.62
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	192
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

1FN1

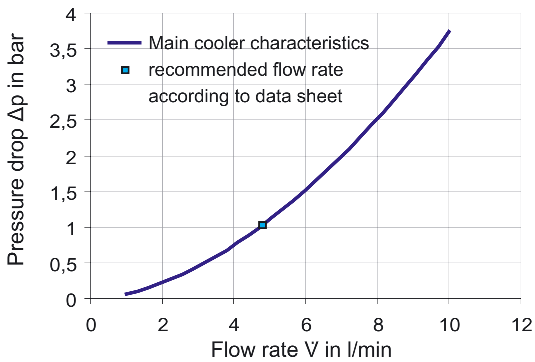
1FN1184-5AF71-0AA0 characteristics

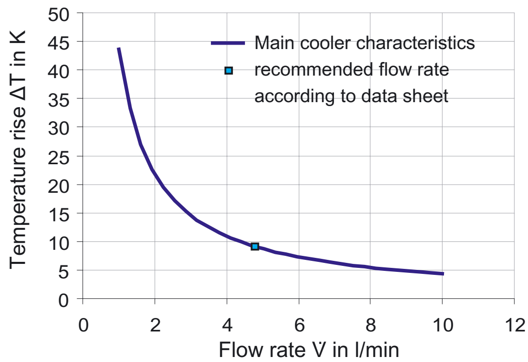
Thrust characteristics



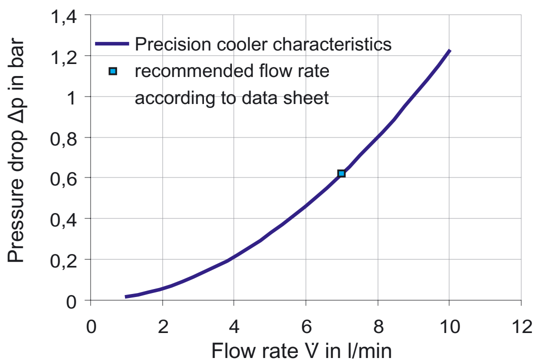


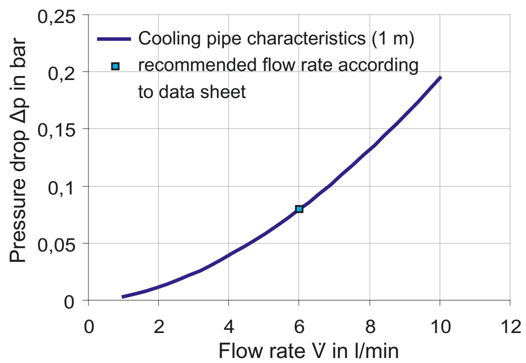
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



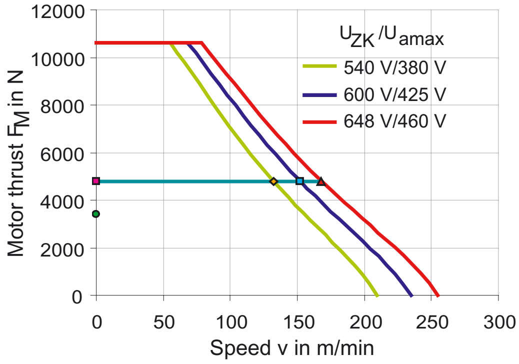


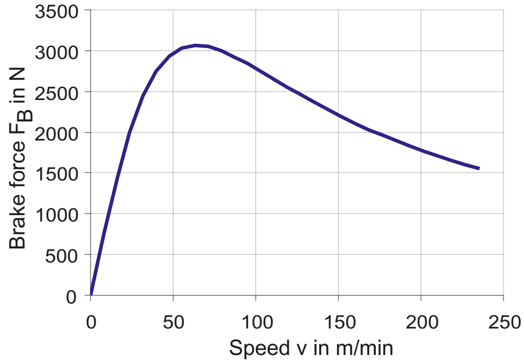
1FN1

1FN1186-5AC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4800
Rated current	I_N	A	27.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	152
Rated power loss	$P_{V,N}$	W	4000
Limiting data			
Maximum thrust	F_{MAX}	N	10600
Maximum current	I_{MAX}	A	68
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	68
Maximum electric power input	$P_{EL,MAX}$	W	37040
Stall thrust	F_0*	N	3394
Stall current	I_0*	A	19.2
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	176
Voltage constant	k_E	Vs/m	58.8
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	89.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.3
Phase inductance	L_{STR}	mH	19.4
Attraction force	F_A	N	21800
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	57.5
Mass of a secondary section (short/long)	m_S	kg/m	10/23.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4005
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	12
Pressure drop	$\Delta p_{P,H}$	bar	1.3
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	430
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	8
Pressure drop	$\Delta p_{P,P}$	bar	0.87
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	247
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

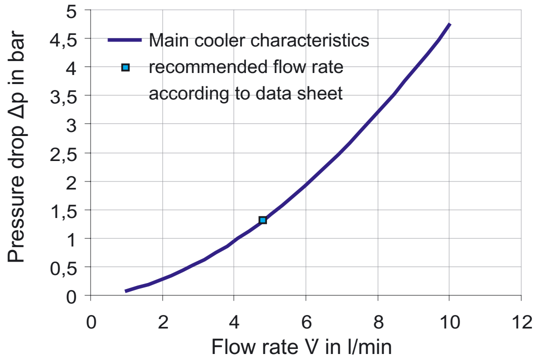
1FN1186-5AC71-0AA0 characteristics

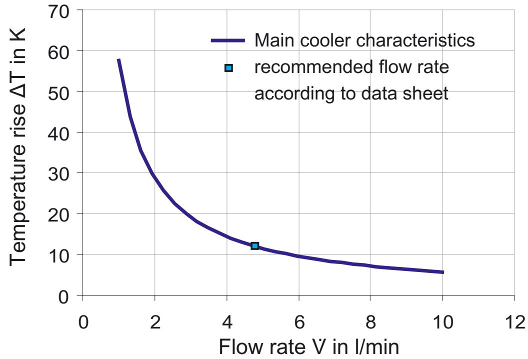
Thrust characteristics



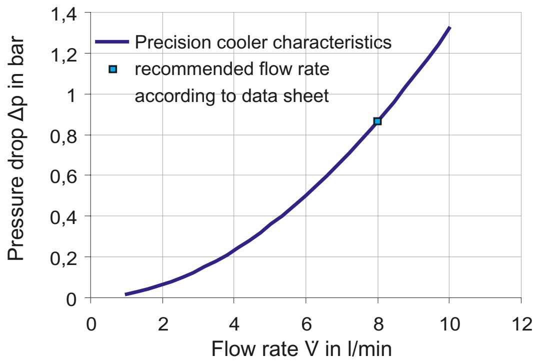


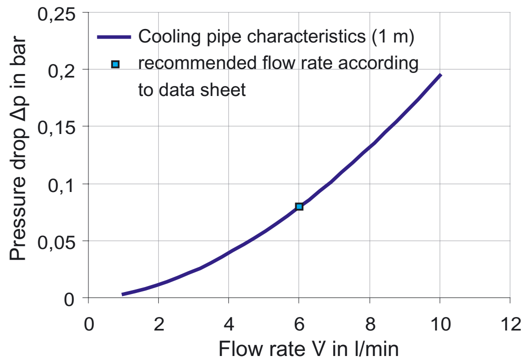
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



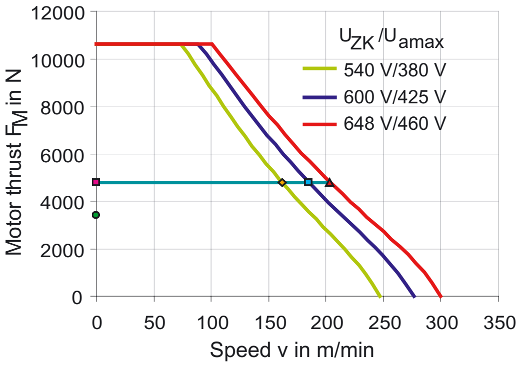


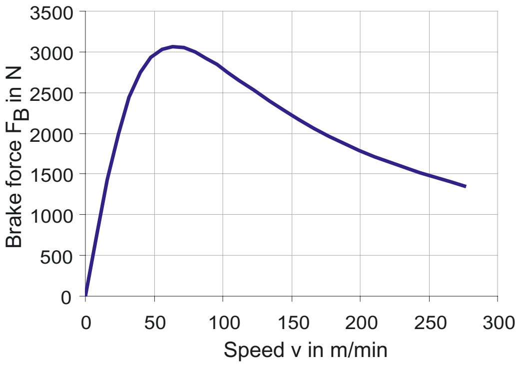
1FN1

1FN1186-5AD71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4800
Rated current	I_N	A	32
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	185
Rated power loss	$P_{V,N}$	W	4030
Limiting data			
Maximum thrust	F_{MAX}	N	10600
Maximum current	I_{MAX}	A	80.1
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	89
Maximum electric power input	$P_{EL,MAX}$	W	40890
Stall thrust	F_0*	N	3394
Stall current	I_0*	A	22.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	150
Voltage constant	k_E	Vs/m	50
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	89.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.9
Phase inductance	L_{STR}	mH	14
Attraction force	F_A	N	21800
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	57.5
Mass of a secondary section (short/long)	m_S	kg/m	10/23.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4035
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	12.1
Pressure drop	$\Delta p_{P,H}$	bar	1.3
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	430
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	8
Pressure drop	$\Delta p_{P,P}$	bar	0.87
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	249
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

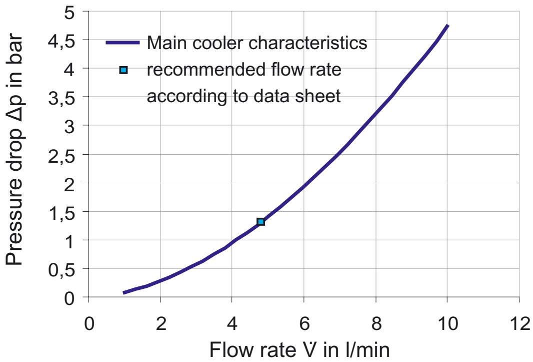
1FN1186-5AD71-0AA0 characteristics

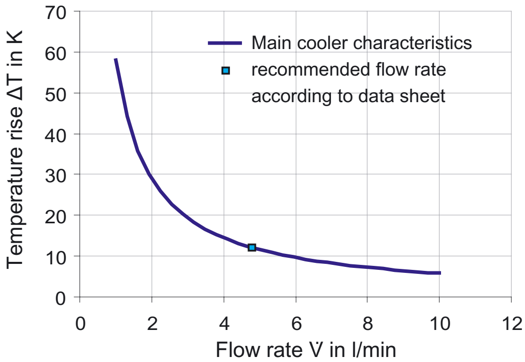
Thrust characteristics



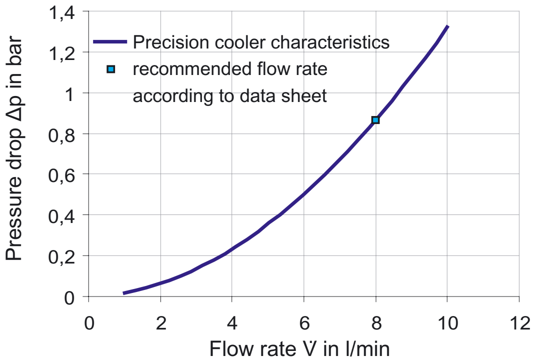


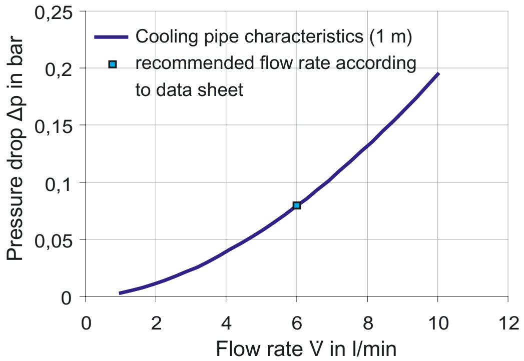
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





1FN1

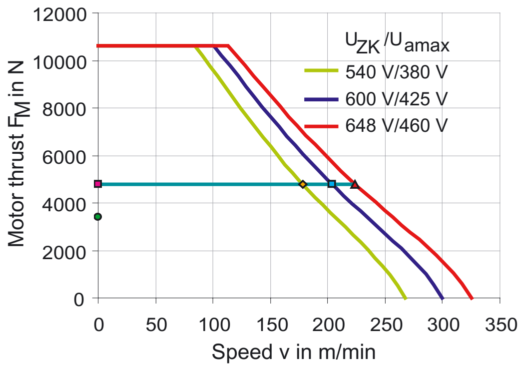
1FN1

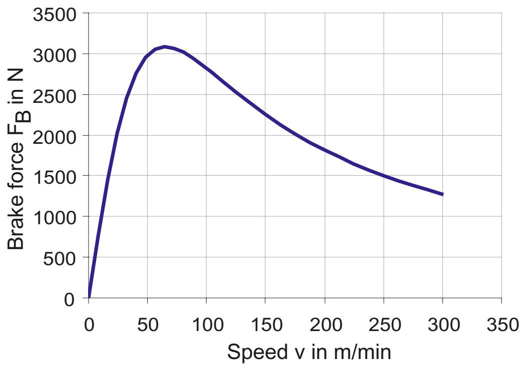
1FN1186-5AF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4800
Rated current	I_N	A	34.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	204
Rated power loss	$P_{V,N}$	W	4050
Limiting data			
Maximum thrust	F_{MAX}	N	10600
Maximum current	I_{MAX}	A	86.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	100
Maximum electric power input	$P_{EL,MAX}$	W	43040
Stall thrust	F_0*	N	3394
Stall current	I_0*	A	24.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	138
Voltage constant	k_E	Vs/m	46.1
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	89.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.8
Phase inductance	L_{STR}	mH	11.8
Attraction force	F_A	N	21800
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	57.5
Mass of a secondary section (short/long)	m_S	kg/m	10/23.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4045
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	12.1
Pressure drop	$\Delta p_{P,H}$	bar	1.3
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	435
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	8
Pressure drop	$\Delta p_{P,P}$	bar	0.87
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	250
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

1FN1

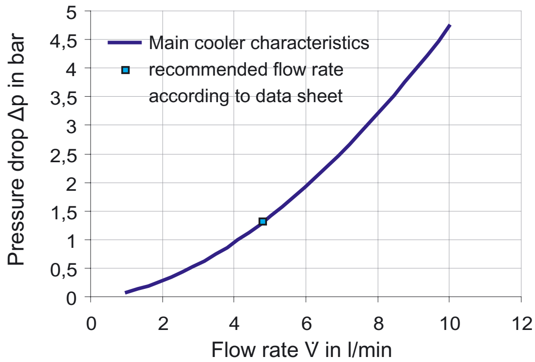
1FN1186-5AF71-0AA0 characteristics

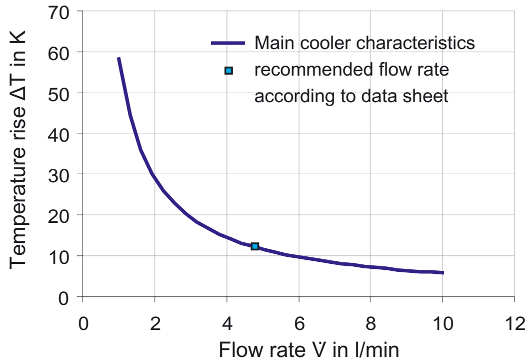
Thrust characteristics



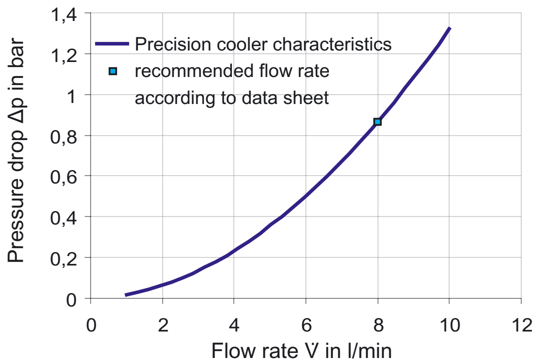


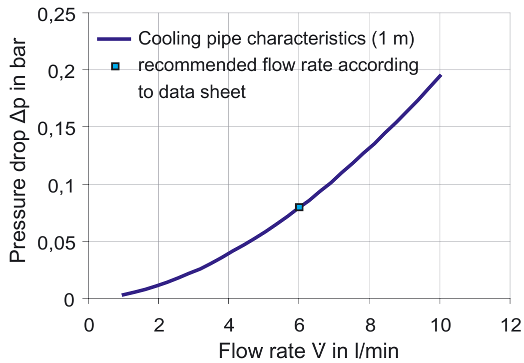
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



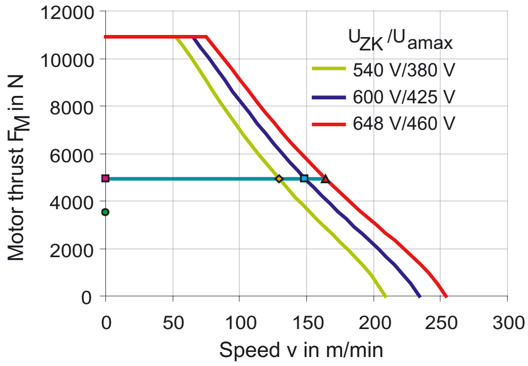


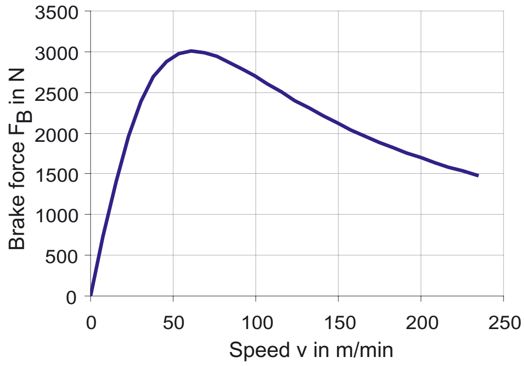
1FN1

1FN1244-5AC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4950
Rated current	I_N	A	28
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	149
Rated power loss	$P_{V,N}$	W	4190
Limiting data			
Maximum thrust	F_{MAX}	N	10900
Maximum current	I_{MAX}	A	69.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	65
Maximum electric power input	$P_{EL,MAX}$	W	37980
Stall thrust	F_0*	N	3500
Stall current	I_0*	A	19.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	177
Voltage constant	k_E	Vs/m	59
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	90.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.3
Phase inductance	L_{STR}	mH	19.9
Attraction force	F_A	N	22700
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	60.1
Mass of a secondary section (short/long)	m_S	kg/m	11.9/27.7
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4190
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.2
Cooling medium temperature increase	$\Delta T_{P,H}$	K	11.6
Pressure drop	$\Delta p_{P,H}$	bar	1.4
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	445
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	8
Pressure drop	$\Delta p_{P,P}$	bar	1.08
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	259
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

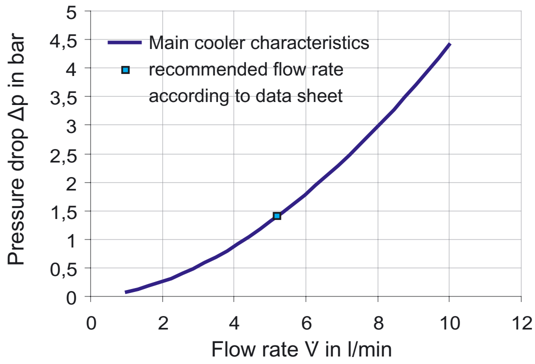
1FN1244-5AC71-0AA0 characteristics

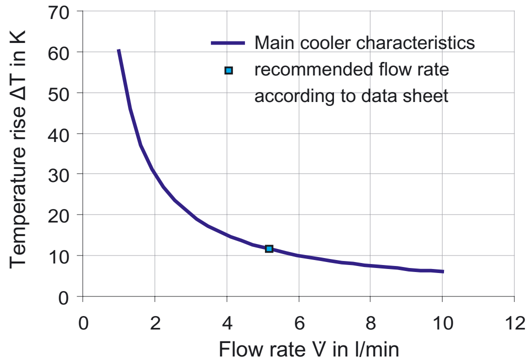
Thrust characteristics



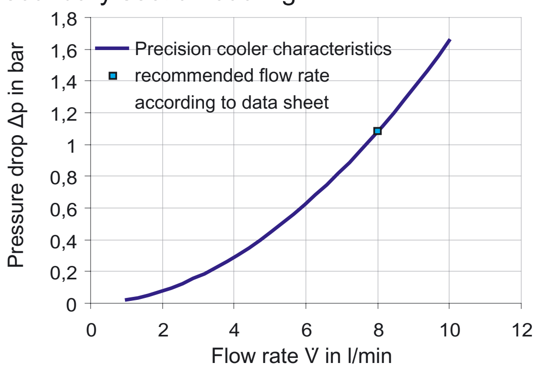


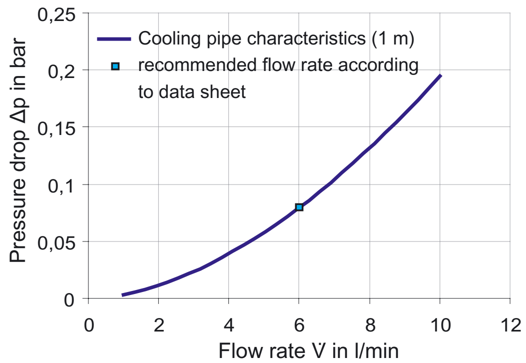
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



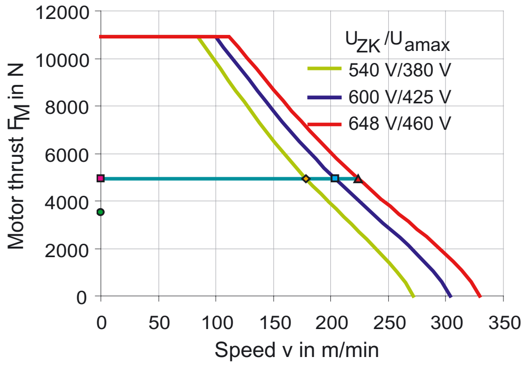


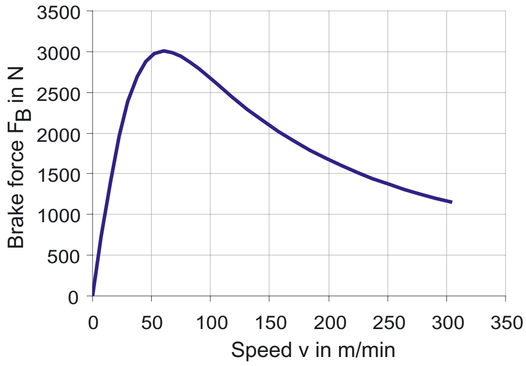
1FN1

1FN1244-5AF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4950
Rated current	I_N	A	36.3
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	203
Rated power loss	$P_{V,N}$	W	4110
Limiting data			
Maximum thrust	F_{MAX}	N	10900
Maximum current	I_{MAX}	A	90.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	100
Maximum electric power input	$P_{EL,MAX}$	W	43800
Stall thrust	F_0*	N	3500
Stall current	I_0*	A	25.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	136
Voltage constant	k_E	Vs/m	45.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	91.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.7
Phase inductance	L_{STR}	mH	11.8
Attraction force	F_A	N	22700
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	60.1
Mass of a secondary section (short/long)	m_S	kg/m	11.9/27.7
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4115
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.2
Cooling medium temperature increase	$\Delta T_{P,H}$	K	11.4
Pressure drop	$\Delta p_{P,H}$	bar	1.4
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	440
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	8
Pressure drop	$\Delta p_{P,P}$	bar	1.08
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	255
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

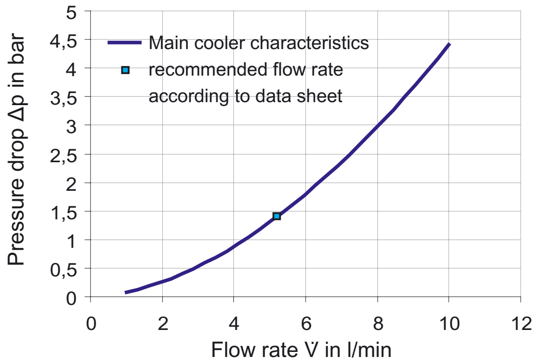
1FN1244-5AF71-0AA0 characteristics

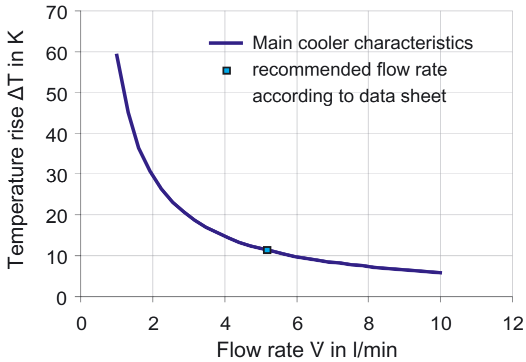
Thrust characteristics



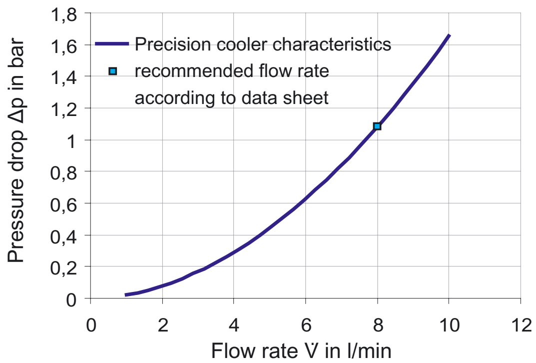


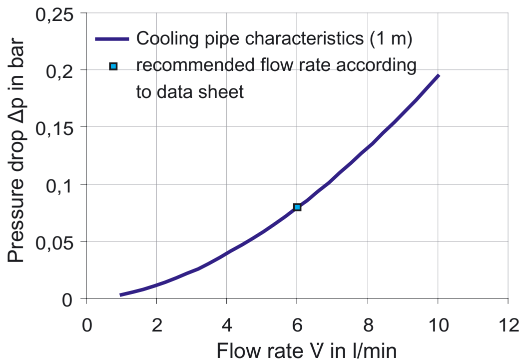
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



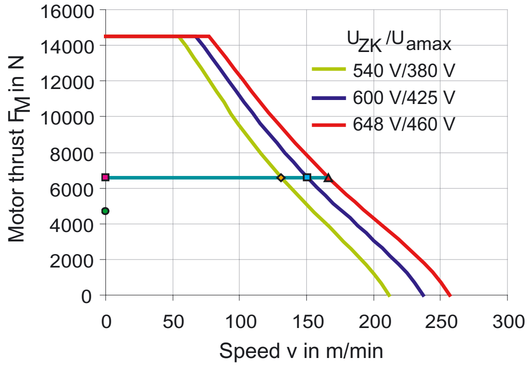


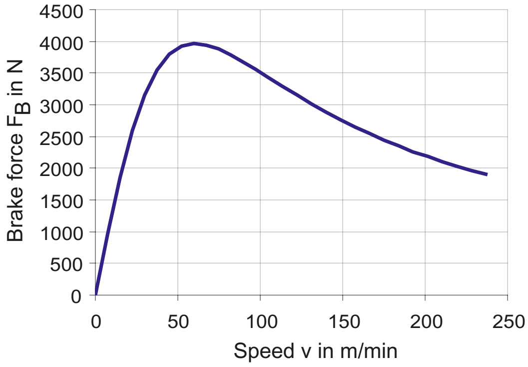
1FN1

1FN1246-5AC71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	6600
Rated current	I_N	A	37.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	151
Rated power loss	$P_{V,N}$	W	5520
Limiting data			
Maximum thrust	F_{MAX}	N	14500
Maximum current	I_{MAX}	A	93.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	67
Maximum electric power input	$P_{EL,MAX}$	W	50300
Stall thrust	F_0*	N	4667
Stall current	I_0*	A	26.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	175
Voltage constant	k_E	Vs/m	58.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	105.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.9
Phase inductance	L_{STR}	mH	14.7
Attraction force	F_A	N	29300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	76
Mass of a secondary section (short/long)	m_S	kg/m	11.9/27.7
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5525
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.2
Cooling medium temperature increase	$\Delta T_{P,H}$	K	15.3
Pressure drop	$\Delta p_{P,H}$	bar	1.78
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	575
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	9
Pressure drop	$\Delta p_{P,P}$	bar	1.48
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	331
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

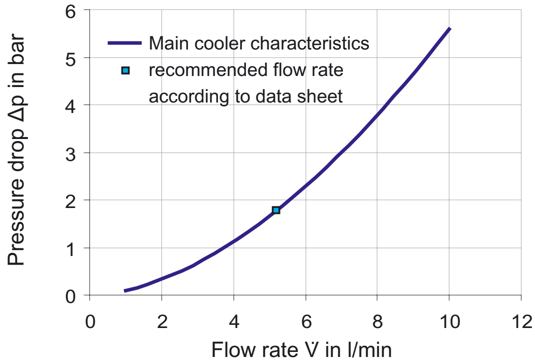
1FN1246-5AC71-0AA0 characteristics

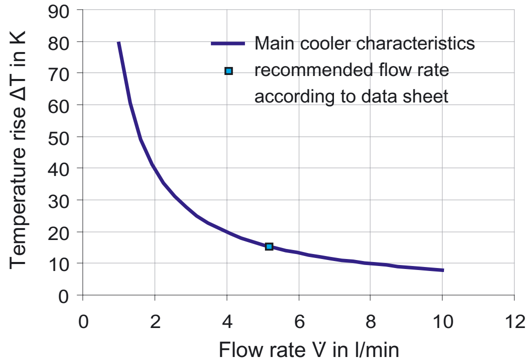
Thrust characteristics



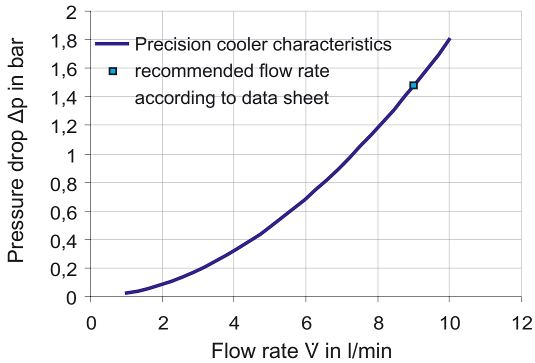


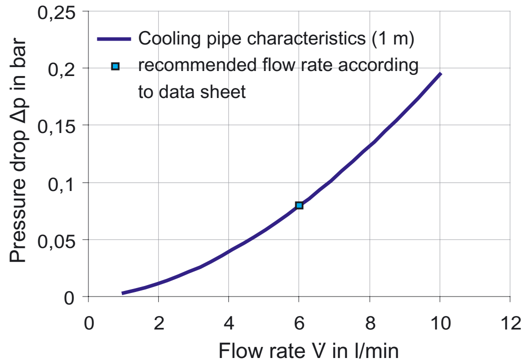
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



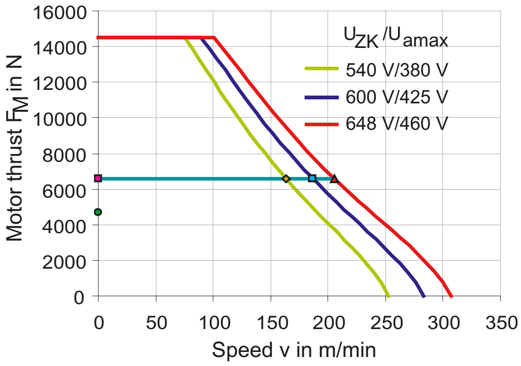


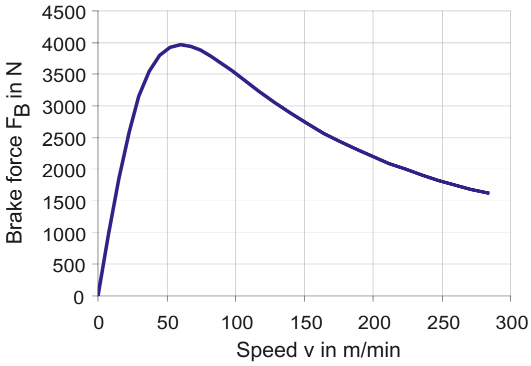
1FN1

1FN1246-5AD71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	6600
Rated current	I_N	A	45.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	187
Rated power loss	$P_{V,N}$	W	5530
Limiting data			
Maximum thrust	F_{MAX}	N	14500
Maximum current	I_{MAX}	A	112.1
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	90
Maximum electric power input	$P_{EL,MAX}$	W	55730
Stall thrust	F_0*	N	4667
Stall current	I_0*	A	31.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	146
Voltage constant	k_E	Vs/m	48.7
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	105
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.6
Phase inductance	L_{STR}	mH	10.3
Attraction force	F_A	N	29300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	76
Mass of a secondary section (short/long)	m_S	kg/m	11.9/27.7
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5530
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.2
Cooling medium temperature increase	$\Delta T_{P,H}$	K	15.3
Pressure drop	$\Delta p_{P,H}$	bar	1.78
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	575
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	9
Pressure drop	$\Delta p_{P,P}$	bar	1.48
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	331
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

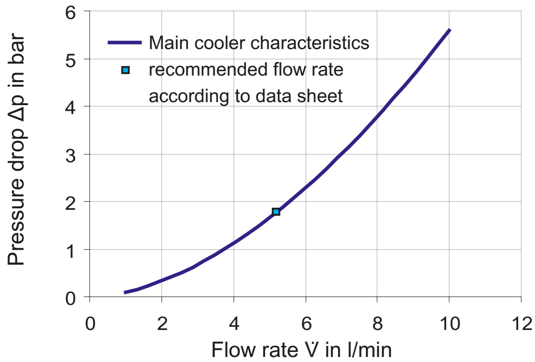
1FN1246-5AD71-0AA0 characteristics

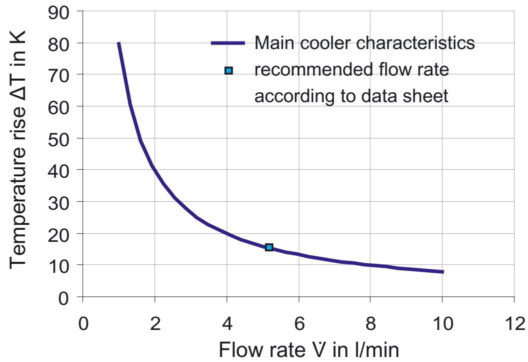
Thrust characteristics



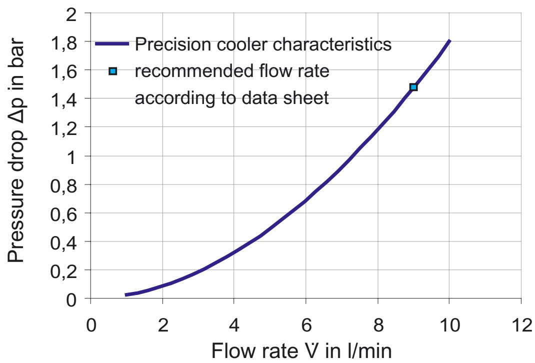


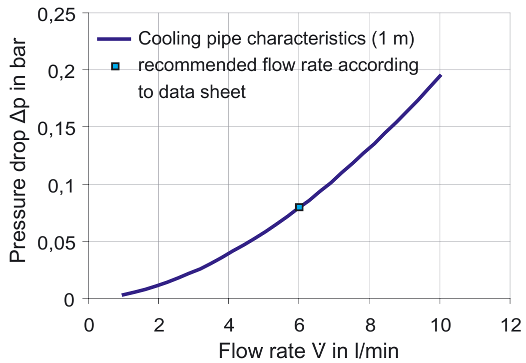
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



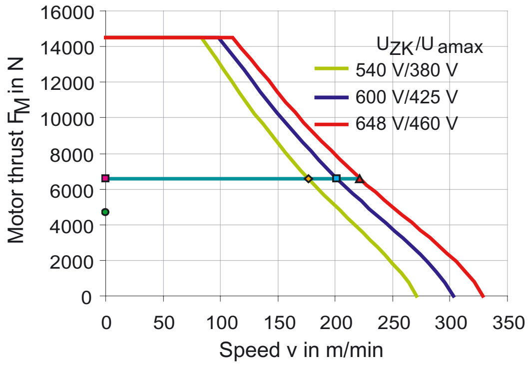


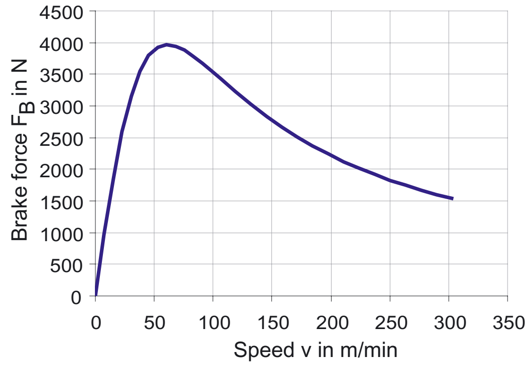
1FN1

1FN1246-5AF71-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	6600
Rated current	I_N	A	48.3
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	201
Rated power loss	$P_{V,N}$	W	5590
Limiting data			
Maximum thrust	F_{MAX}	N	14500
Maximum current	I_{MAX}	A	119.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	98
Maximum electric power input	$P_{EL,MAX}$	W	58240
Stall thrust	F_0*	N	4667
Stall current	I_0*	A	34.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	137
Voltage constant	k_E	Vs/m	45.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	104.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.6
Phase inductance	L_{STR}	mH	9
Attraction force	F_A	N	29300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	36
Mass primary section	m_P	kg	76
Mass of a secondary section (short/long)	m_S	kg/m	11.9/27.7
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5590
Recommended minimum flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.2
Cooling medium temperature increase	$\Delta T_{P,H}$	K	15.5
Pressure drop	$\Delta p_{P,H}$	bar	1.78
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	580
Recommended minimum flow rate	$\dot{V}_{P,P,MIN}$	l/min	9
Pressure drop	$\Delta p_{P,P}$	bar	1.48
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	334
Recommended minimum flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08

1FN1246-5AF71-0AA0 characteristics

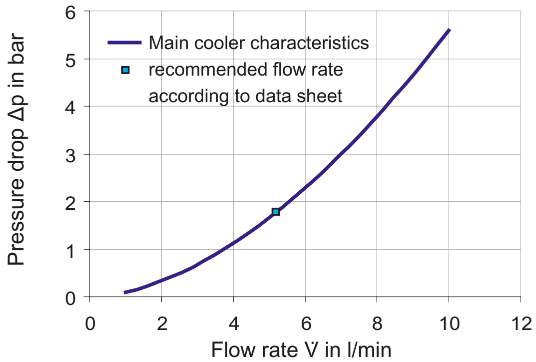
Thrust characteristics

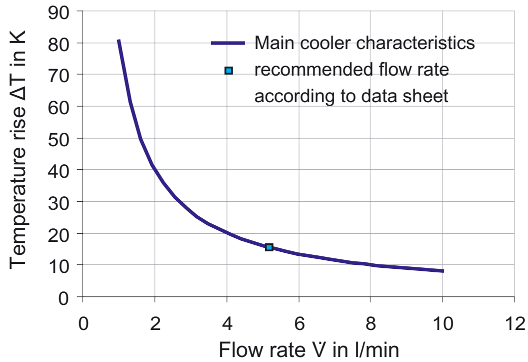




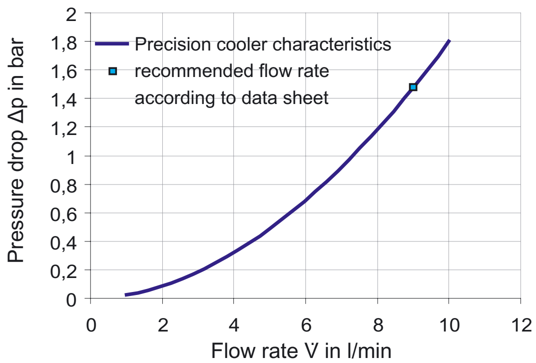
1FN1

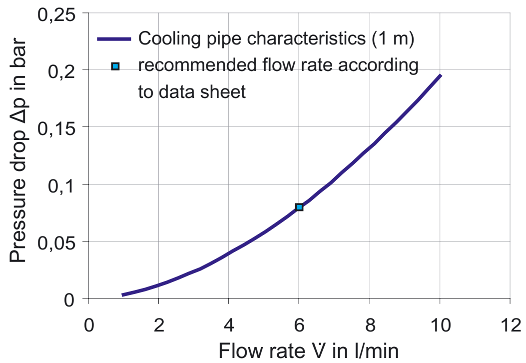
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





11.3 Additional characteristics

11.3.1 Sustained power via intake temperature

The possible sustained power of the motor F_{eff} depends on the intake temperature of the primary section main cooler T_{VORL} (see Figure 11-6). F_{eff} may not exceed the rated thrust F_N of the motor insofar as T_{VORL} = 35 °C applies.

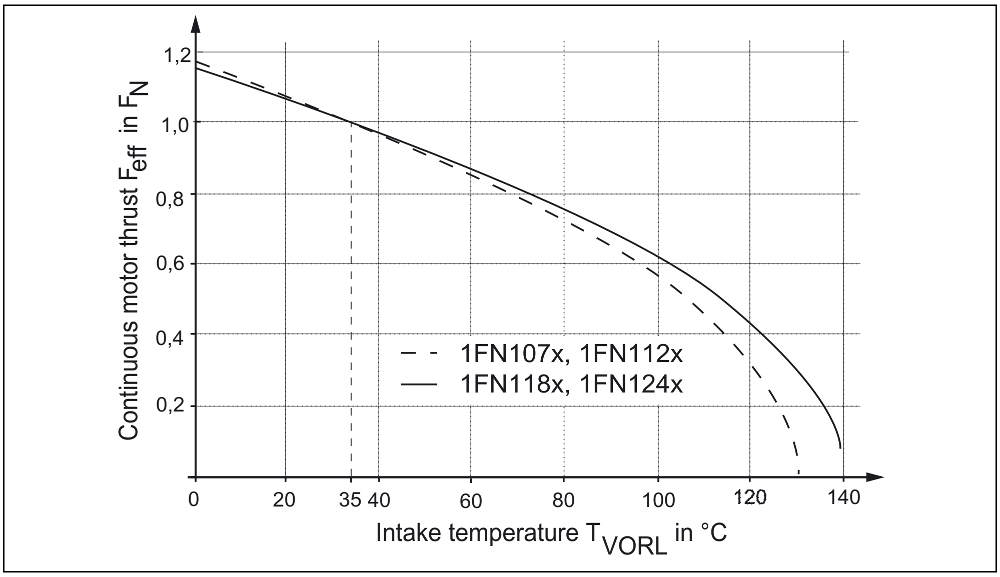


Figure 11-6 Maximum sustained power depending on the intake temperature of the primary section main cooler

11.3.2 Attraction force via relative air gap

The attraction force F_A between the primary section and the secondary section track depends on the air gap (see Figure 11-7).

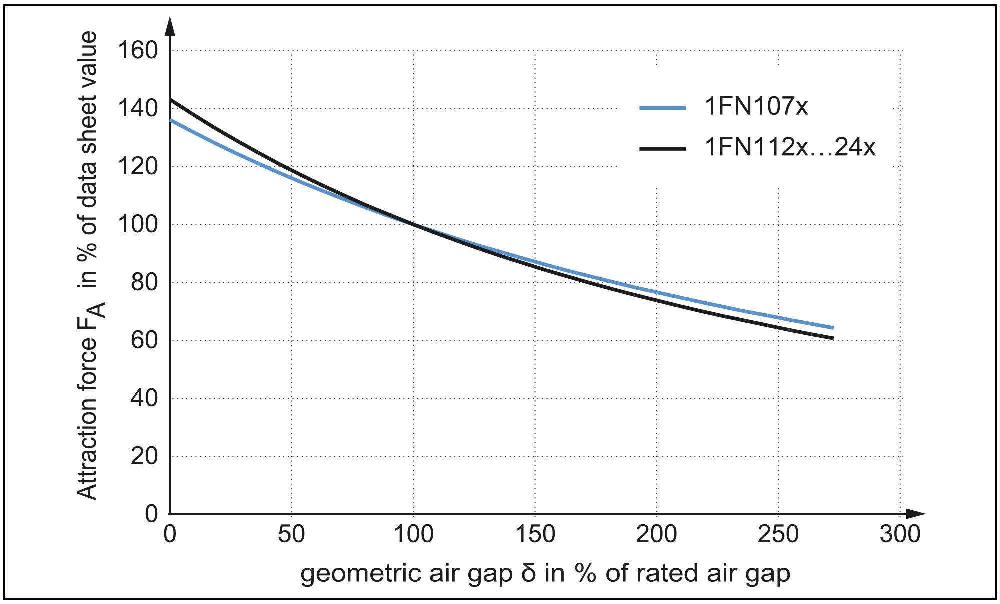


Figure 11-7 Dependency of the attraction force of the air gap for 1FN1-type motors

11.3.3 Motor thrust via relative air gap

The maximum motor thrust F_{MAX} also depends on the air gap. Figure 11-8 shows the characteristic curves.

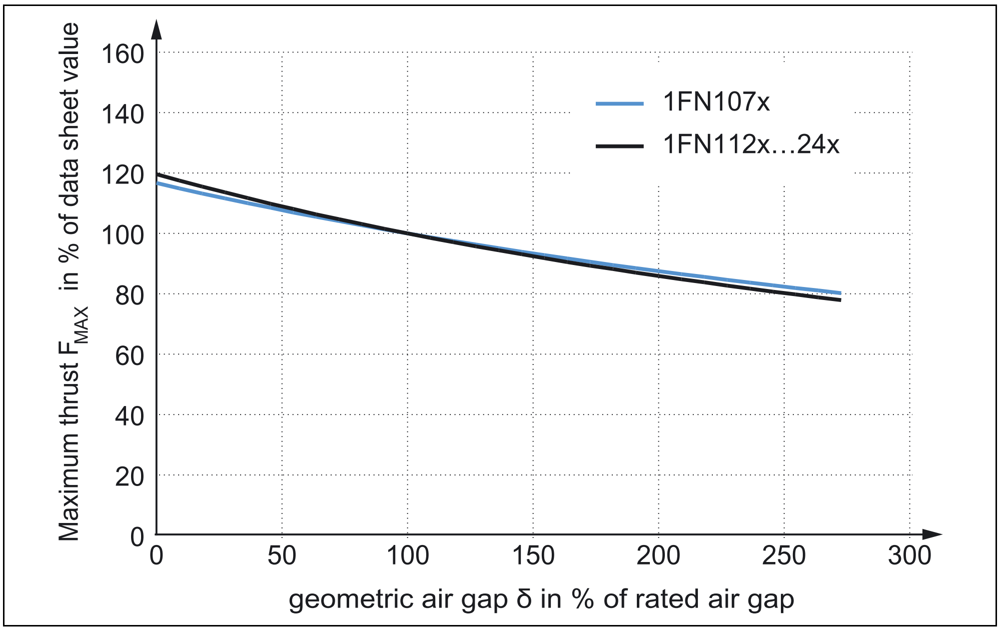


Figure 11-8 Dependency of the motor thrust of the air gap for 1FN1-type motors

■

1FN1

1FN1

12 Dimension drawings

12.1 1FN107x

12.1.1 1FN1072 primary section

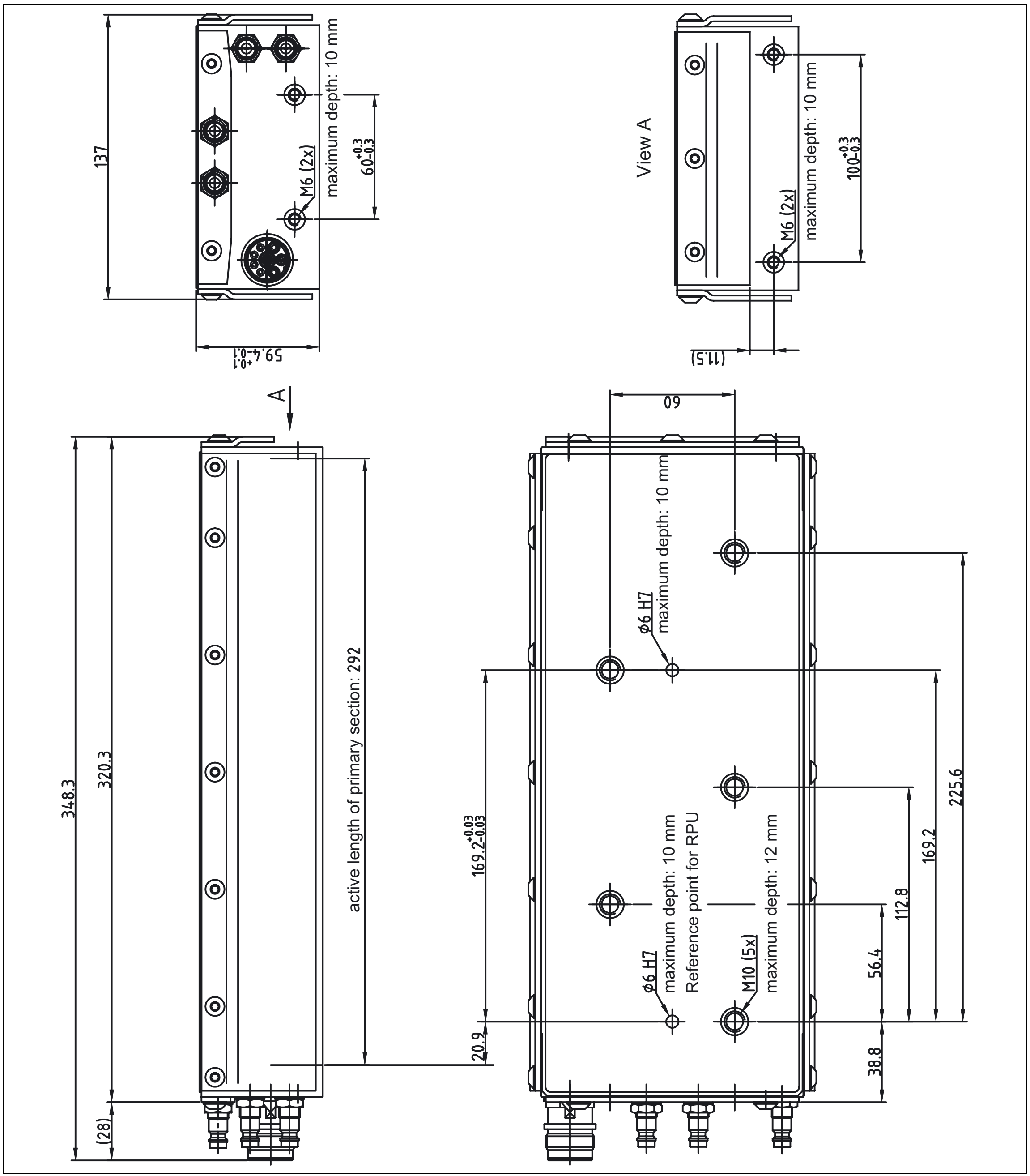


Figure 12-1 1FN1072-3AF7x-0AA0 primary section (plug connection)

12.1.2 1FN1076 primary section

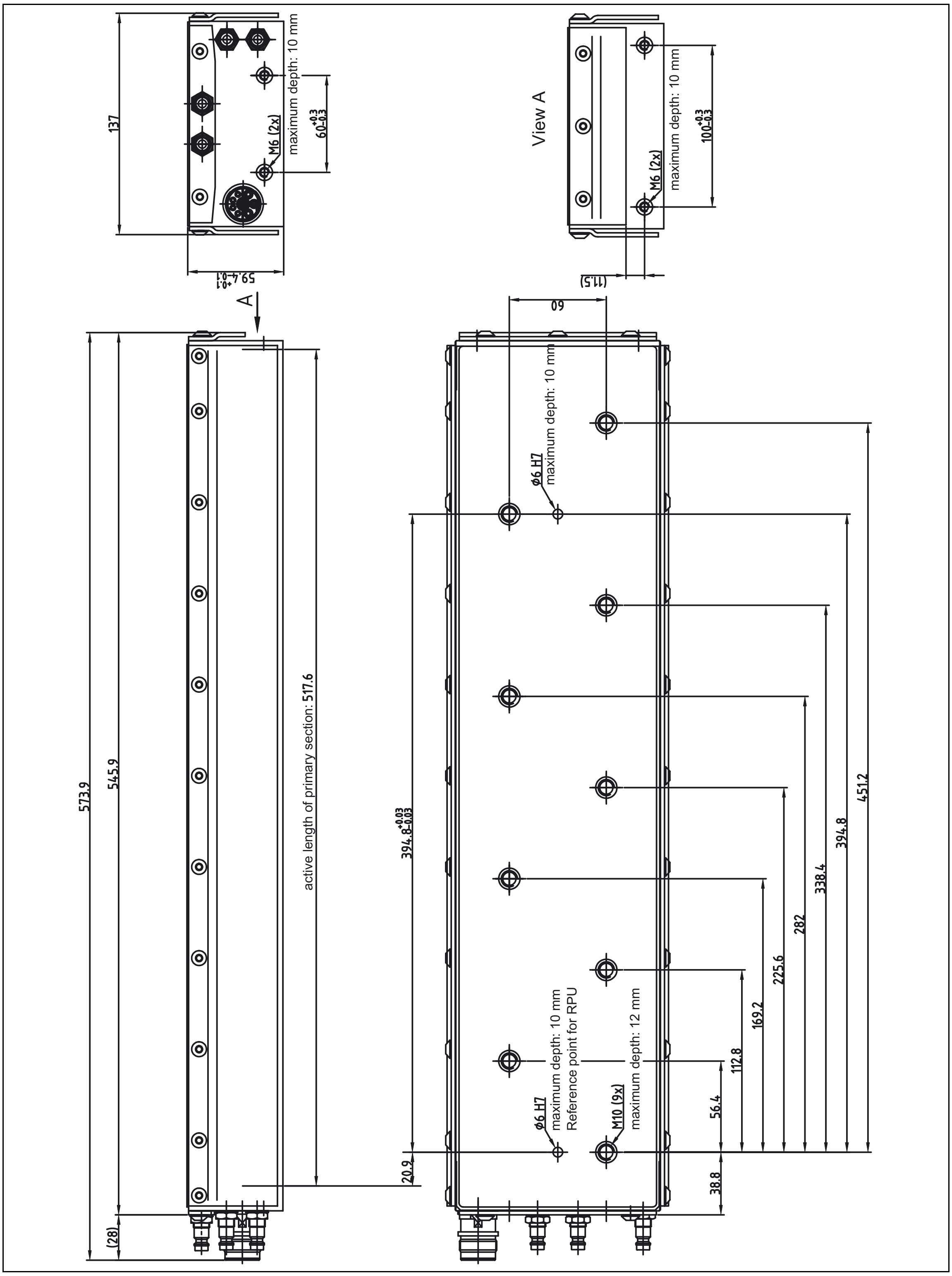


Figure 12-2 1FN1076-3AF7x-0AA0 primary section (plug connection)

12.1.3 1FN1070 secondary sections

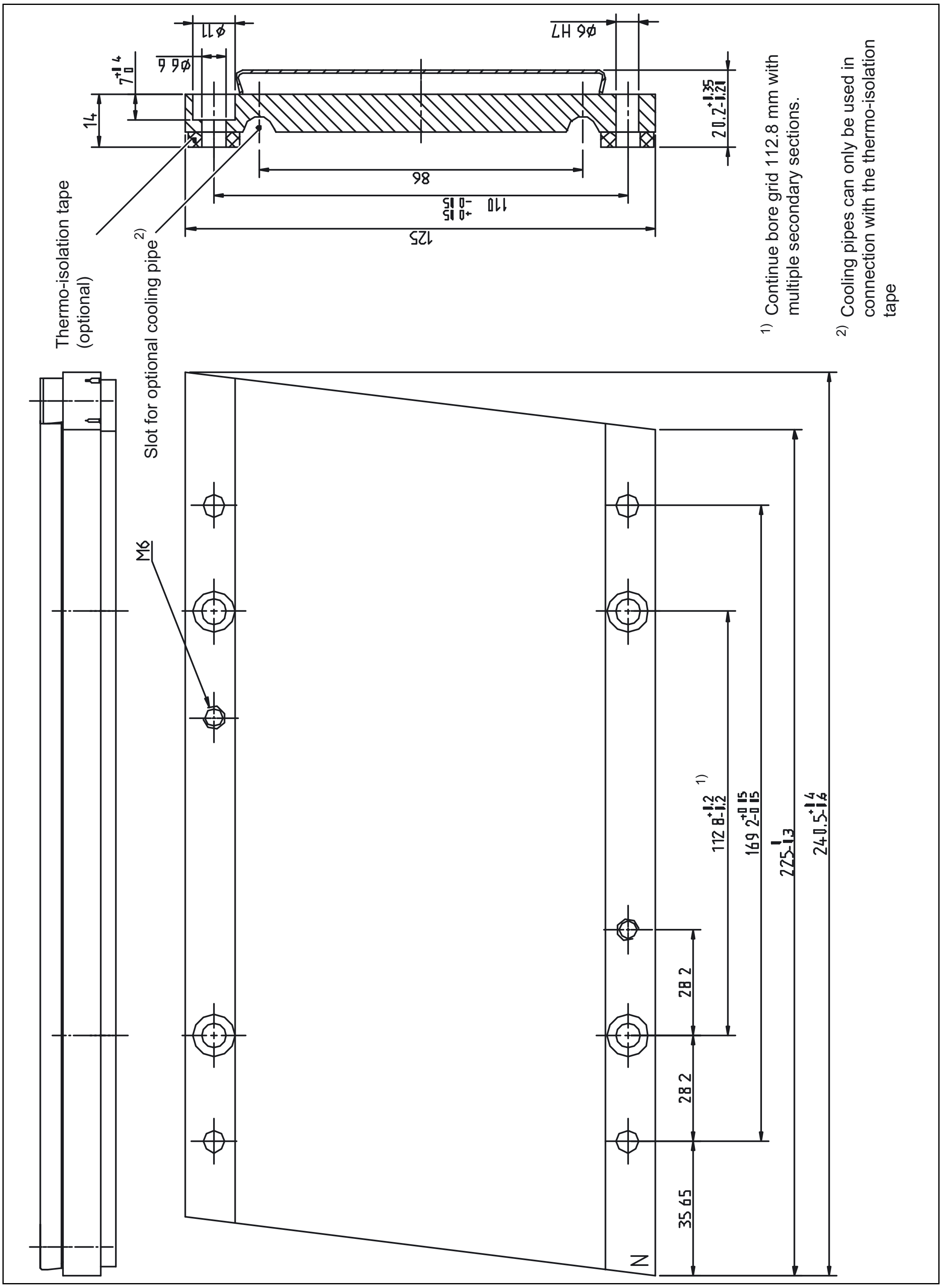


Figure 12-3 1FN1070-0AA00-0AA0 secondary section (short)

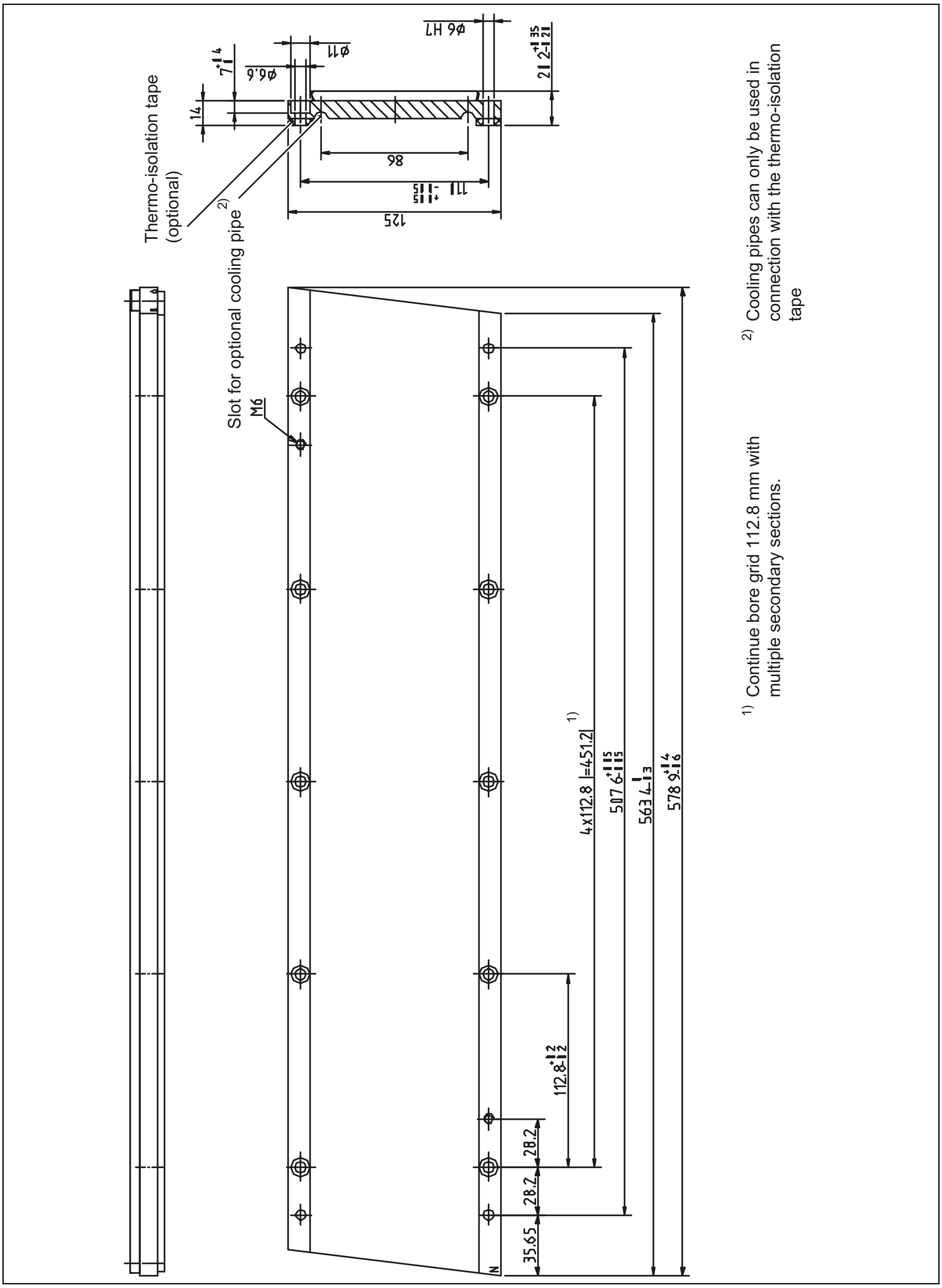


Figure 12-4 1FN1070-0AA00-1AA0 secondary section (long)

1FN1

1FN1

12.2 1FN112x

12.2.1 1FN1122 primary sections

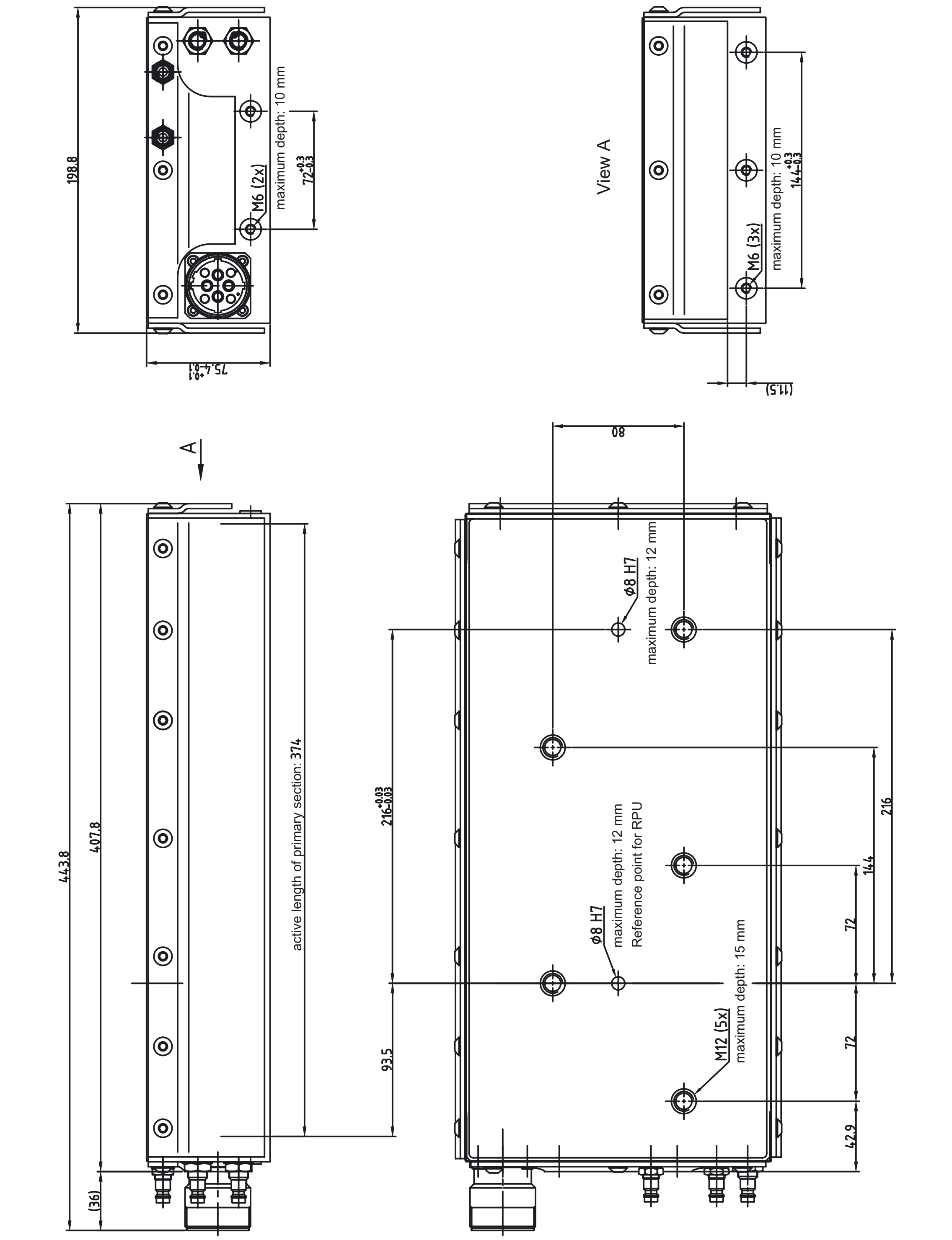


Figure 12-5 1FN1122-3AF7x-0AA0 primary section (plug connection)

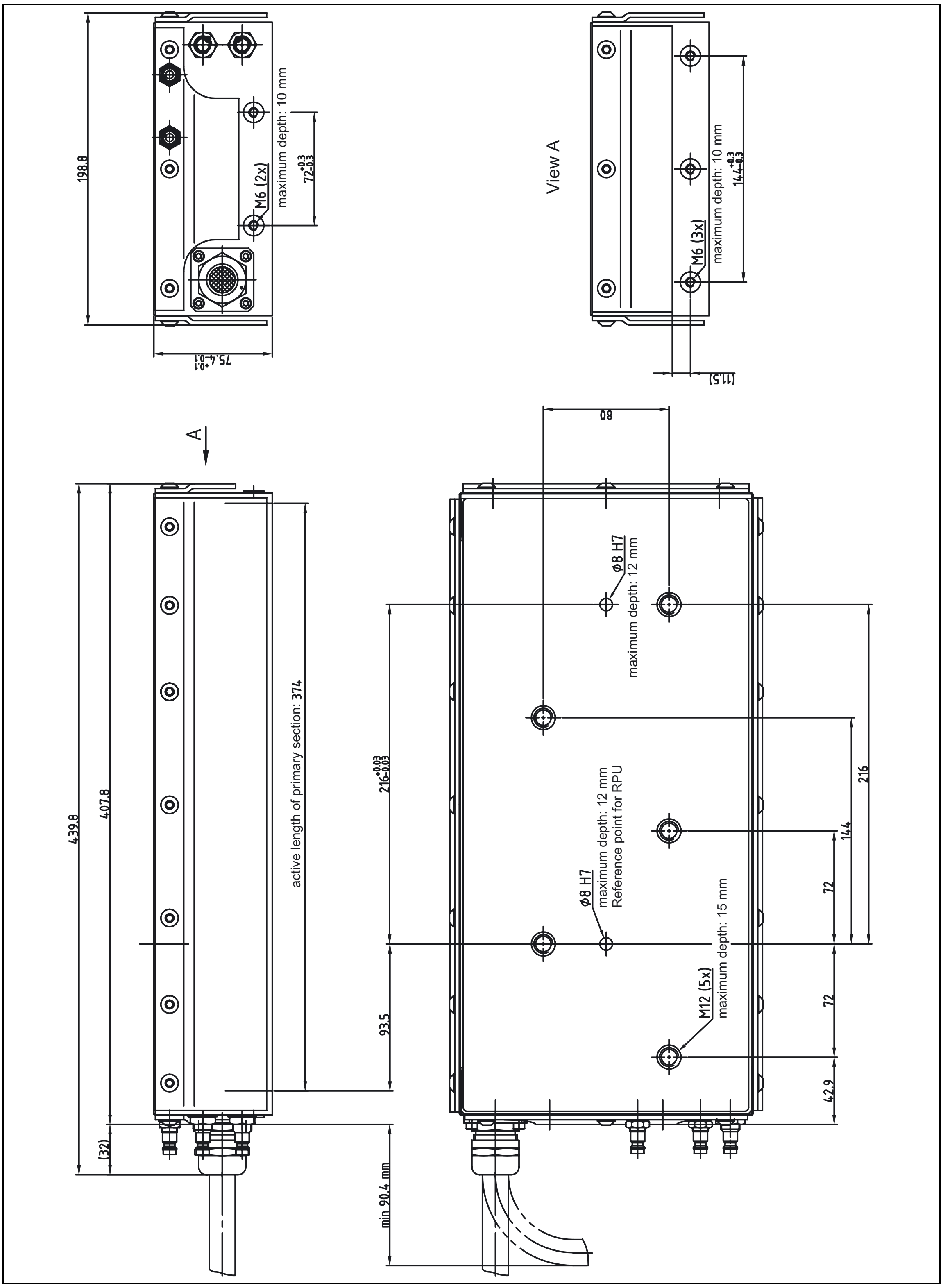


Figure 12-6 1FN1122-3KF7x-0AA0 primary section (previously mounted assembled cable)

1FN1

12.2.2 1FN1124 primary sections

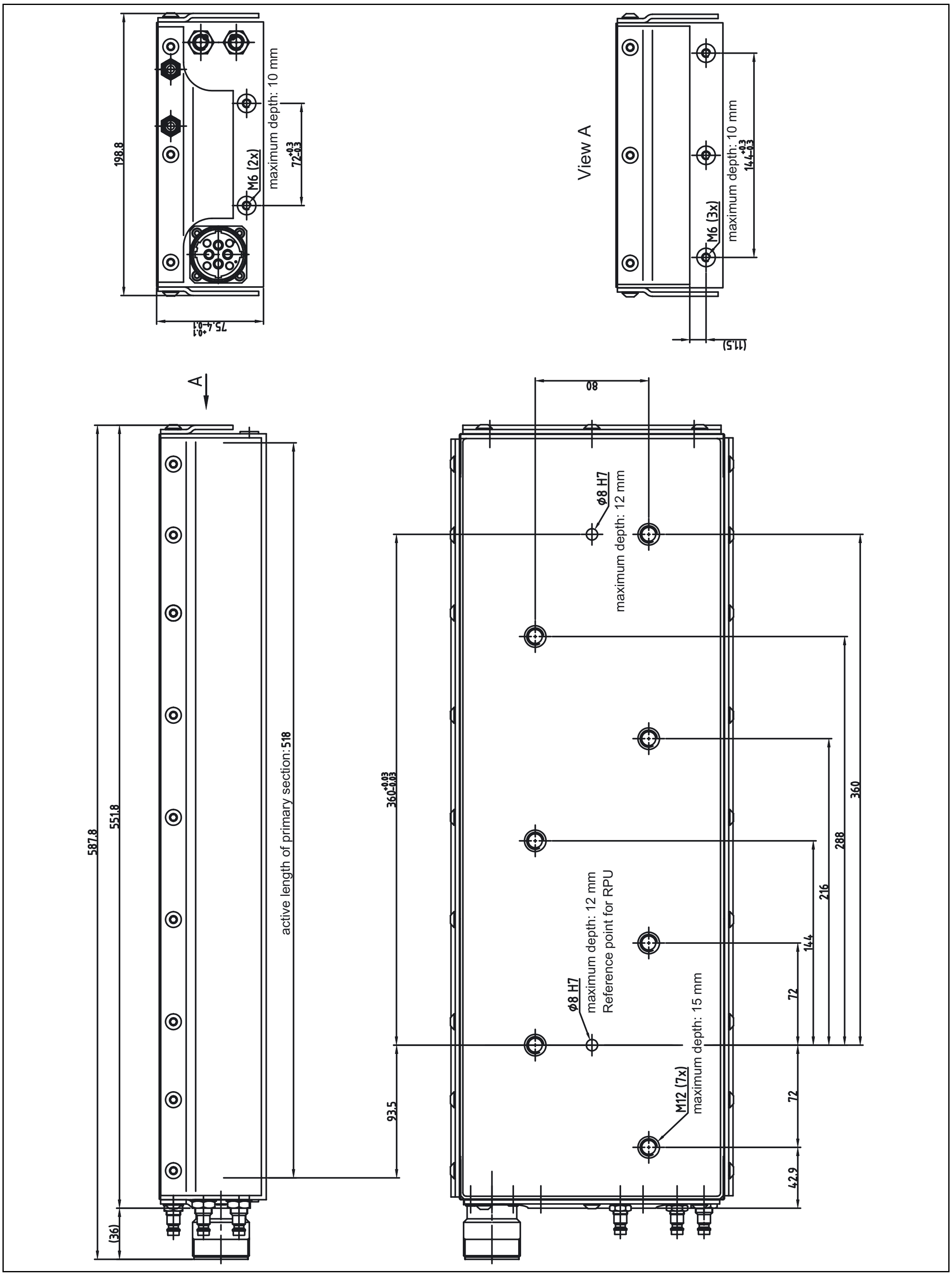


Figure 12-7 1FN1124-3AF7x-0AA0 primary section (plug connection)

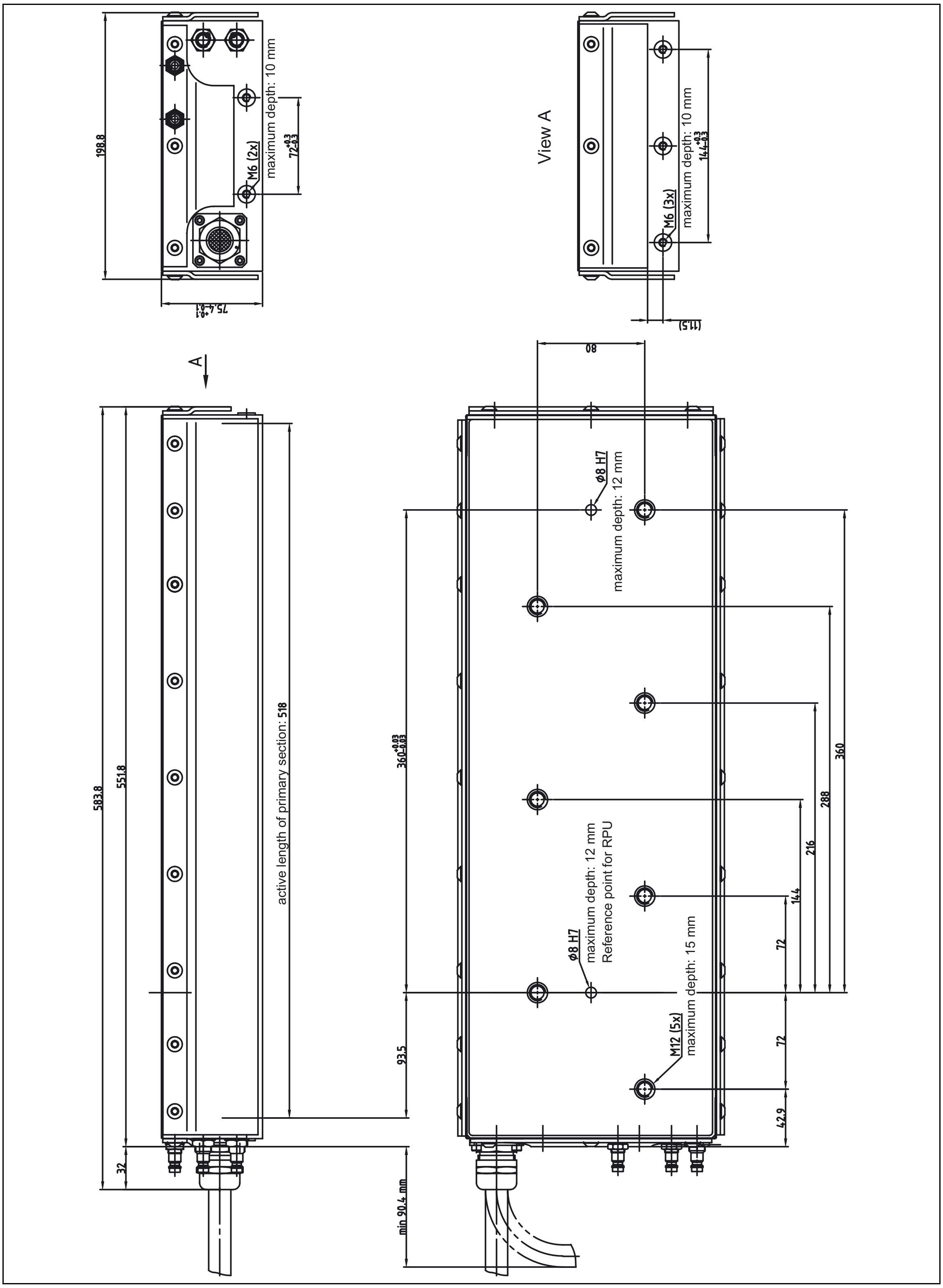


Figure 12-8 1FN1124-3KF7x-0AA0 primary section (previously mounted assembled cable)

1FN1

12.2.3 1FN1126 primary sections

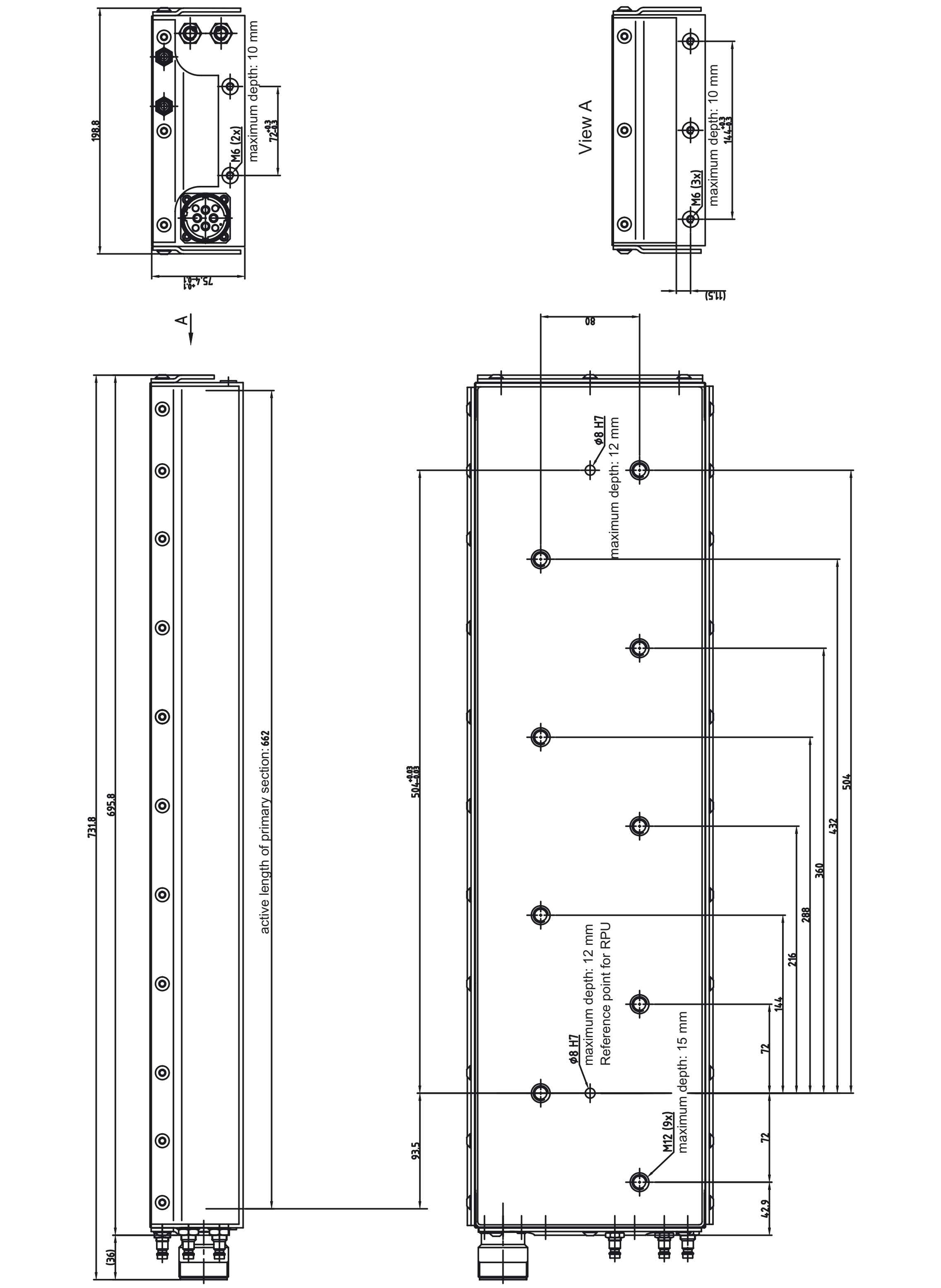


Figure 12-9 1FN1126-3AF7x-0AA0 primary section (plug connection)

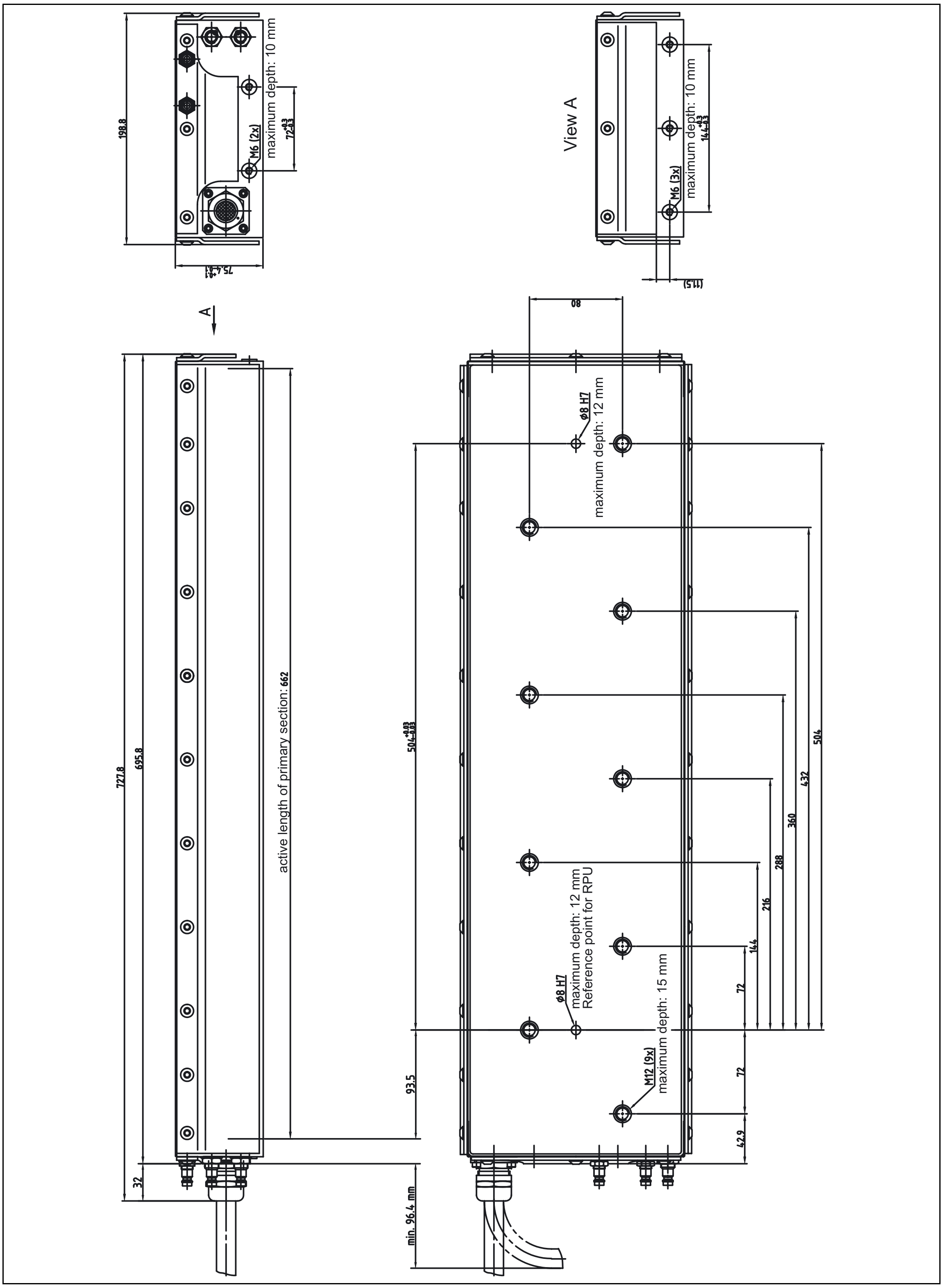


Figure 12-10 1FN1126-3KF7x-0AA0 primary section (previously mounted assembled cable)

12.2.4 1FN1120 secondary sections

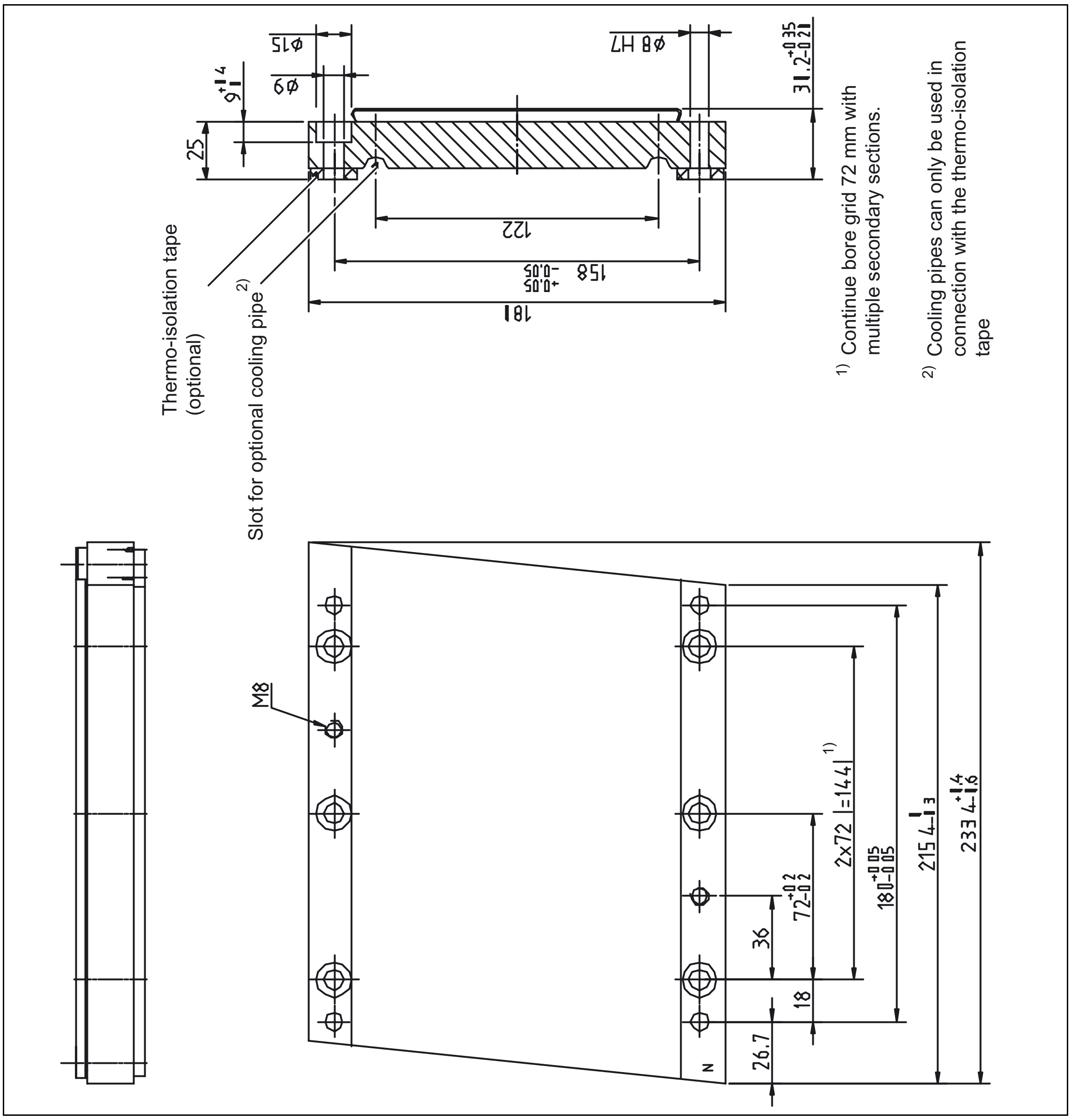


Figure 12-11 1FN1120-0AA00-0AA0 secondary section (short)

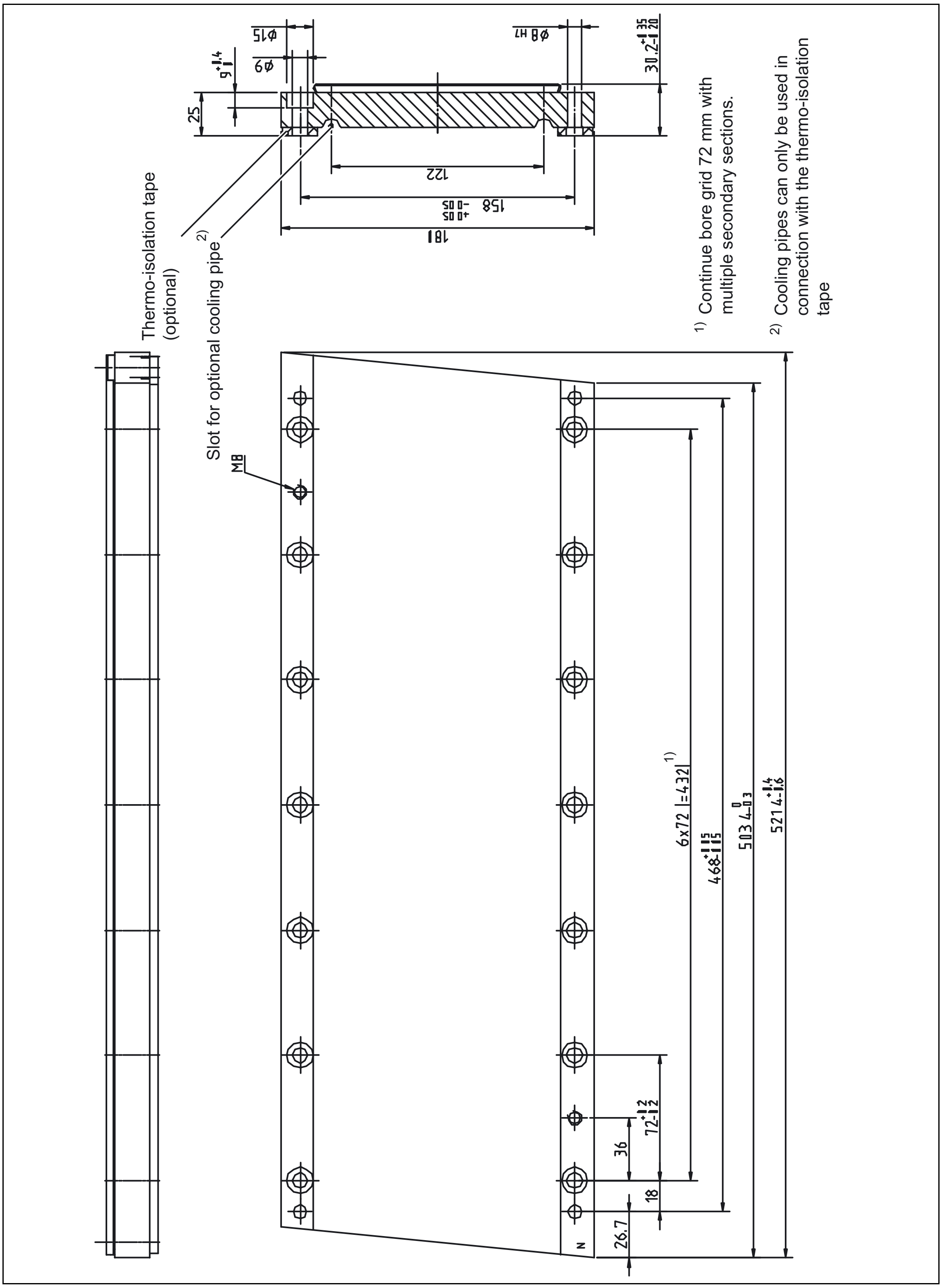


Figure 12-12 1FN1120-0AA00-1AA0 secondary section (long)

1FN1

12.3 1FN118x

12.3.1 1FN1184 primary section

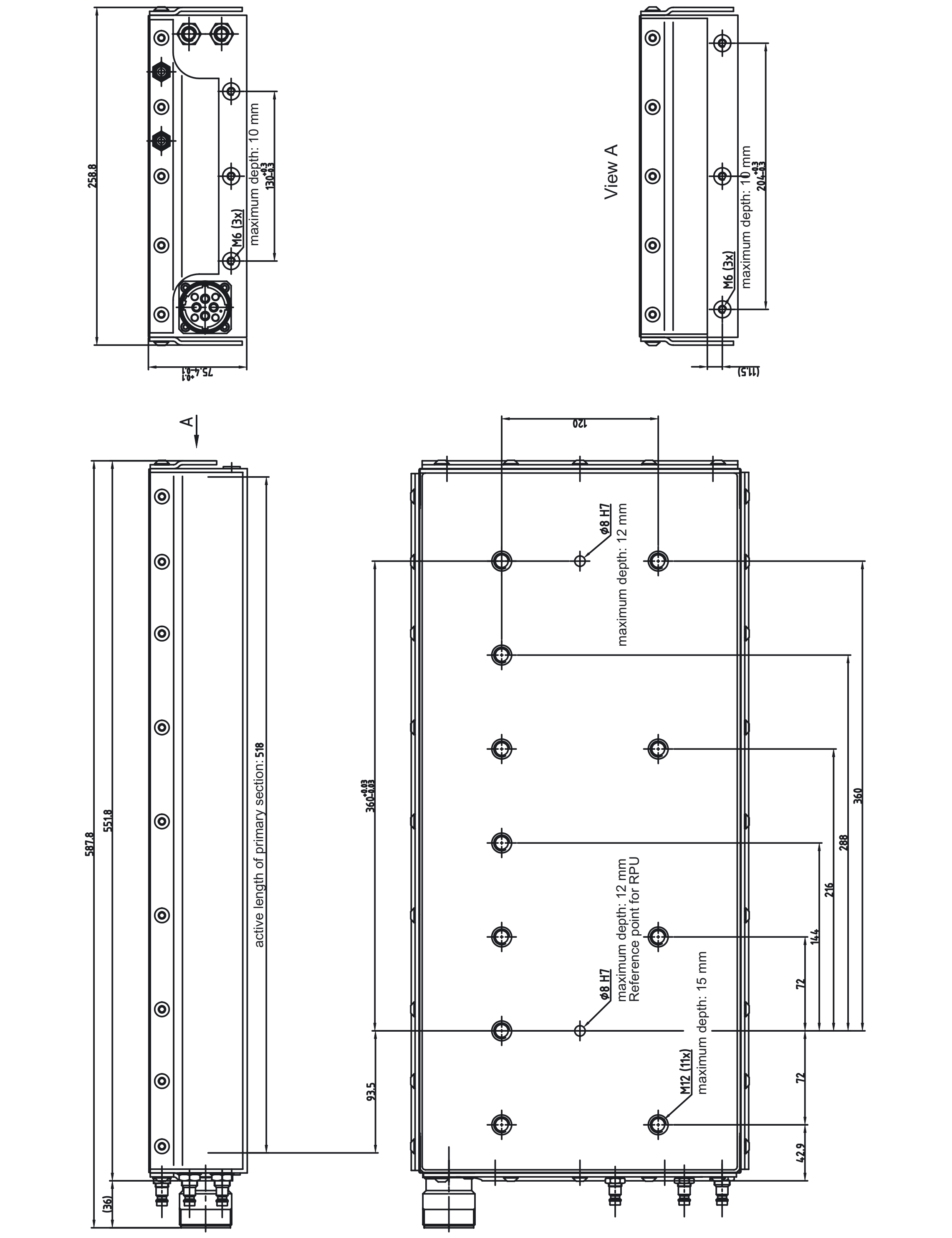


Figure 12-13 1FN1184-3AF7x-0AA0 primary section (plug connection)

12.3.2 1FN1186 primary section

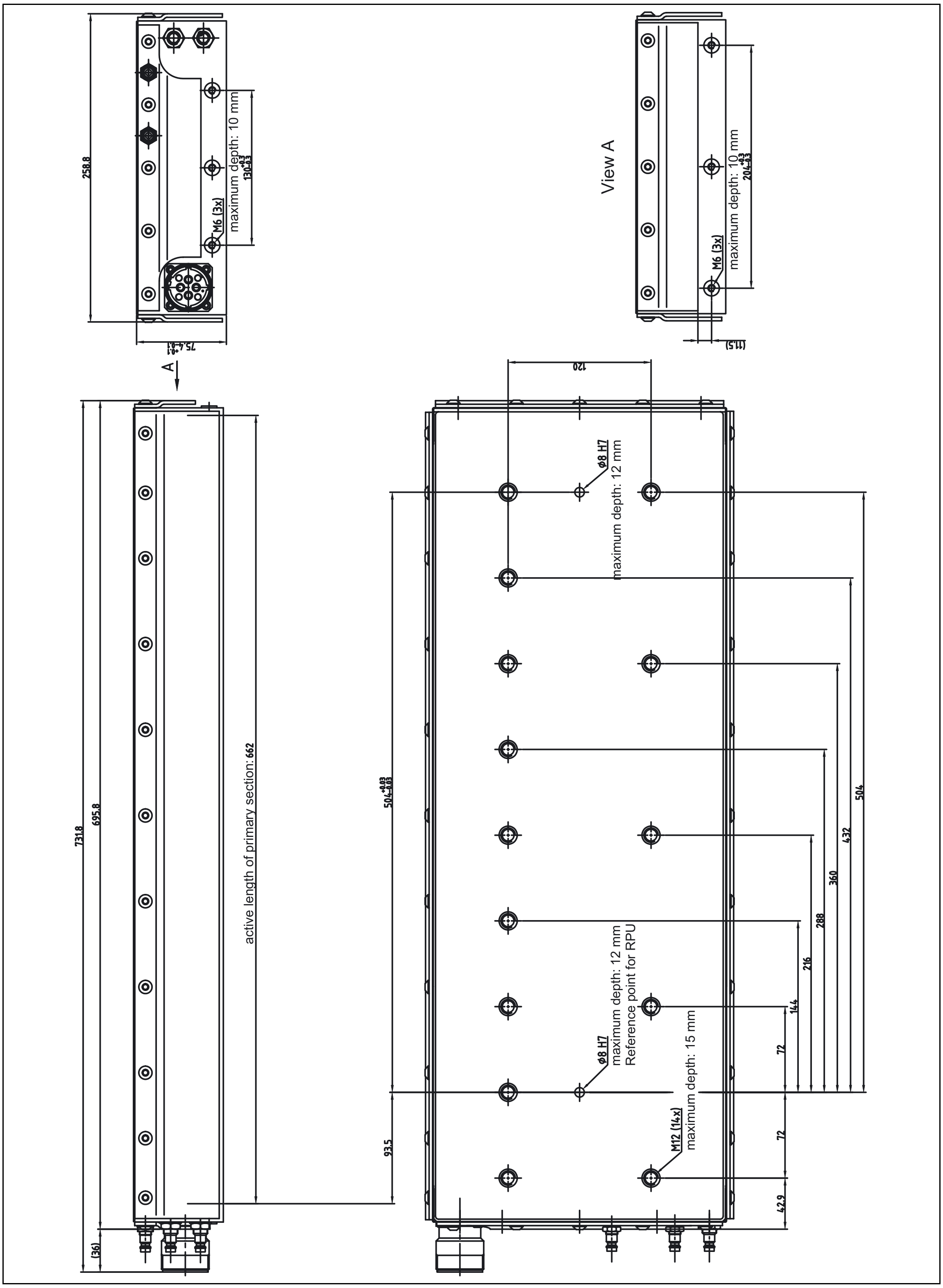


Figure 12-14 1FN1186-3AF7x-0AA0 primary section (plug connection)

12.3.3 1FN1180 secondary sections

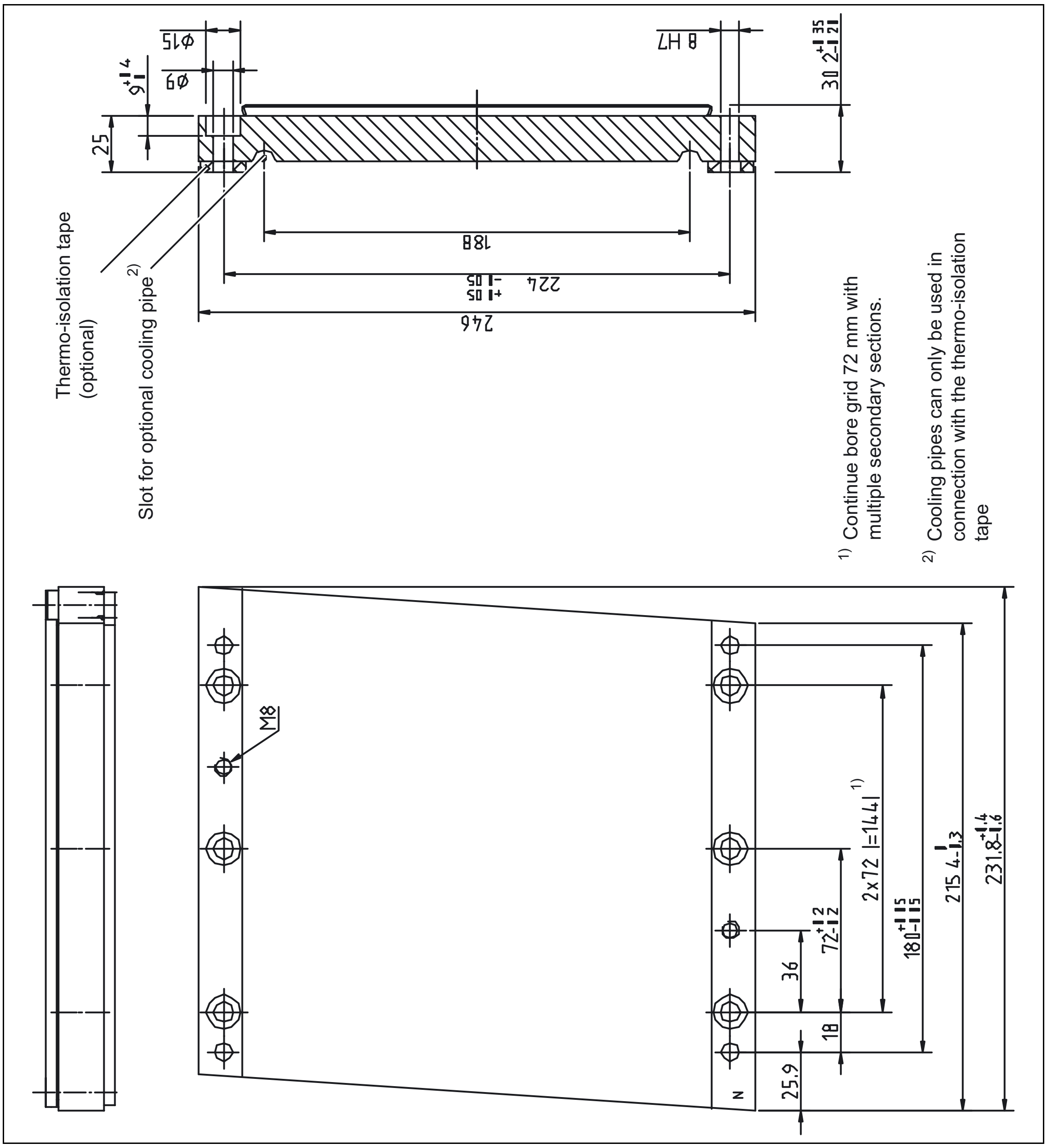


Figure 12-15 1FN1180-0AA00-0AA0 secondary section (short)

1FN1

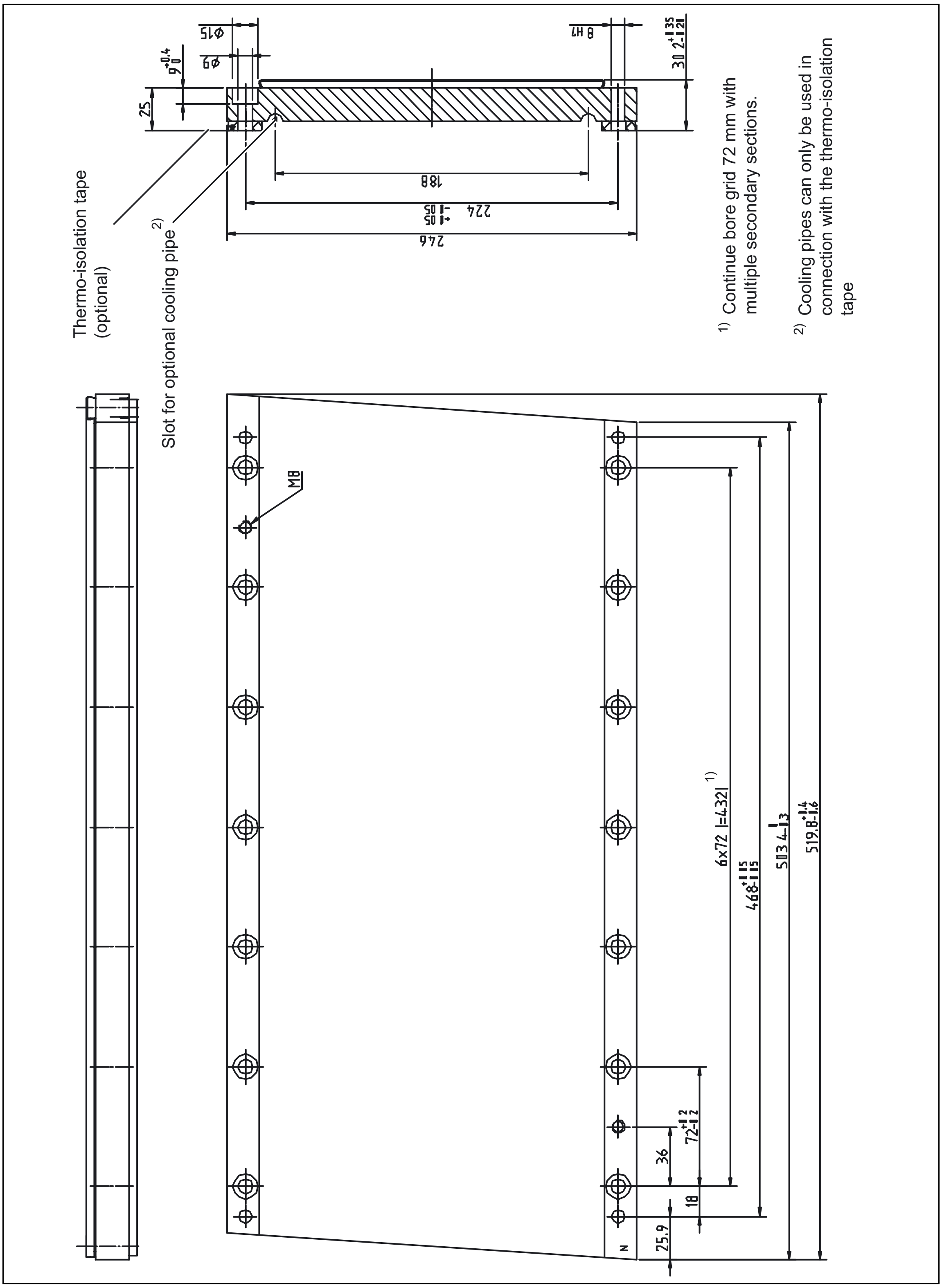


Figure 12-16 1FN1180-0AA00-1AA0 secondary section (long)

1FN1

12.4 1FN124x

12.4.1 1FN1244 primary section

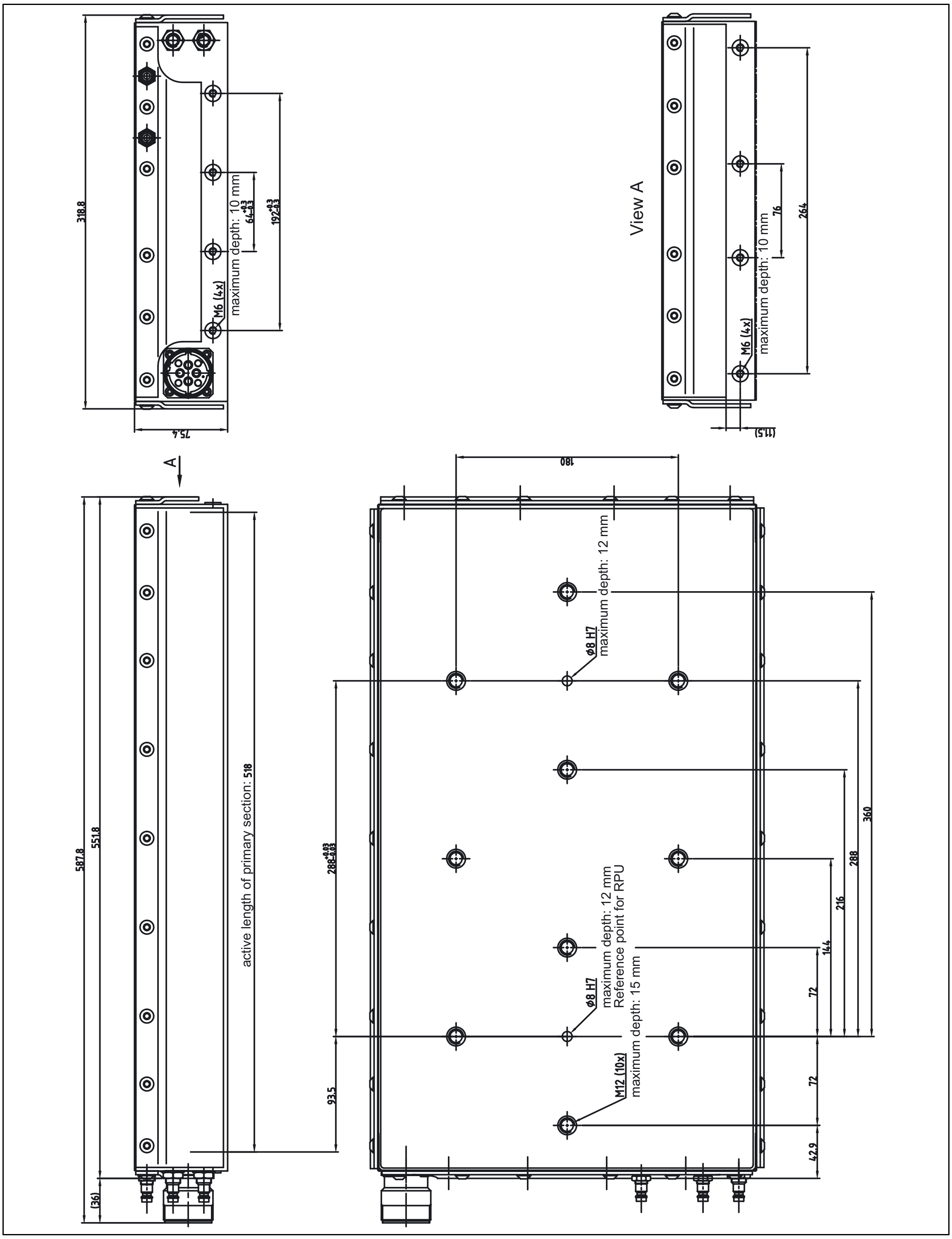


Figure 12-17 1FN1244-3AF7x-0AA0 primary section (plug connection)

12.4.2 1FN1246 primary section

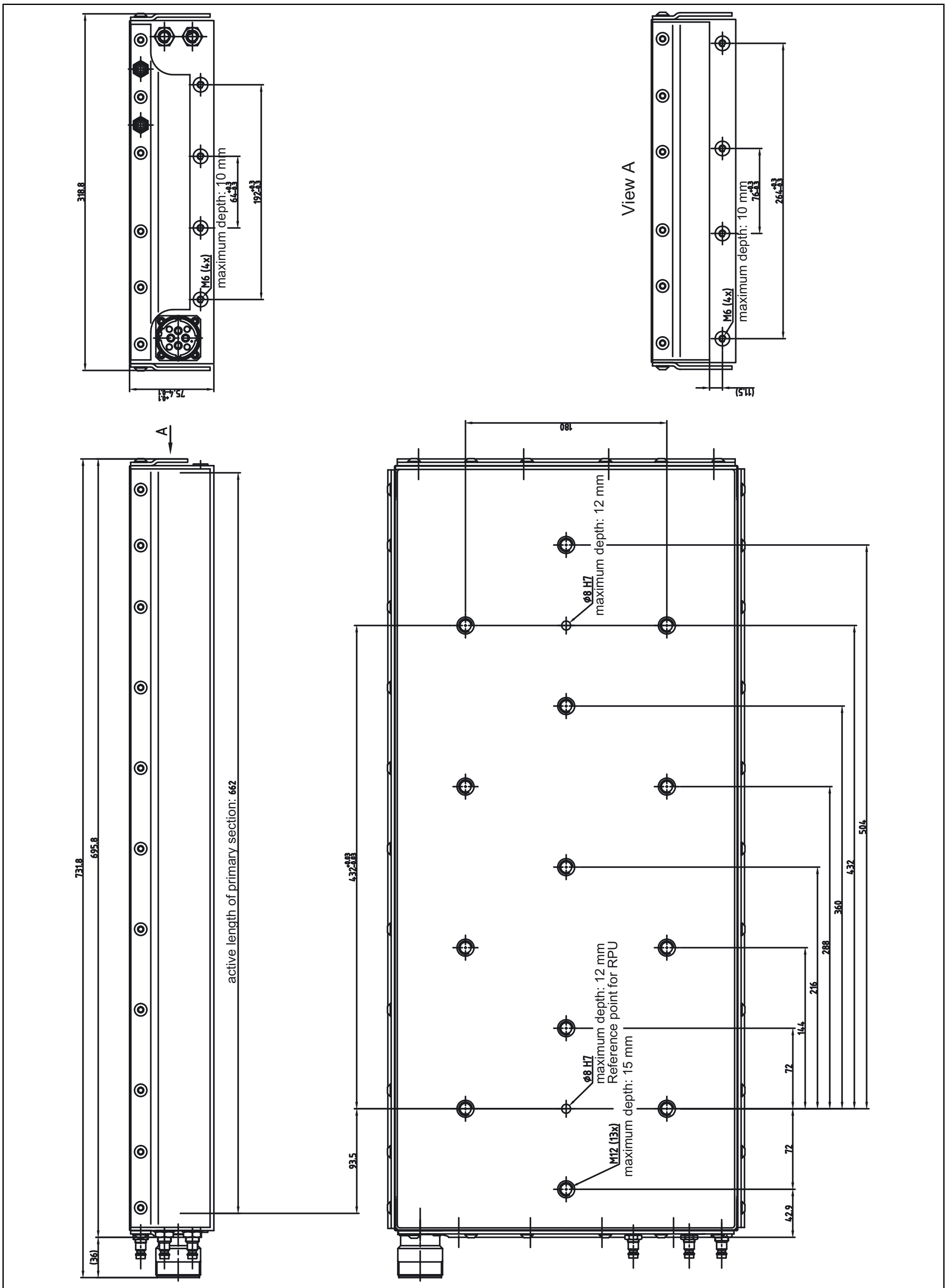


Figure 12-18 1FN1244-3AF7x-0AA0 primary section (plug connection)

12.4.3 1FN1240 secondary sections

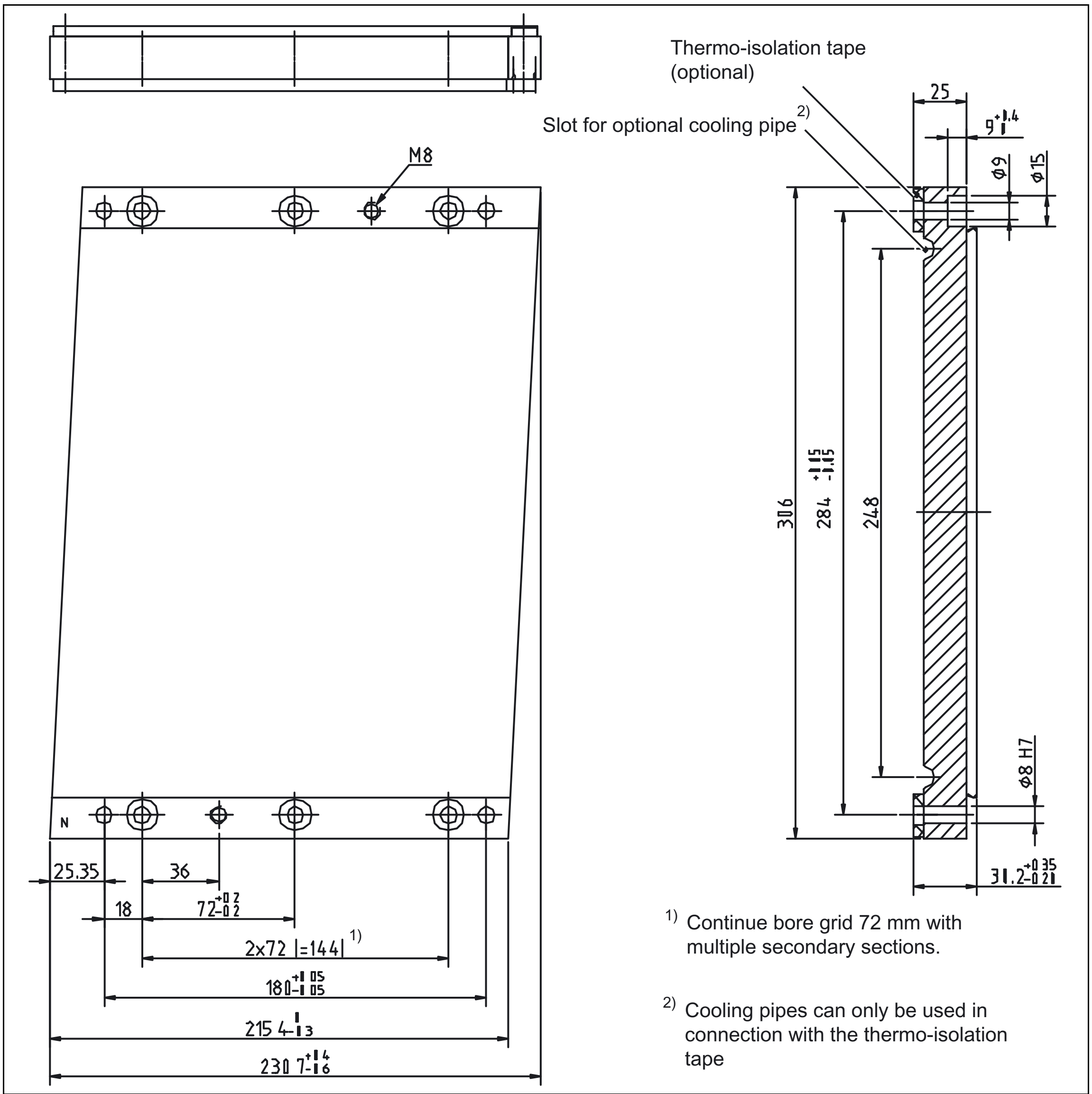


Figure 12-19 1FN1240-0AA00-0AA0 secondary section (short)

1FN1

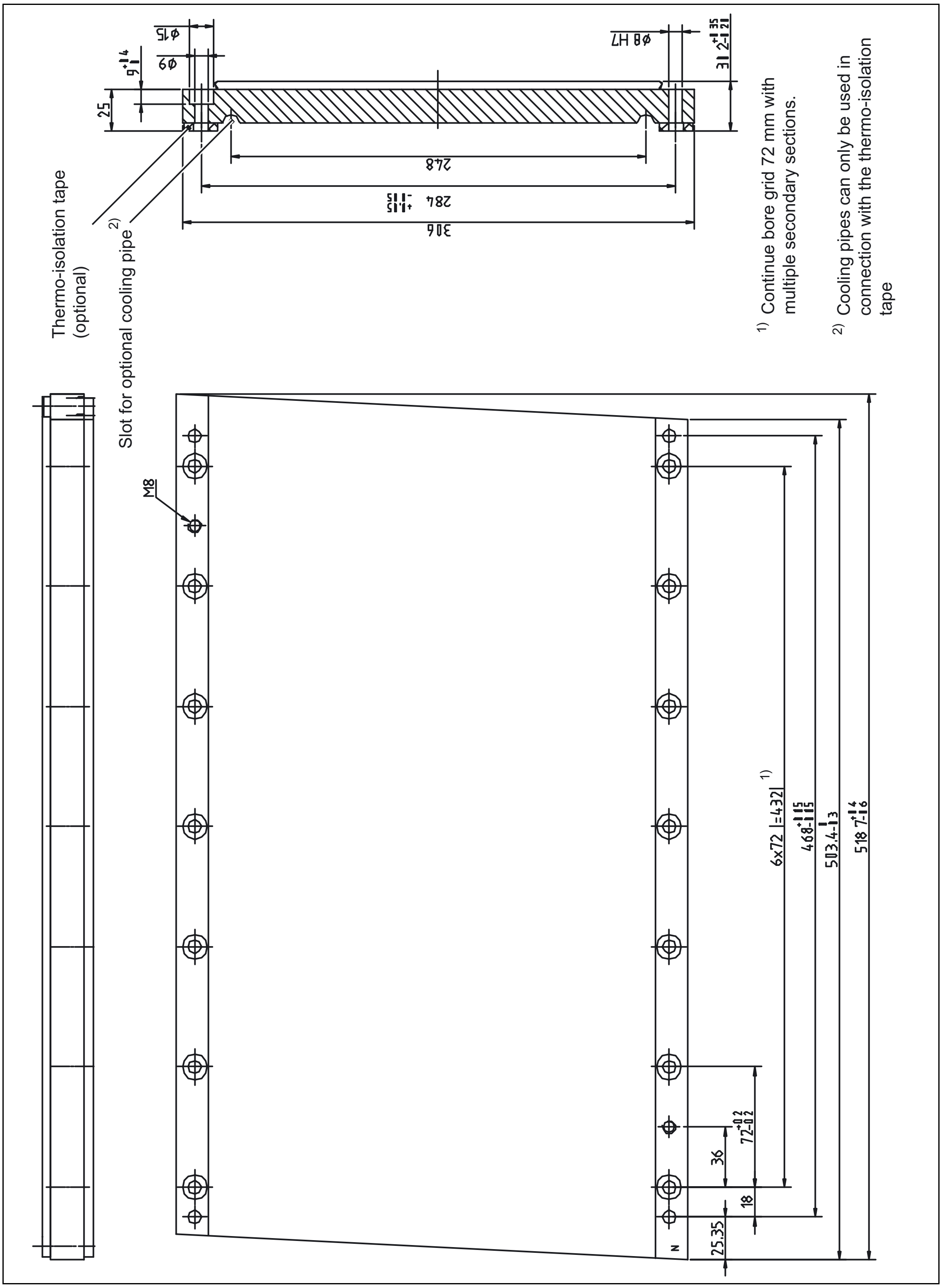


Figure 12-20 1FN1240-0AA00-1AA0 secondary section (long)

1FN1

12.5 Hall sensor box

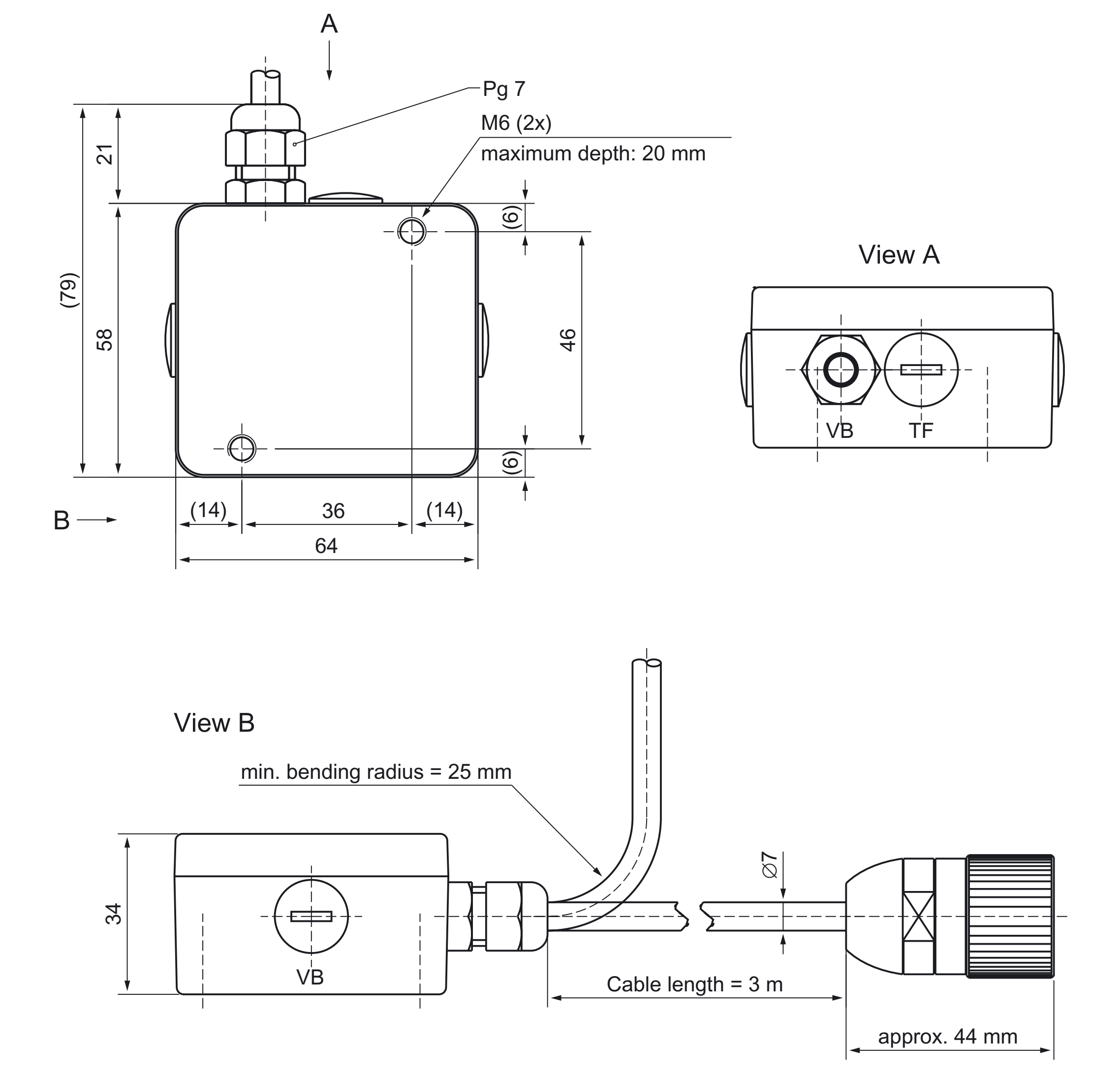
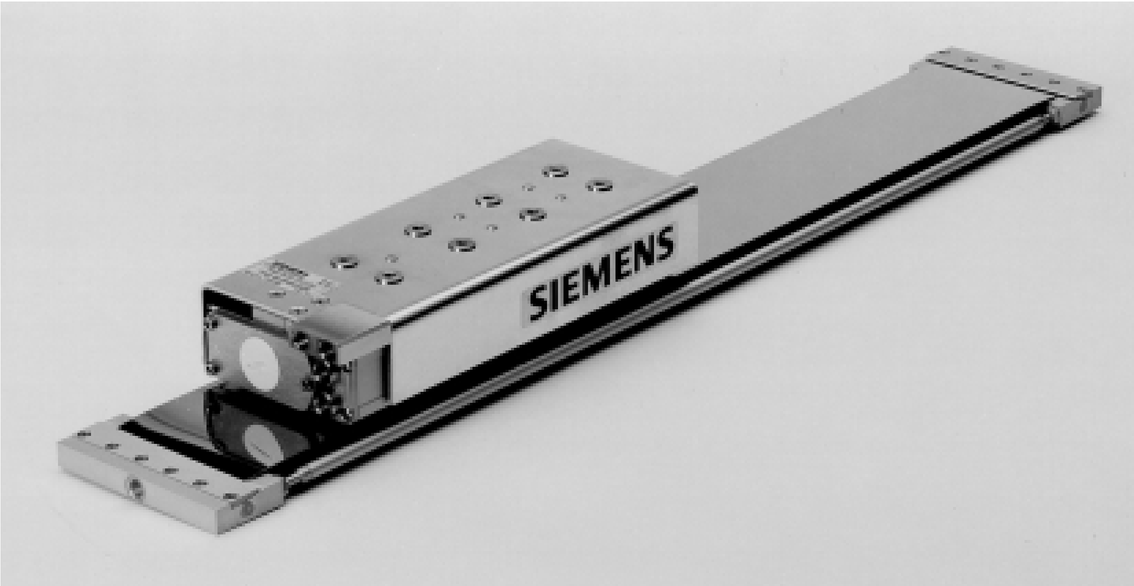


Figure 12-21 Hall sensor box 1FN1910-0ABx0-0AA0

■

1FN3-type peak-load motors



1FN3

Notes

Table of contents

13 1FN3-type peak-load motors

13.1 Features and technical data

Applications

1FN3-type peak-load motors are powerful, cost-effective, universal motors with a broad range of types. They excel in high overload capability and power density.

Combined with a digitally controlled converter system (e. g. SIMODRIVE 611) these motors are well-suited as direct drives for the following areas of application:

- High-dynamic and flexible machine tool construction
- Laser machining
- Handling

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1FN3-type motors show little susceptibility to harsh ambient conditions. In combination with a primary section precision cooler and secondary section cooling these motors are thermally neutral toward the surrounding machine.

These motors are also designed for double-sided motor layouts.

⚠ **Warning**

The motors are not designed to be connected directly to the line supply.

Properties

1FN3-type motors are permanent magnet-triggered, synchronous linear motors with a modular cooling concept: Dependent on the precision requirements, the motor can be operated with a primary section precision cooler and/or secondary cooling (optional). The motors would then be thermally neutral toward the machine.

The base motor is delivered in components (primary and secondary section) and installed directly into the machine. By connecting primary and secondary sections in parallel different motor thrusts and traversing distances can be reached.

Special features:

- Modular design: The motor can thus be configured to the customer's needs with regards to technology and investment costs
- Low mass and high overload capacity: The motor is thus ideally suited as drive for acceleration duty.
- Thermal neutralization of the motor from the machine with the implementation of a primary section precision cooler and secondary cooling based on the Sandwich® principle
- Easy cooling medium connection
- Full metal protection of the primary section and encased secondary sections for greater ruggedness

- The secondary section can be fully covered: This provides an even surface and prevents unwanted particle deposits, especially in the gaps between the secondary sections.
- Easy electrical connection via integrated terminal panel

Motor components

As specified in Figure 13-1 1FN3-type motors consist of the following components:

- Primary section:
  - Base component of the linear motor
  - in most cases the movable part
  - with 3-phase winding
  - integrated main cooler to remove the thermal loss
- Precision cooler (optional):
  - Additional cooler for cooling the primary section
  - Cools the primary section in connection with the primary section main cooler based on the Thermo-Sandwich® principle
  - Recommended for applications with high precision requirements
- Secondary sections:
  - Connected in parallel these form the reacting part of the motor
  - Consist of a steel base with attached permanent magnets
  - The encasing provides greater corrosion and external impact protection
- Secondary section cover (optional)
  - Protects secondary sections
  - Semi-magnetic stainless steel plate (thickness d = 0.4 mm)
  - Adheres to secondary sections
  - Can be removed without tools if worn
  - Available as continuous band material or in cut lengths, see Mounting the secondary section cooling component page 13-192
- Cooling sections with plug-type coupling/nipple (optional):
  - Secondary section cooling component
  - Aluminum section tracks with continuous cooling channels
  - are placed under the secondary sections when high machine precision is required
- Secondary section end pieces
  - Secondary cooling component
  - Available in different variants, see Thermo-insulation of the primary section / primary section precision cooler page 13-184

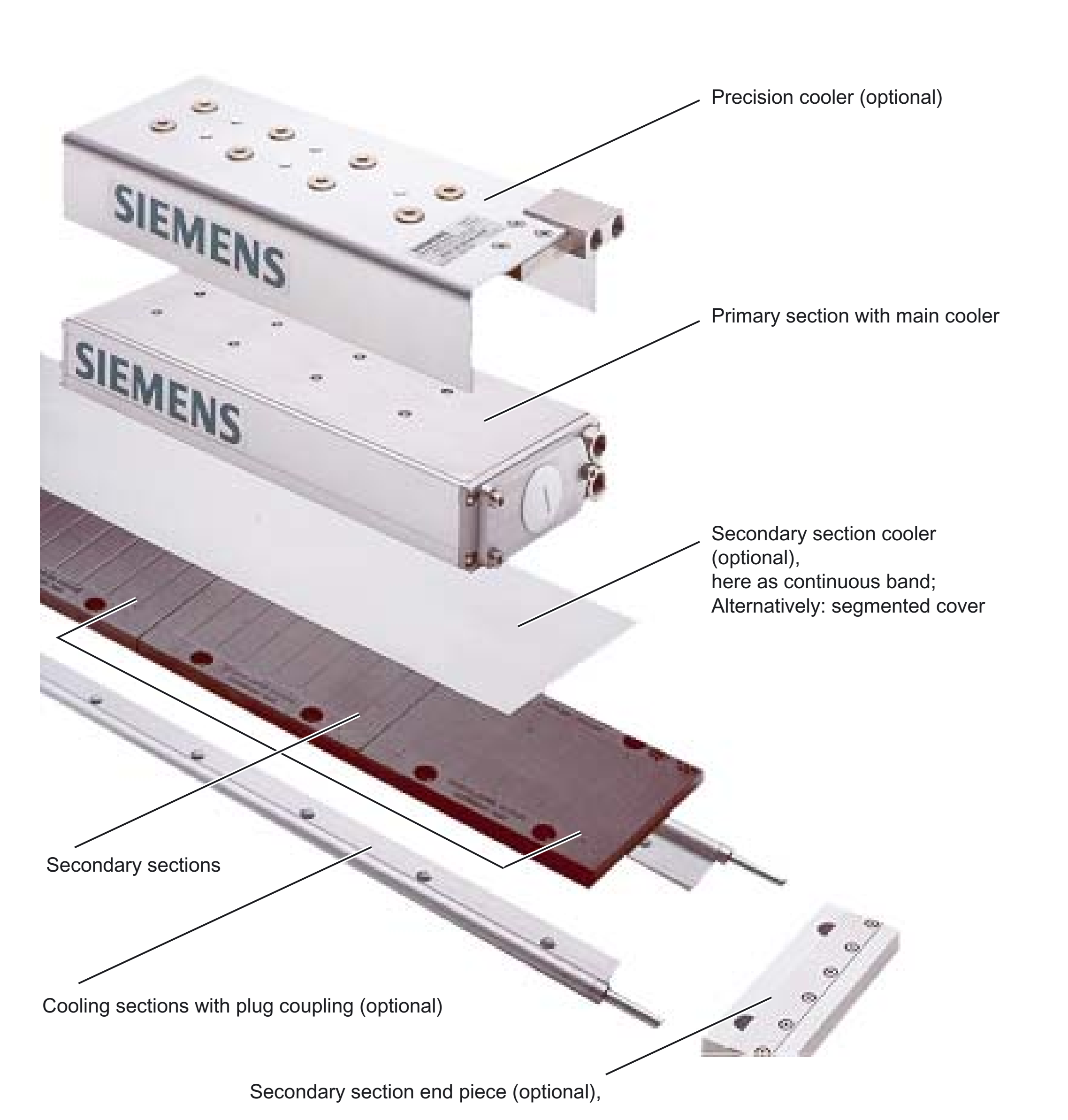

Figure 13-1 Components of a 1FN3-type linear motor

Note

Standard components and optional components must be listed individually on the order form.

Standards and regulations

The appropriate standards and regulations are directly assigned to the functional requirements.

Certifications

The rating plate lists the motor certifications, see chapter 13.2.

As long as not stated otherwise, these certifications apply to the operating condition specified in the data sheets in chapter 15.2. In order for a certification to apply the following must be carefully observed when operating the motors:

- The limiting data specified in the respective data sheets must not be exceeded.
- The motor's cooling system must be operated with water. For information refer to section 4.4.
- The intake temperature T_{VORL} must not be exceeded.

Underwriters Laboratories Inc. (UL)

The 1FN3-type peak-load motors are certified by Underwriters Laboratories Inc. (USA) – UL in short – for the following conditions:

- Rated current I_N < 67 A

Canadian Standards Association (CSA)

1FN3-type peak-load motors certified by the Canadian Standards Association (Canada) – CSA in short – are available upon request. These motors are delivered with a mounted, assembled, open-end cable. The terminal panel cover is sealed.

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In addition to the above-mentioned conditions the following must be carefully observed when operating the motors in order for the certification to be valid:

- The power cable temperature must not exceed 80° C.
- The terminal panel cover seal must not be damaged.

Technical features

Table 13-1 Standard model 1FN3-type peak-load motors: Technical features

Technical feature	Version
Machine type	permanent magnet-triggered synchronous linear motor
Type of construction	Individual components (IM 5110 acc. to IEC 60034-7)
Mounting dimension	Tolerance ± 0.3 mm
Rated air gap	1.3 mm
Cooling	Liquid cooling, see chapter 4.4. • maximum pressure in the cooling circuit: 10 bar = 1 MPa • Connection: with G1/8 pipe thread (in compliance with DIN EN ISO 228-1); special connectors are required to connect hoses/pipes
Thermal motor protection	PTC resistor/temperature sensor in triple circuit (in compliance with DIN 44081/DIN 44082) and KTY84 resistor/temperature sensor (according to IEC 60034-11) in the primary section
Rating plate	for each motor a second rating plate is enclosed, see chapter 13.2
Winding insulation	Class of insulation F (according to DIN EN 60034-1)

Technical feature	Version
Permanent magnets	• Material: Rare earth compounds • Aging: Loss due to aging for the operating temperatures and magnetic operating points is under 1%. To prevent long-term losses (10 to 100 years) a magnetizing reserve of 1-2% is available.
Electrical connection	Motor integrated terminal panel with cover and interior PG thread; the adapter cable is connected directly via angled cable lugs, see chapter 13.3.2
Contact, foreign object and water protection	• Primary section: IP 65 (according to DIN EN 60529) • Secondary section: as electrical component IP 65 would apply for the secondary sections • Assembled Motor: the protection class depends on the machine type and must be specified by the machine manufacturer; minimum requirement: IP 23

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Options, supplements

Table 13-2 Special design motors: additional optional technical features

Technical feature	Type
Electrical connection	Power plug or screwed PG cable gland (90° angle); the latter must be installed by the customer
Winding	Inverse winding for double-sided motors, see chapter 13.5.2

13.2 Rating plate specifications

Each primary section of a 1FN3-type peak-load motor has a rating plate attached according to Figure 13-2

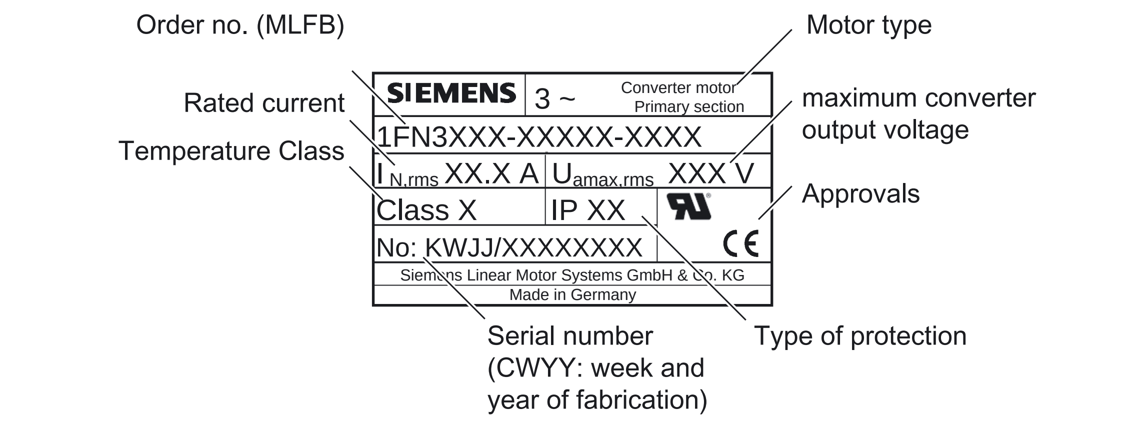

Figure 13-2 Rating plate specifications (diagram)

In addition, a second rating plate is supplied which can be attached to the machine in which the motor is installed. This rating plate must not be tampered with! A rating plate that was removed is to be considered unusable.

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13.3 Electricity and cooling interfaces

13.3.1 Position of terminals

The electricity and cooling connectors are combined and located on one side of the primary section in order to provide easy access for installation and service.

Figure 13-3 shows an example of the connector layout. The dimensions are the same for all 1FN3-type motors. The values for the peak-load motors are specified in Table 13-3.

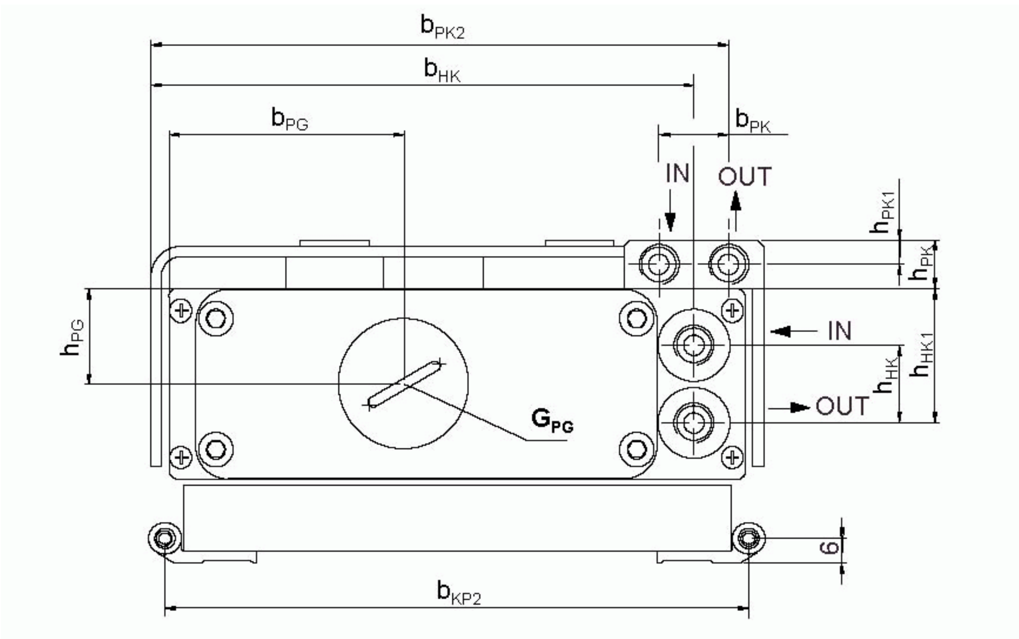


Figure 13-3 Layout of the 1FN3 connectors (face top view)

Table 13-3 Connector layout dimensions, see Figure 13-3

Motor type	b_{HK} [mm]	h_{HK} [mm]	h_{HK1} [mm]	b_{PK} [mm]	b_{PK2} [mm]	h_{PK} [mm]	h_{PK1} [mm]	b_{PG} [mm]	h_{PG} [mm]	G_{PG} [mm]	b_{KP2} [mm]
1FN3050	55	17	26.4	17	68	11.9	6	26.5	17.9	PG16	67
1FN3100	84	17	26.4	17	97	11.9	6	42	17.9	PG16	97
1FN3150	114	17	26.4	17	127	11.9	6	42	17.9	PG16	127
1FN3300	128.5	19	32.9 / 32.8*	17	141.5	11.9	6	53.5	23.4 / 23.3*	PG21/29*	143
1FN3450	176	19	32.9 / 32.8*	17	141.5	11.9	6	53.5	23.4 / 23.3*	PG21/29*	189
1FN3600	236	19	32.9 / 32.8*	17	248.5	11.9	6	53.5	23.4 / 23.3*	PG21/29*	222
1FN3900	330	19	32.9 / 32.8*	17	343	11.9	6	53.5	23.4 / 23.3*	PG21/29*	316

* Values for the 1FN3300-3WG00, 1FN3450-3WE00, 1FN3450-4WE00, 1FN3900-4WB50, 1FN3900-4WC00 motor models

13.3.2 Electrical connection

Internal circuit of the primary section

Figure 13-4 shows the internal circuit of the primary section.

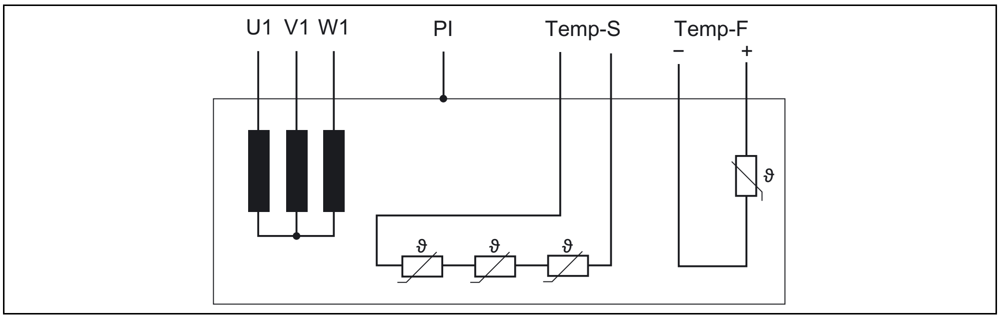


Figure 13-4 Internal circuit of the primary section

1FN3

Connecting the power supply line

The supply line with 4 power conductors (3 phase and PE) and 2x2 conductors for the temperature sensors is connected directly to the terminal panel by using cables with angled cable lugs, see Figure 13-5.

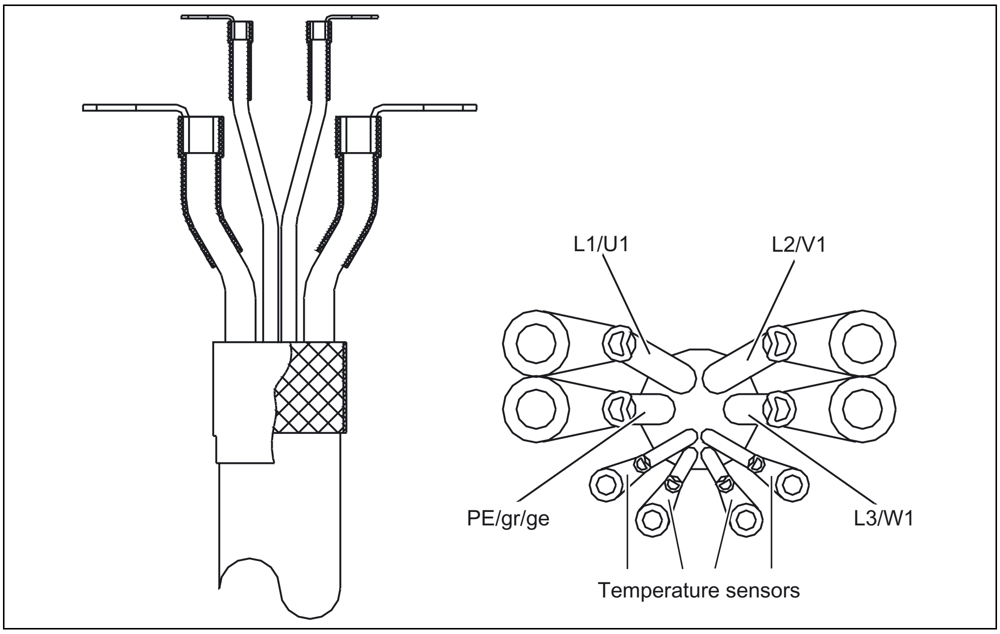


Figure 13-5 Connecting the supply line with angled cable lugs

The cables must be connected to the motor with EMC-safe, metal PG screwed cable glands. This ensures cable connections with low bending radii in all directions.

For straight PG screwed cable glands assembled adapter cables have been available since March 2005. These cables allow for a quick connection to the motor with adjusted ring cable lugs and PG screwed cable glands with an integrated EMC-compliant shield. Order numbers for these items are listed in the online catalog A&D Mall under "Motor power cables".

90° angle PG screwed cable glands must be provided and installed by the customer. Metric threaded joint connections are possible with the use of corresponding adapters.

Terminal panel

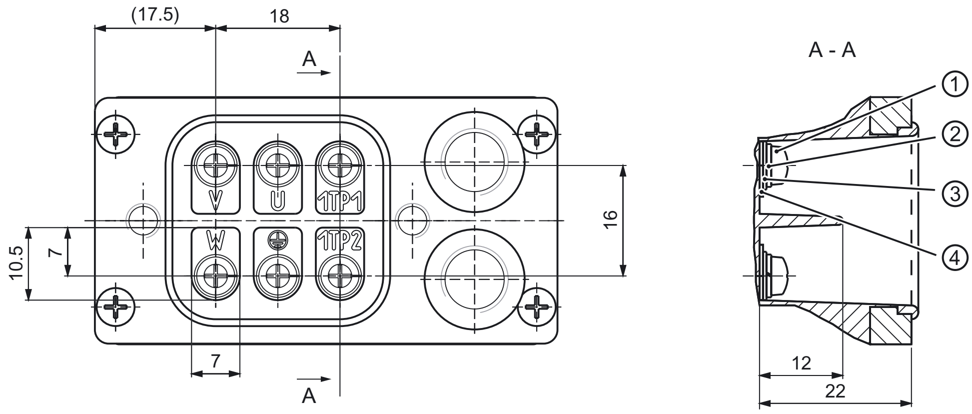
Note

The terminal panel is not easily accessible with a preinstalled primary section. It is therefore recommended to premount the primary section with an open end cable and to run this cable to an easier accessible terminal.

Figure 13-6 to Figure 13-8 show the terminal assignment and geometry of the terminal panel for the different motor types.

Note

With the EN 60034-8:2002 norm the terminal markings have changed. For the old terminal markings, see appendix C.

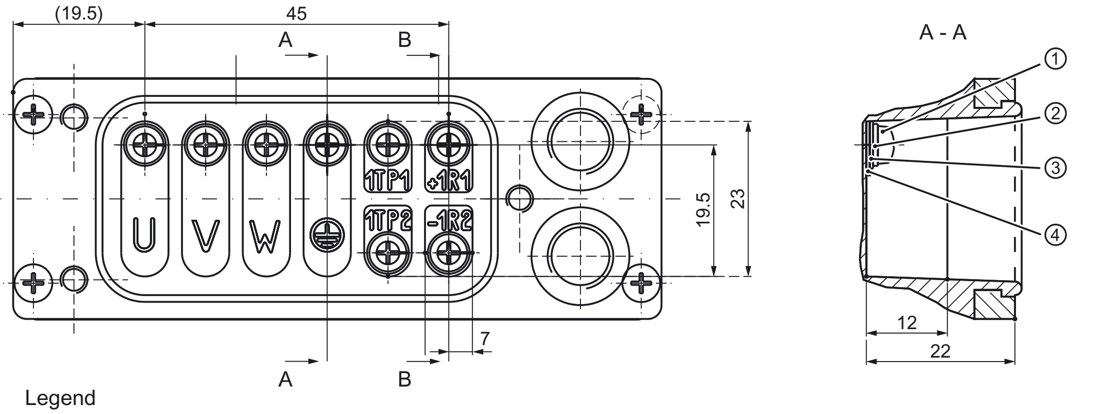


Legend

U	Phase U
V	Phase V
W	Phase W
⏚	Grounding
1TP1	Temp-S (PTC)
1TP2	Temp-S (PTC)

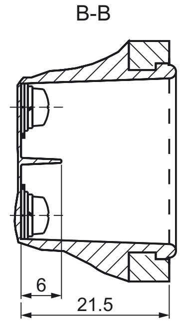
①	Phillips head tallow-drop screw, ISO 7985 - M3 x 10 - A2; Tightening torque 0.6 Nm...0.8 Nm
②	Spring washer DIN 128 - A3.1 - Fst
③	Washer DIN 125 - A3.2 - A2
④	e.g. crimp-type socket DIN 46234, not included with the primary section

Figure 13-6 Terminal assignment and geometry of the terminal panel for 1FN3050 models



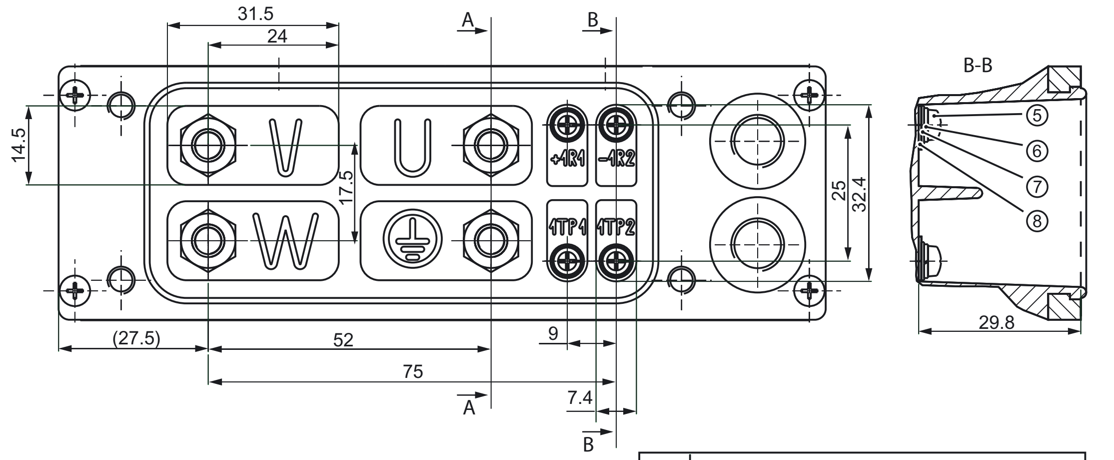
Legend

U	Phase U
V	Phase V
W	Phase W
⏚	Grounding
1TP1	Temp-S (PTC)
1TP2	Temp-S (PTC)
+1R1	Temp-F (KTY 84) ⊕
-1R2	Temp-F (KTY 84) ⊖



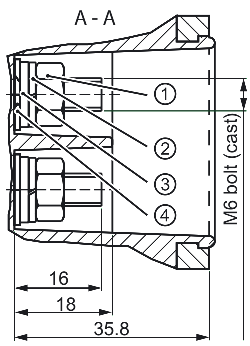
①	Phillips head tallow-drop screw ISO 7985-M3x10-A2; Tightening torque: 0.6 Nm ... 0.8 Nm
②	Spring washer DIN 128-A 3.1-Fst
③	Washer DIN 125-A 3.2-A2
④	e. g. crimp-type socket DIN 46234; not included with the primary section!

Figure 13-7 Terminal assignment and geometry of the terminal panel for 1FN3100 and 1FN3150 models



Legend

U	Phase U
V	Phase V
W	Phase W
⏚	Grounding
1TP1	Temp-S (PTC)
1TP2	Temp-S (PTC)
+1R1	Temp-F (KTY 84) ⊕
-1R2	Temp-F (KTY 84) ⊖



①	Nut ISO 4032-M6-A2; Tightening torque: 3.6 Nm ... 3.7 Nm
②	Spring washer DIN 128-A 6.1-Fst
③	Washer DIN 125-A 6.4-A2
④	e. g. crimp-type socket DIN 46234; not included with the primary section!
⑤	Phillips head tallow-drop screw ISO 7985-M3x10-A2; Tightening torque: 0.6 Nm ... 0.8 Nm
⑥	Spring washer DIN 128-A 3.1-Fst
⑦	Washer DIN 125-A 3.2-A2
⑧	e. g. crimp-type socket DIN 46234; not included with the primary section!

Figure 13-8 Terminal assignment and geometry of the terminal panel for 1FN3300…900 models

1FN3

1FN3

Screwing on the terminal panel cover

The terminal panel is sealed with a PG threaded cover in compliance with protection class IP 65. Figure 13-9 shows how the terminal panel cover is mounted. The supplied or pre-mounted screws and torques to be used are specified in Table 13-4.

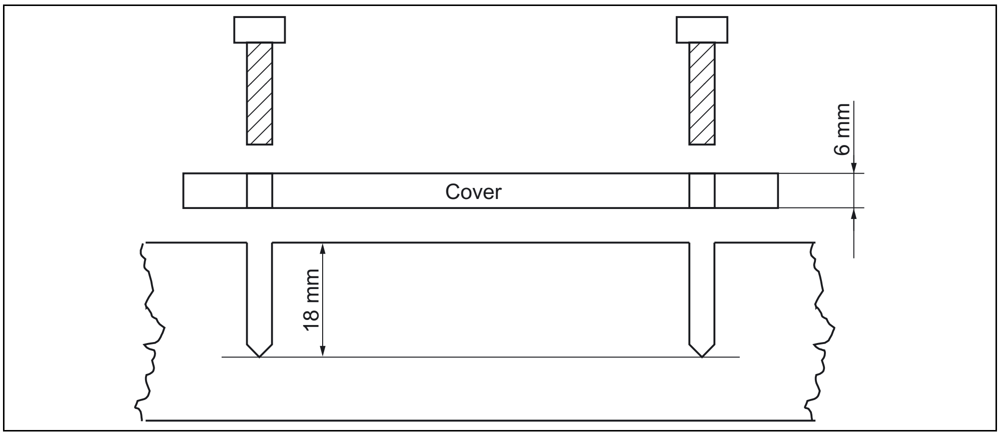


Figure 13-9 Mounting the terminal panel cover

Table 13-4 Screws and torque for the terminal panel cover

Motor type 1FN3...	Screw compliant with DIN EN ISO 4762	Tightening torque
050, 100, 150	M4–20–A2	2.2 Nm
300, 450, 600, 900	M5–20–A4	3.4 Nm

Connecting the temperature monitoring circuits

For further instructions on connecting the temperature monitoring circuits, see chapter 18.1.

13.3.3 Connecting the cooling unit

Primary section main cooler and primary section precision cooler

All cooling connectors for the primary section main cooler and primary section precision cooler are supplied with a G1/8 pipe thread according to DIN 2999. For the hose connections corresponding connectors are required.

Recommended manufacturers

Manufacturers of connectors for cooling 1FN3-type motors are listed in Appendix B.

Caution!

Use only new, unused connectors!

The connector and gasket materials must be checked for tolerability with each other and with the cooling medium used!

Properties of the sealing materials used:

- Viton: temperature- and glycol-proof
- Buna N: resistant to a water temperature of 80° C
- Ethylene-propylene: temperature- and glycol-proof

The connector installation can generally be performed with standard tools.

Notice

The primary section cooling connectors are permanent connections that cannot be removed!

If a connection structure of the primary section protrudes beyond the primary section, a chase above the cooling connections must be provided for this connection, for example see Figure 13-10.

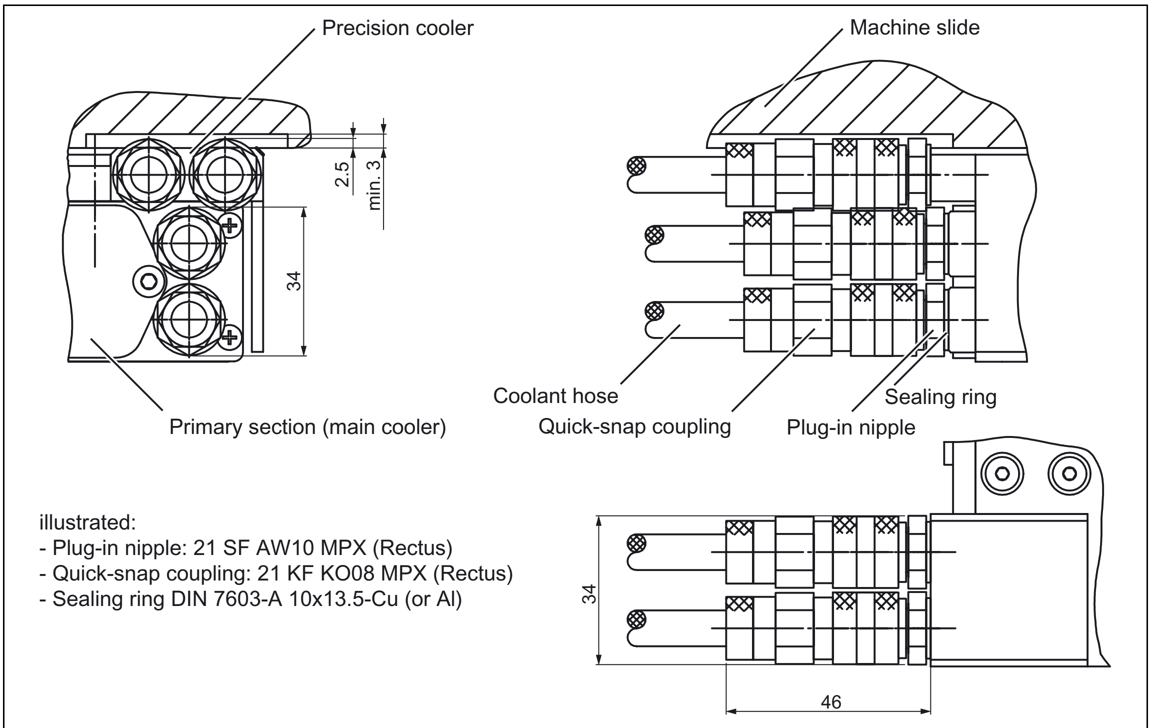


Figure 13-10 Example of a cooling connection with a chase on the machine slide

Secondary section cooling

Connecting the cooling medium hoses

For 1FN3-type motors the intake and runback of the secondary section cooling can be routed via the secondary section end pieces, see chapter 13.4.2. Another option - if the continuous secondary section cover band is not used – would be to connect the plastic hoses directly to the cooling sections using hose connector nipples.

The plastic hoses must be cooling medium resistant, flexible, and abrasion resistant.

Recommended manufacturers

Recommended plastic hose manufacturers are listed in Appendix B.

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Connection via secondary section end pieces

To connect plastic hoses to secondary section end pieces screwed connectors with screwed nipples and reinforcing sleeves can be used. However, the plastic hoses can also be attached with hose clamps over the hose connector nipples.

For this connection be sure to note the maximum outer diameter (12 mm) and the maximum square span (SW10) of the screwed joint or the screwed nipple: If larger screw joints or screwed nipples are used, the connection point of the secondary section must be fitted with corresponding chases.

Screwed nipples can be sealed to the end piece by using an axial-acting O-ring, a sealing ring or a thread sealer. It is recommended to use conical nipples.

Recommended manufacturers

Recommended manufacturers of screwed connections with nipples and reinforcing sleeves are listed in Appendix B.

Direct connection

To connect plastic hoses directly cold water units with hose connector nipples can be ordered at SIEMENS. The inner diameter of the hose should be 5 mm (e. g. SMC TU … 0805). Hose and hose connector nipple are connected with a hose clamp.

Connector layout for the secondary section end pieces

To connect the secondary section cooling unit G 1/8 threaded connectors are used. These are located on the faces of the secondary section end pieces.

For models with combi distributor the intake is located on the secondary section track side and the runback on the opposite side, see also Figure 13-11.

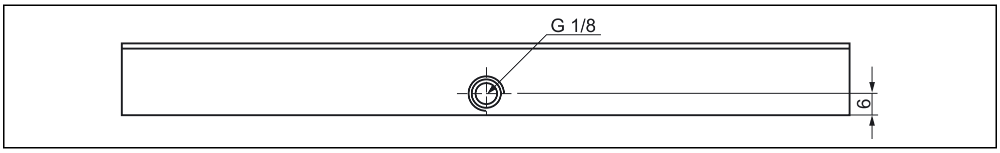

Figure 13-11 Connector layout of the secondary section cooling with combi distributor (face view)

For models with combi adapter/combi end piece the cooling medium intake and runback are located on the combi adapter, see Figure 13-12.

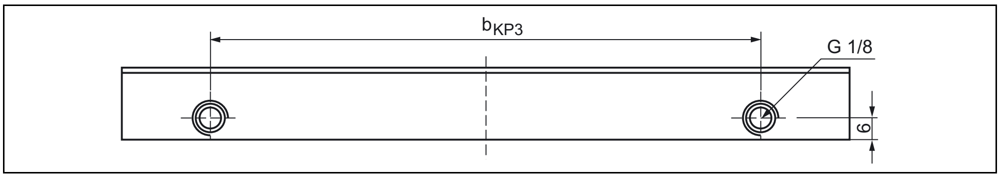

Figure 13-12 Connector layout of the secondary section cooling with combi adapter (face view)

Table 13-5 Connector dimensions of the secondary section cooling with combi adapter (available only for 1FN3050…450)

Motor type	1FN3050	1FN3100	1FN3150	1FN3300	1FN3450
b_{KP3} [mm]	40	40	100	50	100

13.3.4 Mounting space for the connection system

Depending on the connection system and the cables and hoses used sufficient mounting space must be provided lengthwise of the primary section.

13.4 Protecting the motor from overheating

13.4.1 Temperature monitoring

Since the 4th quarter of 2000 1FN3-type peak-load motors have been supplied with the two temperature monitoring circuits Temp-F and Temp-S (order no. 1FN3xxx-…-0AA**1**).. Exception: 1FN3050 models are supplied with the Temp-S temperature monitoring circuit only (order no. 1FN3050-…-0AA**0**).

Temp-F

The temperature monitoring circuit consists of a KTY 84 temperature sensor which is located between two phase windings. Under certain circumstances, especially in case of unequal current loads on the individual phases, the maximum temperature of the three phase windings may not be measured. An evaluation of Temp-F for motor protection purposes is thus not permitted. Temp-F is rather intended for temperature monitoring and signaling a drive shut off triggered by Temp-S.

Temp-S

One PTC element per motor phase winding is implemented.

Response temperature:

- steep resistance rise at 120 ± 5° C

Response time

The response time of the drive system from the steep resistance rise of the PTC elements to the power shut off (impulse lock of the converter) must not exceed one second.

Notice

At the time of commissioning the proper function of Temp-S must be checked before the first test run.

13.4.2 Cooling

How the cooling works has already been described in chapter 4.4. Figure 13-13 illustrates details of the thermal encapsulation of 1FN3-type motors.

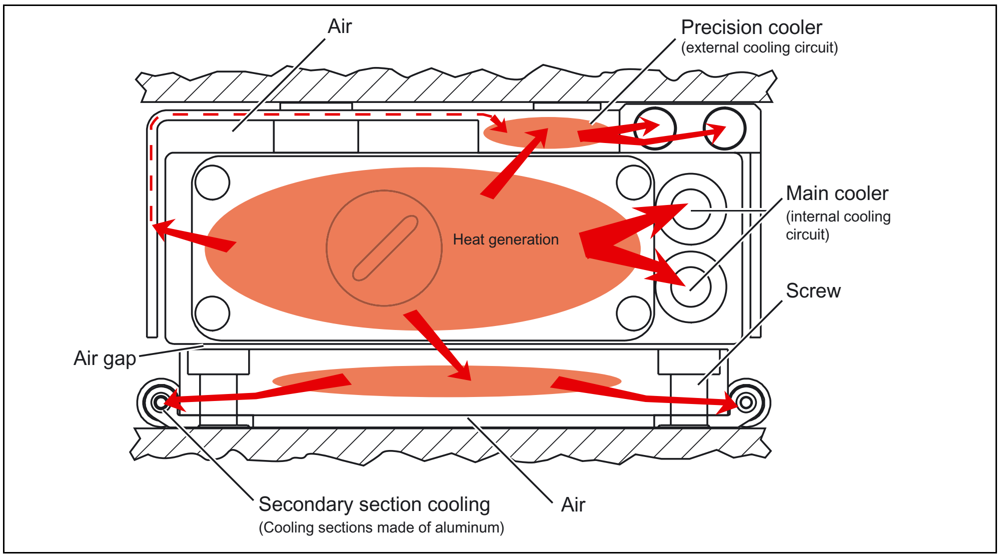

Figure 13-13 Thermal encapsulation of 1FN3-type motors

Primary section main cooler

By default a water cooling system is used with an intake temperature T_{VORL} = 35 °C. If this temperature value is changed the permanent thrust of the motor changes with regards to the table value F_N according to the characteristics specified in chapter 15.3.1.

Thermo-insulation of the primary section / primary section precision cooler

On the bottom side the primary section is insulated by the air gap. On the top the (optional) primary section precision cooler shields the surrounding area from the high motor temperatures. Thermo-insulators on the screwed connections and the air chamber located in between reduce the heat transfer from the primary section. The lateral radiation panels of the primary section precision cooler also form air filled spaces and insulate the primary section laterally from the machine.

The general function of the primary section precision cooler is described in chapter 4.4.

Thermo-insulation of the secondary section / secondary section cooling

The secondary section is cooled by a cooling circuit which, by default, consists of cooling sections and two combi distributors as secondary section end pieces. For applications with high thermal loss input the secondary sections must be cooled. Otherwise cooling of the secondary section is optional.

Caution!

High temperatures can result in demagnetization of the permanent magnets!

The secondary sections must not exceed a temperature of 70° C!

1FN3

For 1FN3600 and 1FN3900 models secondary section cooling is imperative for the proper function of the motors since, due to the geometry, the heat transferred into the secondary sections could otherwise not be removed.

Cooling sections

The cooling sections are positioned between the machine bed and the secondary section and screwed onto the machine bed together with the secondary sections. Figure 13-14 and Figure 13-15 illustrate how this arrangement effects the cooling without using secondary section end pieces.

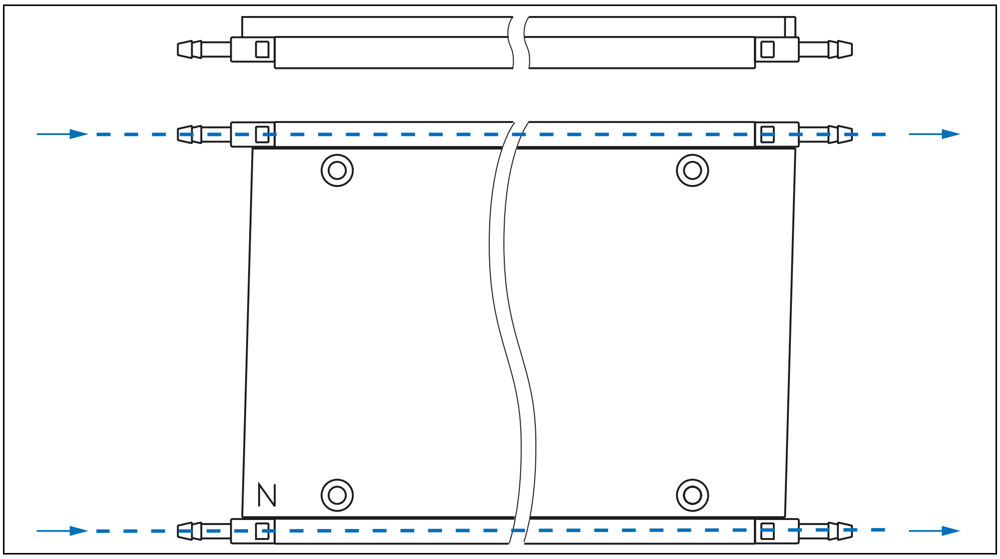

Figure 13-14 Secondary section cooling consisting of cooling sections with hose connector nipples for 1FN050…450 motor models (side and top view)

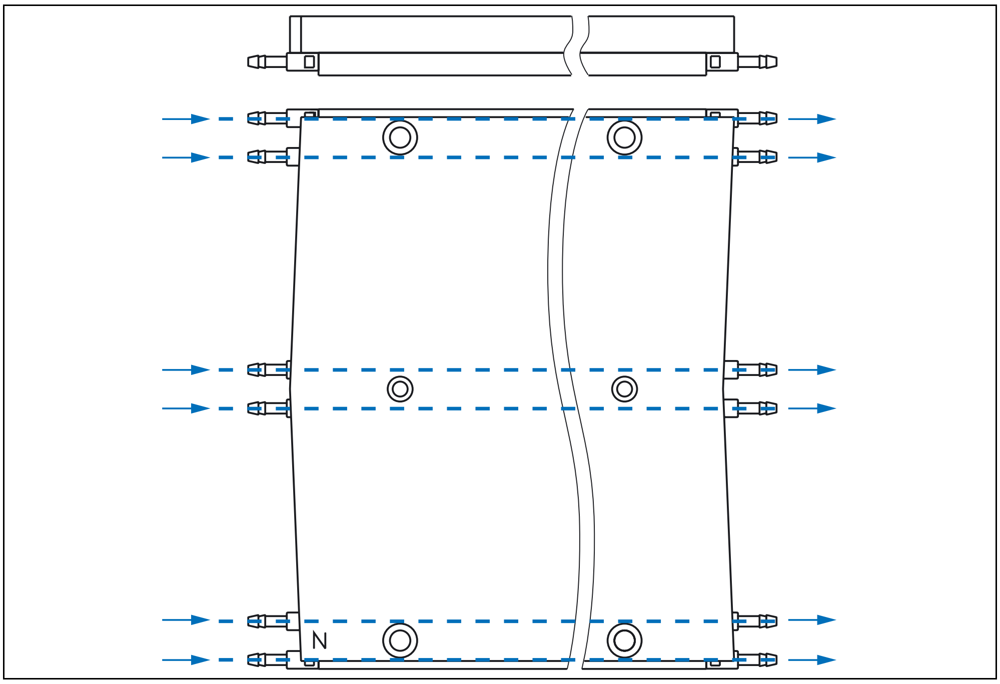

Figure 13-15 Secondary section cooling consisting of cooling sections with hose connector nipples for 1FN600…900 motor models (side and top view)

Starting with model 600 three cooling sections with a total of six cooling channels are used. The lateral profiles protrude just a little beyond the secondary section. The middle (additional) cooling section is attached by the line of screws in the center of the secondary sections.

1FN3

The surfaces of the cooling sections are thermally optimized. The heat is transferred to the contact area of the secondary section track and from there to the cooling channel. Toward the machine structure, however, the contact area is small, so that the heat transfer is kept at a minimum.

The cooling sections are available in lengths of up to 3 m, longer pieces may be available upon request from your local SIEMENS dealer.

Secondary section end pieces

The secondary section end pieces at the front and end of the secondary section track close the cooling circuit and facilitate uniform cooling medium connectors. In addition, the secondary section end pieces also serve as fixing devices for the full secondary section cover by means of a wedge which closes the cover flush with the surface, see Figure 13-16.

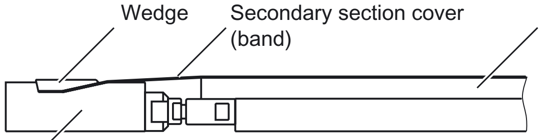

Figure 13-16 Secondary section end piece (side view)

By default *combi distributors* are used as secondary section end pieces. These are available for all models. For 1FN3050…450 models *combi adapter/combi end pieces* or *cover band end pieces* may be used as well.

In summary the following secondary section end piece variants are available:

- Combi distributor:
  - Standard solution with the use of secondary section end pieces
  - available for all models
  - attaches the secondary section cover (band) to the front and back of the secondary section track
  - facilitates the connection and parallel junction of the cooling medium to two (1FN3050…450) or three (1FN3600…900) cooling sections at the front and back of the secondary section track, see Figure 13-17 and Figure 13-18.
  - facilitates the merging of the cooling medium flow and cooling medium discharge connection at the end of the secondary section track, see Figure 13-17 and Figure 13-18.
- Combi adapter/combi end piece:
  - available for 1FN3050…1FN3450 models
  - attaches the secondary section cover (band) to the front and back of the secondary section track
  - facilitates the cooling medium connection and cooling medium return: The cooling medium intake and runback connections are located on the combi adapter. The combi end piece is used for the cooling medium runback at the other end of the secondary section track, see Figure 13-19
- Cover end piece:
  - available for 1FN3050…1FN3450 models
  - attaches the secondary section cover (band) to the front and back of the secondary section track, see Figure 13-20

The following illustrations show the secondary section cooling with different secondary section end piece models. The blue dotted lines indicate the cooling medium flow.

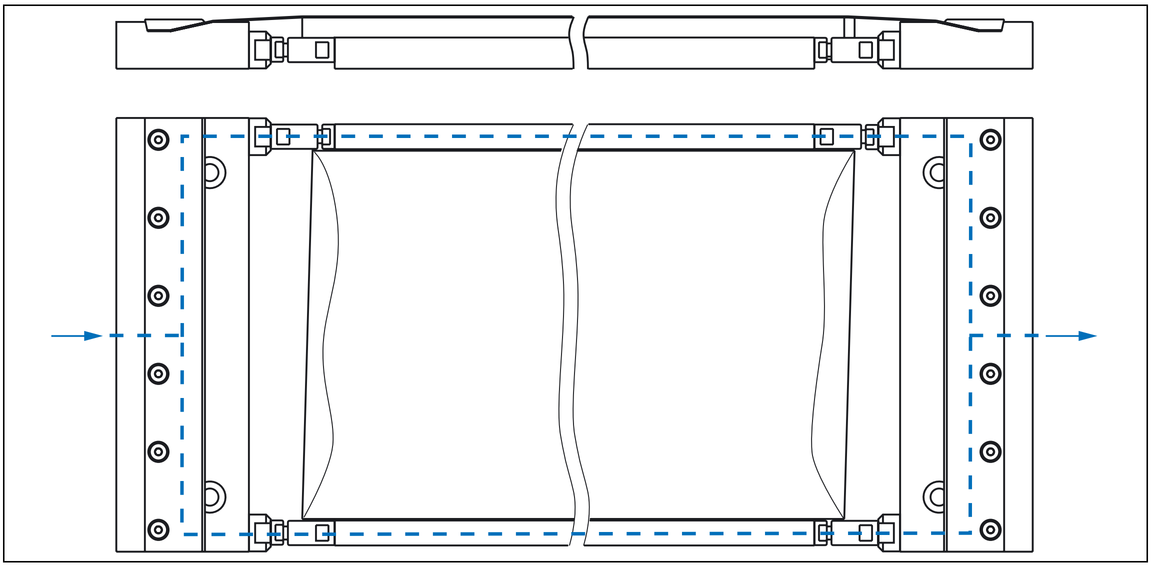

Figure 13-17 Secondary section cooling for 1FN3050...1FN3450-type motors with combi distributors (side and top view)

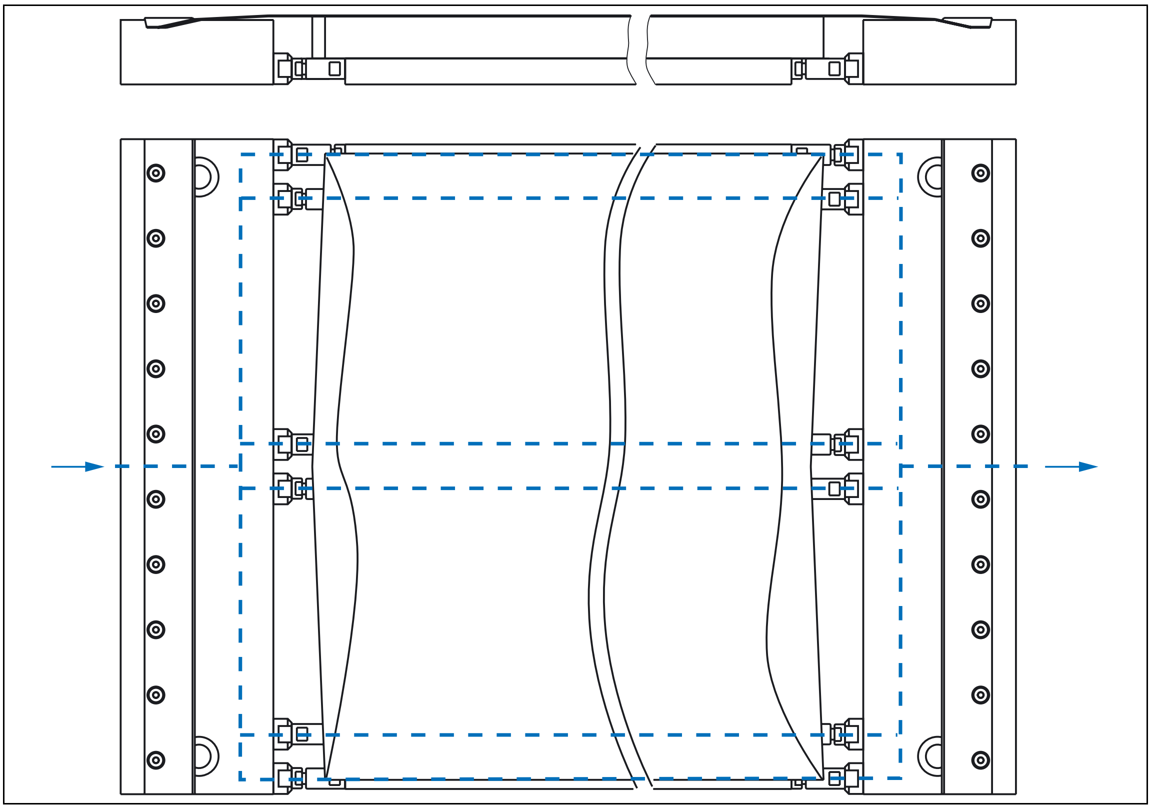

Figure 13-18 Secondary section cooling for 1FN3600- and 1FN3900-type motors with combi distributors (side and top view)

1FN3

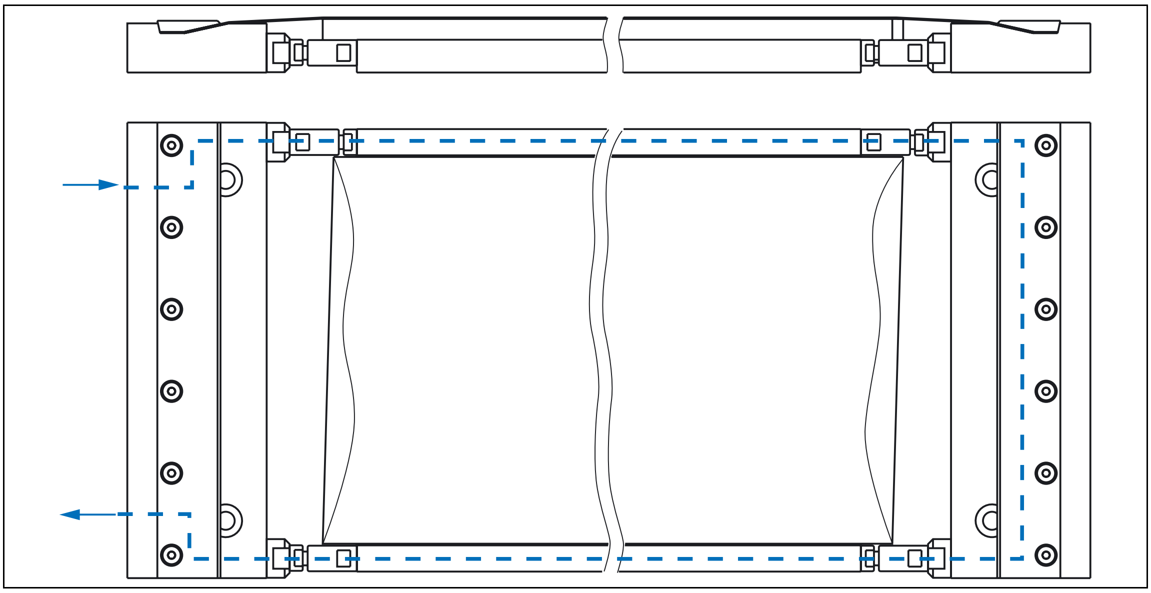

Figure 13-19 Secondary section cooling for 1FN3050...1FN3450-type motors with combi adapter and combi end piece (side and top view)

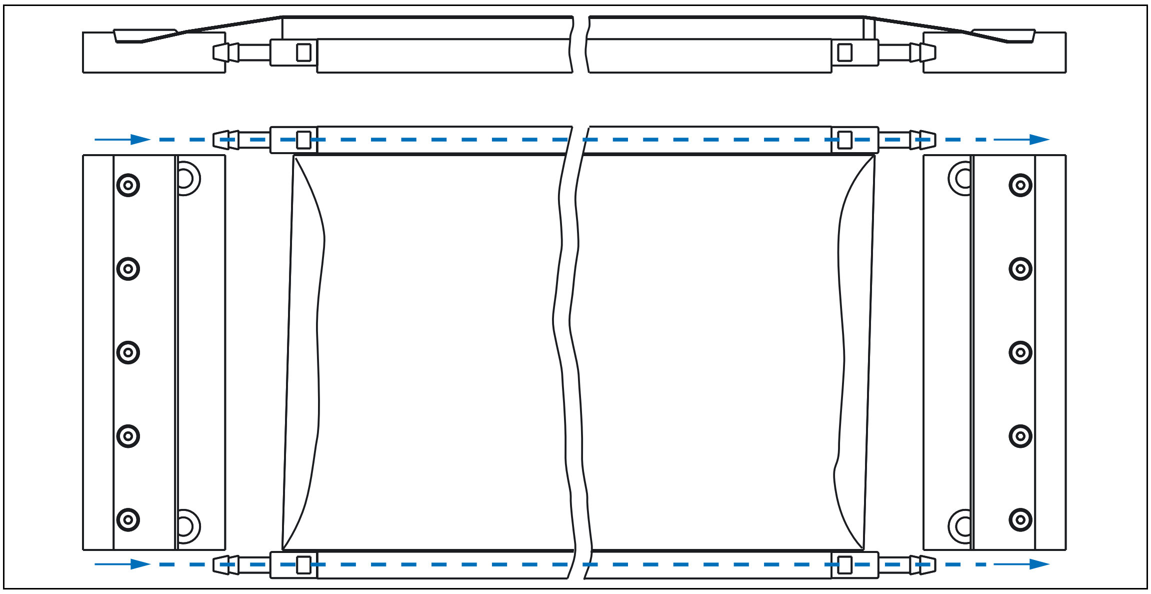

Figure 13-20 Secondary section cooling consisting of cooling sections with hose connector nipple and cover end pieces on both sides for all 1FN3050…1FN3450 motor models (side and top view)

When using a secondary section cooling with combi distributors the cooling medium is distributed evenly to all cooling sections and is not returned, see Figure 13-17 and Figure 13-18. On the other hand, when combi adapters/combi end pieces are used the cooling medium flows in a ring around the secondary section, see Figure 13-19. The pressure drop of a secondary section cooling with combi adapter/combi end piece is substantially higher due to the higher flow speeds and flow lengths than with a cooling using combi distributors.

Note

Due to the high pressure drop a secondary section cooling with combi adapter/combi end piece can only be used for short traversing distances – such as a length of four secondary sections – due to the high pressure drop. The pressure drop must be monitored for the entire cooling system!

13.5 Parallel and double-sided motor specifications

13.5.1 Parallel circuit configuration

Critical for the layout of primary sections connected in parallel are the pole pair width $2\tau_M$ and, with opposed cable outlet, the minimum distance Δs_0, see Chapter 6.1. Both dimensions are specified in Table 13-6.

Table 13-6 Pole pair width and minimum distance of 1FN3-type peak-load motors connected in parallel

	1FN3050…150	1FN3300…900
Pole pair width $2\tau_M$ [mm]	30	46
Minimum distance Δs_0 [mm]	72.5	111.2

13.5.2 Double-sided motor

To set up a double-sided motor with an application-specific secondary section, primary sections with inverse winding are required, see chapter 6.2. These primary sections are available upon request only.

1FN3

Design specifications are listed in Figure 13-21.

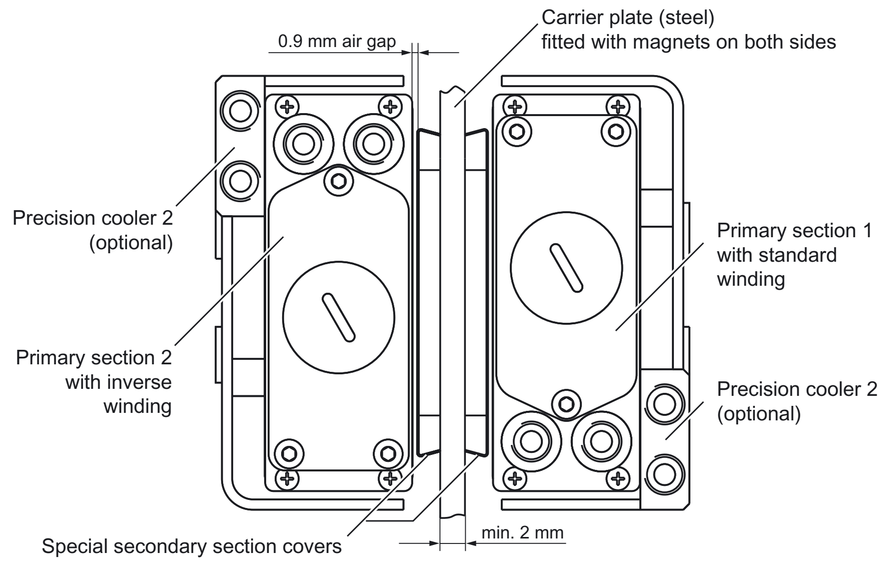

Figure 13-21 Double-sided motor layout using 1FN3-type peak-load motors

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Note

The dimensions specified for the steel carrier plate reflect the minimum thickness! Attraction forces between the secondary sections do not neutralize.

For the overall dynamic masses, the masses of the enclosure of the carrier plate, the guiding system, and the length measurement system have to be taken into consideration in addition to the mass of the secondary section and the secondary section cover.

13.6 Mounting the motor - Details

Basic instructions for mounting the motor are provided in chapter 7. In this chapter you will find special information about 1FN3-type peak-load motors.

1FN3

13.6.1 Important motor mounting dimensions

Figure 13-22 shows the dimensions for mounting the motor. The corresponding values are specified in Table 13-7. In addition, this table specifies the air gap value

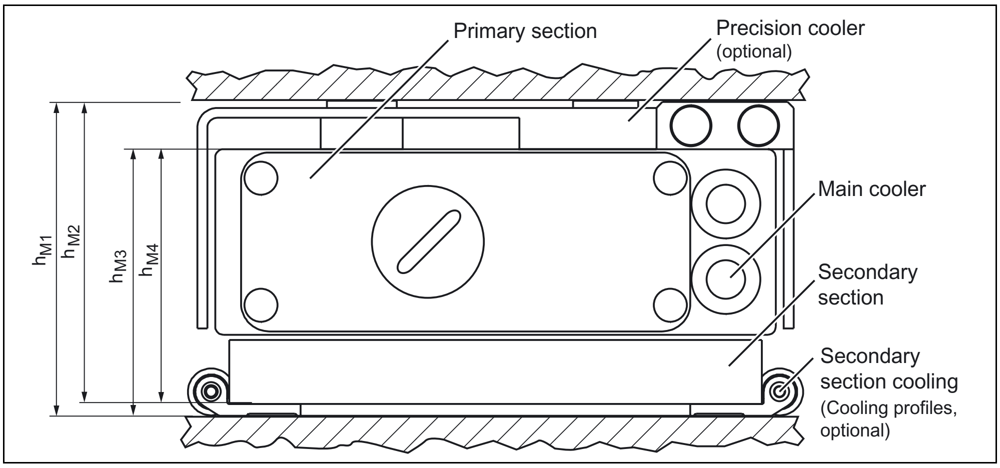

Figure 13-22 Control dimensions for mounting the motor

Table 13-7 Air gap dimensions and control dimensions for mounting the motor as specified in Figure 13-22

	Mounting tolerance [mm]	Rated air gap with secondary section cover [mm]	Rated air gap without secondary section cover [mm]	Mounting dimension with precision and secondary section cooler h_{M1} [mm]	Mounting dimension with precision cooler and without secondary section cooler h_{M2} [mm]	Mounting dimension without precision cooler and secondary section cooler h_{M3} [mm]	Mounting dimension without precision cooler and with secondary section cooler h_{M4} [mm]
1FN3050, 1FN3100	± 0.3	0.9	1.3	63.4	60.4	48.5	51.1
1FN3150	± 0.3	0.9	1.3	65.4	62.4	50.5	53.5
1FN3300	± 0.3	0.9	1.3	79.0	76.0	64.1	67.1
1FN3450	± 0.3	0.9	1.3	81.0	78.0	66.1	69.1
1FN3600	± 0.3	0.9	1.3	86.0	--	--	67.1
1FN3900	± 0.3	0.9	1.3	88.0	--	--	69.1

13.6.2 Mounting individual motor components

Mounting the secondary section

The secondary sections are mounted to the machine bed by means of a friction-locked screw joint. The optional cooling sections are screwed onto the secondary sections in between the secondary sections and the machine bed. The mounting dimensions without secondary section cooling are reduced by the height of the cooling sections, see Figure 13-22 and Table 13-7.

For each secondary section the letter N located on the secondary sections must always point in the same direction, see Figure 13-23.

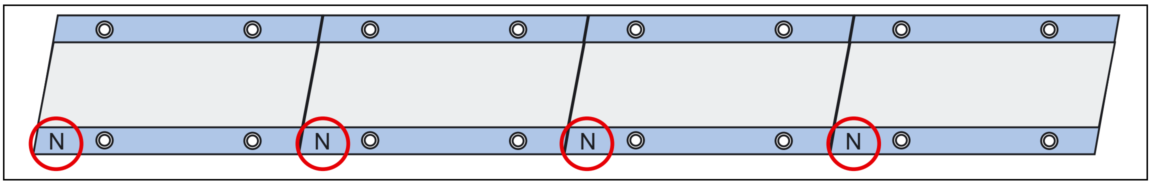

Figure 13-23 Position of the "N" mark on 1FN3-type secondary sections

Danger

Handling unpackaged secondary sections poses a high risk of crushing!

Carefully observe the guidelines in chapter 2.3!

Mounting the secondary section cooling component

1FN3

If secondary section cooling is used the cooling sections and secondary section end pieces are to be installed before mounting the secondary sections.

In order to attach the secondary section end pieces the wedges must be removed. By default, the mounting screws of the wedges are stainless steel socket head cap screws (hex socket, DIN 7984 A2 M3x6). Talllow-drop screws (Phillips head H1, DIN 7985 - M3, maximum length 8 mm) may be used as well. The respective number of screws for each option is specified in Table 13-8.

Table 13-8 Number of wedge mounting screws for the secondary section end pieces

	1FN3...						
	050	100	150	300	450	600	900
Combi adapter	4	6	6	6	8	--	--
Combi end piece	4	6	6	6	8	--	--
Combi distributor	4	6	6	6	8	10	14
Cover end piece	2	5	5	6	7	--	--

To mount the secondary section end pieces use the same screws as for mounting the secondary sections.

Note

The secondary section end pieces can be a little lower than the secondary section track, see the mounting specifications in chapter 16. Note that the mounting threads on the machine bed must be sufficiently deep!

Steps

If cooling sections with plug nipples are used, proceed as follows:

(1) First tack the cooling sections with only a few screws to hold them in place. These screws have to be removed later, so do not tighten!

(2) Slide secondary section end piece no. 1 without wedge axially onto the plug nipples of the cooling sections.

(3) Screw in the mounting screws of secondary section no. 1, but do not tighten.

(4) Slide secondary section end piece no. 2 without wedge axially onto the plug nipples of the cooling sections.

(5) Screw in the mounting screws of secondary section no. 2, but do not tighten.

(6) Tighten the mounting screws of the secondary section end pieces.

(7) Check cooling circuit seal (pressure check at a maximum of 10 bar with water or other coolants).
(8) Check if all threads in the machine bed are visible.
(9) Screw on the secondary sections together with the cooling sections. But first remove the fastening screws!
(10) Mount the secondary section end piece wedges if the cover band is not used as secondary section cover.

Note

Removing the fastening screws too early may result in excessive plug nipple deformation and overload due to the tare weight of the cooling sections and especially with a vertically arranged secondary section track. Therefore, especially with a vertically arranged secondary section track, remove the screws used to position the cooling sections gradually.

Figure 13-24 shows how to position and fasten the cooling sections and combi distributors.

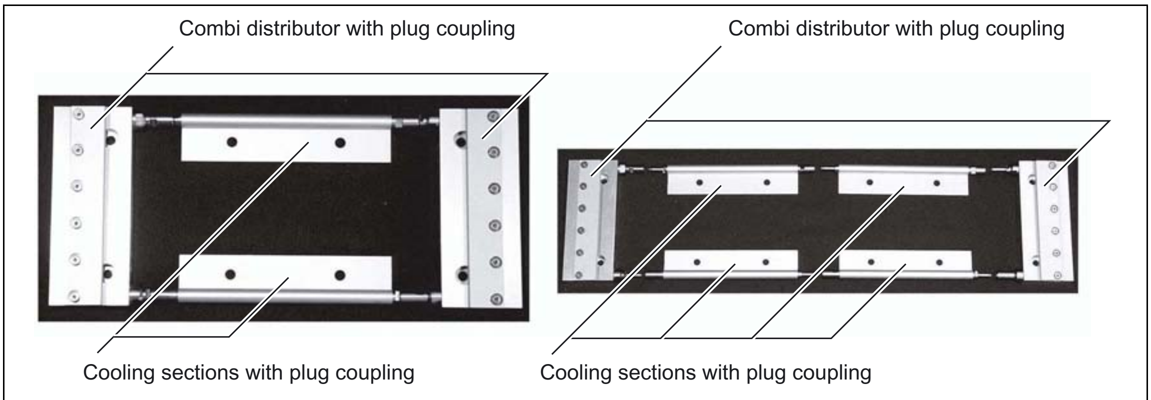

Figure 13-24 Position of the cooling sections and combi distributors (illustration without fastening screws)

Mounting the secondary section cover

The secondary section cover protects the secondary section track. The installation depends on the type of cover used. Two different variants are available:

- continuous band
- segmented cover

Cover band

The cover band is used in environments with heavy dust loads which could deposit in the spaces of the segmented cover.

Note

Blocking the air gap can result in damage to the primary section and secondary section track. Besides the use of strippers, the work space and especially the air gap must be kept free of chips and other particles.

Covering long secondary section tracks with cover bands is more complicated than with segments.

If the traversing distance of the axle is greater than twice the slide length, proceed as follows:

(1) Mount the primary section under the slide.
(2) Push the slide on one side of the traversing distance and mount the secondary sections on the other side up to the middle of the traversing distance.
(3) Mark the length of the mounted secondary sections plus the required clamping length on the cover band.
(4) From the mark, slide the cover band under the primary section to the side without secondary sections. Starting from the mark, place the other half onto the secondary sections.
(5) Push the slide over the covered secondary sections. The magnetic forces are transferred to the guide rods.
(6) Lift the cover band carefully from the machine frame and mount the remaining secondary sections underneath.
(7) Place the second half of the secondary section cover onto the secondary section track.
(8) Lock both ends on the secondary section end pieces using the wedges.

If the traversing distance of the axle is smaller than the double slide length or access to mounting the secondary section cover is limited, proceed as follows:

(1) Mounting the secondary sections with the slide plate removed.
(2) Starting from one end, place the magnetic secondary section cover onto the secondary sections and fasten both ends on the secondary section end pieces with the wedge.
(3) Place the primary section with spacer and extractor onto the secondary section track.
(4) Mount the slide onto the guide rod. Align the slide with the mounting holes of the primary section.
(5) Remove the primary section from the secondary section track using the extractor (Figure 7-2 in the section ALL) and mount it to the slide.

Segmented cover

Mounting the segmented cover is usually easier than mounting the cover band:

(1) Mounting the first segment:
Position the edge of the first segment from the top in an angle of 45° flush with the outer edge of the last secondary section and lower it in alignment with the secondary section track, see Figure 13-25. As soon as you feel the magnetic attraction force, the segment can be released: It will align itself to the correct position.
(2) Checking the correct position:
The first cover segment should reach to the middle of a secondary section Figure 13-27.
(3) All other segments are mounted the same way as the first one,
see Figure 13-26.

Figure 13-25 Mounting the first segment of a segmented secondary section cover

Figure 13-26 Mounting another segment of a segmented secondary section cover

For better dust protection it is recommended to offset the butt joints of the cover segments with those of the secondary sections, see Figure 13-27. This is possible if the cover segments at the ends of the secondary section track have a (n+0.5) length instead of the integral length of the secondary sections.

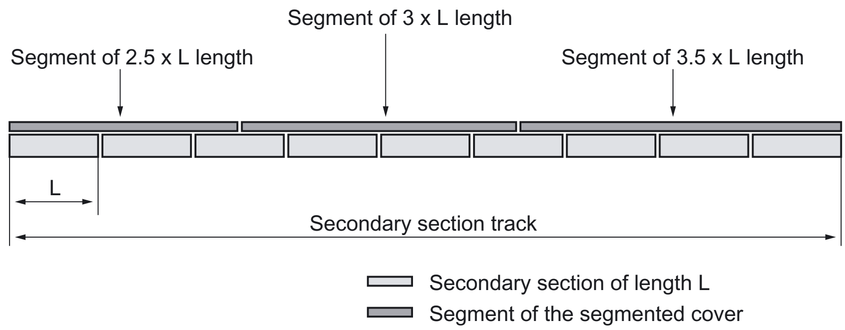

Figure 13-27 Example: Segment position of the segmented secondary section cover

To demount the segmented secondary section cover, lift the segments on one side perpendicular to the travel direction, see Figure 13-28.

Figure 13-28 Demounting a segment of a segmented secondary section cover

Mounting the primary section

The primary section is screwed to the primary section back via the threaded bore holes in a friction-locked joint. Note that the connection side of the primary section usually points in the same direction as the north pole mark “N” on the secondary sections, see also the installation diagrams in chapter 16.

Caution!

Wrong bore hole depths for the fastening screws can damage the motor components or, due to an insufficiently solid attachment of the motor components to the machine, cause other unfavorable conditions.

Ensure maximum and minimum bore hole depths for the fastening screws!

Mounting the Hall sensor box

Which Hall sensor box to use depends on

- the motor type (050…150 or 300…900)
- the location where the Hall sensor box is attached
  - opposite of the connection panel (standard)
  - at the connection panel (standard)
- the required cable outlet direction
  - straight (see Figure 13-29)
  - lateral (see Figure 13-30)

For the respective order numbers, see chapter 14.3.2.

Note

If several primary sections are running on one converter (e. g. PARALLEL layout, see Chapter 6.1.1) the master is to be used as reference for installing the Hall sensor box.

The cable outlet direction and position of the Hall sensor within the Hall sensor box are specifically specified and firmly allocated. Therefore, be sure to follow the respective installation diagrams (chapter 16) when installing the Hall sensor box with regards to position and alignment with the primary section.

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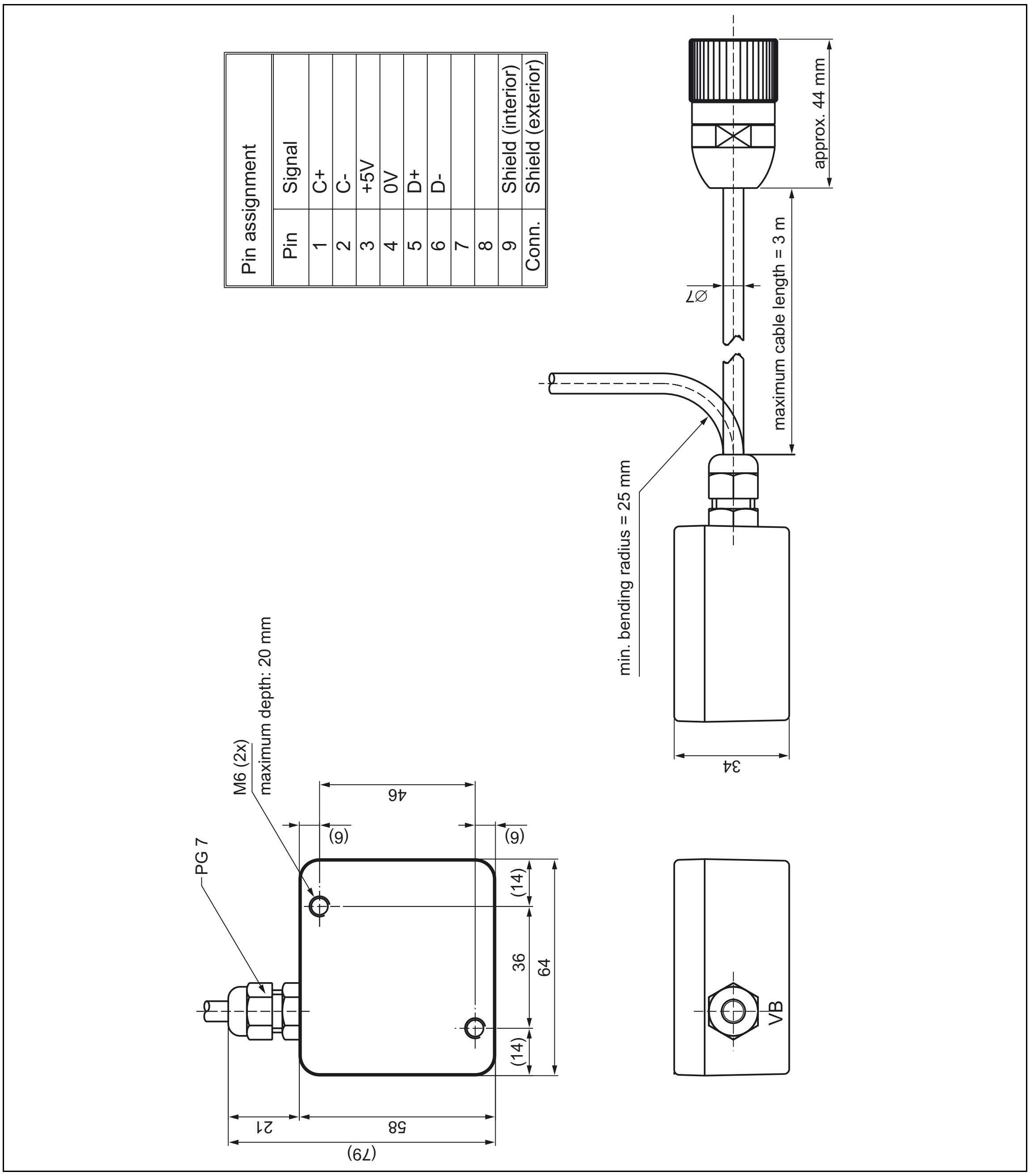
Caution

An incorrect installation of the Hall sensor box can result in uncontrollable travel movements of the motor and damage to the machine.

Be sure to follow the installation diagrams! Starting at a certain minimum distance, the distance between the primary section and the Hall sensor box can only be increased by the multiple of the pole pair width $2\tau_M$ - specified in the diagrams as count factor N_P.



Pin assignment	
Pin	Signal
1	C+
2	C-
3	+5V
4	0V
5	D+
6	D-
7	
8	
9	Shield (interior)
Conn.	Shield (exterior)

Figure 13-29 Hall sensor box with straight cable outlet

Pin assignment	
Pin	Signal
1	C+
2	C-
3	+5V
4	0V
5	D+
6	D-
7	
8	
9	Shield (interior)
Conn.	Shield (exterior)

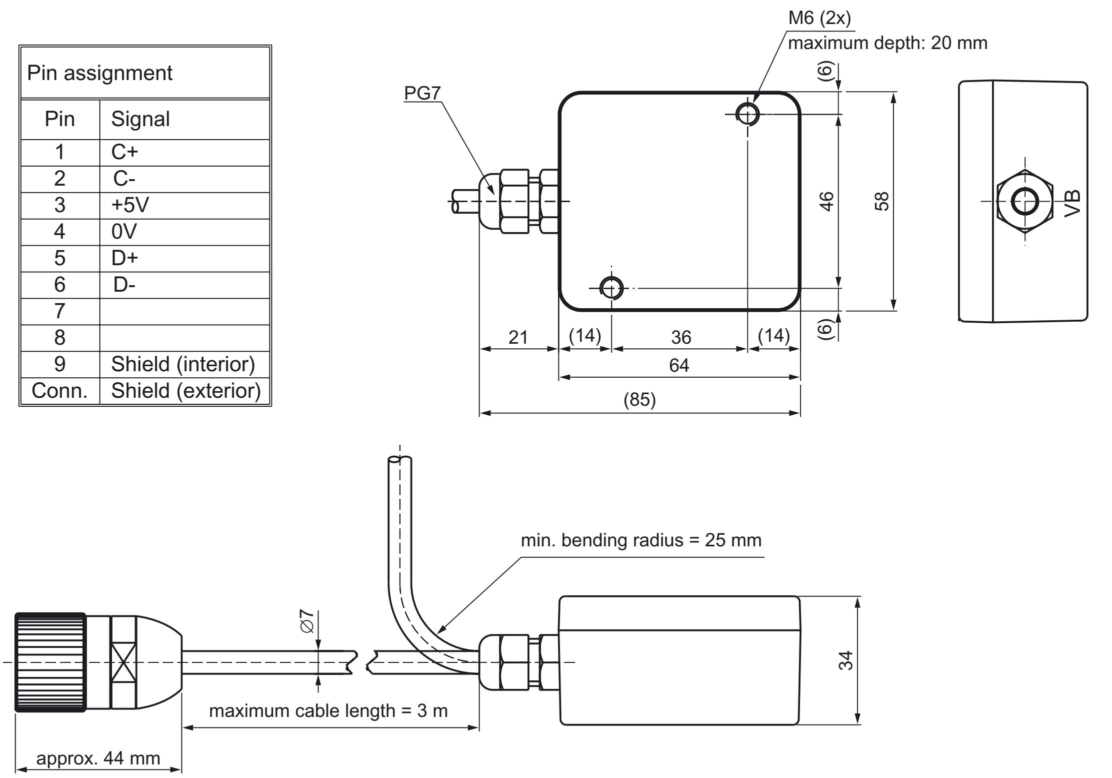


Figure 13-30 Hall sensor box with lateral cable outlet

Be sure to mount the Hall sensor box so that a distance of x = 35 mm between the top of the Hall sensor box and the bottom of the primary section is kept, see Figure 13-31. This ensures an automatic adjustment of the correct distance between the Hall sensor box and the secondary section track.

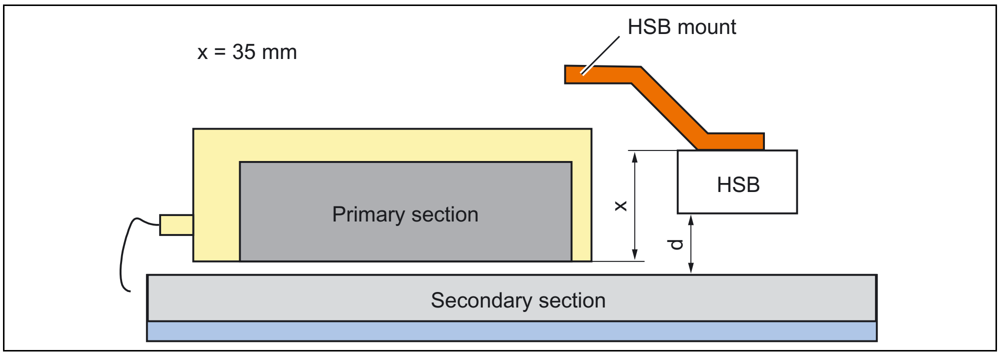


Figure 13-31 Nominal dimensions for mounting the Hall sensor box (HSB)

The Hall sensor box cable is drag-capable and can thus be integrated into cable carriers.

13.7 Guidelines for Commissioning

The best way to adjust motors is described in chapter 4.2. For the identification of the pole position there may be restrictions for the 1FN3-type motor control with regards to the methods used. For further information, see the Installation and Start-Up Guide /IAD/.

■

1FN3

14 Order designations

The order numbers consist of a combination of letters and numbers, i.e. a machine-readable product code (MLFB). When placing an order it suffices to specify the unique MLFB.

The MLFB consists of three blocks separated by hyphens. The first block of the MLFB comprises 7 characters. These represent the model and type of the primary section or the secondary section. Additional features are coded in the second block. The third block is provided for additional specifications.

14.1 Primary sections

1FN3xxx - xWxx0 - 0AAx

- electrical machine
- Synchronous motor
- Linear motor
- Type series
- Size
- Length
  - 1 ≙ primary section, very short
  - 2 ≙ primary section, short
  - 3 ≙ primary section, medium short
  - 4 ≙ primary section, medium long
  - 5 ≙ primary section, long
- Primary section type
  - W ≙ primary section with main cooler
- $v_{MAX,FN}$ range
  - Ax ≙ $v_{MAX,FN}$ < 50 m/min
  - Bx ≙ 50 m/min ≤ $v_{MAX,FN}$ < 100 m/min
  - Cx ≙ 100 m/min ≤ $v_{MAX,FN}$ < 150 m/min
  - Dx ≙ 150 m/min ≤ $v_{MAX,FN}$ < 200 m/min
  - Ex ≙ 200 m/min ≤ $v_{MAX,FN}$ < 250 m/min
  - Fx ≙ 250 m/min ≤ $v_{MAX,FN}$ < 300 m/min
  - Gx ≙ 300 m/min ≤ $v_{MAX,FN}$
  - x0 ≙ $v_{MAX,FN}$ in the first half of the interval
  - x5 ≙ $v_{MAX,FN}$ in the second half of the interval
- Type
  - 0 ≙ models with Temp-S
  - 1 ≙ models with Temp-S and Temp-F

14.2 Secondary sections

1FN3xxx - 4Sx00 - 0AA0

- Size (as primary section)
- Length
  - 4 ≙ 4 pole pairs
- Type of construction
  - A ≙ standard
- Version (standard)

14.3 Primary section accessories

14.3.1 Precision cooler

1FN3xxx - xPK00 - 0AA0

Size
(as primary section)

Length
(as primary section)

14.3.2 Hall sensor box

The Hall sensor box can be mounted opposite of the primary section's connection panel or at the connection side of the primary section, see "Mounting the Hall sensor box " page 13-195. The standard location is opposite of the primary section's connection panel.

1FN300x - 0PH0x - 0AA0

Size

2 ≙ 1FN3050...150, for standard mounting lengths 2 and 4 only
3 ≙ 1FN3300...900, for standard mounting lengths 2 and 4 only
5 ≙ standard mounting only: 1FN3050...150, lengths 1, 3, and 5
6 ≙ standard mounting only: 1FN3300...900, lengths 1, 3, and 5

Cable outlet

0 ≙ straight
1 ≙ lateral

14.3.3 SME9x

1FN1910 - 0AA20 - xAA0

Accessories

Module

A2 ≙ SME9x

Type

1 ≙ SME91
2 ≙ SME92
3 ≙ SME93
4 ≙ SME94

14.3.4 Connector box

1FN1910 - 0AA00 - 0AA0

Accessories

Module

A0 ≙ connector box to connect to a Hall sensor box

14.4 Secondary section accessories

14.4.1 Cooling sections

1FN300x - 0TKx0 - 1xx0

Size

- 2 ≙ for 1FN3050...150
- 3 ≙ for 1FN3300...450
- 4 ≙ for 1FN3600
- 5 ≙ for 1FN3900

Connection type

- 4 ≙ plug coupling
- 6 ≙ nipple right for 1FN3050...450; nipple left/right for 1FN3600...900
- 7 ≙ nipple left for 1FN3050...450

Number of the secondary sections to be supplied

Letters stand for numbers:

A	B	C	D	E	F	G	H	J	K
0	1	2	3	4	5	6	7	8	9

Examples:
1 secondary section is encoded with AB (minimum length of the cooling section)
16 secondary sections are encoded with BG (maximum number for 1FN3300...600) [1]
24 secondary sections are encoded with CE (maximum number for 1FN3050...150) [1]

1 The maximum length of a one-piece cooling system is 3 m. This corresponds to the number of secondary sections specified here.

1FN3

14.4.2 Secondary section end pieces

1FN3xxx - 0Tx01 - 0AA0

Size
(as primary section/secondary section)

End piece type

- C ≙ end piece for cover band; not for 1FN3600...900
- G ≙ combi adapter (plug coupling); not for 1FN3600...900
- F ≙ end piece for adapter (plug coupling); not for 1FN3600...900
- J ≙ combi distributor (plug coupling)

14.4.3 Secondary section cover

Segmented cover

1FN3xxx - 4TP00 - 1Axx

Size
(as primary section/secondary section)

Length
(L_S: length of secondary sections to be covered)

- C5 ≙ 2.5 L_S
- D0 ≙ 3 L_S
- D5 ≙ 3.5 L_S
- E0 ≙ 4 L_S
- F0 ≙ 5 L_S
- F5 ≙ 5.5 L_S ; for 1FN3600...900 only
- G5 ≙ 6.5 L_S ; for 1FN3600...900 only

Metal band cover

1 F N 3 x x x - 0 T B 0 0 - 1 x x 0

Size
(as primary section/secondary section)

Number of secondary sections to be covered

Letters stand for numbers:

A	B	C	D	E	F	G	H	J	K
0	1	2	3	4	5	6	7	8	9

Examples:
1 secondary section is encoded with AB (minimum length of the secondary section cover)
32 secondary sections are encoded with DC (maximum number for 1FN3300...600) [1]
50 secondary sections are encoded with FA (maximum number for 1FN3050...150) [1]

1 The maximum length of the secondary section cover is 6 m. This corresponds to the number of secondary sections specified here.

14.5 Order example

1FN3

Component	Stück	MLFB
Primary section	1	1FN3150–3WC00–0AA1
Primary section precision cooler	1	1FN3150–3PK00–0AA0
Secondary sections	12	1FN3150–4SA00–0AA0
Length of the secondary section track: 1440 mm)		
Secondary section cover (metal band)	1	1FN3150–0TB00–1BC0
Cooling sections with plug nipples	2	1FN3002–0TK04–1BC0
Combi distributor	2	1FN3150–0TJ01–0AA0
Hall sensor box (standard, straight cable outlet)	1	1FN3005–0PH00–0AA0
SME93 (SME9x for one motor and HSB, see chapter 18.2.2)	1	1FN1910-0AA20-3AA0

■

15 Technical Data and Characteristics

This chapter contains the technical specifications and characteristics of 1FN3-type peak-load motors. This data collection provides the necessary motor data for designing a system and contains additional data for in-depth calculations based on detailed and problem analyses. The data specified here is subject to change.

Note

ong as not stated otherwise the following limitations apply with regards to the specifications:

- The DC link voltage U_{ZK} is 600 V, the converter output voltage U_{amax} is 425 V
- The motor is water-cooled with an intake temperature of T_{VORL} 35° C and the specified flow rate of $\dot{V}_{P,H,MIN}$
- Voltages and currents are specified as actual values

15.1 Description

15.1.1 Definitions of the 1FN3-type motor data

Limitations/secondary conditions

U_{ZK}

Converter DC link voltage

Note: For converter voltages U_{amax} see chapter 4.1.

T_{VORL}

Maximum intake temperature for the water cooling if the motor is to be used to its rated thrust capacity F_N .

T_N

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Rated temperature

Note: The rated temperature of the motor winding corresponds to the shut off temperature of the Temp-S temperature monitoring circuit, see chapter 13.4.1.

Rating data

F_N

Rated thrust of the motor.

I_N

Rated motor current at rated thrust F_N.

$v_{MAX,FN}$

Maximum speed up to which the drive can deliver the rated thrust F_N

$P_{V,N}$

Power loss of the motor within the scope of the rated data (F_N,$v_{MAX,FN}$) at rated temperature T_N. Loss due to friction and eddy currents is ignored.

Note: Power loss results from phase resistance $R_{STR}(T)$ (see here) and the present current load: $P_V = 3 \cdot R_{STR}(T) \cdot I^2$. Correspondingly $P_{V,N}$ is calculated by

$P_{V,N} = 3 \cdot R_{STR}(T_N) \cdot I_N^2$

Limiting data

F_{MAX}

Maximum thrust of the motor.

I_{MAX}

Maximum motor current at maximum thrust F_{MAX}.

$v_{MAX,FMAX}$

Maximum speed up to which the drive can deliver the maximum thrust F_{MAX}

$P_{EL,MAX}$

Motor absorbed electrical power at point (F_{MAX},$v_{MAX,FMAX}$) at rated temperature T_N. Loss due to friction and eddy currents is ignored.

Note: Total delivered mechanical power P_{MECH} and power loss P_V equals the electrical power absorbed by the motor P_{EL}:

$P_{EL} = P_{MECH} + P_V = F \cdot v + 3 \cdot R_{STR}(T) \cdot I^2$

$P_{EL,MAX}$ is thus calculated correspondingly:

$P_{EL,MAX} = P_{MECH,MAX} + P_{V,MAX} = F_{MAX} \cdot v_{MAX,FMAX} + 3 \cdot R_{STR}(T_N) \cdot I^2_{MAX}$

F_0*

Stall thrust: Motor thrust that can be reached permanently if only one of the three phases is charged (maximum uneven charge of the phases).

Note: F_0* can roughly be calculated from the motor's rated thrust F_N if the impact of the motor saturation is ignored:

$F_0^* \approx \frac{1}{\sqrt{2}} F_N$.

I_0*

Stall current of the motor at stall thrust F_0* .

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Note: I_0* can be calculated from the rated current I_N:

$I_0^* = \frac{1}{\sqrt{2}} I_N$.

Physical constants

$k_{F,20}$

Thrust constant of the motor at rated air gap and a secondary section temperature of 20° C.

Note: The thrust constant refers to the linear (bottom) part of the motor thrust current characteristics.

k_E

Voltage constant to calculate the mutually induced voltages between phase and star point at the rated air gap.

$k_{M,20}$

Motor constant at winding temperature of 20° C.

Note: The motor constant k_M can be calculated for other temperatures:
$k_M(T) = k_{M,20}\,[1 + \alpha\,(T - 20\,°C)]$ with the temperature coefficient $\alpha = -0.001$ 1/K for the magnets used.

$R_{STR,20}$

Winding phase resistance at a winding temperature of 20° C.

Note: The phase resistance R_{STR} can be calculated for other temperatures:
$R_{STR}(T) = R_{STR,20}\,[1 + \alpha\,(T - 20\,°C)]$ with the temperature coefficient
$\alpha = 0.00393$ 1/K for copper.

L_{STR}

Winding phase inductance at the rated air gap

F_A

Attraction force between the primary section and the secondary section at the rated air gap

t_{TH}

Thermal time constant of the winding

Note: The thermal time constant results from the temperature flow in the winding with constant current surges at a given time t = 0 , see Figure 15-1. After the time t_{TH} has elapsed the motor winding reaches approximately 63% of its end temperature T_{GRENZ} if the temperature protection is not activated before.

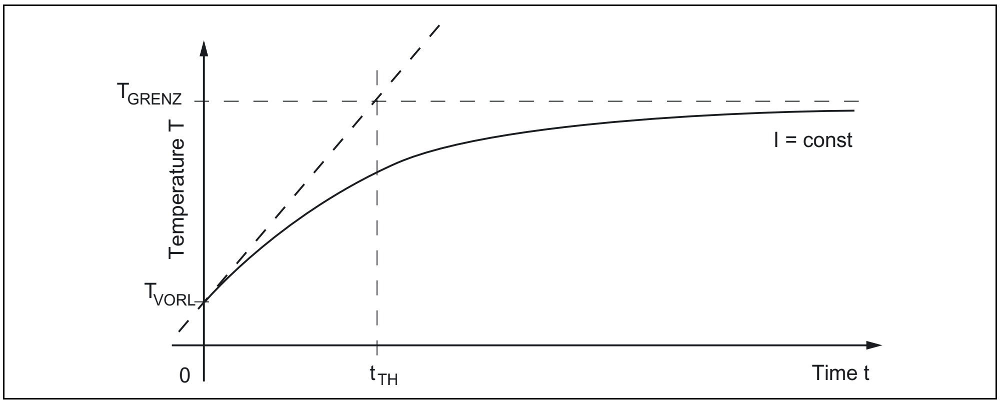


Figure 15-1 Definition of the thermal time constants

τ_M

The pole width of the motor corresponds to the distance between the respective center of the north and south pole of two adjacent magnets on one secondary section.

m_P

Mass of the primary section without precision cooler, mounting screws, plugs, connection cables, and cooling medium.

$m_{P,P}$

Mass of the primary section with precision cooler but without mounting screws, plugs, connection cables, and cooling medium.

m_S

Mass of a secondary section without mounting screws, cover, and optional cooling sections

$m_{S,P}$

Mass of a secondary section with cooling sections but without mounting screws, cover, and cooling medium

Primary section main cooler data

$Q_{P,H,MAX}$

Maximum heat output removed by the main cooler using the rated thrust F_N and the rated temperature T_N

$\dot{V}_{P,H,MIN}$

Recommended minimum flow rate in the main cooler in order to reach the rated thrust F_N

$\Delta T_{P,H}$

Temperature increase of the cooling medium between intake and runback of the main cooler for the rated data ($Q_{P,H,MAX}$;$\dot{V}_{P,H,MIN}$)

$\Delta p_{P,H}$

Pressure drop of the cooling medium between intake and runback of the main cooler for the flow rate $\dot{V}_{P,H,MIN}$

Primary section precision cooler data

$Q_{P,P,MAX}$

Maximum heat output removed by the primary section precision cooler using the rated thrust F_N and the rated temperature T_N

$\dot{V}_{P,P,MIN}$

Recommended minimum flow rate in the primary section precision cooler to reach the maximum surface temperature T_{VORL} + 4 K

$\Delta p_{P,H}$

Pressure drop of the cooling medium between intake and runback of the primary section precision cooler for the flow rate $\dot{V}_{P,P,MIN}$

Secondary section cooling data

$Q_{S,MAX}$

Maximum heat output removed by the secondary section cooler using the rated thrust F_N and the rated temperature $T_N \dot{V}_{S,MIN}$

Recommended minimum flow rate for the secondary section cooling

Δp_S

Pressure drop of the cooling medium between the intake and runback of the secondary section cooling for the flow rate $\dot{V}_{S,MIN}$ and a reference length of one meter

Δp_{KS}

Pressure drop of the cooling medium at a coupling point of the secondary section cooling

Note: for the term “coupling point”, see Figure 15-2

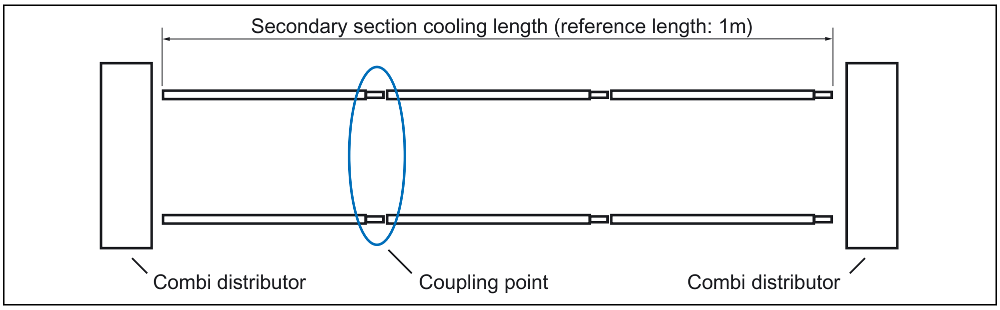


Figure 15-2 Components of the standard secondary section cooling, schematic

Δp_{KV}

Pressure drop of the cooling medium in a combi distributor

Note: Usually two combi distributors are used in the secondary section cooling, see Figure 15-2.

15.1.2 Description of the characteristics

Motor thrust vs. speed

For each diagram depicting the motor thrust F_M dependent on the speed of the given illustrated motor there are three characteristics:

- for a DC link voltage U_{ZK} = 540 V (U_{amax} = 380 V)
- for a DC link voltage U_{ZK} = 600 V (U_{amax} = 425 V)
- for a DC link voltage U_{ZK} = 648 V (U_{amax} = 460 V)

One of these characteristics is illustrated with descriptions for the most important points Figure 15-3.

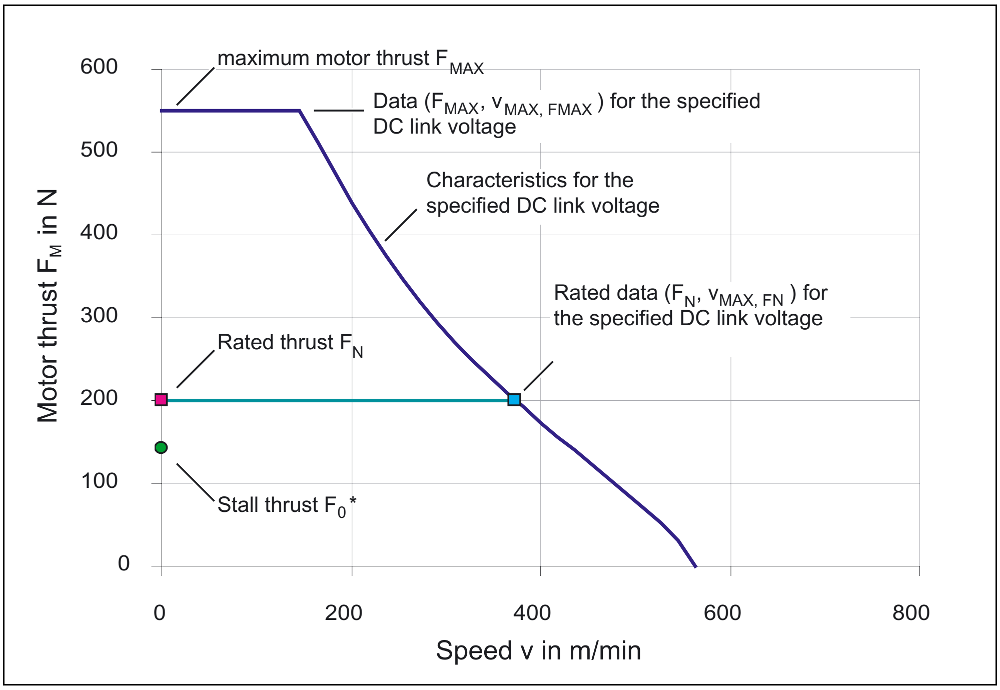


Figure 15-3 Characteristic of motor thrust vs. speed, schematic

Brake force vs. speed

This characteristic describes the brake force of the short-circuited motor in connection with the speed. The friction factor is ignored here. Figure 15-4 shows a rough course of such a characteristic.

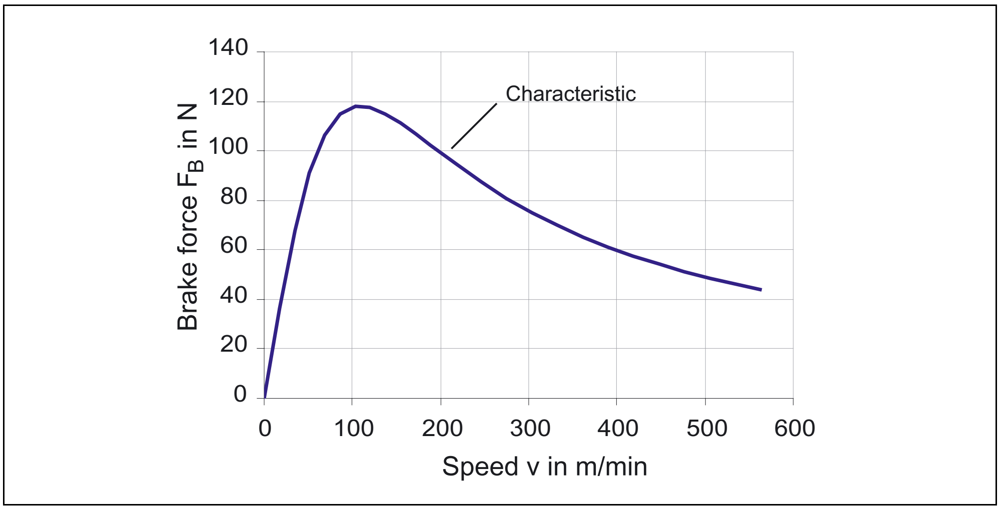


Figure 15-4 Characteristic of brake force vs. speed for short-circuited motors, schematic

Temperature increase of the primary section mail cooler vs. flow rate

This characteristic describes the temperature increase between the intake and runback of the primary section main cooler in connection with the flow rate, see Figure 15-5.

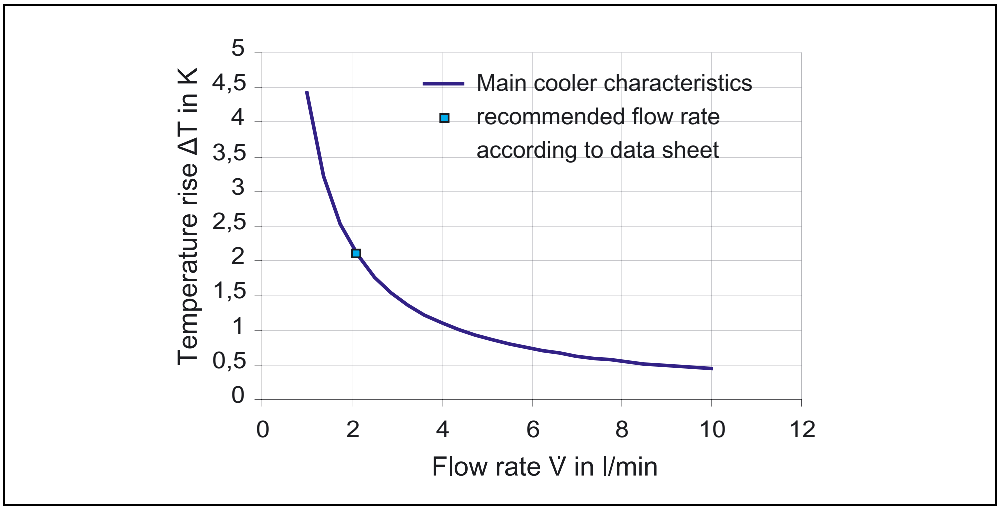


Figure 15-5 Characteristic of temperature increase vs. flow rate in the primary section main cooler, schematic

1FN3

Pressure drop of the coolers vs. flow rate

These characteristics describe the pressure drop between the intake and runback of the respective cooler in connection with the flow rate, see Figure 15-6. One diagram shows the characteristic of the primary section main cooler and another one shows the characteristic of the primary section precision cooler. The third diagram shows characteristics of the individual components of the standard secondary section cooling with combi distributor.

Note

The order of the characteristics specified in Figure 15-6 is not absolute! Please note the legends contained in the individual characteristics!

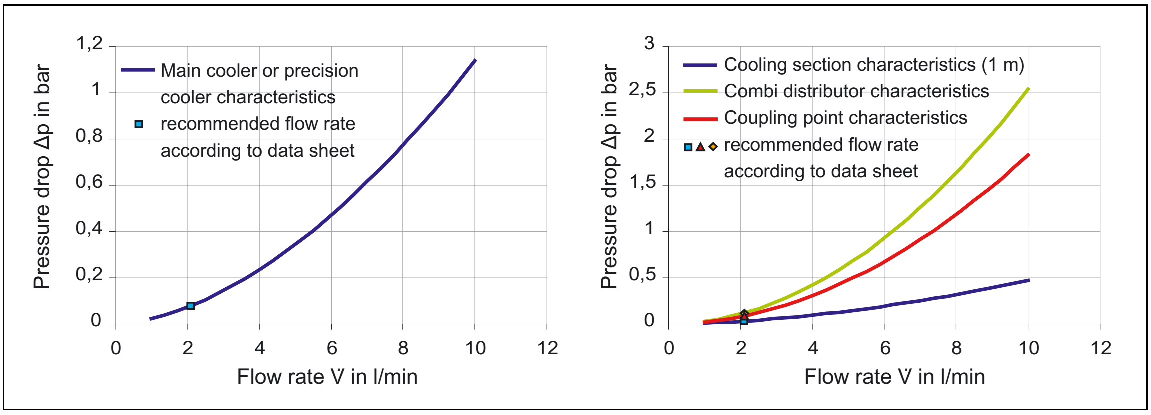


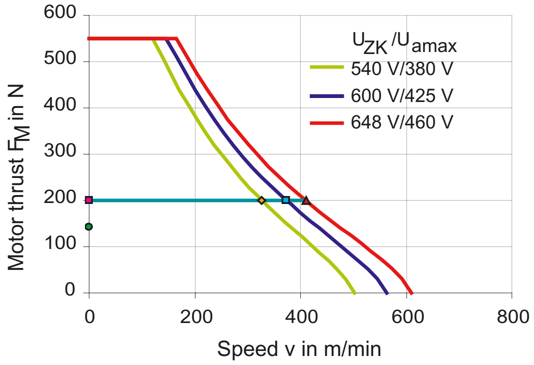
Figure 15-6 Characteristics of pressure drop vs. flow rate, schematic

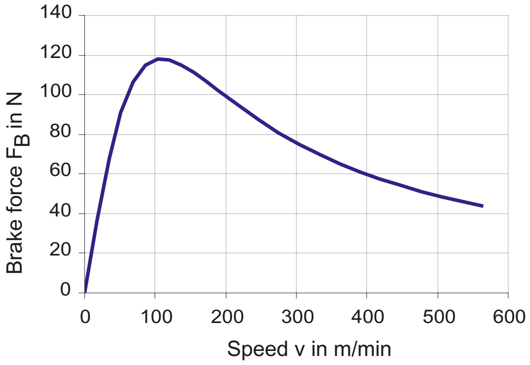
15.2 Motor data

1FN3050-2WC00-0AA0			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	200
Rated current	I_N	A	2.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	373
Rated power loss	$P_{V,N}$	W	310
Limiting data			
Maximum thrust	F_{MAX}	N	550
Maximum current	I_{MAX}	A	8.2
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	146
Maximum electric power input	$P_{EL,MAX}$	W	4110
Stall thrust	F_0*	N	141
Stall current	I_0*	A	1.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	74
Voltage constant	k_E	Vs/m	24.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	13.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	10
Phase inductance	L_{STR}	mH	36.5
Attraction force	F_A	N	1330
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	2.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	2.9
Mass secondary section	m_S	kg	0.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	310
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.1
Cooling medium temperature increase	$\Delta T_{P,H}$	K	2.1
Pressure drop	$\Delta p_{P,H}$	bar	0.64
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	15
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.1
Pressure drop	$\Delta p_{P,P}$	bar	0.08
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	27
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.1
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.12
Pressure drop per coupling point	Δp_{KS}	bar	0.09

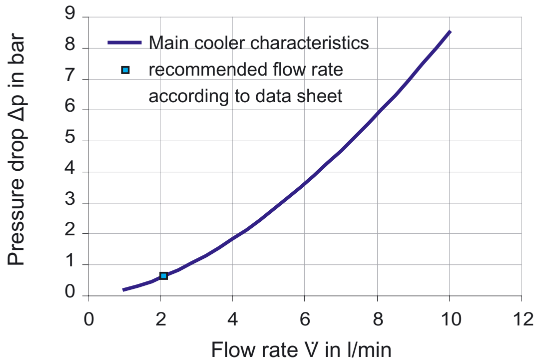
1FN3050-2WC00-0AA0 characteristics

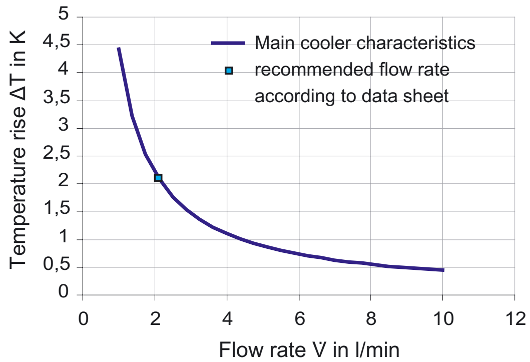
Thrust characteristics



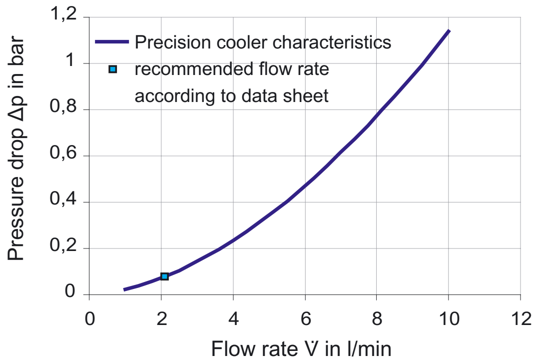


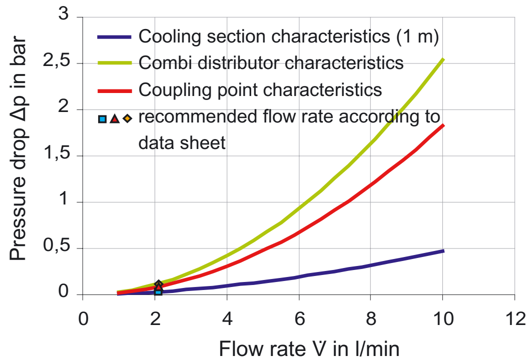
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



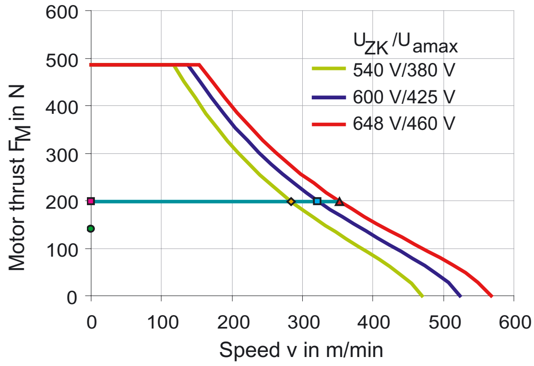


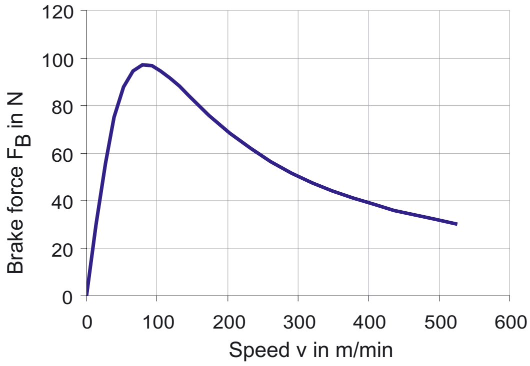
1FN3

1FN3100-1WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	200
Rated current	I_N	A	2.4
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	322
Rated power loss	$P_{V,N}$	W	280
Limiting data			
Maximum thrust	F_{MAX}	N	490
Maximum current	I_{MAX}	A	6.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	138
Maximum electric power input	$P_{EL,MAX}$	W	3130
Stall thrust	F_0*	N	141
Stall current	I_0*	A	1.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	82
Voltage constant	k_E	Vs/m	27.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	13.9
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	11.4
Phase inductance	L_{STR}	mH	54.5
Attraction force	F_A	N	1330
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	2.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	–
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	285
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	1.6
Pressure drop	$\Delta p_{P,H}$	bar	0,57
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	–
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	–
Pressure drop	$\Delta p_{P,P}$	bar	–
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	23
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3100-1WC00-0AA1 characteristics

Thrust characteristics





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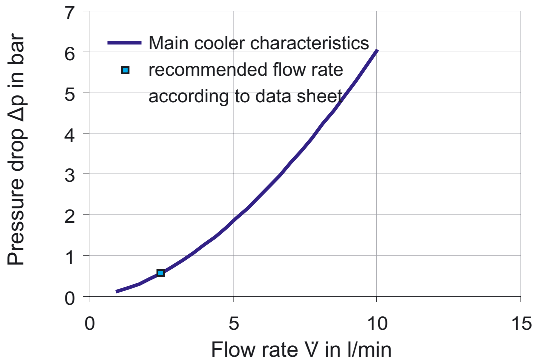
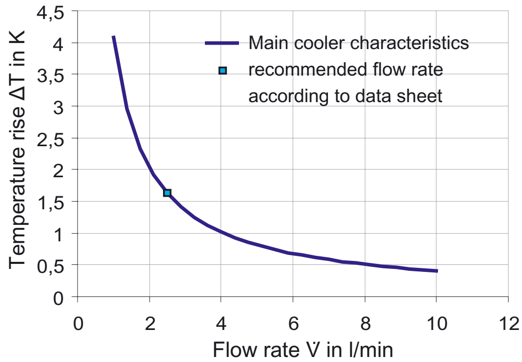
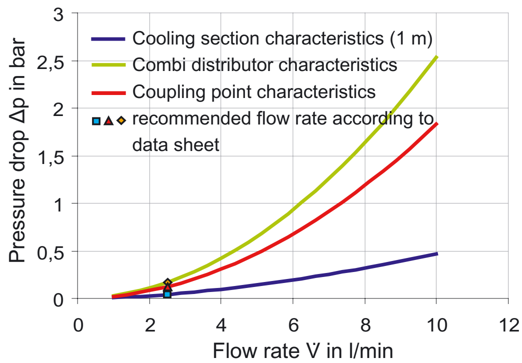
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

no precision cooler installed!



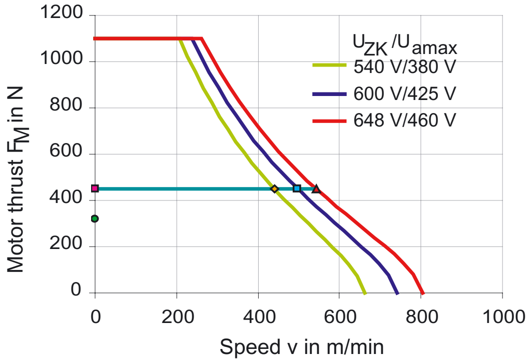
1FN3

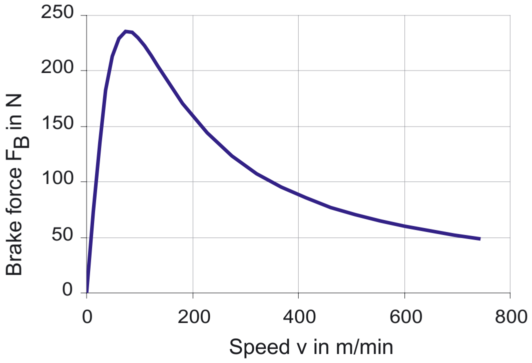
1FN3100-2WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	450
Rated current	I_N	A	5.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	297
Rated power loss	$P_{V,N}$	W	550
Limiting data			
Maximum thrust	F_{MAX}	N	1100
Maximum current	I_{MAX}	A	13.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	131
Maximum electric power input	$P_{EL,MAX}$	W	6310
Stall thrust	F_0*	N	318
Stall current	I_0*	A	3.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	89
Voltage constant	k_E	Vs/m	29.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	22.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	5.1
Phase inductance	L_{STR}	mH	26.6
Attraction force	F_A	N	2650
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	3.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	4.4
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	550
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.2
Pressure drop	$\Delta p_{P,H}$	bar	1.03
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	15
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.11
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	41
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3

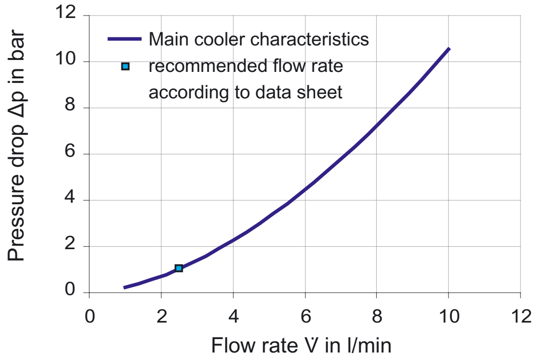
1FN3100-2WC00-0AA1 characteristics

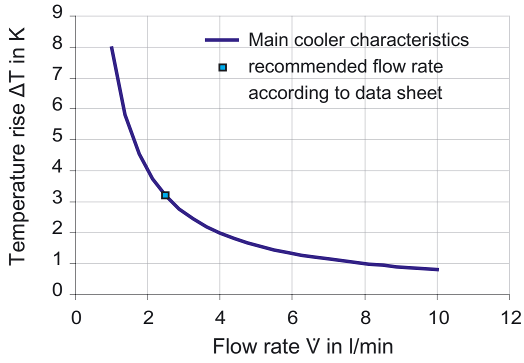
Thrust characteristics



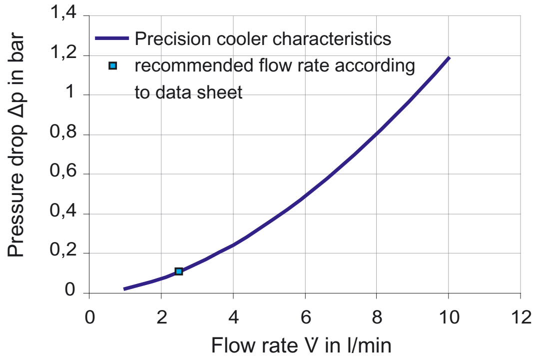


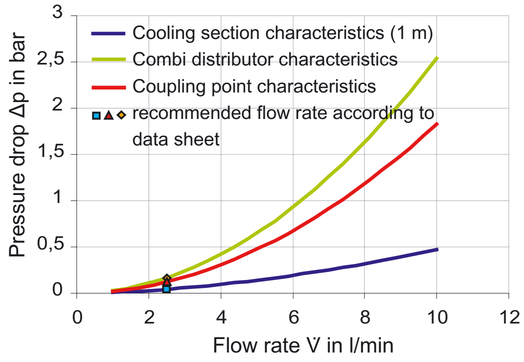
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



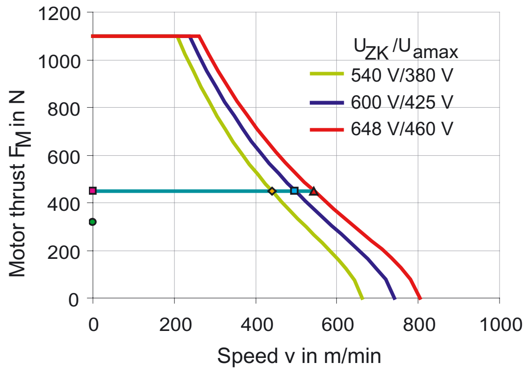


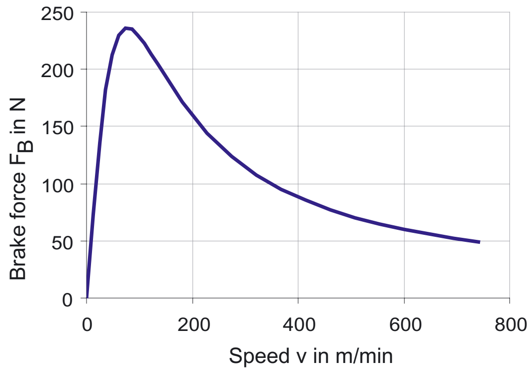
1FN3

1FN3100-2WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	450
Rated current	I_N	A	8.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	497
Rated power loss	$P_{V,N}$	W	550
Limiting data			
Maximum thrust	F_{MAX}	N	1100
Maximum current	I_{MAX}	A	21.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	237
Maximum electric power input	$P_{EL,MAX}$	W	8280
Stall thrust	F_0*	N	318
Stall current	I_0*	A	5.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	56
Voltage constant	k_E	Vs/m	18.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	22.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2
Phase inductance	L_{STR}	mH	10.5
Attraction force	F_A	N	2650
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	3.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	4.4
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	555
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.2
Pressure drop	$\Delta p_{P,H}$	bar	1.03
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	15
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.11
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	41
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3100-2WE00-0AA1 characteristics

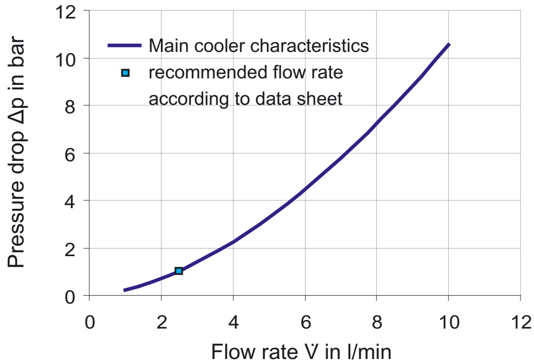
Thrust characteristics

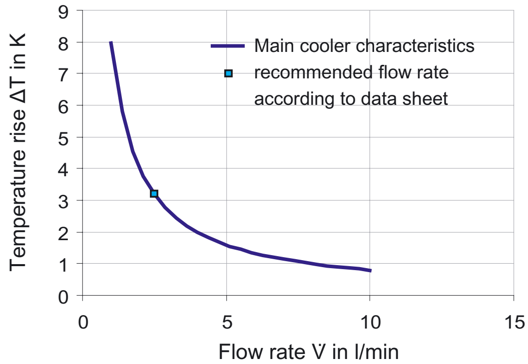




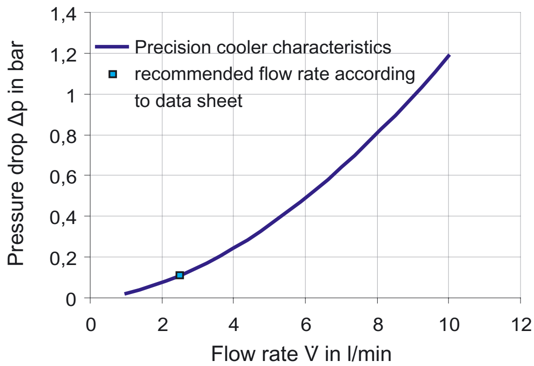
1FN3

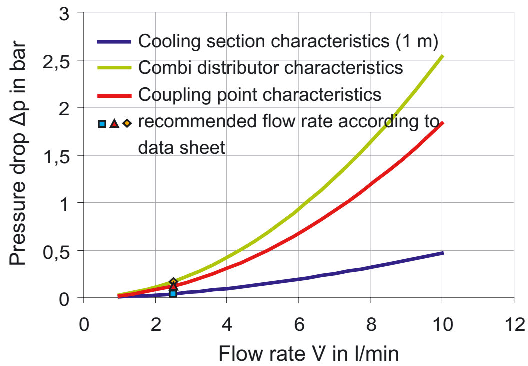
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



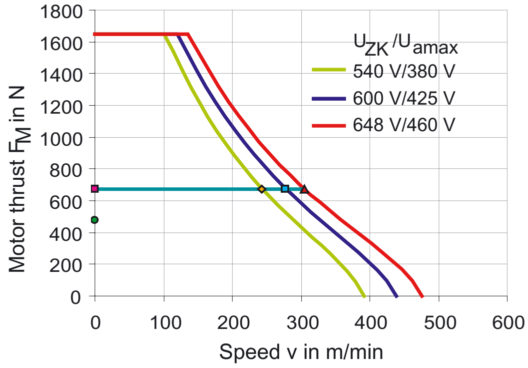


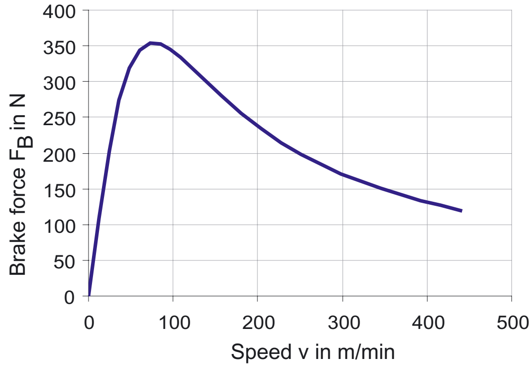
1FN3100-3WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	675
Rated current	I_N	A	7.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	277
Rated power loss	$P_{V,N}$	W	820
Limiting data			
Maximum thrust	F_{MAX}	N	1650
Maximum current	I_{MAX}	A	19.1
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	120
Maximum electric power input	$P_{EL,MAX}$	W	9160
Stall thrust	F_0*	N	477
Stall current	I_0*	A	5.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	27.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.8
Phase inductance	L_{STR}	mH	20
Attraction force	F_A	N	3980
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	5.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	6.2
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	825
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	4.7
Pressure drop	$\Delta p_{P,H}$	bar	1.49
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	25
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.14
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	60
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3

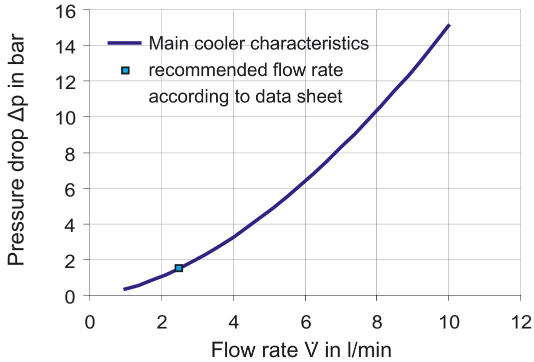
1FN3100-3WC00-0AA1 characteristics

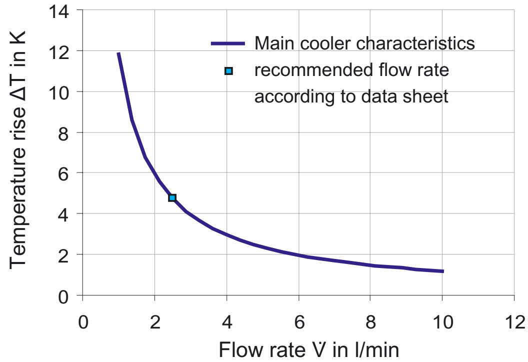
Thrust characteristics



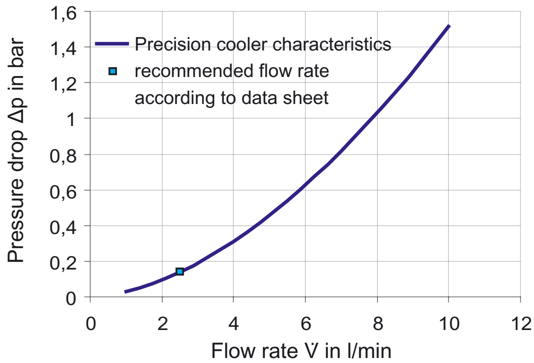


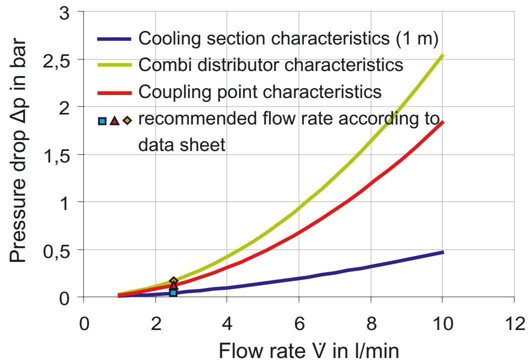
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



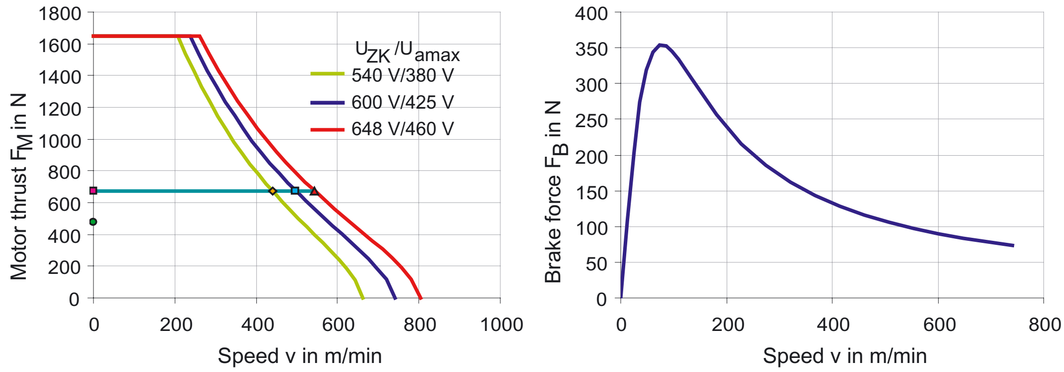


1FN3

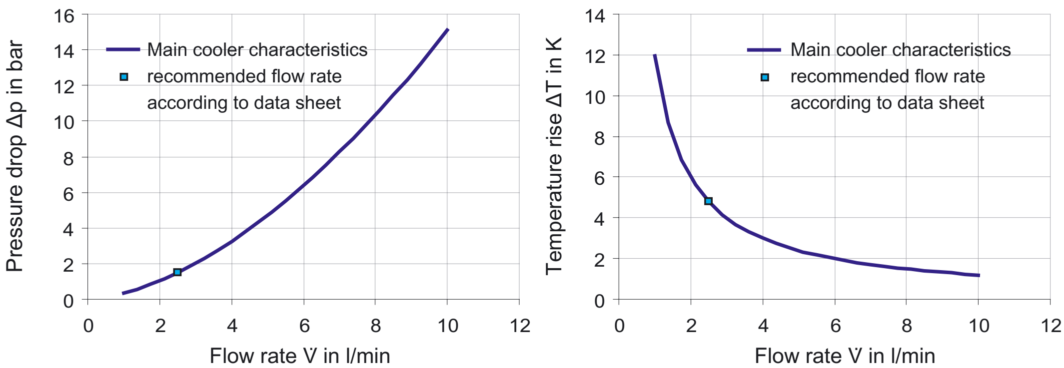
1FN3100-3WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	675
Rated current	I_N	A	12.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	497
Rated power loss	$P_{V,N}$	W	830
Limiting data			
Maximum thrust	F_{MAX}	N	1650
Maximum current	I_{MAX}	A	32.2
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	237
Maximum electric power input	$P_{EL,MAX}$	W	12420
Stall thrust	F_0*	N	477
Stall current	I_0*	A	8.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	56
Voltage constant	k_E	Vs/m	18.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	27.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.4
Phase inductance	L_{STR}	mH	7
Attraction force	F_A	N	3980
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	5.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	6.2
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	830
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2,5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	4,8
Pressure drop	$\Delta p_{P,H}$	bar	1,49
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	25
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.14
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	60
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3100-3WE00-0AA1 characteristics

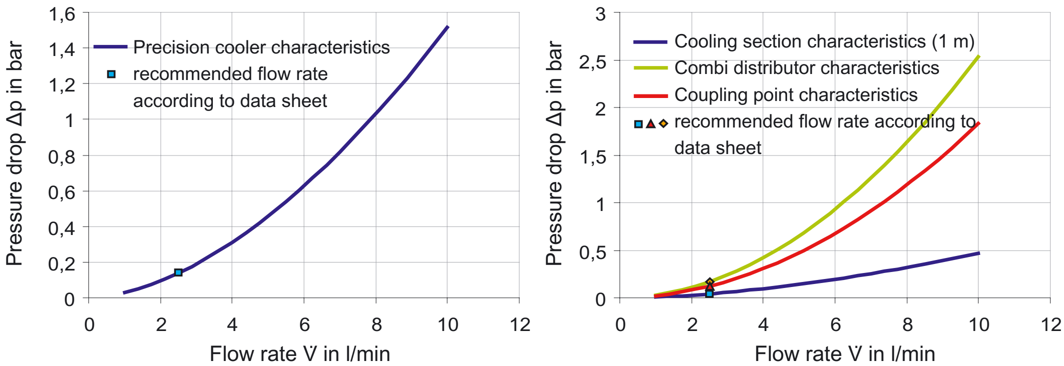
Thrust characteristics



Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



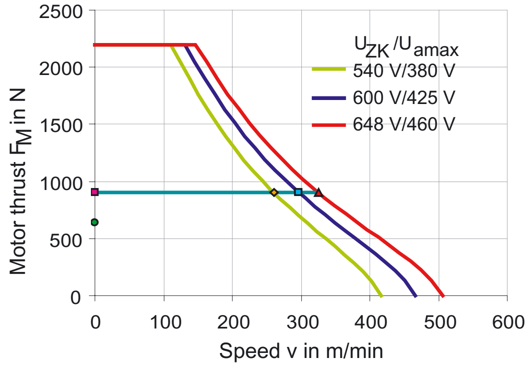
1FN3

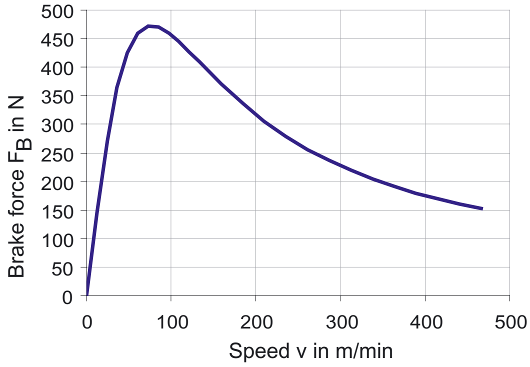
1FN3

1FN3100-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	900
Rated current	I_N	A	10.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	297
Rated power loss	$P_{V,N}$	W	1100
Limiting data			
Maximum thrust	F_{MAX}	N	2200
Maximum current	I_{MAX}	A	27
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	131
Maximum electric power input	$P_{EL,MAX}$	W	12620
Stall thrust	F_0*	N	636
Stall current	I_0*	A	7.2
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	89
Voltage constant	k_E	Vs/m	29.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	32
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.6
Phase inductance	L_{STR}	mH	13.3
Attraction force	F_A	N	5310
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	7.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	8.5
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1100
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	6.3
Pressure drop	$\Delta p_{P,H}$	bar	1.94
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	30
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.17
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	79
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3100-4WC00-0AA1 characteristics

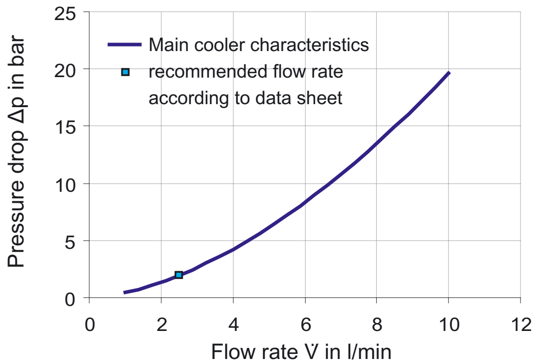
Thrust characteristics

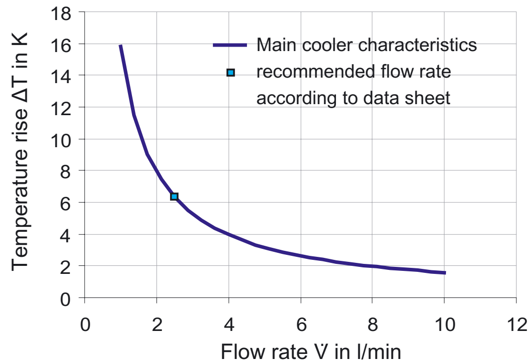




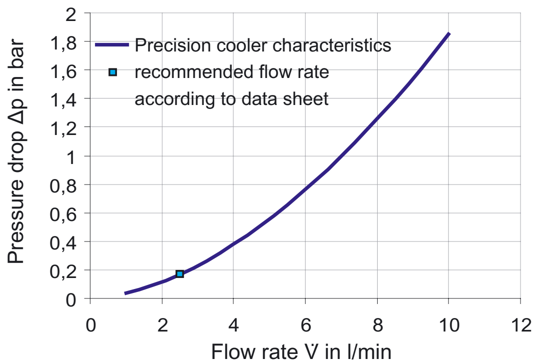
1FN3

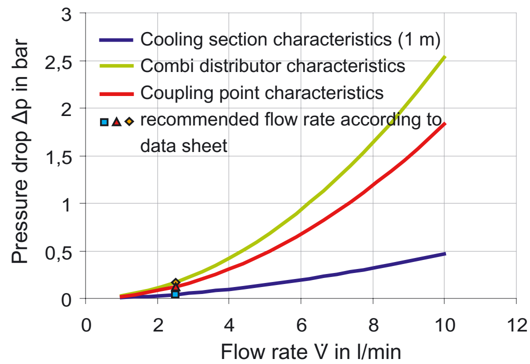
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





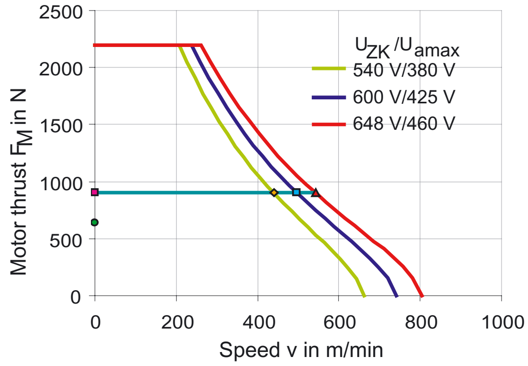
1FN3

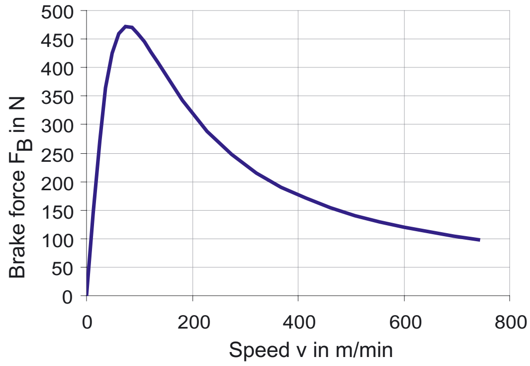
1FN3100-4WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	900
Rated current	I_N	A	16.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	497
Rated power loss	$P_{V,N}$	W	1110
Limiting data			
Maximum thrust	F_{MAX}	N	2200
Maximum current	I_{MAX}	A	43
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	237
Maximum electric power input	$P_{EL,MAX}$	W	16560
Stall thrust	F_0*	N	636
Stall current	I_0*	A	11.4
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	56
Voltage constant	k_E	Vs/m	18.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	31.9
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1
Phase inductance	L_{STR}	mH	5.3
Attraction force	F_A	N	5310
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	7.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	8.5
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1110
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	6.4
Pressure drop	$\Delta p_{P,H}$	bar	1.94
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	30
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.17
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	79
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3

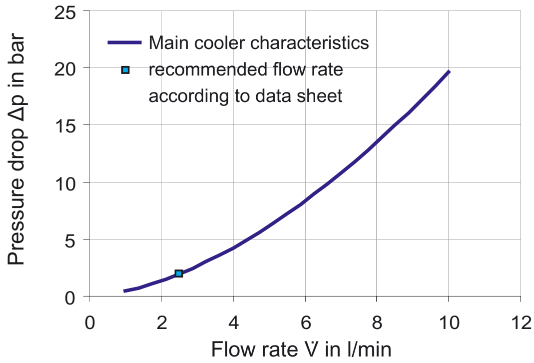
1FN3100-4WE00-0AA1 characteristics

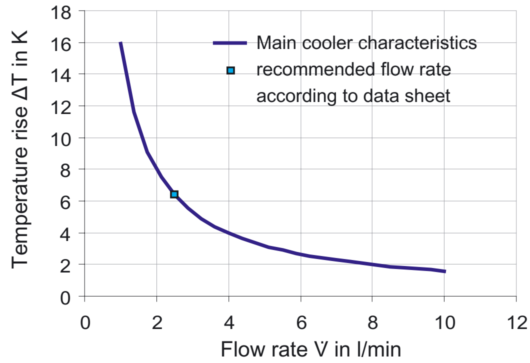
Thrust characteristics



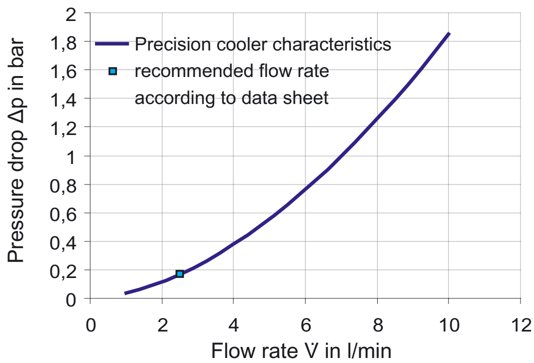


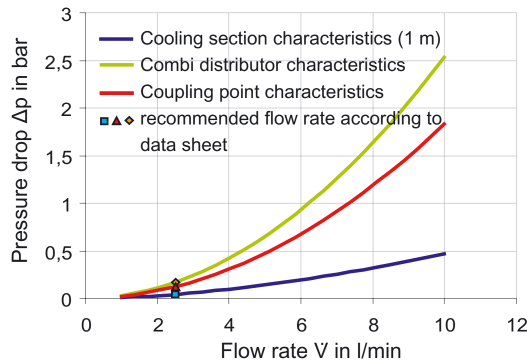
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



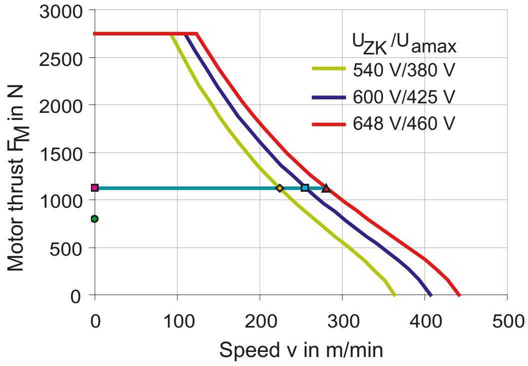


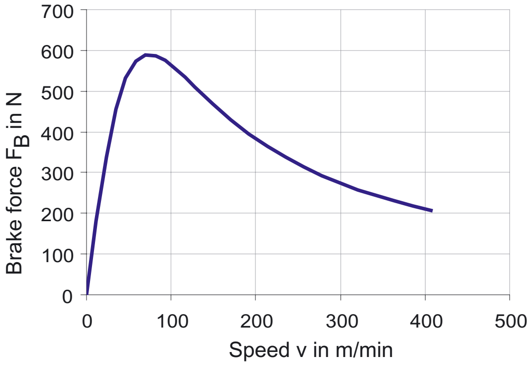
1FN3

1FN3100-5WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1125
Rated current	I_N	A	11
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	255
Rated power loss	$P_{V,N}$	W	1320
Limiting data			
Maximum thrust	F_{MAX}	N	2750
Maximum current	I_{MAX}	A	29.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	109
Maximum electric power input	$P_{EL,MAX}$	W	14390
Stall thrust	F_0*	N	795
Stall current	I_0*	A	7.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	102
Voltage constant	k_E	Vs/m	33.9
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	36.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.6
Phase inductance	L_{STR}	mH	14
Attraction force	F_A	N	6630
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	9.1
Mass of the primary section with precision cooler	$m_{P,P}$	kg	10.4
Mass secondary section	m_S	kg	0.7
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	0.8
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1320
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.6
Pressure drop	$\Delta p_{P,H}$	bar	2.4
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.5
Pressure drop	$\Delta p_{P,P}$	bar	0.2
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	97
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.04
Pressure drop per combi distributor	Δp_{KV}	bar	0.17
Pressure drop per coupling point	Δp_{KS}	bar	0.12

1FN3100-5WC00-0AA1 characteristics

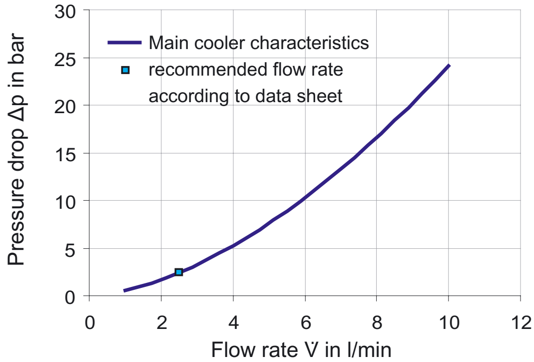
Thrust characteristics

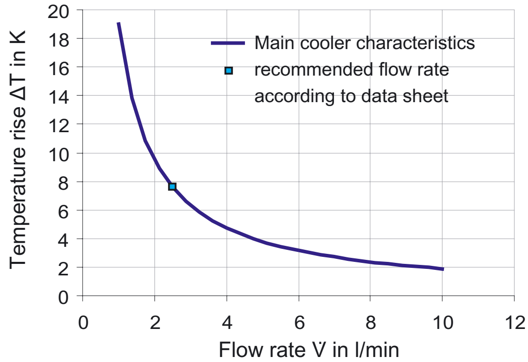




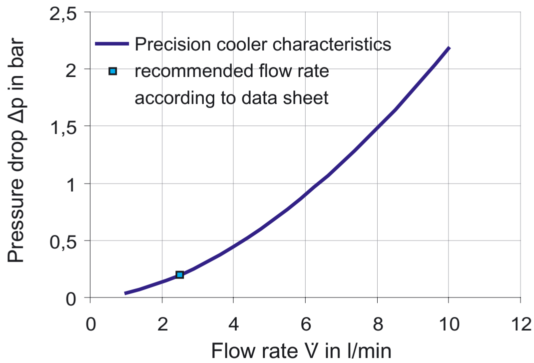
1FN3

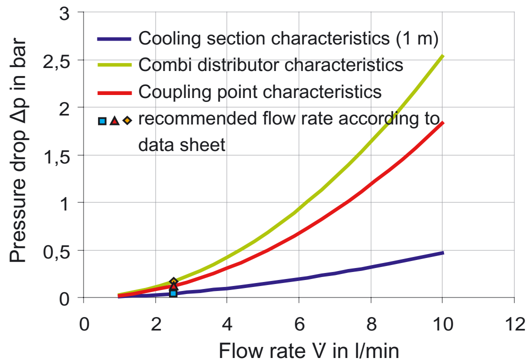
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



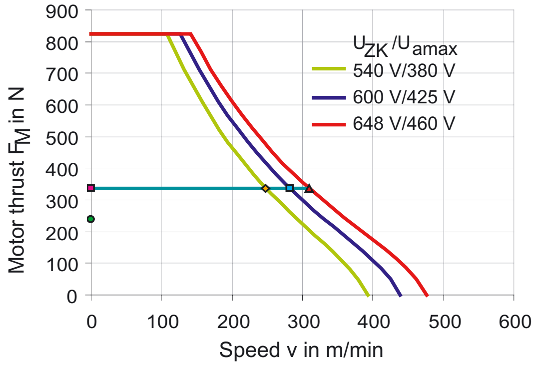


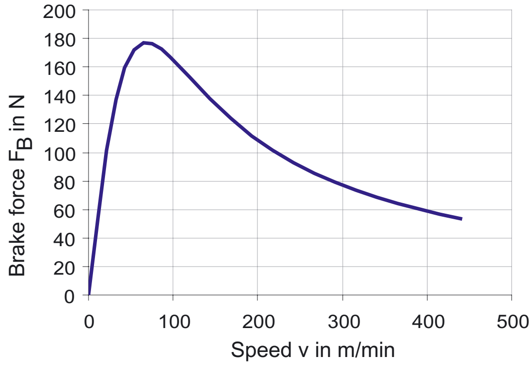
1FN3

1FN3150-1WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	340
Rated current	I_N	A	3.6
maximum speed at rated thrust	$v_{MAX,FN}$	m/min	282
Rated power loss	$P_{V,N}$	W	370
Limiting data			
Maximum thrust	F_{MAX}	N	820
Maximum current	I_{MAX}	A	9.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	126
Maximum electric power input	$P_{EL,MAX}$	W	4340
Stall thrust	F_0*	N	239
Stall current	I_0*	A	2.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	20.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	6.8
Phase inductance	L_{STR}	mH	39.9
Attraction force	F_A	N	1990
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	3
Mass of the primary section with precision cooler	$m_{P,P}$	kg	–
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	365
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	1.9
Pressure drop	$\Delta p_{P,H}$	bar	0.81
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	–
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	–
Pressure drop	$\Delta p_{P,P}$	bar	–
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	30
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0.05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

1FN3150-1WC00-0AA1 characteristics

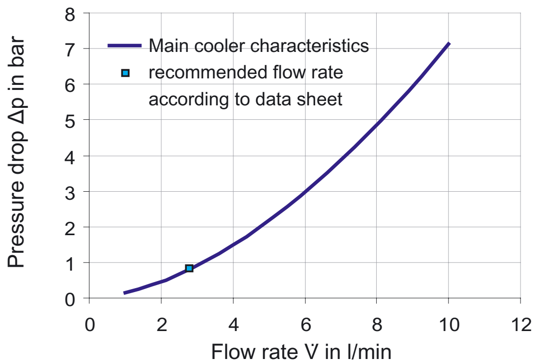
Thrust characteristics

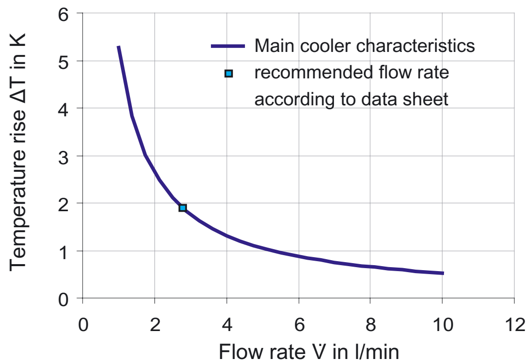




1FN3

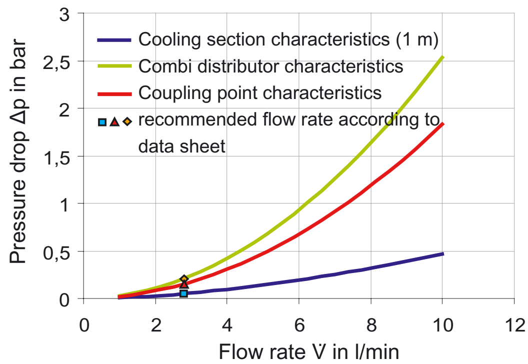
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

no precision cooler installed!

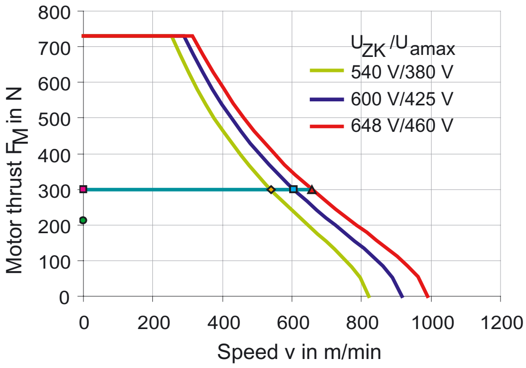


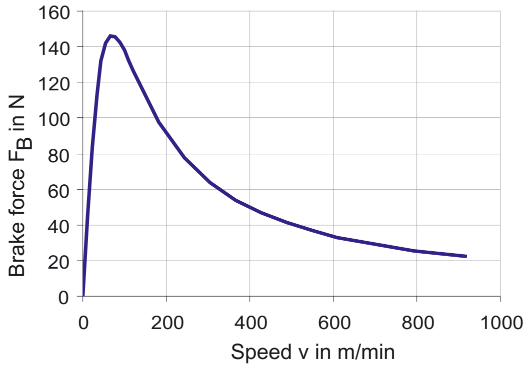
1FN3

1FN3150-1WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	300
Rated current	I_N	A	6.4
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	605
Rated power loss	$P_{V,N}$	W	350
Limiting data			
Maximum thrust	F_{MAX}	N	730
Maximum current	I_{MAX}	A	17
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	288
Maximum electric power input	$P_{EL,MAX}$	W	6010
Stall thrust	F_0*	N	211
Stall current	I_0*	A	4.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	47
Voltage constant	k_E	Vs/m	15.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	18.7
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.1
Phase inductance	L_{STR}	mH	12.7
Attraction force	F_A	N	2270
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	3
Mass of the primary section with precision cooler	$m_{P,P}$	kg	–
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	355
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	1.8
Pressure drop	$\Delta p_{P,H}$	bar	0.81
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	–
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	–
Pressure drop	$\Delta p_{P,P}$	bar	–
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	30
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0.05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

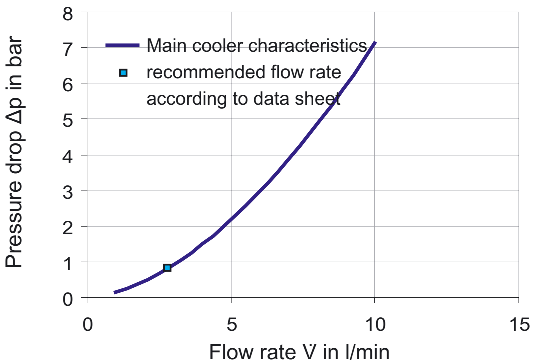
1FN3150-1WE00-0AA1 characteristics

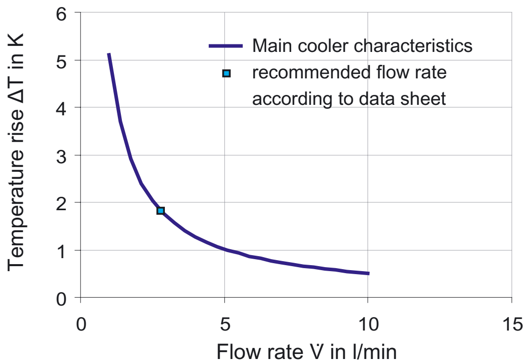
Thrust characteristics





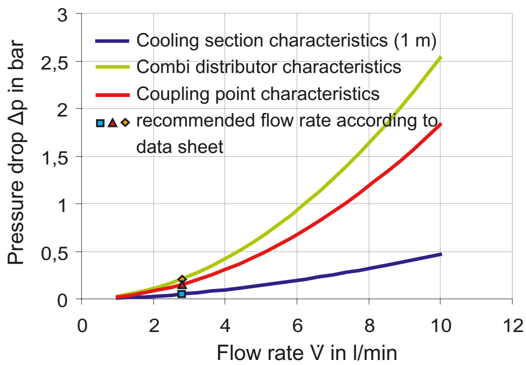
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

no precision cooler installed!

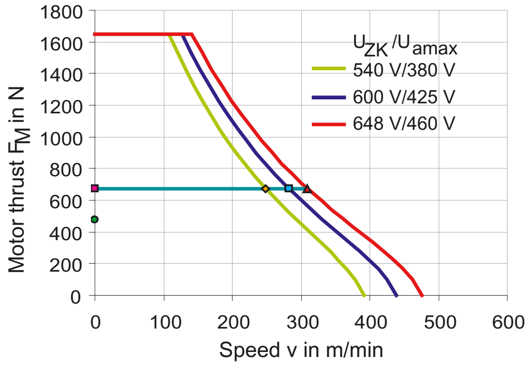


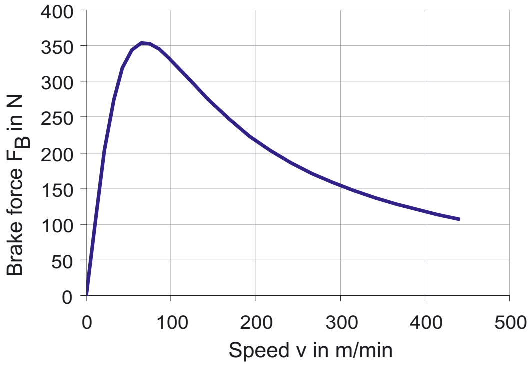
1FN3

1FN3150-2WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	675
Rated current	I_N	A	7.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	282
Rated power loss	$P_{V,N}$	W	730
Limiting data			
Maximum thrust	F_{MAX}	N	1650
Maximum current	I_{MAX}	A	19.1
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	126
Maximum electric power input	$P_{EL,MAX}$	W	8680
Stall thrust	F_0*	N	477
Stall current	I_0*	A	5.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	29.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.4
Phase inductance	L_{STR}	mH	20
Attraction force	F_A	N	3980
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	5.3
Mass of the primary section with precision cooler	$m_{P,P}$	kg	6
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	735
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.8
Pressure drop	$\Delta p_{P,H}$	bar	1.49
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	20
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.8
Pressure drop	$\Delta p_{P,P}$	bar	0.14
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0.05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

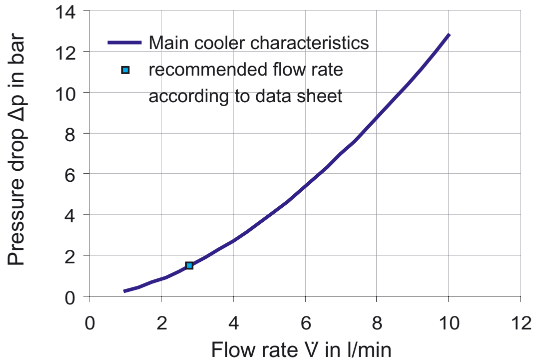
1FN3150-2WC00-0AA1 characteristics

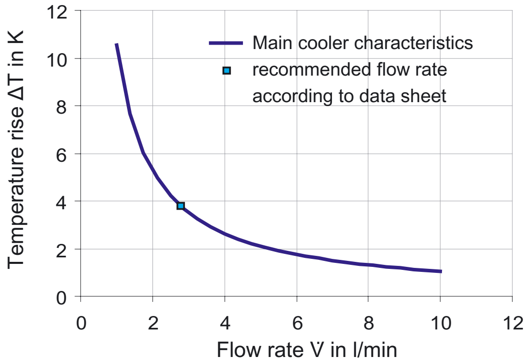
Thrust characteristics



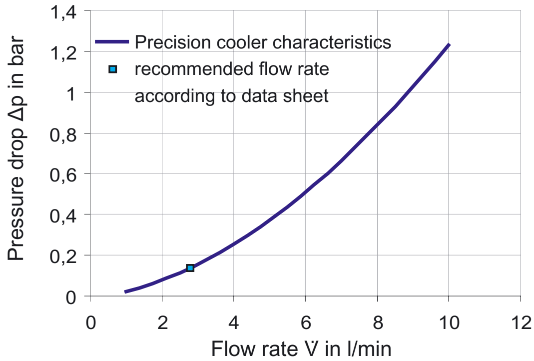


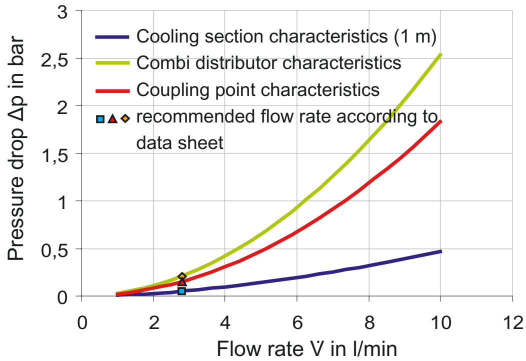
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



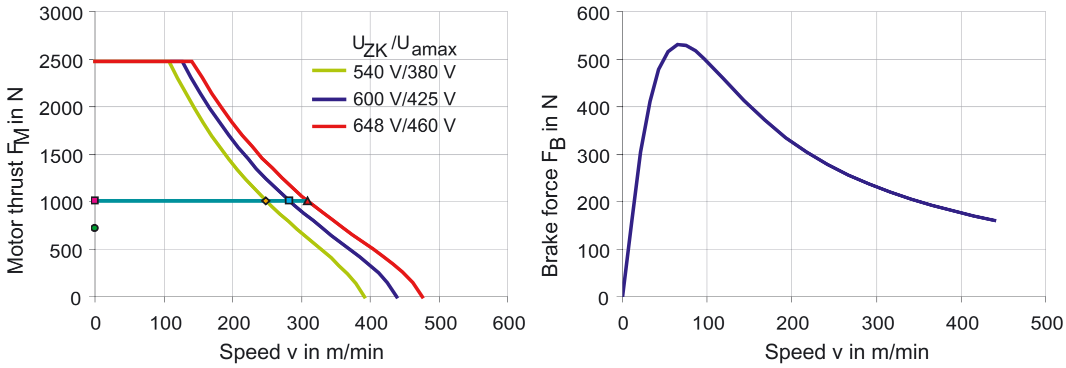


1FN3

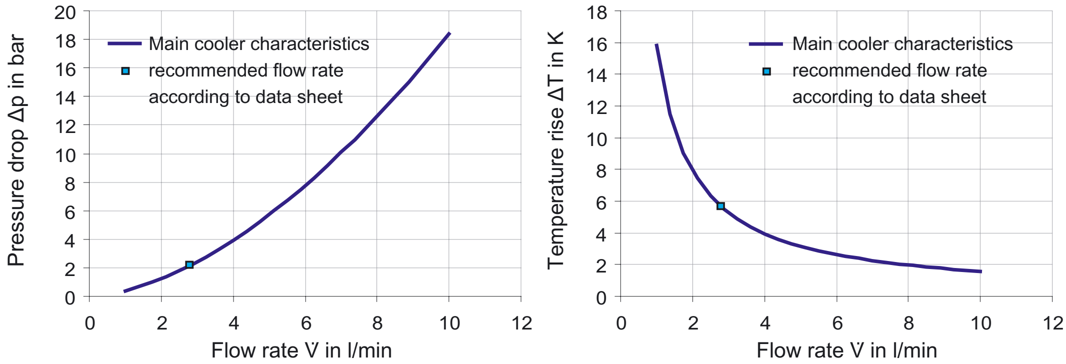
1FN3150-3WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1010
Rated current	I_N	A	10.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	282
Rated power loss	$P_{V,N}$	W	1100
Limiting data			
Maximum thrust	F_{MAX}	N	2470
Maximum current	I_{MAX}	A	28.6
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	126
Maximum electric power input	$P_{EL,MAX}$	W	13020
Stall thrust	F_0*	N	716
Stall current	I_0*	A	7.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	36
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2.3
Phase inductance	L_{STR}	mH	13.3
Attraction force	F_A	N	5970
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	7.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	8.7
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1100
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.6
Pressure drop	$\Delta p_{P,H}$	bar	2.16
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	25
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.8
Pressure drop	$\Delta p_{P,P}$	bar	0.17
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	81
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0,05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

1FN3150-3WC00-0AA1 characteristics

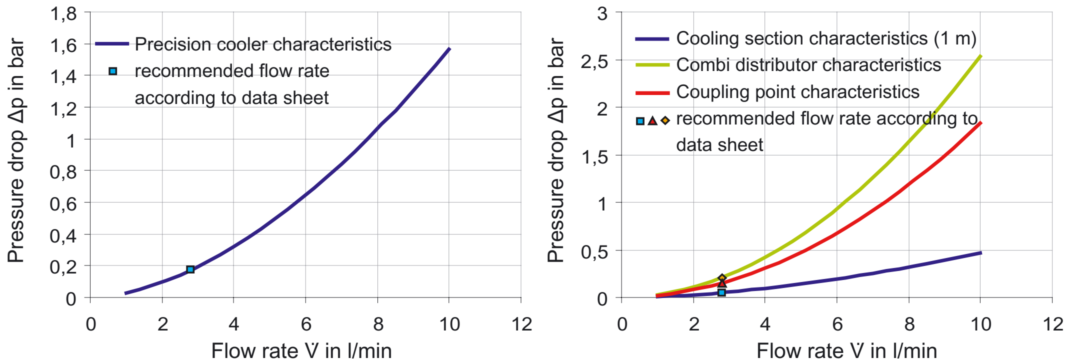
Thrust characteristics



Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



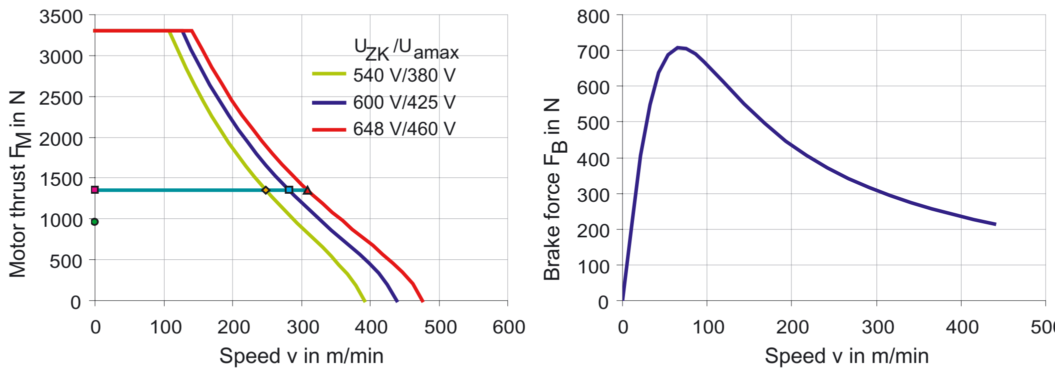
1FN3

1FN3150-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1350
Rated current	I_N	A	14.3
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	282
Rated power loss	$P_{V,N}$	W	1470
Limiting data			
Maximum thrust	F_{MAX}	N	3300
Maximum current	I_{MAX}	A	38.2
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	126
Maximum electric power input	$P_{EL,MAX}$	W	17360
Stall thrust	F_0*	N	955
Stall current	I_0*	A	10.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	41.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.7
Phase inductance	L_{STR}	mH	10
Attraction force	F_A	N	7960
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	10.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	11.4
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1465
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.5
Pressure drop	$\Delta p_{P,H}$	bar	2.84
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.8
Pressure drop	$\Delta p_{P,P}$	bar	0.21
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	106
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0.05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

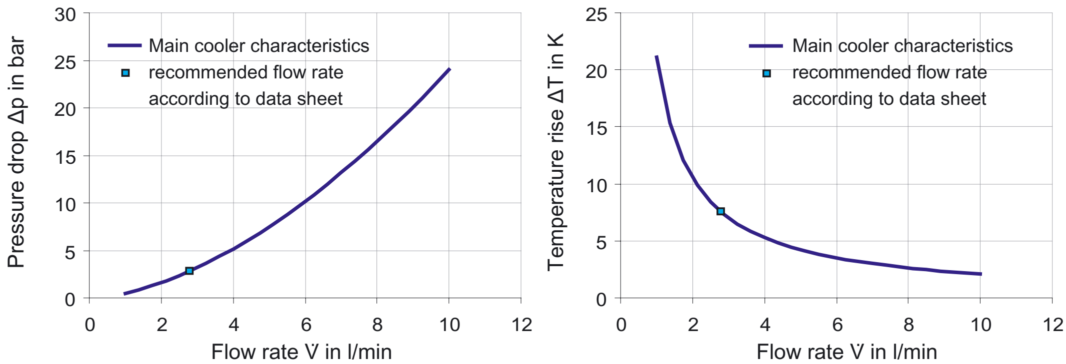
1FN3

1FN3150-4WC00-0AA1 characteristics

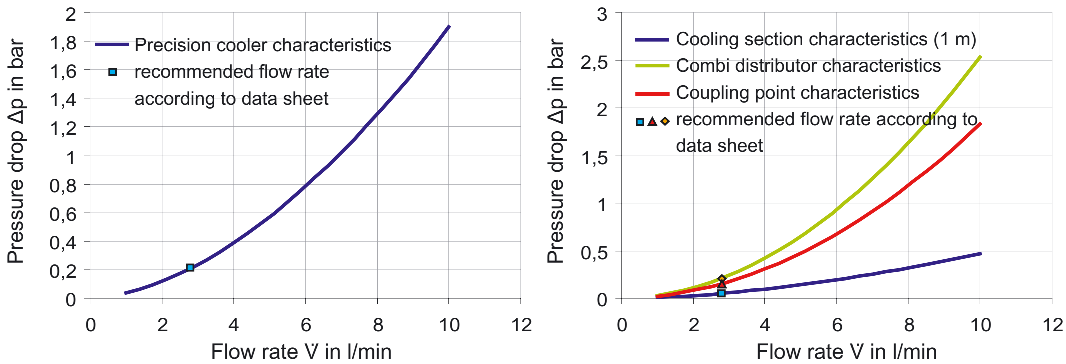
Thrust characteristics



Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

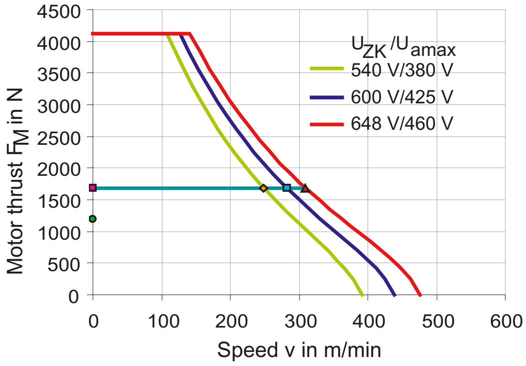


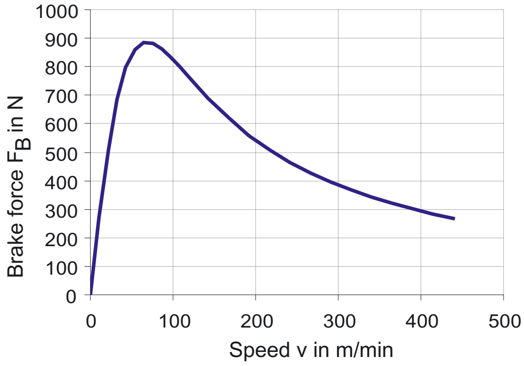
1FN3

1FN3150-5WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1690
Rated current	I_N	A	17.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	282
Rated power loss	$P_{V,N}$	W	1830
Limiting data			
Maximum thrust	F_{MAX}	N	4120
Maximum current	I_{MAX}	A	47.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	126
Maximum electric power input	$P_{EL,MAX}$	W	21700
Stall thrust	F_0*	N	1193
Stall current	I_0*	A	12.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	94
Voltage constant	k_E	Vs/m	31.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	46.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.4
Phase inductance	L_{STR}	mH	8
Attraction force	F_A	N	9950
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	15
Mass primary section	m_P	kg	12.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	14.2
Mass secondary section	m_S	kg	1.2
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	1.3
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1830
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	2.8
Cooling medium temperature increase	$\Delta T_{P,H}$	K	9.4
Pressure drop	$\Delta p_{P,H}$	bar	3.51
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	40
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	2.8
Pressure drop	$\Delta p_{P,P}$	bar	0.24
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	131
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	2.8
Pressure drop per meter secondary section cooling	Δp_S	bar	0.05
Pressure drop per combi distributor	Δp_{KV}	bar	0.21
Pressure drop per coupling point	Δp_{KS}	bar	0.15

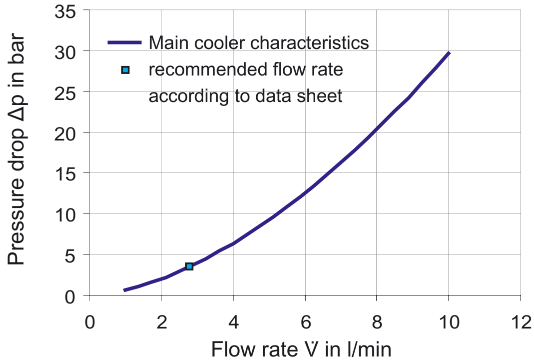
1FN3150-5WC00-0AA1 characteristics

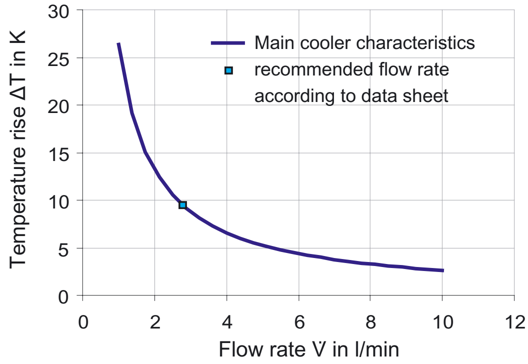
Thrust characteristics



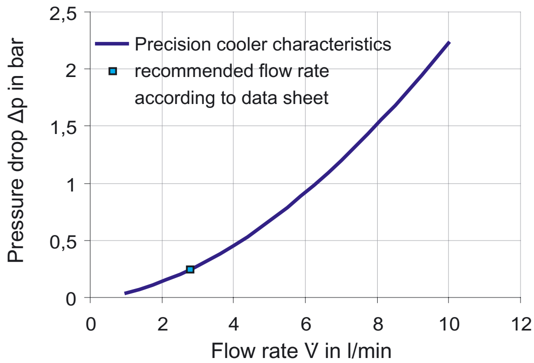


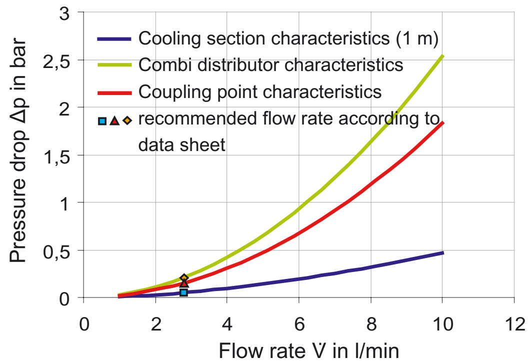
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



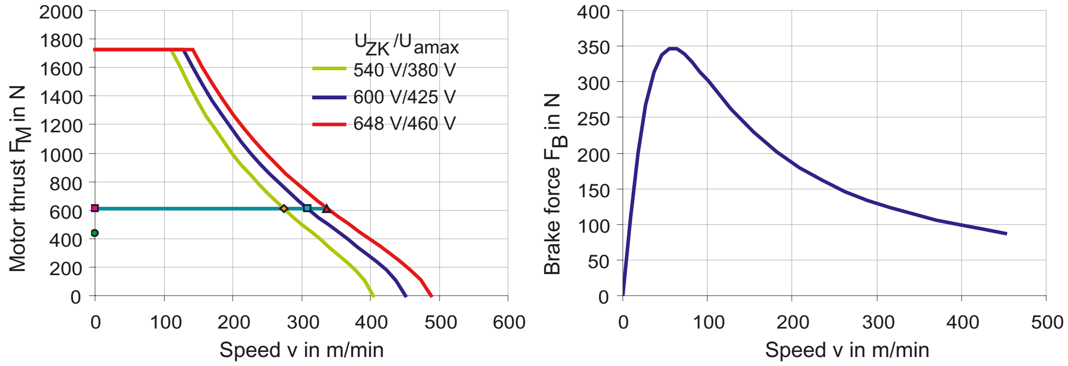


1FN3

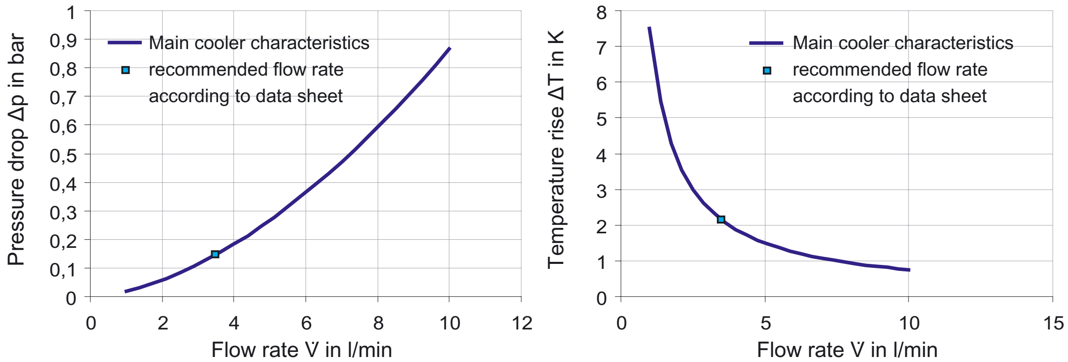
1FN3300-1WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	610
Rated current	I_N	A	6.5
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	309
Rated power loss	$P_{V,N}$	W	520
Limiting data			
Maximum thrust	F_{MAX}	N	1720
Maximum current	I_{MAX}	A	20
Maximum speed at maximum power	$v_{MAX,FMAX}$	m/min	128
Maximum electric power input	$P_{EL,MAX}$	W	8680
Stall thrust	F_0*	N	433
Stall current	I_0*	A	4.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	95
Voltage constant	k_E	Vs/m	31.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	31.7
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3
Phase inductance	L_{STR}	mH	31.5
Attraction force	F_A	N	3430
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	6.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	–
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	520
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	3.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	2.1
Pressure drop	$\Delta p_{P,H}$	bar	0.15
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	–
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	–
Pressure drop	$\Delta p_{P,P}$	bar	–
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	50
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	3.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.08
Pressure drop per combi distributor	Δp_{KV}	bar	0.32
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3300-1WC00-0AA1 characteristics

Thrust characteristics

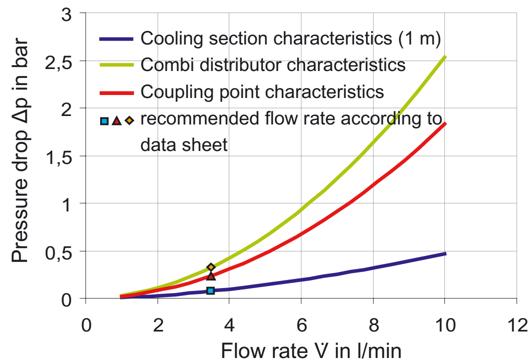


Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

no precision cooler installed!

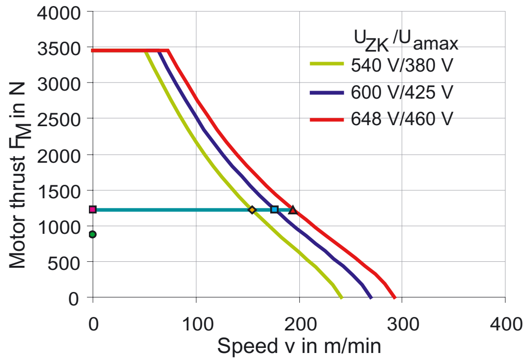


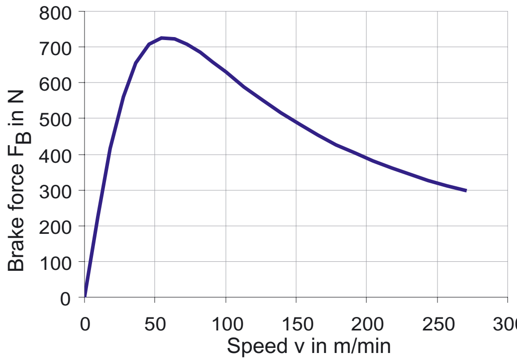
1FN3

1FN3300-2WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1225
Rated current	I_N	A	8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	176
Rated power loss	$P_{V,N}$	W	990
Limiting data			
Maximum thrust	F_{MAX}	N	3450
Maximum current	I_{MAX}	A	24.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	63
Maximum electric power input	$P_{EL,MAX}$	W	13160
Stall thrust	F_0*	N	866
Stall current	I_0*	A	5.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	153
Voltage constant	k_E	Vs/m	51.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	45.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.7
Phase inductance	L_{STR}	mH	39.5
Attraction force	F_A	N	6870
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	11.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	12.4
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.6
Pressure drop	$\Delta p_{P,H}$	bar	0.32
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.33
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	93
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

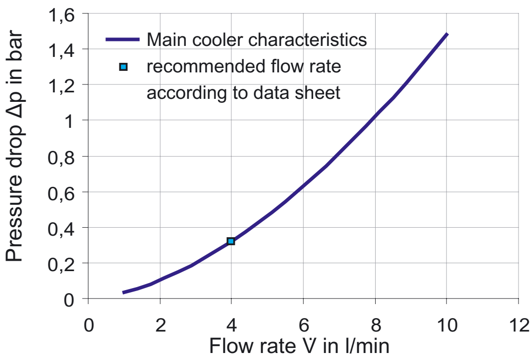
1FN3300-2WB00-0AA1 characteristics

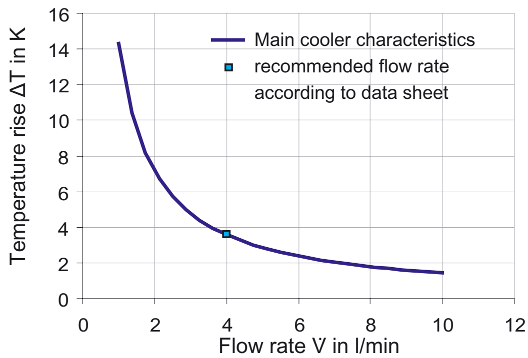
Thrust characteristics



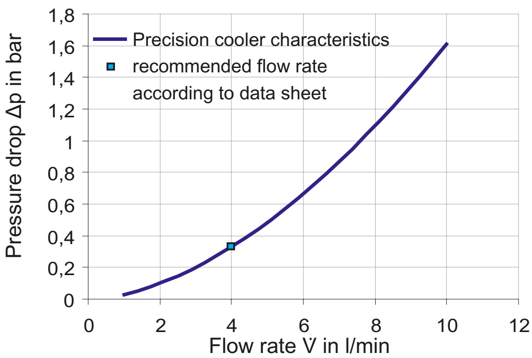


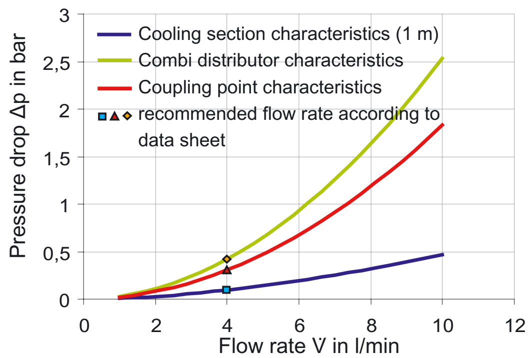
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

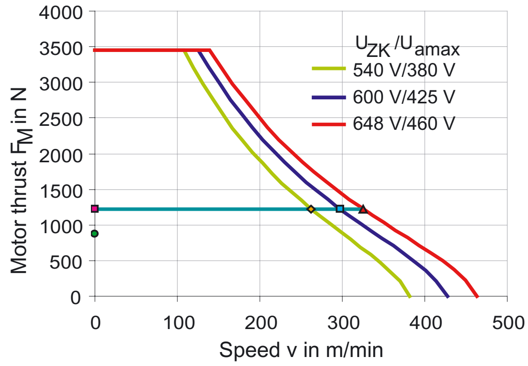


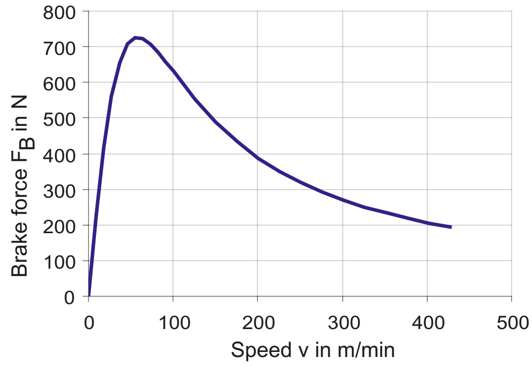


1FN3300-2WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1225
Rated current	I_N	A	12.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	297
Rated power loss	$P_{V,N}$	W	1000
Limiting data			
Maximum thrust	F_{MAX}	N	3450
Maximum current	I_{MAX}	A	39.2
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	125
Maximum electric power input	$P_{EL,MAX}$	W	16750
Stall thrust	F_0*	N	866
Stall current	I_0*	A	8.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	97
Voltage constant	k_E	Vs/m	32.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	45.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.5
Phase inductance	L_{STR}	mH	15.7
Attraction force	F_A	N	6870
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	11.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	12.4
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.6
Pressure drop	$\Delta p_{P,H}$	bar	0.32
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.33
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	93
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

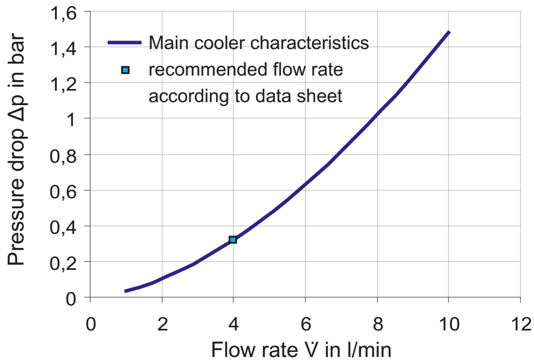
1FN3300-2WC00-0AA1 characteristics

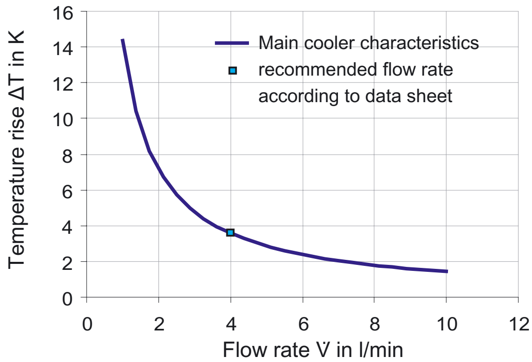
Thrust characteristics



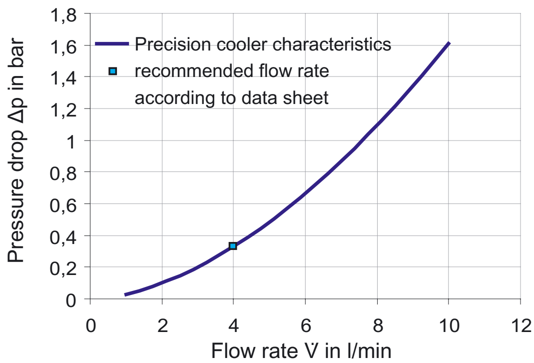


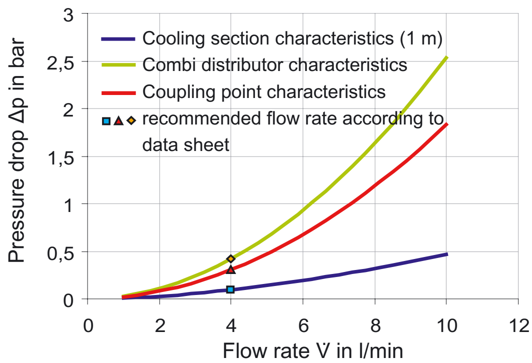
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





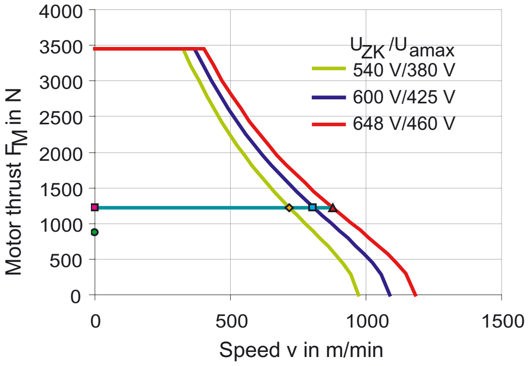
1FN3

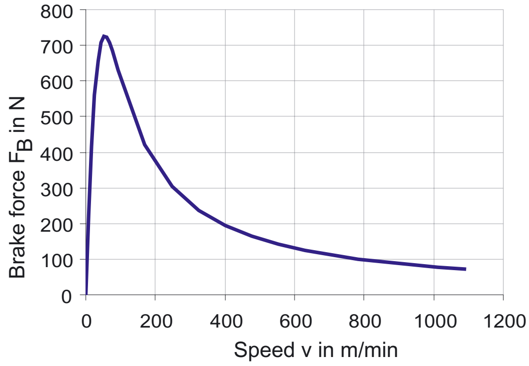
1FN3300-2WG00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1225
Rated current	I_N	A	32.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	805
Rated power loss	$P_{V,N}$	W	930
Limiting data			
Maximum thrust	F_{MAX}	N	3450
Maximum current	I_{MAX}	A	99.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	369
Maximum electric power input	$P_{EL,MAX}$	W	30140
Stall thrust	F_0*	N	866
Stall current	I_0*	A	22.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	38
Voltage constant	k_E	Vs/m	12.7
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	47.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.2
Phase inductance	L_{STR}	mH	2.4
Attraction force	F_A	N	6870
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	11.4
Mass of the primary section with precision cooler	$m_{P,P}$	kg	12.4
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	930
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	3.4
Pressure drop	$\Delta p_{P,H}$	bar	0.32
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.33
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	93
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

1FN3

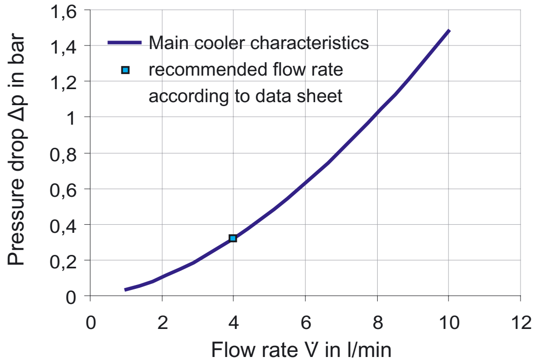
1FN3300-2WG00-0AA1 characteristics

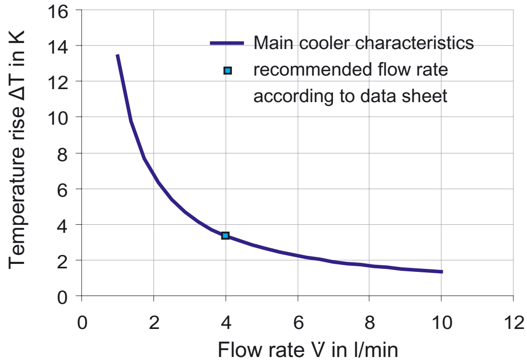
Thrust characteristics



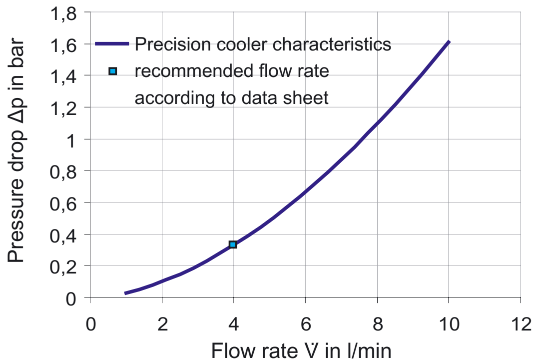


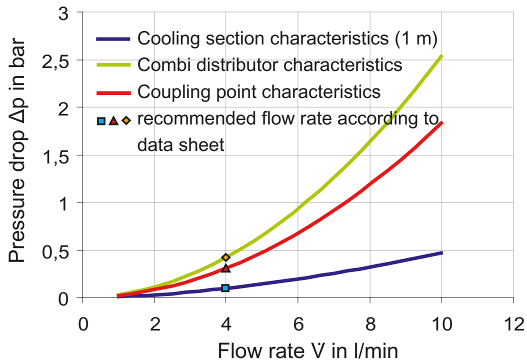
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



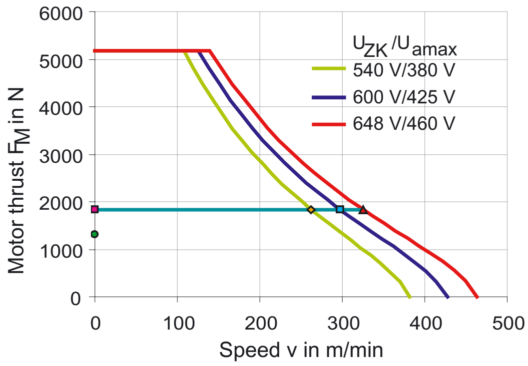


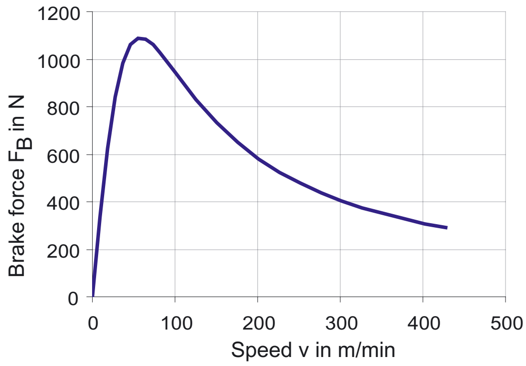
1FN3

1FN3300-3WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1840
Rated current	I_N	A	19
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	297
Rated power loss	$P_{V,N}$	W	1500
Limiting data			
Maximum thrust	F_{MAX}	N	5170
Maximum current	I_{MAX}	A	58.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	125
Maximum electric power input	$P_{EL,MAX}$	W	25120
Stall thrust	F_0*	N	1299
Stall current	I_0*	A	13.4
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	97
Voltage constant	k_E	Vs/m	32.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	56.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1
Phase inductance	L_{STR}	mH	10.5
Attraction force	F_A	N	10300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	17
Mass of the primary section with precision cooler	$m_{P,P}$	kg	18.4
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1495
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	4.8
Pressure drop	$\Delta p_{P,H}$	bar	0.56
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	50
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.53
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	136
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

1FN3300-3WC00-0AA1 characteristics

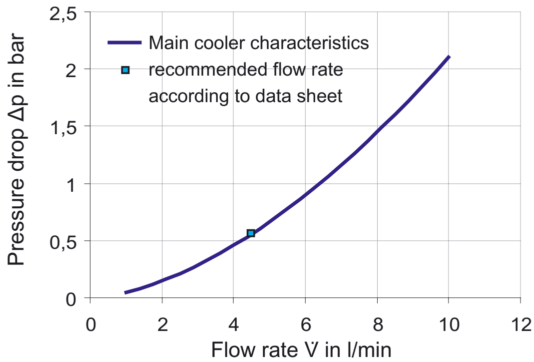
Thrust characteristics

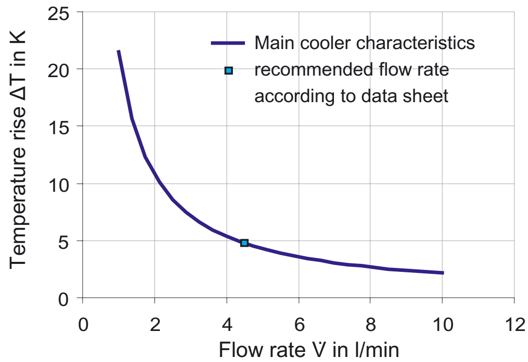




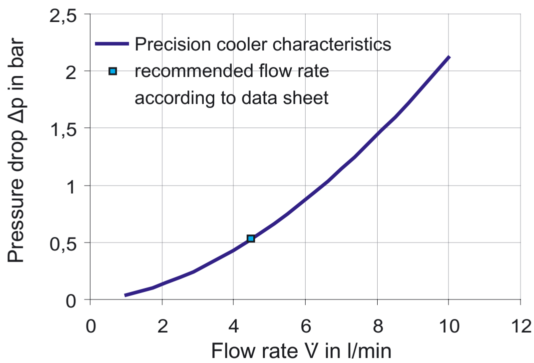
1FN3

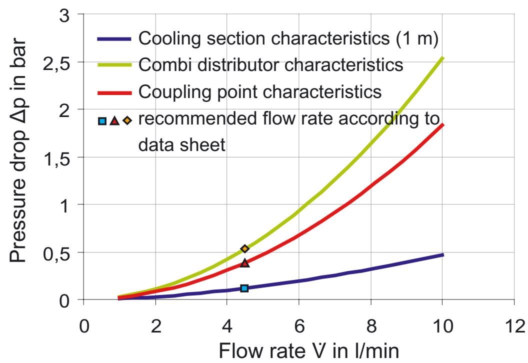
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





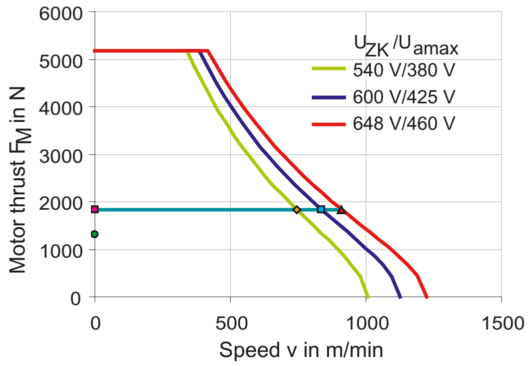
1FN3

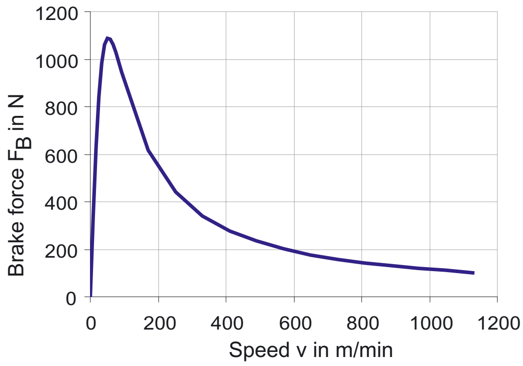
1FN3300-3WG00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1840
Rated current	I_N	A	50
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	836
Rated power loss	$P_{V,N}$	W	1370
Limiting data			
Maximum thrust	F_{MAX}	N	5170
Maximum current	I_{MAX}	A	154.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	383
Maximum electric power input	$P_{EL,MAX}$	W	46180
Stall thrust	F_0*	N	1299
Stall current	I_0*	A	35.4
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	37
Voltage constant	k_E	Vs/m	12.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	58.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.1
Phase inductance	L_{STR}	mH	1.5
Attraction force	F_A	N	10300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	17
Mass of the primary section with precision cooler	$m_{P,P}$	kg	18.4
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1370
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	4.4
Pressure drop	$\Delta p_{P,H}$	bar	0.56
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	50
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.53
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	136
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

1FN3

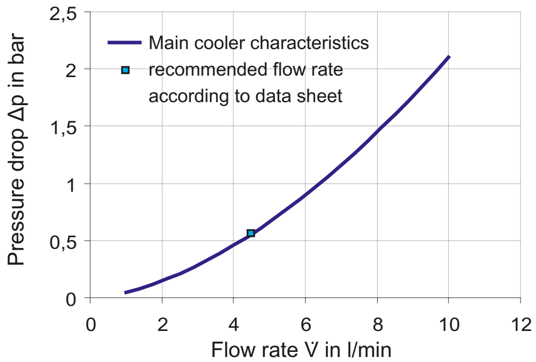
1FN3300-3WG00-0AA1 characteristics

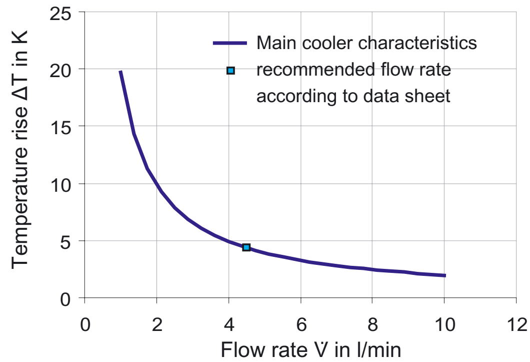
Thrust characteristics



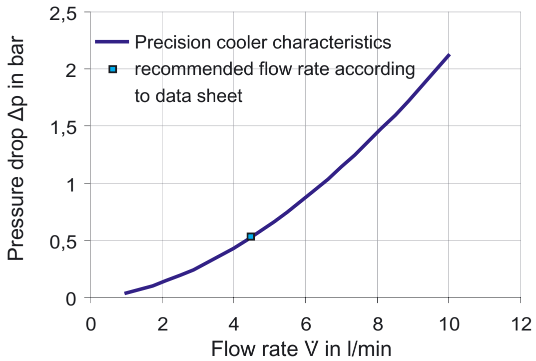


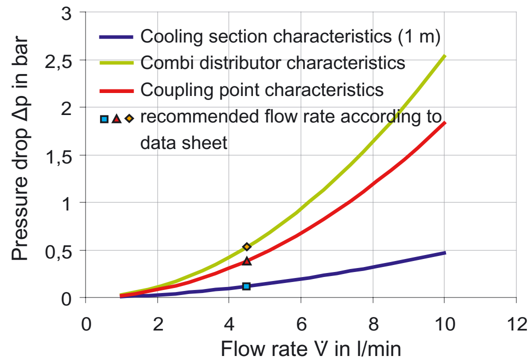
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



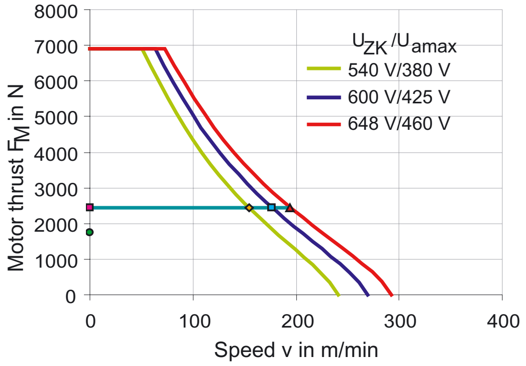


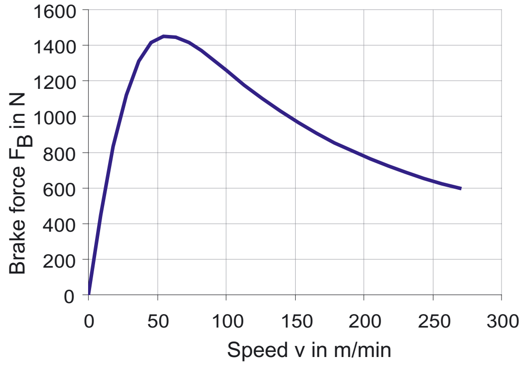
1FN3

1FN3300-4WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2450
Rated current	I_N	A	16
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	176
Rated power loss	$P_{V,N}$	W	1990
Limiting data			
Maximum thrust	F_{MAX}	N	6900
Maximum current	I_{MAX}	A	49.4
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	63
Maximum electric power input	$P_{EL,MAX}$	W	26330
Stall thrust	F_0*	N	1732
Stall current	I_0*	A	11.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	153
Voltage constant	k_E	Vs/m	51.2
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	64.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.9
Phase inductance	L_{STR}	mH	19.8
Attraction force	F_A	N	13730
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1990
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.7
Pressure drop	$\Delta p_{P,H}$	bar	0.86
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	65
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.79
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	180
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

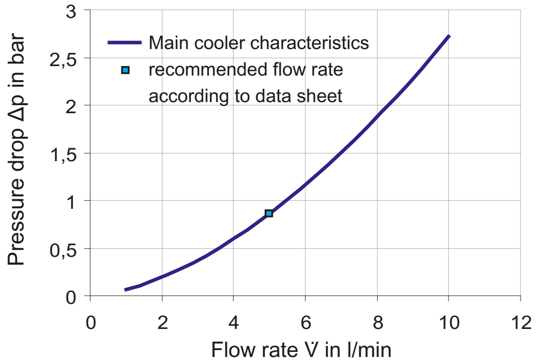
1FN3300-4WB00-0AA1 characteristics

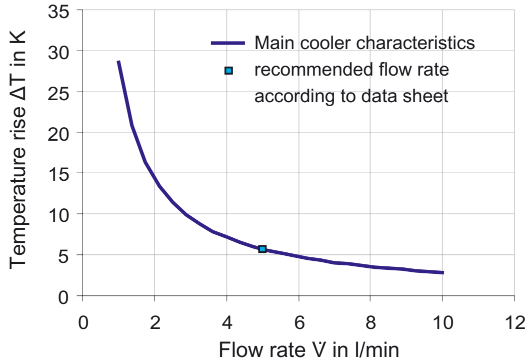
Thrust characteristics



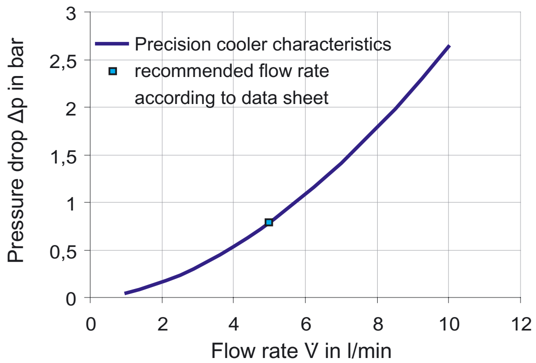


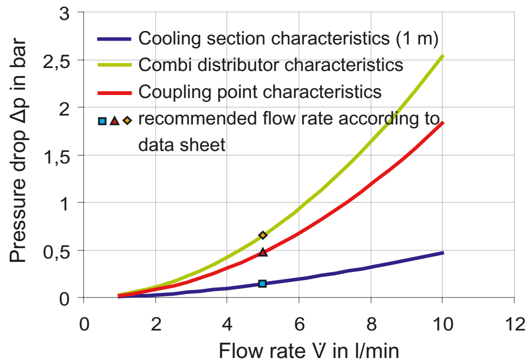
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



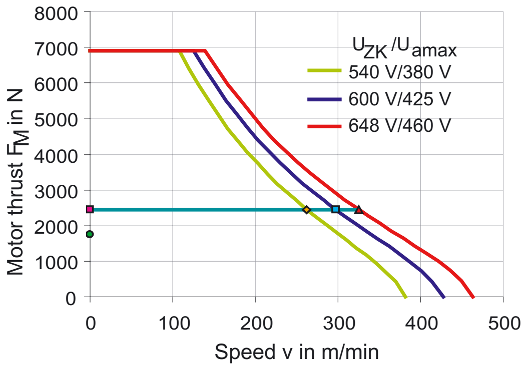


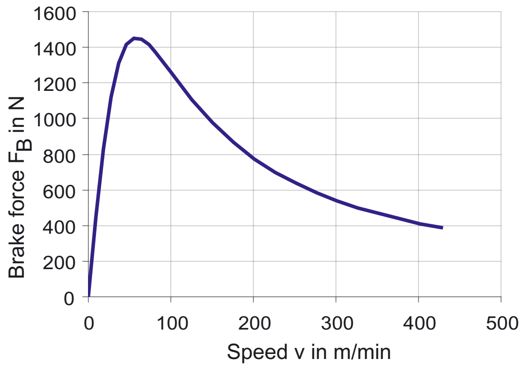
1FN3

1FN3300-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2450
Rated current	I_N	A	25.3
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	297
Rated power loss	$P_{V,N}$	W	1990
Limiting data			
Maximum thrust	F_{MAX}	N	6900
Maximum current	I_{MAX}	A	78.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	125
Maximum electric power input	$P_{EL,MAX}$	W	33500
Stall thrust	F_0*	N	1732
Stall current	I_0*	A	17.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	97
Voltage constant	k_E	Vs/m	32.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	64.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.7
Phase inductance	L_{STR}	mH	7.9
Attraction force	F_A	N	13730
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24
Mass secondary section	m_S	kg	2.4
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	2.6
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.7
Pressure drop	$\Delta p_{P,H}$	bar	0.86
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	65
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.79
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	180
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

1FN3300-4WC00-0AA1 characteristics

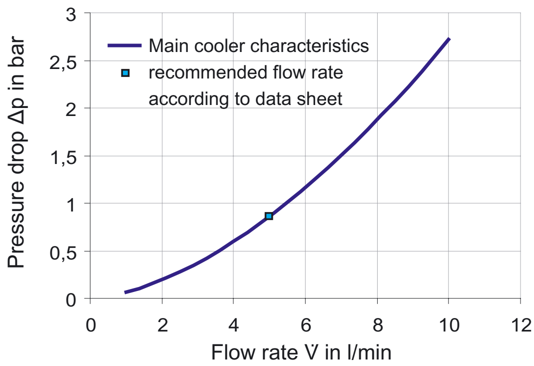
Thrust characteristics

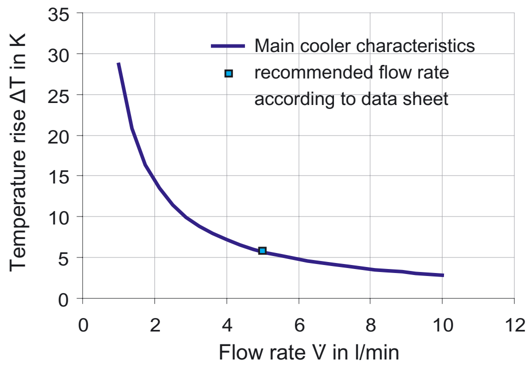




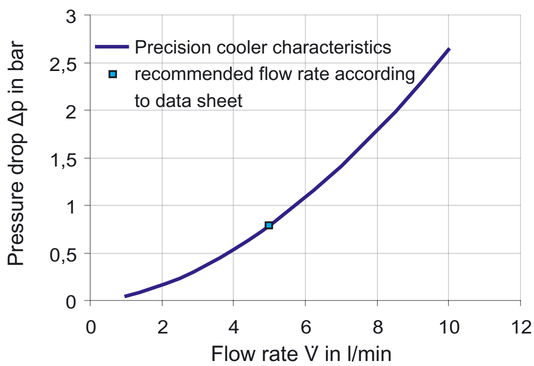
1FN3

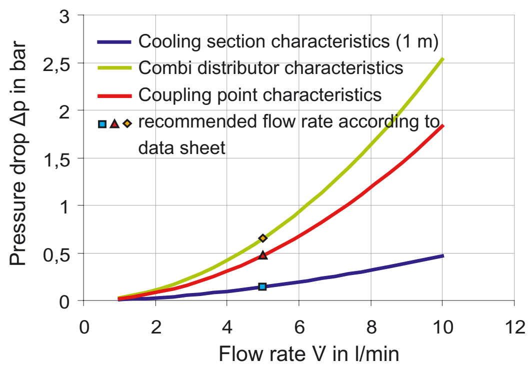
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



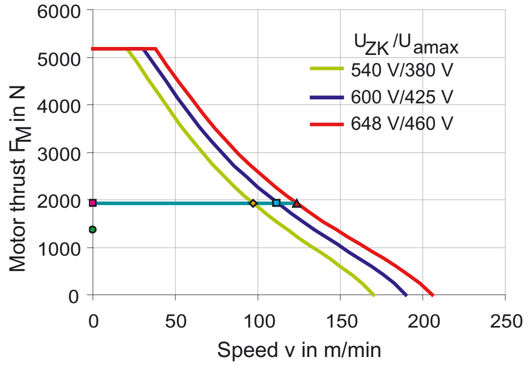


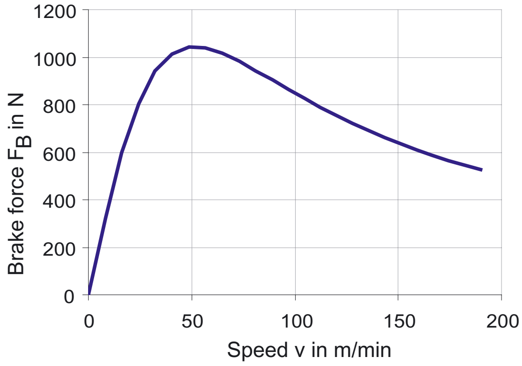
1FN3

1FN3450-2WA50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1930
Rated current	I_N	A	8.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	112
Rated power loss	$P_{V,N}$	W	1530
Limiting data			
Maximum thrust	F_{MAX}	N	5180
Maximum current	I_{MAX}	A	25.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	30
Maximum electric power input	$P_{EL,MAX}$	W	15940
Stall thrust	F_0*	N	1365
Stall current	I_0*	A	6.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	225
Voltage constant	k_E	Vs/m	75
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	58.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	5
Phase inductance	L_{STR}	mH	59.3
Attraction force	F_A	N	10300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	15.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	17.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1530
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.5
Pressure drop	$\Delta p_{P,H}$	bar	0.37
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.34
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	125
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

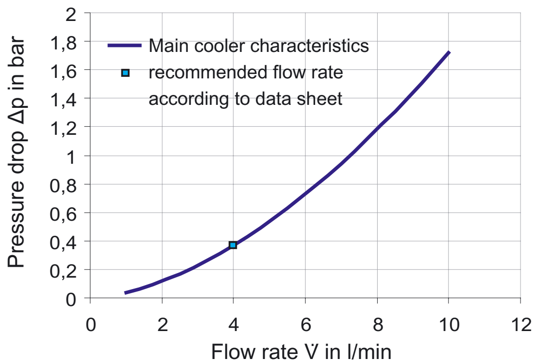
1FN3450-2WA50-0AA1 characteristics

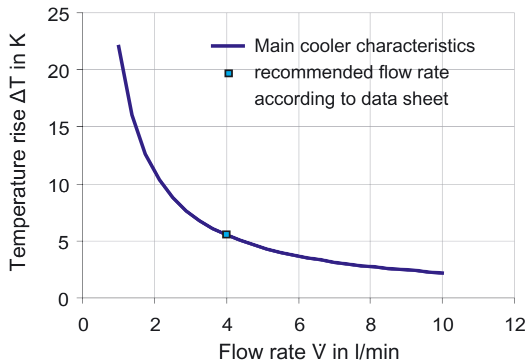
Thrust characteristics



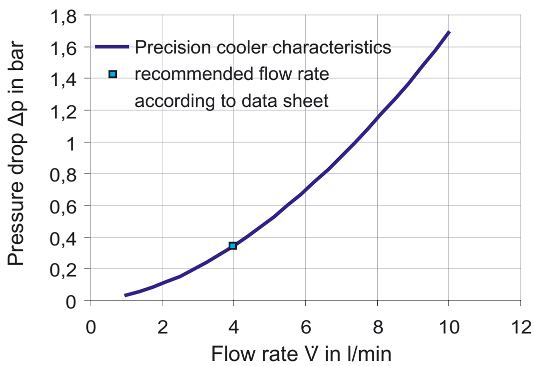


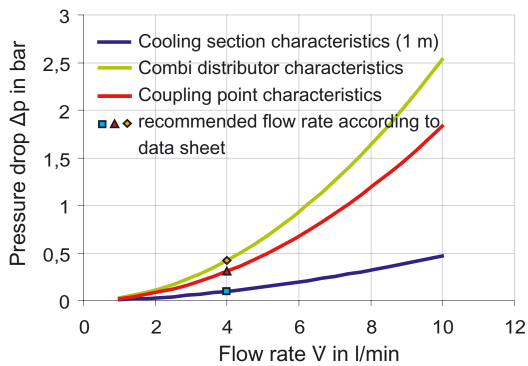
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



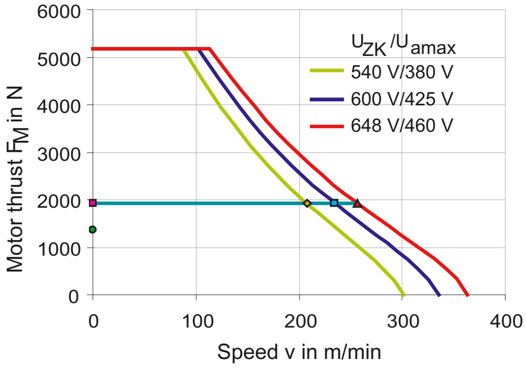


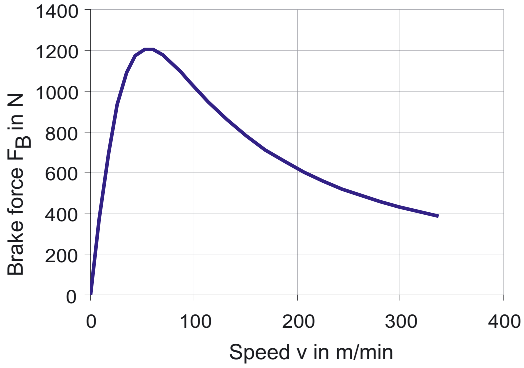
1FN3

1FN3450-2WB70-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1930
Rated current	I_N	A	15.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	235
Rated power loss	$P_{V,N}$	W	1420
Limiting data			
Maximum thrust	F_{MAX}	N	5170
Maximum current	I_{MAX}	A	45.1
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	102
Maximum electric power input	$P_{EL,MAX}$	W	21330
Stall thrust	F_0*	N	1365
Stall current	I_0*	A	10.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	127
Voltage constant	k_E	Vs/m	42.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	60.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.5
Phase inductance	L_{STR}	mH	17.5
Attraction force	F_A	N	12240
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	15.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	17.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1420
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.1
Pressure drop	$\Delta p_{P,H}$	bar	0.37
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.34
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	125
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

1FN3450-2WB70-0AA1 characteristics

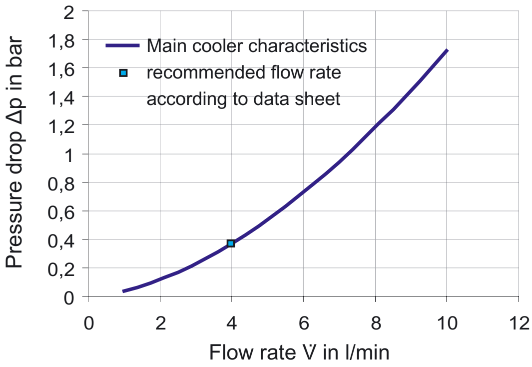
Thrust characteristics

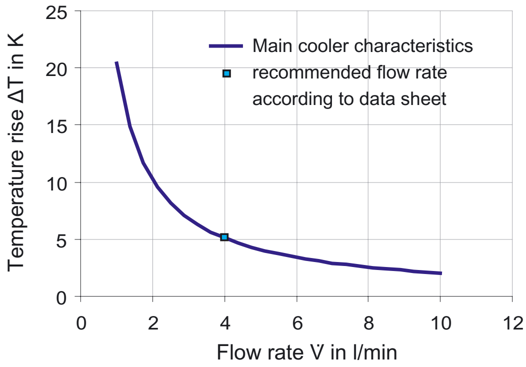




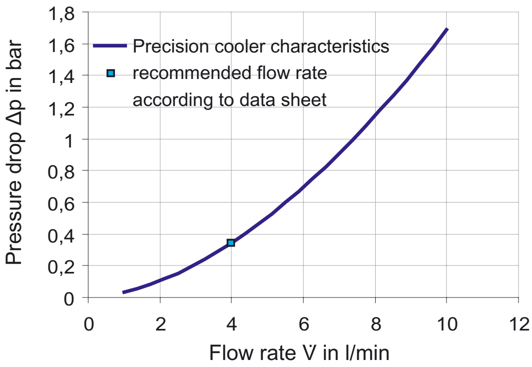
1FN3

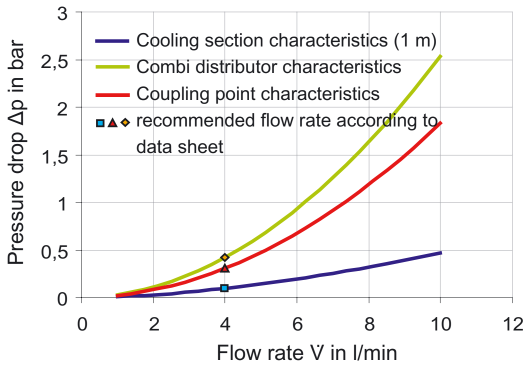
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



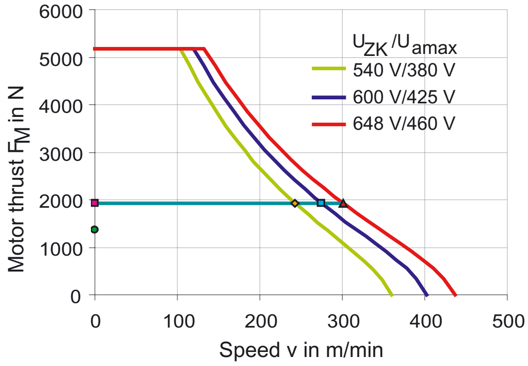


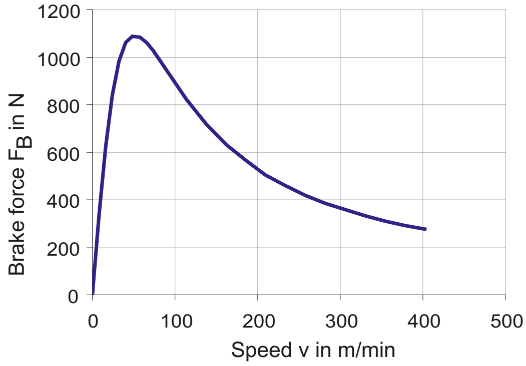
1FN3

1FN3450-2WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1930
Rated current	I_N	A	18.8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	275
Rated power loss	$P_{V,N}$	W	1470
Limiting data			
Maximum thrust	F_{MAX}	N	5180
Maximum current	I_{MAX}	A	55.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	120
Maximum electric power input	$P_{EL,MAX}$	W	23090
Stall thrust	F_0*	N	1365
Stall current	I_0*	A	13.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	103
Voltage constant	k_E	Vs/m	34.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	59.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1
Phase inductance	L_{STR}	mH	11.8
Attraction force	F_A	N	10300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	15.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	17.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1470
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	5.3
Pressure drop	$\Delta p_{P,H}$	bar	0.37
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.34
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	125
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

1FN3450-2WC00-0AA1 characteristics

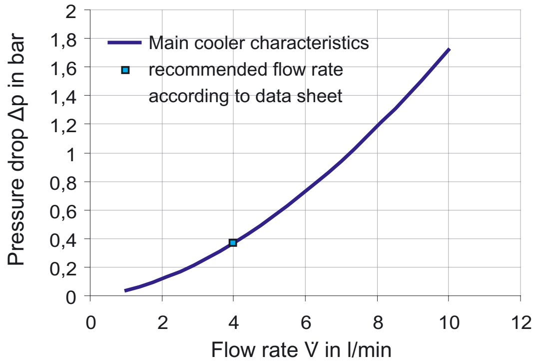
Thrust characteristics

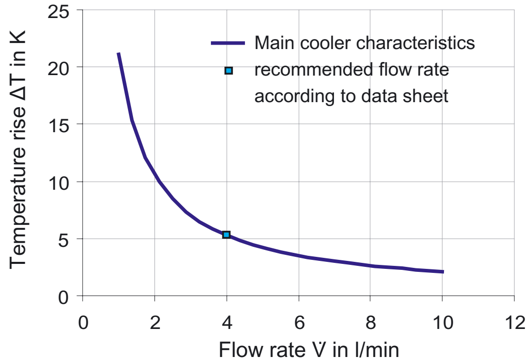




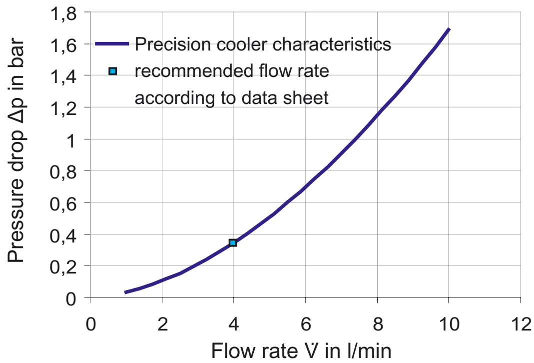
1FN3

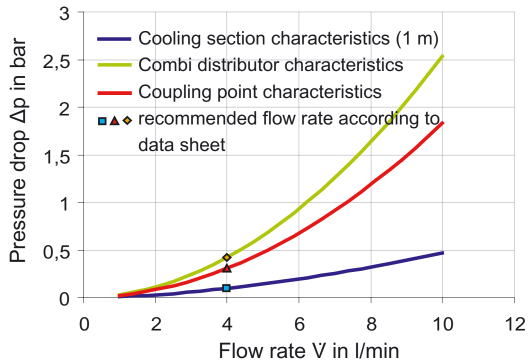
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



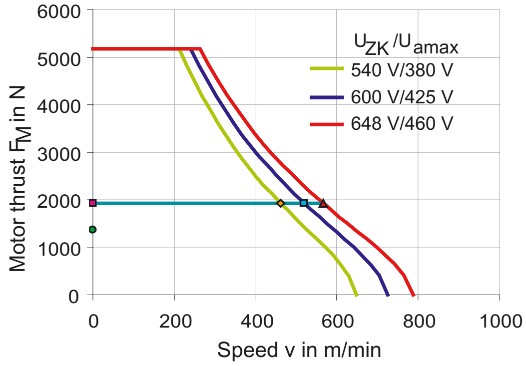


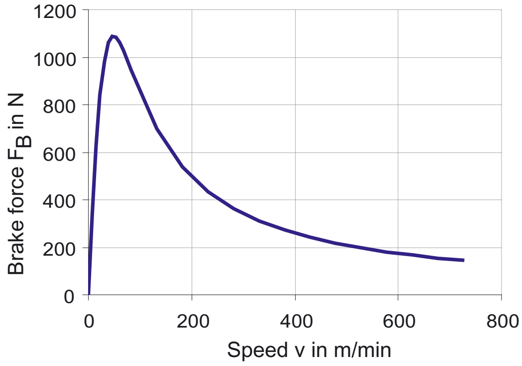
1FN3

1FN3450-2WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	1930
Rated current	I_N	A	33.8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	519
Rated power loss	$P_{V,N}$	W	1370
Limiting data			
Maximum thrust	F_{MAX}	N	5180
Maximum current	I_{MAX}	A	99.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	240
Maximum electric power input	$P_{EL,MAX}$	W	32650
Stall thrust	F_0*	N	1365
Stall current	I_0*	A	23.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	57
Voltage constant	k_E	Vs/m	19
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	61.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.3
Phase inductance	L_{STR}	mH	3.6
Attraction force	F_A	N	10300
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	15.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	17.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	1370
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4
Cooling medium temperature increase	$\Delta T_{P,H}$	K	4.9
Pressure drop	$\Delta p_{P,H}$	bar	0.37
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	35
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4
Pressure drop	$\Delta p_{P,P}$	bar	0.34
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	125
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4
Pressure drop per meter secondary section cooling	Δp_S	bar	0.09
Pressure drop per combi distributor	Δp_{KV}	bar	0.42
Pressure drop per coupling point	Δp_{KS}	bar	0.31

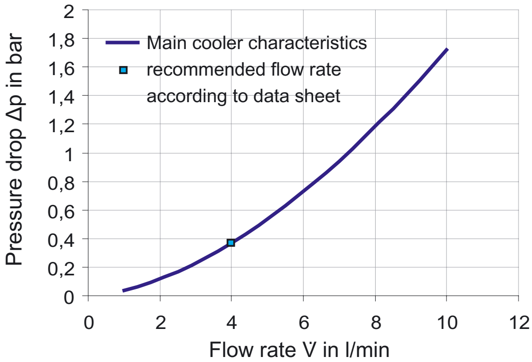
1FN3450-2WE00-0AA1 characteristics

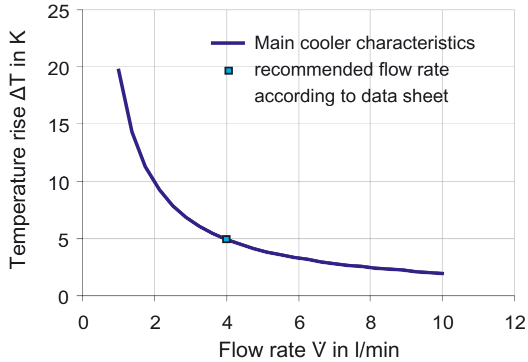
Thrust characteristics



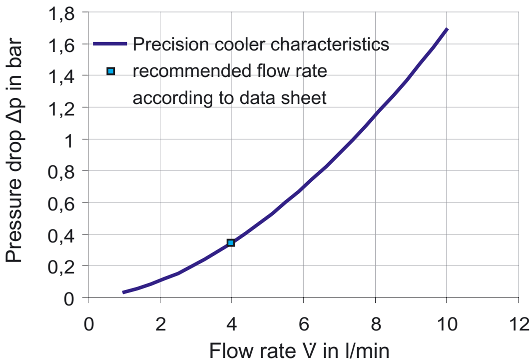


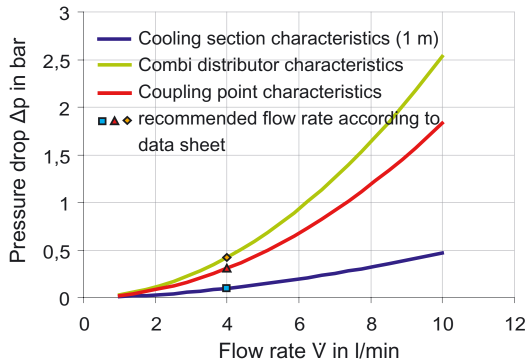
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





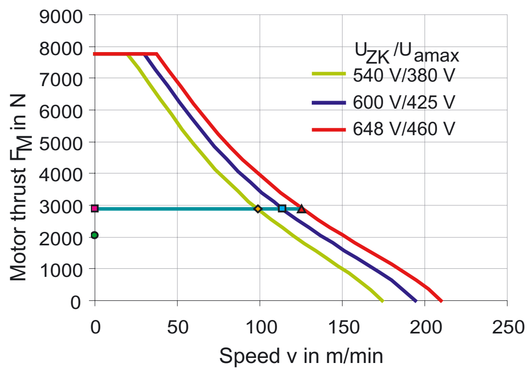
1FN3

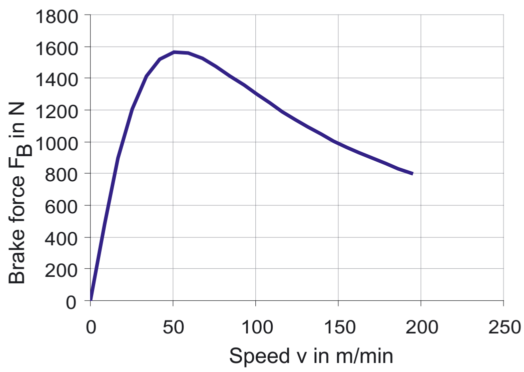
1FN3450-3WA50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2895
Rated current	I_N	A	13.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	114
Rated power loss	$P_{V,N}$	W	2390
Limiting data			
Maximum thrust	F_{MAX}	N	7760
Maximum current	I_{MAX}	A	38.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	30
Maximum electric power input	$P_{EL,MAX}$	W	24680
Stall thrust	F_0*	N	2047
Stall current	I_0*	A	9.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	220
Voltage constant	k_E	Vs/m	73.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	69.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.3
Phase inductance	L_{STR}	mH	37.9
Attraction force	F_A	N	15450
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.6
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.3
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2395
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.7
Pressure drop	$\Delta p_{P,H}$	bar	0.65
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.55
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	184
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

1FN3

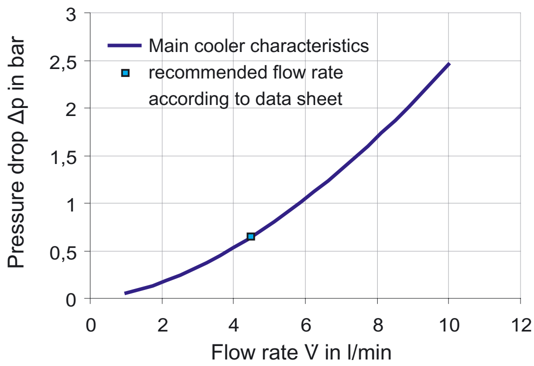
1FN3450-3WA50-0AA1 characteristics

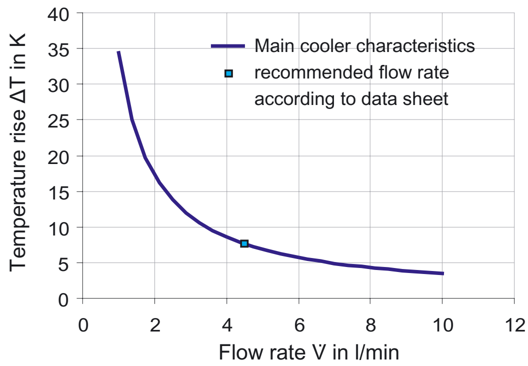
Thrust characteristics



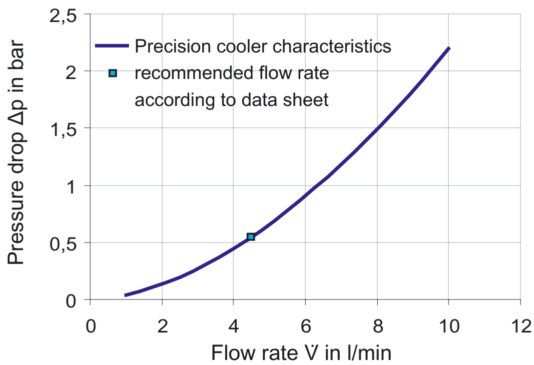


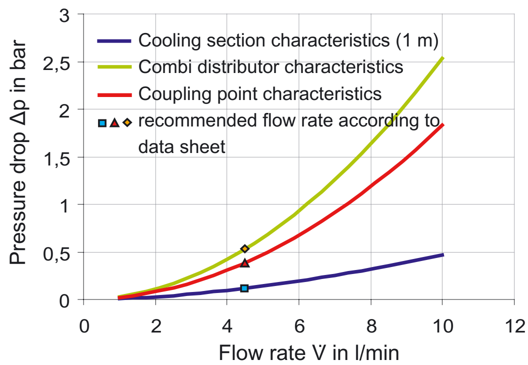
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



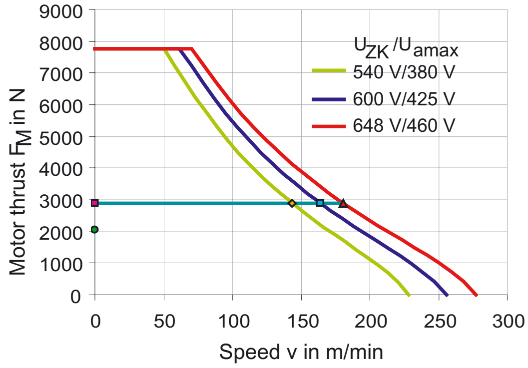


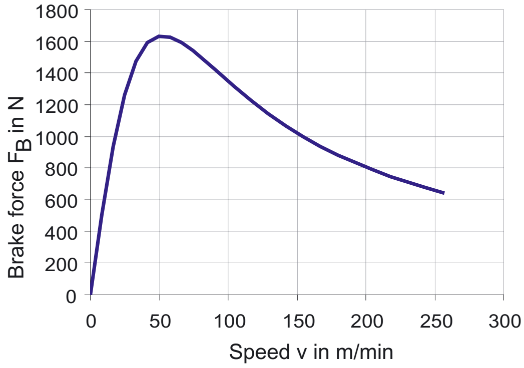
1FN3

1FN3450-3WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2895
Rated current	I_N	A	17.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	164
Rated power loss	$P_{V,N}$	W	2250
Limiting data			
Maximum thrust	F_{MAX}	N	7760
Maximum current	I_{MAX}	A	52.7
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	62
Maximum electric power input	$P_{EL,MAX}$	W	27510
Stall thrust	F_0*	N	2047
Stall current	I_0*	A	12.6
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	162
Voltage constant	k_E	Vs/m	54
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	72.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.7
Phase inductance	L_{STR}	mH	19.5
Attraction force	F_A	N	15450
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.6
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.3
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2245
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.2
Pressure drop	$\Delta p_{P,H}$	bar	0.65
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.55
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	184
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

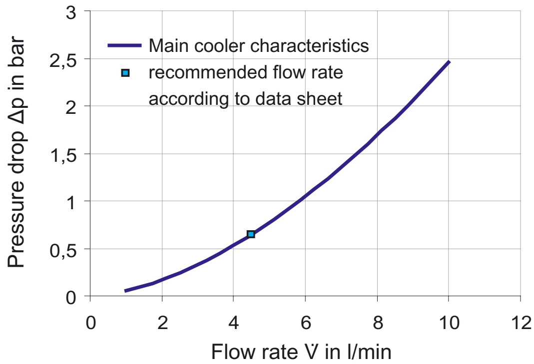
1FN3450-3WB00-0AA1 characteristics

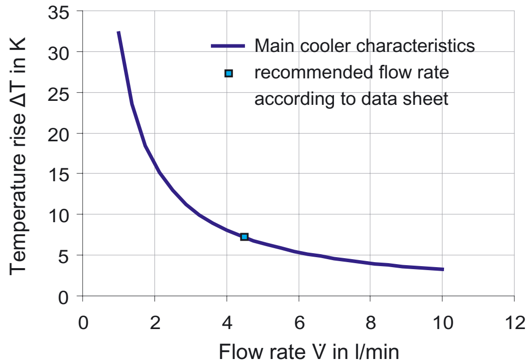
Thrust characteristics



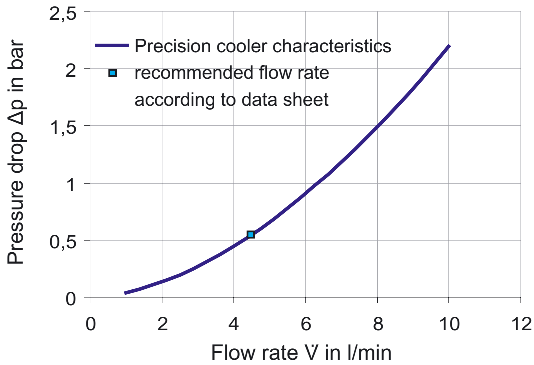


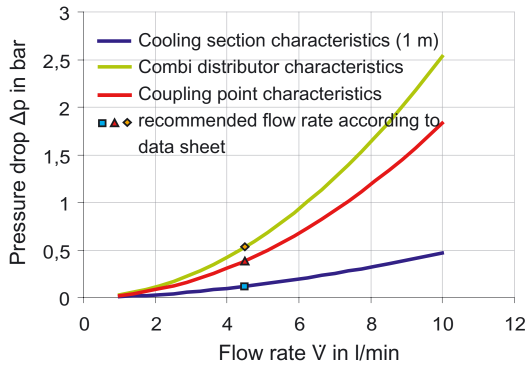
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



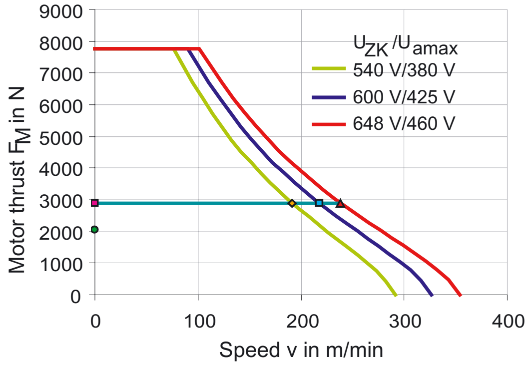


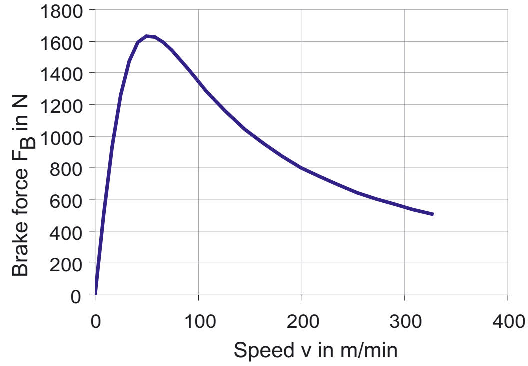
1FN3

1FN3450-3WB50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2895
Rated current	I_N	A	22.8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	217
Rated power loss	$P_{V,N}$	W	2230
Limiting data			
Maximum thrust	F_{MAX}	N	7760
Maximum current	I_{MAX}	A	67.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	90
Maximum electric power input	$P_{EL,MAX}$	W	31080
Stall thrust	F_0*	N	2047
Stall current	I_0*	A	16.1
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	127
Voltage constant	k_E	Vs/m	42.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	72.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1
Phase inductance	L_{STR}	mH	12
Attraction force	F_A	N	15450
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.6
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.3
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2235
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.1
Pressure drop	$\Delta p_{P,H}$	bar	0.65
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.55
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	184
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

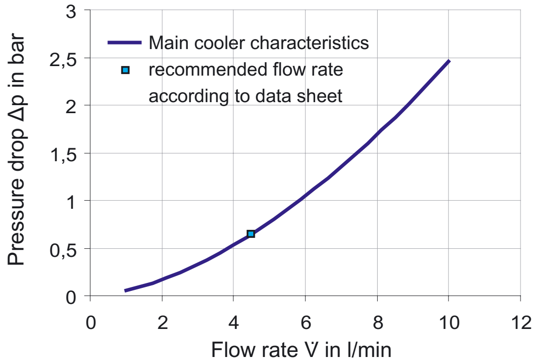
1FN3450-3WB50-0AA1 characteristics

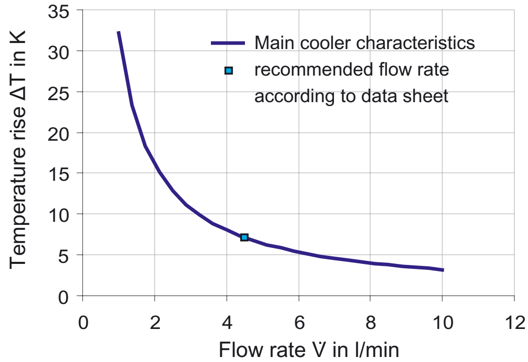
Thrust characteristics



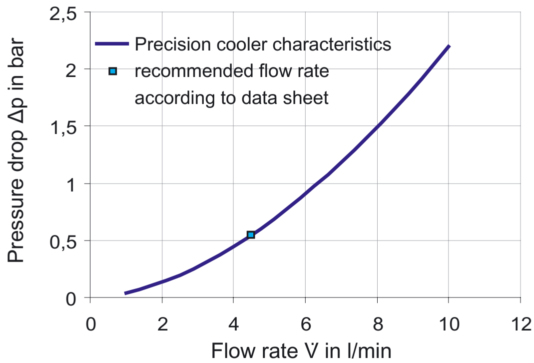


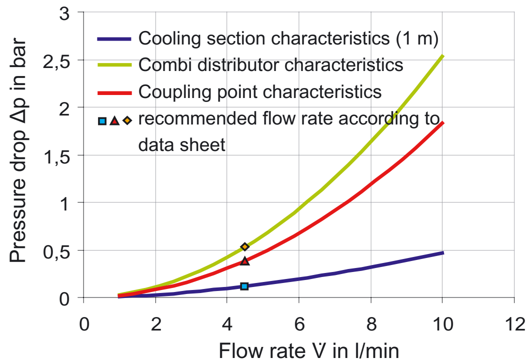
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





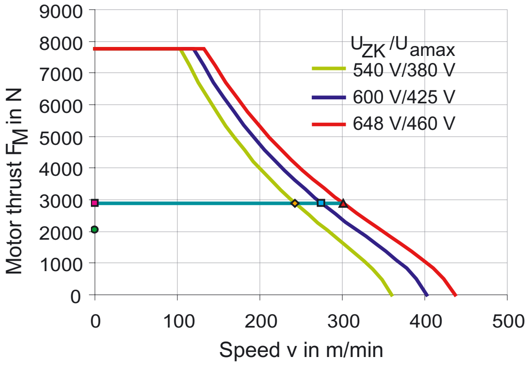
1FN3

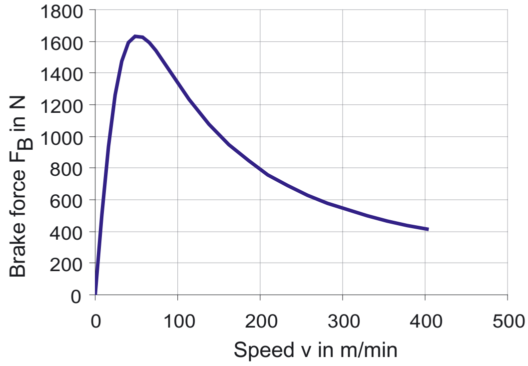
1FN3450-3WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2895
Rated current	I_N	A	28.1
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	275
Rated power loss	$P_{V,N}$	W	2200
Limiting data			
Maximum thrust	F_{MAX}	N	7760
Maximum current	I_{MAX}	A	83
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	120
Maximum electric power input	$P_{EL,MAX}$	W	34630
Stall thrust	F_0*	N	2047
Stall current	I_0*	A	19.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	103
Voltage constant	k_E	Vs/m	34.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	72.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.7
Phase inductance	L_{STR}	mH	7.9
Attraction force	F_A	N	15450
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.6
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.3
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2205
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7
Pressure drop	$\Delta p_{P,H}$	bar	0.65
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.55
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	184
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

1FN3

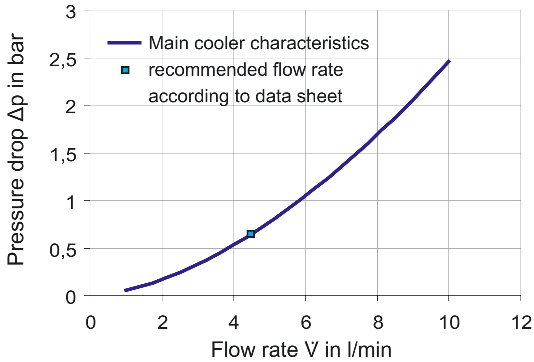
1FN3450-3WC00-0AA1 characteristics

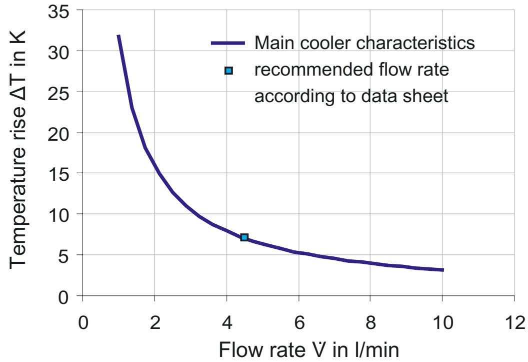
Thrust characteristics



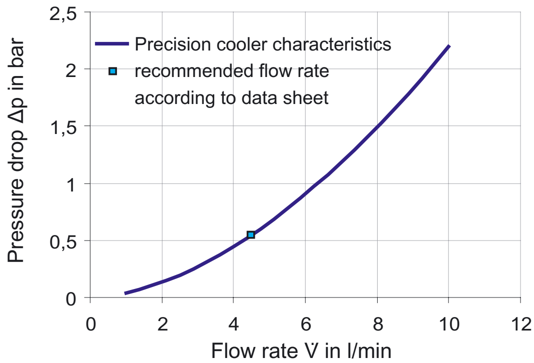


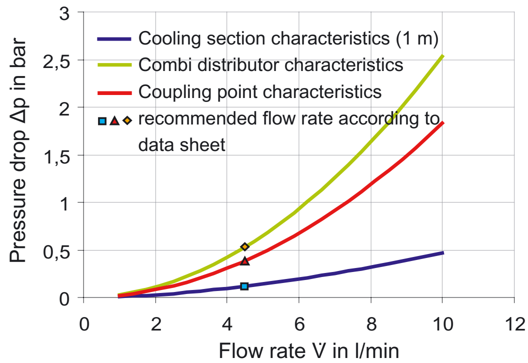
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



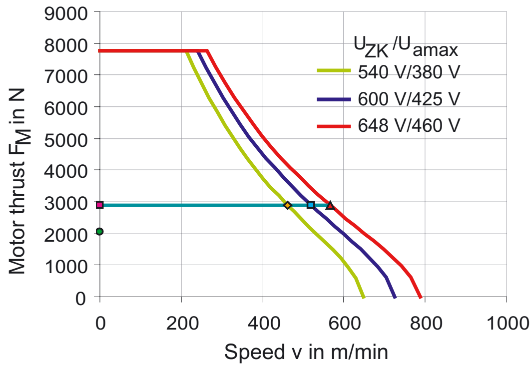


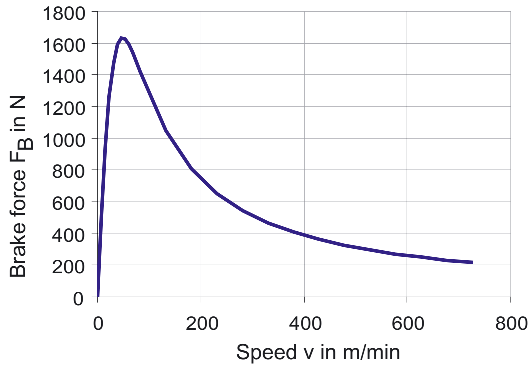
1FN3

1FN3450-3WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2895
Rated current	I_N	A	50.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	519
Rated power loss	$P_{V,N}$	W	2060
Limiting data			
Maximum thrust	F_{MAX}	N	7760
Maximum current	I_{MAX}	A	149.6
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	240
Maximum electric power input	$P_{EL,MAX}$	W	48970
Stall thrust	F_0*	N	2047
Stall current	I_0*	A	35.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	57
Voltage constant	k_E	Vs/m	19
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	75.3
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.2
Phase inductance	L_{STR}	mH	2.4
Attraction force	F_A	N	15450
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.6
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.3
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2060
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	6.6
Pressure drop	$\Delta p_{P,H}$	bar	0.65
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	55
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.55
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	184
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.12
Pressure drop per combi distributor	Δp_{KV}	bar	0.53
Pressure drop per coupling point	Δp_{KS}	bar	0.39

1FN3450-3WE00-0AA1 characteristics

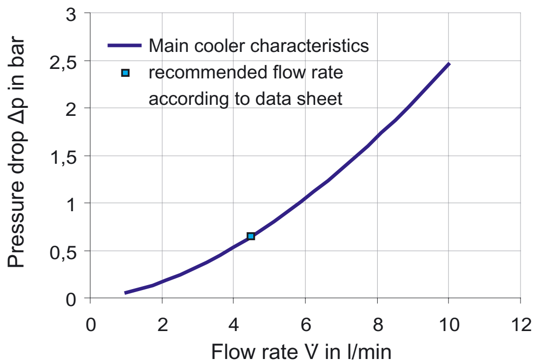
Thrust characteristics

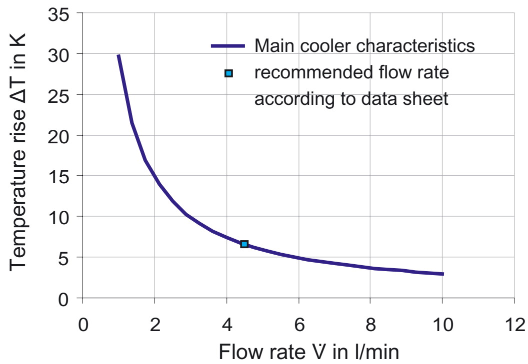




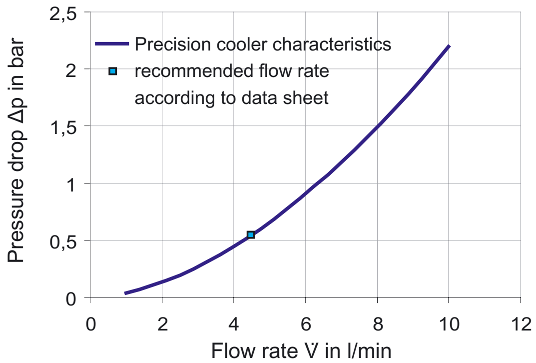
1FN3

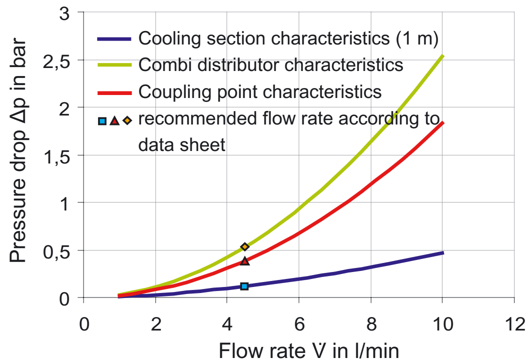
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





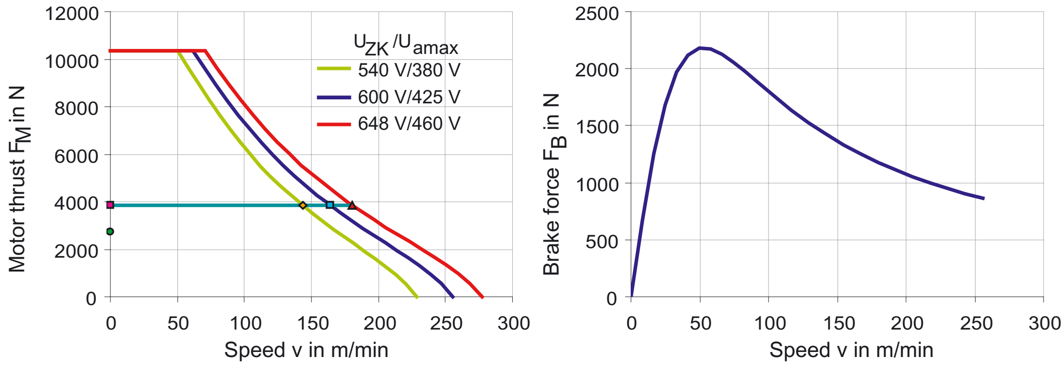
1FN3

1FN3450-4WB00-0AA1			
Technical data	Brief designation	Units	Value
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3860
Rated current	I_N	A	23.8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	164
Rated power loss	$P_{V,N}$	W	3000
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	70.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	62
Maximum electric power input	$P_{EL,MAX}$	W	36680
Stall thrust	F_0*	N	2729
Stall current	I_0*	A	16.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	162
Voltage constant	k_E	Vs/m	54
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	83.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.3
Phase inductance	L_{STR}	mH	14.7
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	30.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	8.6
Pressure drop	$\Delta p_{P,H}$	bar	1
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	70
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.81
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	242
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

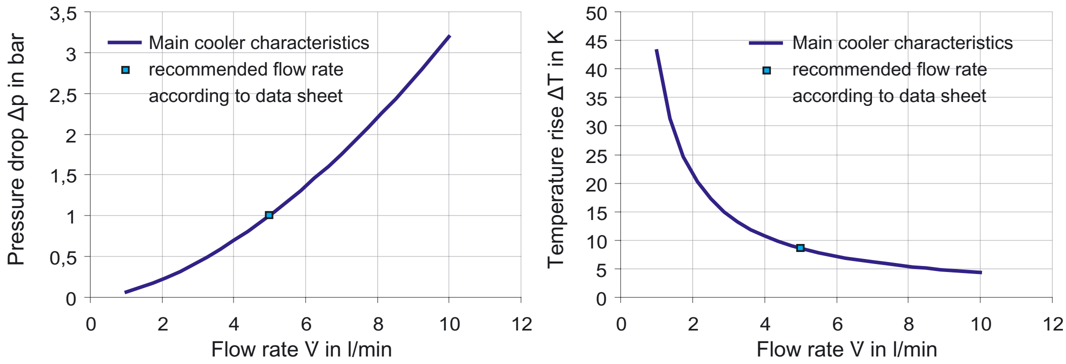
1FN3

1FN3450-4WB00-0AA1 characteristics

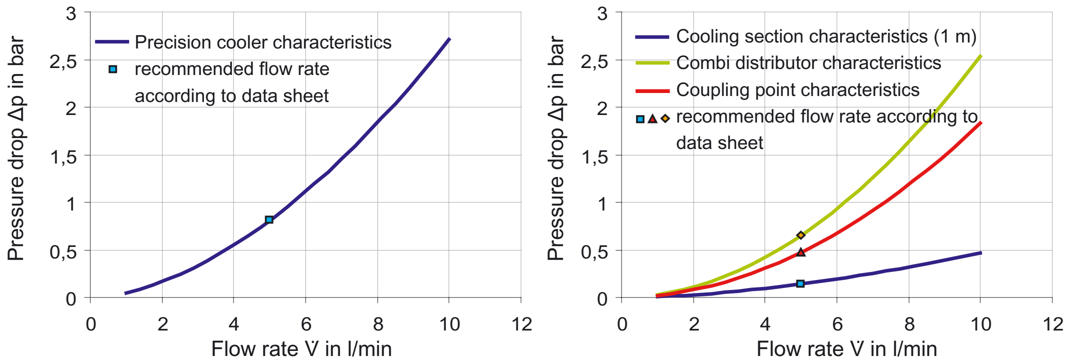
Thrust characteristics



Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling

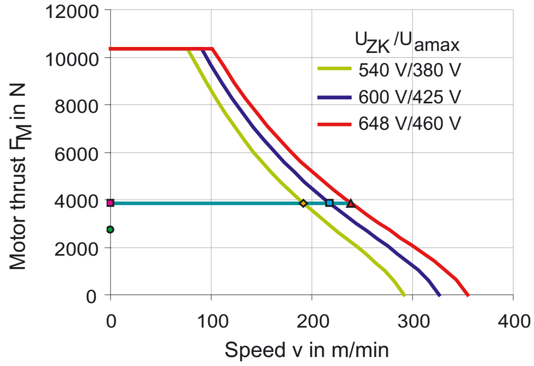


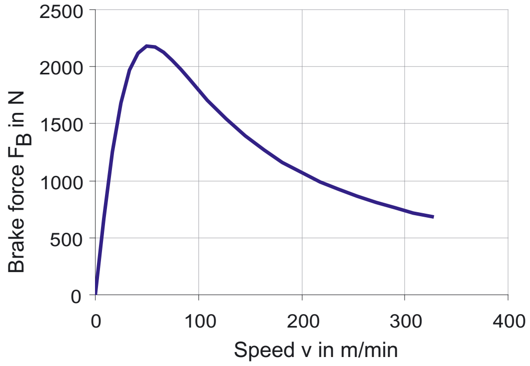
1FN3

1FN3450-4WB50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3860
Rated current	I_N	A	30.4
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	217
Rated power loss	$P_{V,N}$	W	2980
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	89.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	90
Maximum electric power input	$P_{EL,MAX}$	W	41440
Stall thrust	F_0*	N	2729
Stall current	I_0*	A	21.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	127
Voltage constant	k_E	Vs/m	42.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	83.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.8
Phase inductance	L_{STR}	mH	9
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	30.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2980
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	8.6
Pressure drop	$\Delta p_{P,H}$	bar	1
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	70
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.81
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	242
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

1FN3450-4WB50-0AA1 characteristics

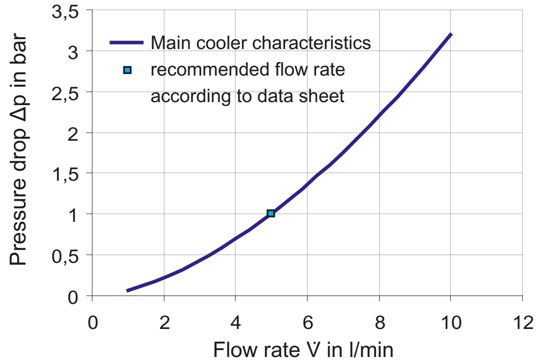
Thrust characteristics

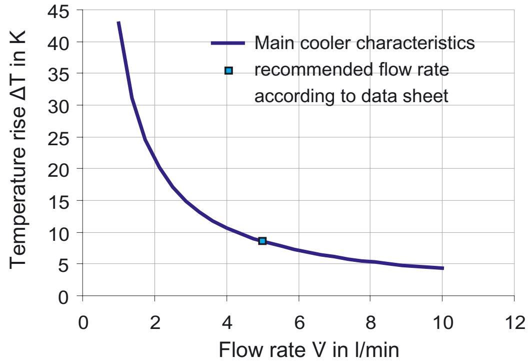




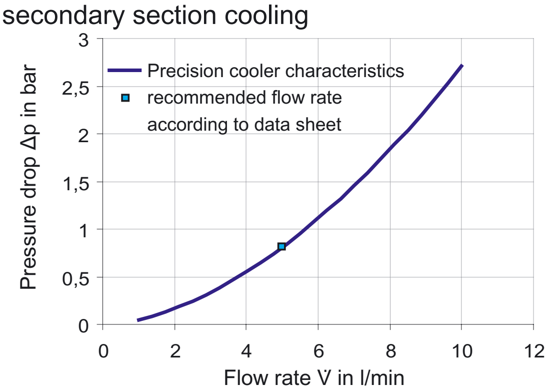
1FN3

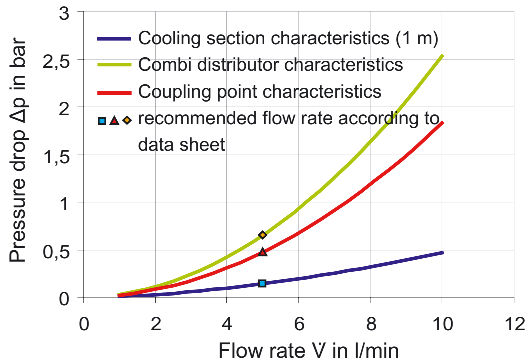
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



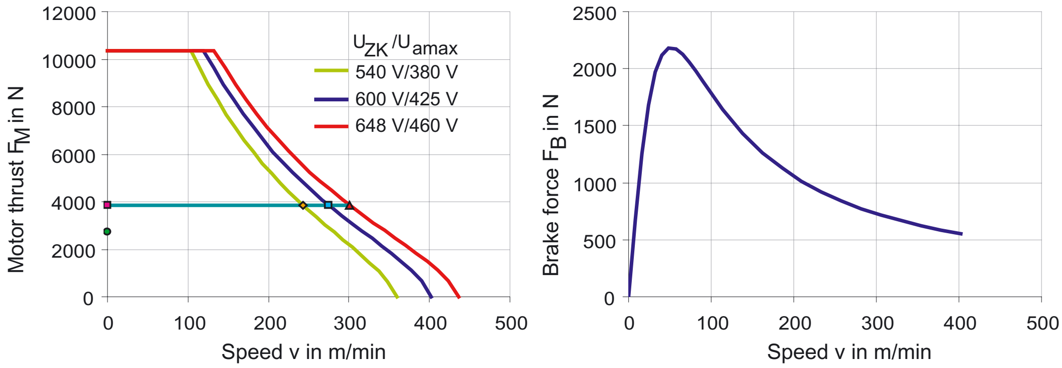


1FN3

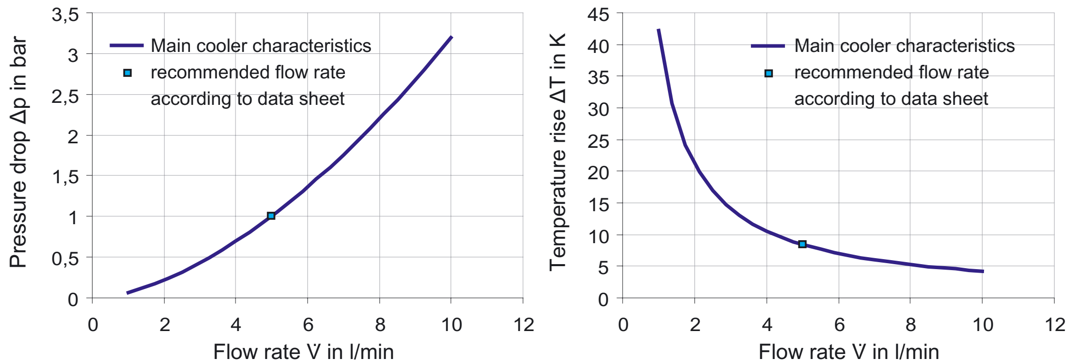
1FN3450-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3860
Rated current	I_N	A	37.5
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	275
Rated power loss	$P_{V,N}$	W	2940
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	110.6
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	120
Maximum electric power input	$P_{EL,MAX}$	W	46170
Stall thrust	F_0*	N	2729
Stall current	I_0*	A	26.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	103
Voltage constant	k_E	Vs/m	34.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	84.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.5
Phase inductance	L_{STR}	mH	5.9
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	30.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2940
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	8.5
Pressure drop	$\Delta p_{P,H}$	bar	1
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	70
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.81
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	242
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

1FN3450-4WC00-0AA1 characteristics

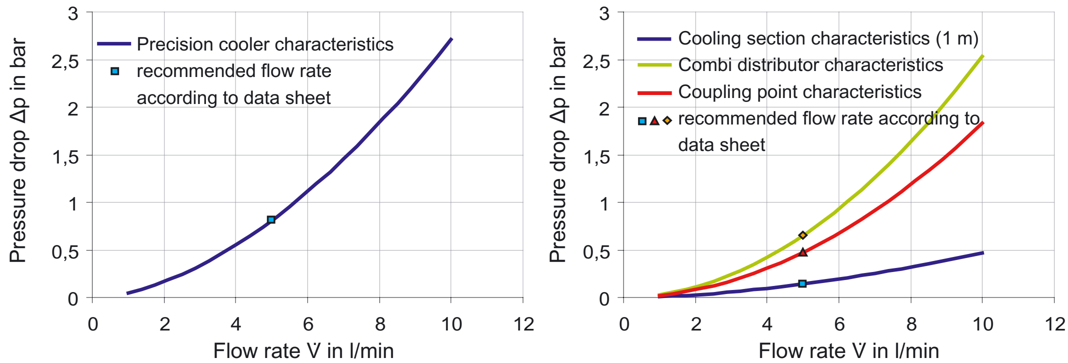
Thrust characteristics



Primary section main cooler characteristics



Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



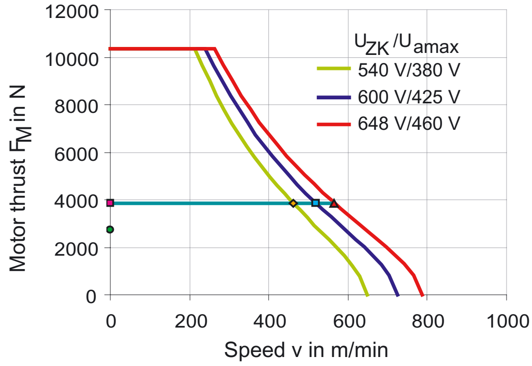
1FN3

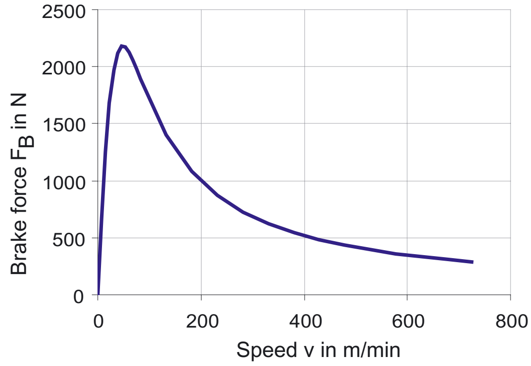
1FN3450-4WE00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3860
Rated current	I_N	A	67.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	519
Rated power loss	$P_{V,N}$	W	2740
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	199.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	240
Maximum electric power input	$P_{EL,MAX}$	W	65300
Stall thrust	F_0*	N	2729
Stall current	I_0*	A	47.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	57
Voltage constant	k_E	Vs/m	19
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	87
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.1
Phase inductance	L_{STR}	mH	1.8
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	30.9
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.1
Mass secondary section	m_S	kg	3.8
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	4
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2745
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.9
Pressure drop	$\Delta p_{P,H}$	bar	1
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	70
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5
Pressure drop	$\Delta p_{P,P}$	bar	0.81
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	242
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.14
Pressure drop per combi distributor	Δp_{KV}	bar	0.65
Pressure drop per coupling point	Δp_{KS}	bar	0.47

1FN3

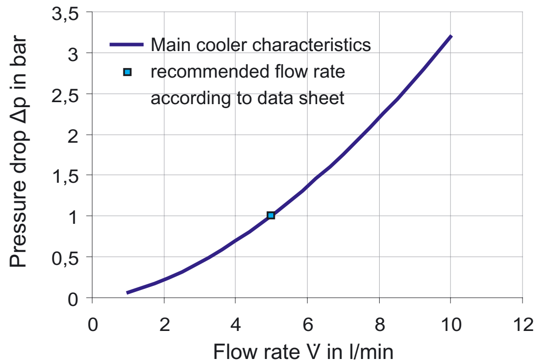
1FN3450-4WE00-0AA1 characteristics

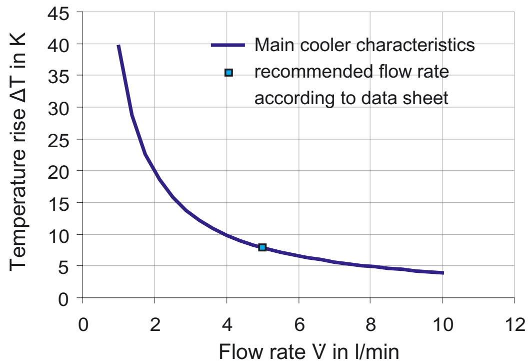
Thrust characteristics



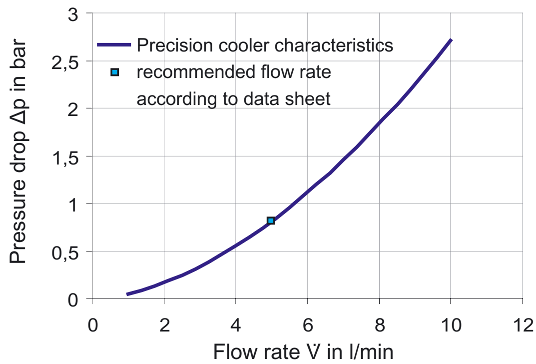


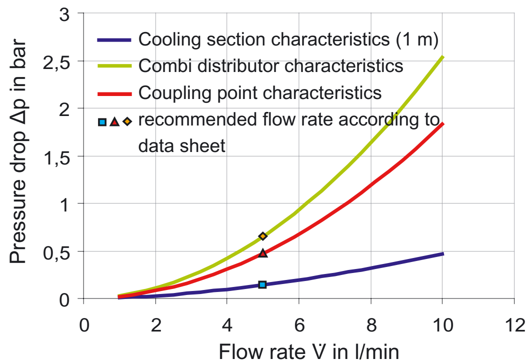
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





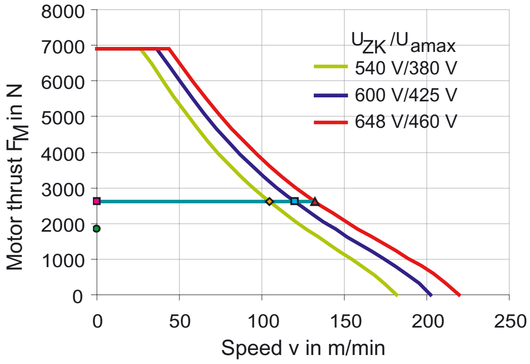
1FN3

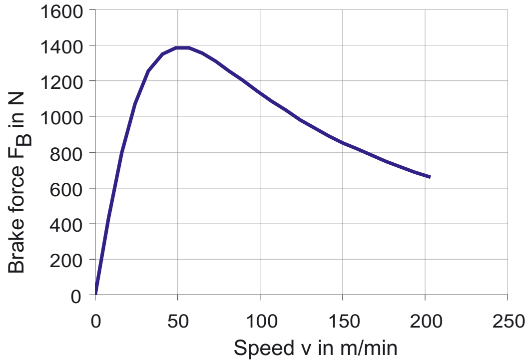
1FN3600-2WA50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	2610
Rated current	I_N	A	12.4
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	120
Rated power loss	$P_{V,N}$	W	2100
Limiting data			
Maximum thrust	F_{MAX}	N	6900
Maximum current	I_{MAX}	A	36
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	36
Maximum electric power input	$P_{EL,MAX}$	W	21940
Stall thrust	F_0*	N	1846
Stall current	I_0*	A	8.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	211
Voltage constant	k_E	Vs/m	70.3
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	67.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	3.3
Phase inductance	L_{STR}	mH	39.1
Attraction force	F_A	N	13730
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	22.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	24.7
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2105
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	4.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	6.7
Pressure drop	$\Delta p_{P,H}$	bar	0.5
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	45
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	4.5
Pressure drop	$\Delta p_{P,P}$	bar	0.84
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	168
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	4.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.02
Pressure drop per combi distributor	Δp_{KV}	bar	0.13
Pressure drop per coupling point	Δp_{KS}	bar	0.14

1FN3

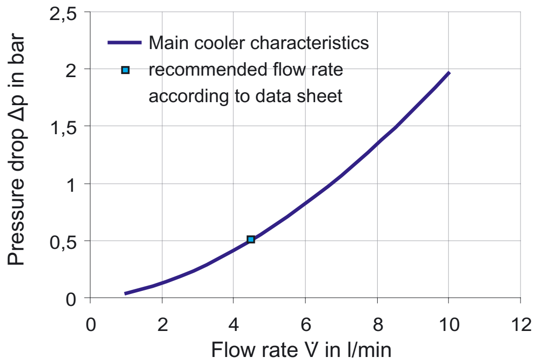
1FN3600-2WA50-0AA1 characteristics

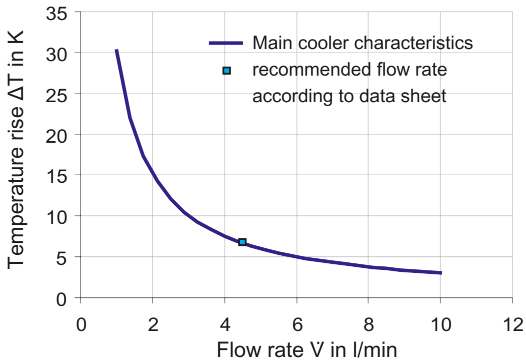
Thrust characteristics



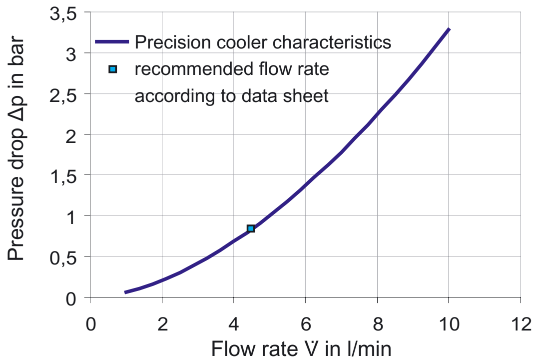


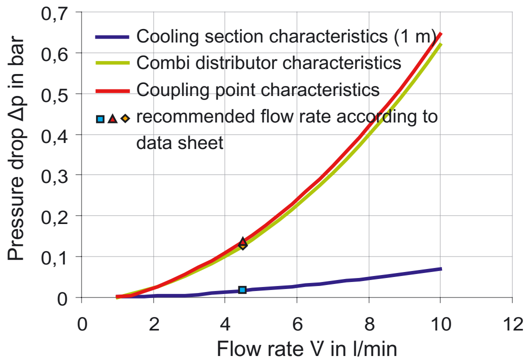
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





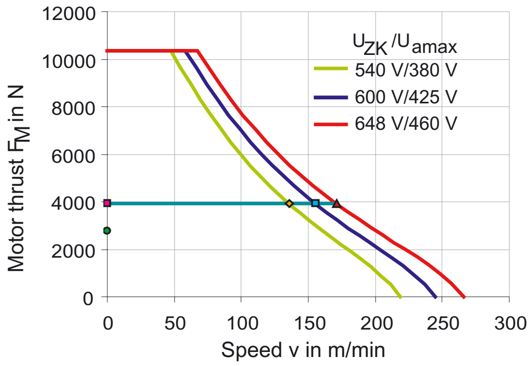
1FN3

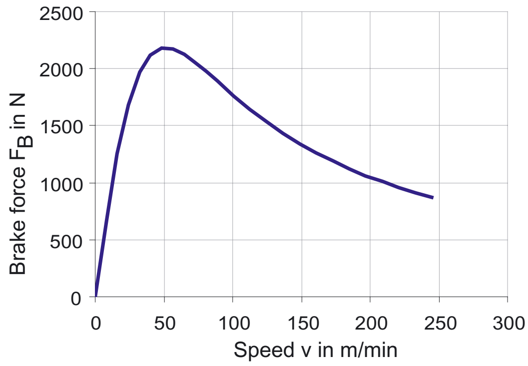
1FN3600-3WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3915
Rated current	I_N	A	23.2
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	155
Rated power loss	$P_{V,N}$	W	3000
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	67.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	58
Maximum electric power input	$P_{EL,MAX}$	W	35400
Stall thrust	F_0*	N	2768
Stall current	I_0*	A	16.4
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	169
Voltage constant	k_E	Vs/m	56.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	84.4
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.3
Phase inductance	L_{STR}	mH	16
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	31.5
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.4
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.8
Pressure drop	$\Delta p_{P,H}$	bar	1.02
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	65
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	1.54
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	246
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.02
Pressure drop per combi distributor	Δp_{KV}	bar	0.19
Pressure drop per coupling point	Δp_{KS}	bar	0.2

1FN3

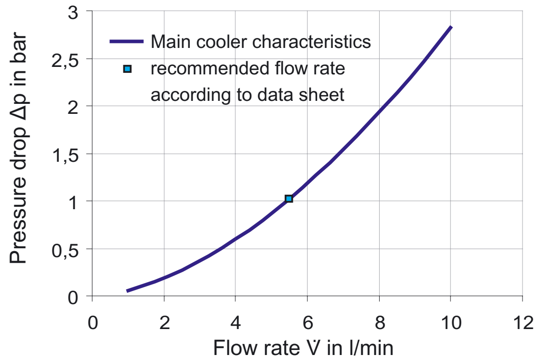
1FN3600-3WB00-0AA1 characteristics

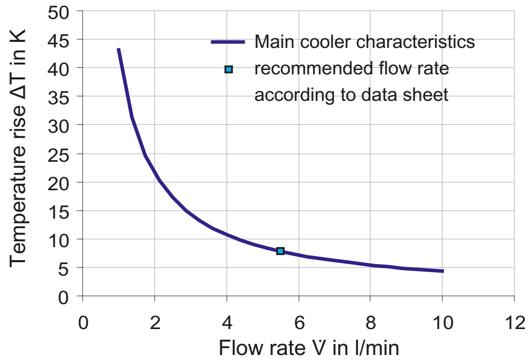
Thrust characteristics



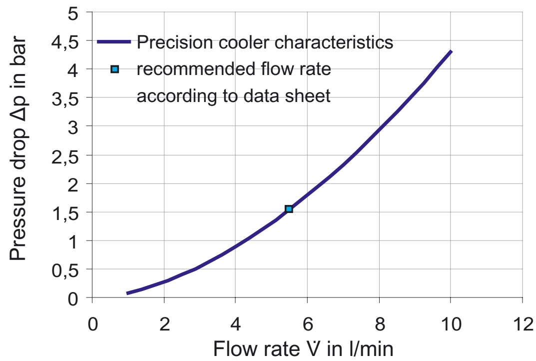


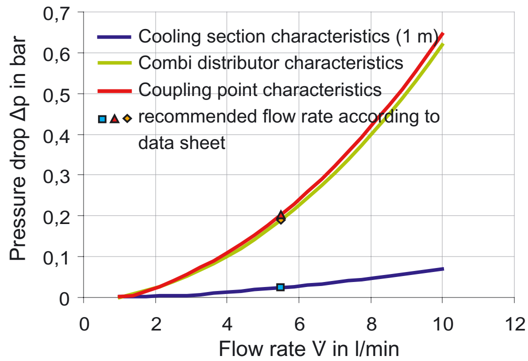
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



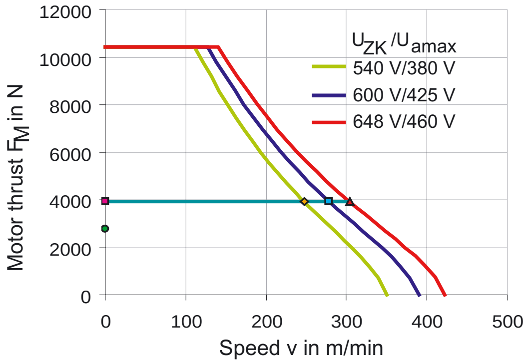


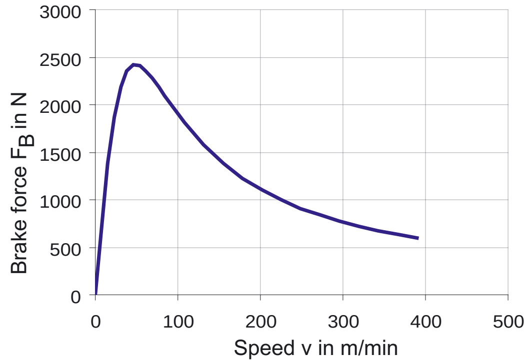
1FN3

1FN3600-3WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	3915
Rated current	I_N	A	35.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	279
Rated power loss	$P_{V,N}$	W	2560
Limiting data			
Maximum thrust	F_{MAX}	N	10430
Maximum current	I_{MAX}	A	105.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	127
Maximum electric power input	$P_{EL,MAX}$	W	44620
Stall thrust	F_0*	N	2768
Stall current	I_0*	A	25.3
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	110
Voltage constant	k_E	Vs/m	36.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	91.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.5
Phase inductance	L_{STR}	mH	6.5
Attraction force	F_A	N	24480
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	31.5
Mass of the primary section with precision cooler	$m_{P,P}$	kg	33.4
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2565
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	6.7
Pressure drop	$\Delta p_{P,H}$	bar	1.02
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	65
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	1.54
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	246
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.02
Pressure drop per combi distributor	Δp_{KV}	bar	0.19
Pressure drop per coupling point	Δp_{KS}	bar	0.2

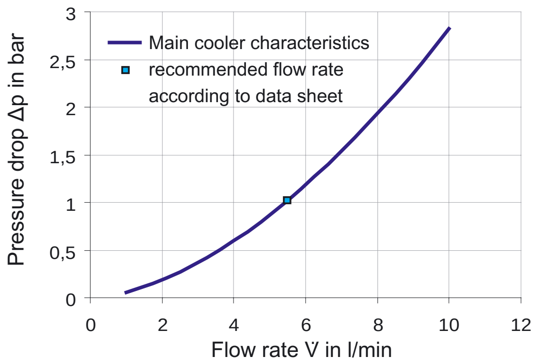
1FN3600-3WC00-0AA1 characteristics

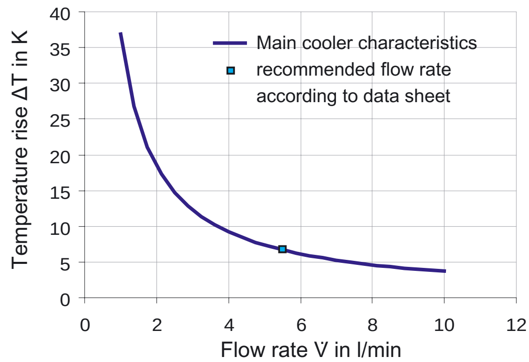
Thrust characteristics



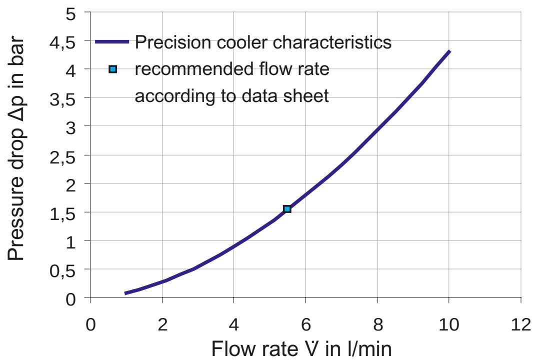


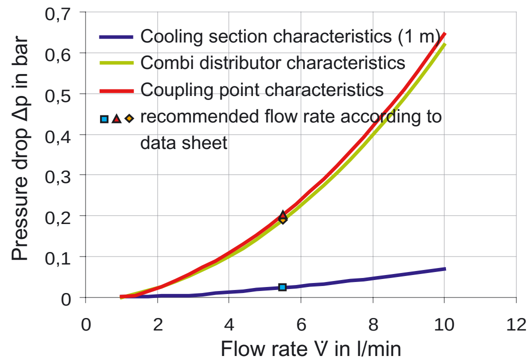
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





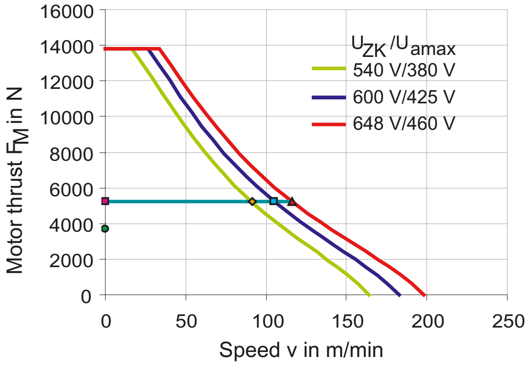
1FN3

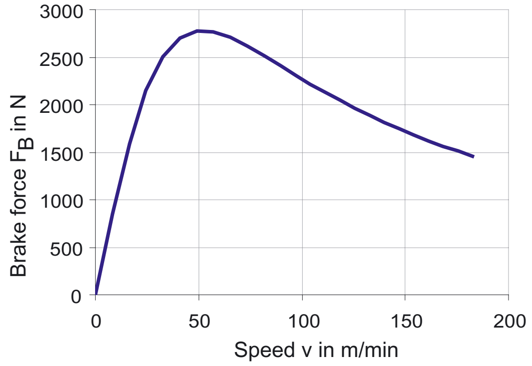
1FN3600-4WA30-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	5220
Rated current	I_N	A	22.3
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	105
Rated power loss	$P_{V,N}$	W	4230
Limiting data			
Maximum thrust	F_{MAX}	N	13800
Maximum current	I_{MAX}	A	64.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	26
Maximum electric power input	$P_{EL,MAX}$	W	41870
Stall thrust	F_0*	N	3691
Stall current	I_0*	A	15.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	234
Voltage constant	k_E	Vs/m	78
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	94.7
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	2
Phase inductance	L_{STR}	mH	24
Attraction force	F_A	N	27460
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	40.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	43.3
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4235
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6
Cooling medium temperature increase	$\Delta T_{P,H}$	K	10.2
Pressure drop	$\Delta p_{P,H}$	bar	1.55
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	90
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6
Pressure drop	$\Delta p_{P,P}$	bar	2.2
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	324
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.23
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3

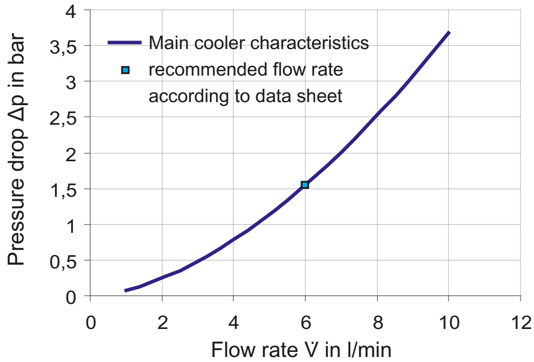
1FN3600-4WA30-0AA1 characteristics

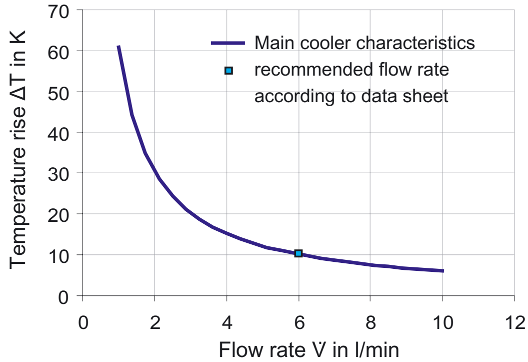
Thrust characteristics



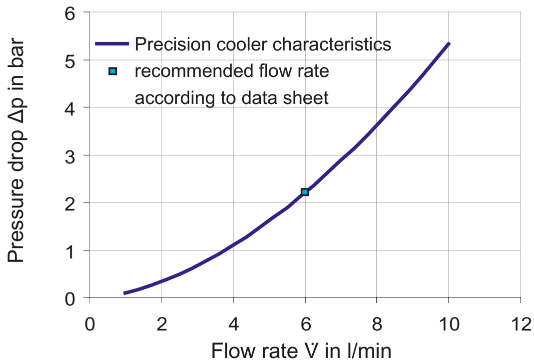


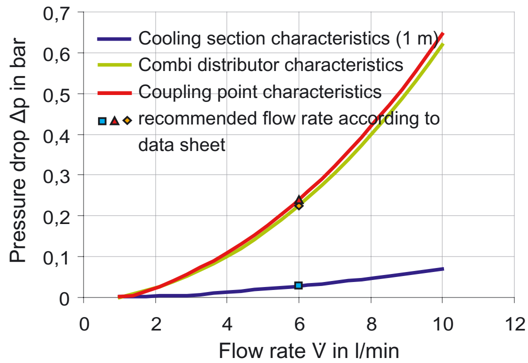
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





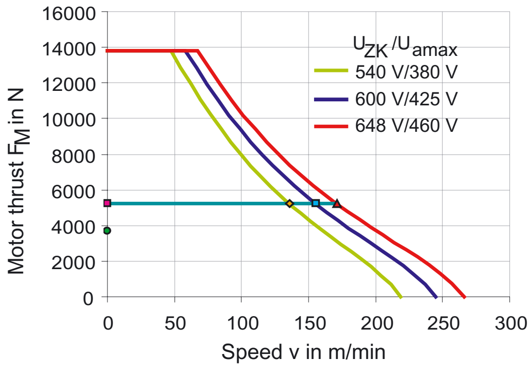
1FN3

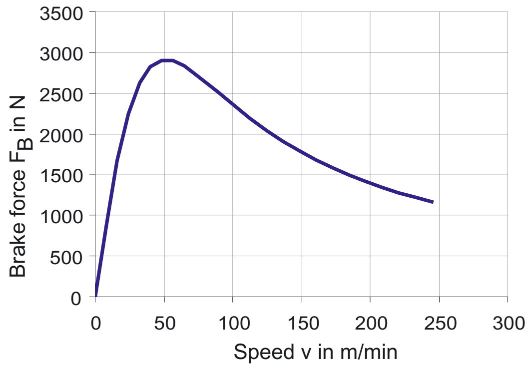
1FN3600-4WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	5220
Rated current	I_N	A	30.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	155
Rated power loss	$P_{V,N}$	W	4000
Limiting data			
Maximum thrust	F_{MAX}	N	13800
Maximum current	I_{MAX}	A	89.8
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	58
Maximum electric power input	$P_{EL,MAX}$	W	47190
Stall thrust	F_0*	N	3691
Stall current	I_0*	A	21.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	169
Voltage constant	k_E	Vs/m	56.4
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	97.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1
Phase inductance	L_{STR}	mH	12
Attraction force	F_A	N	27460
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	40.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	43.3
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	3995
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6
Cooling medium temperature increase	$\Delta T_{P,H}$	K	9.6
Pressure drop	$\Delta p_{P,H}$	bar	1.55
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	90
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6
Pressure drop	$\Delta p_{P,P}$	bar	2.2
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	324
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.23
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3

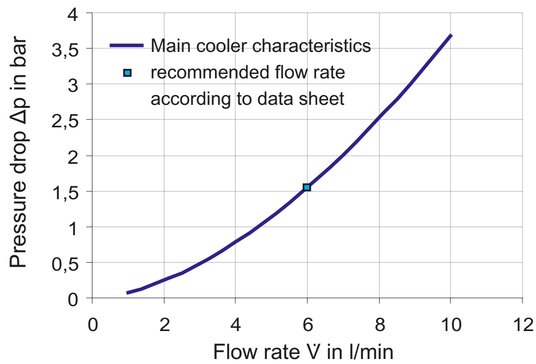
1FN3600-4WB00-0AA1 characteristics

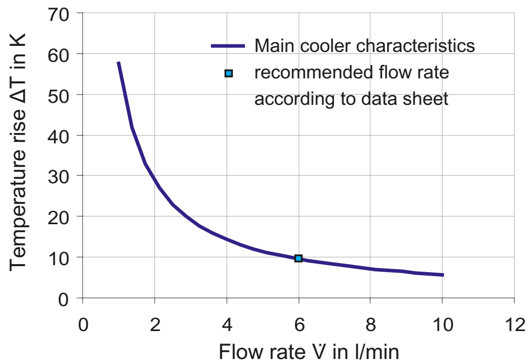
Thrust characteristics



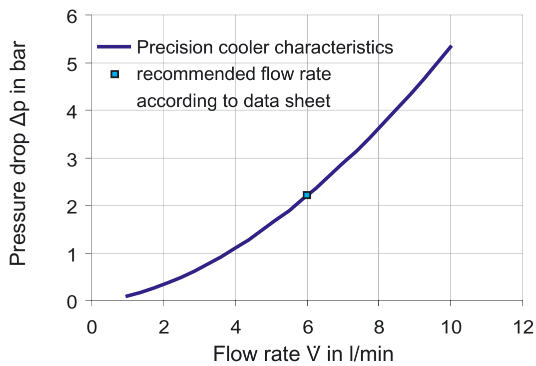


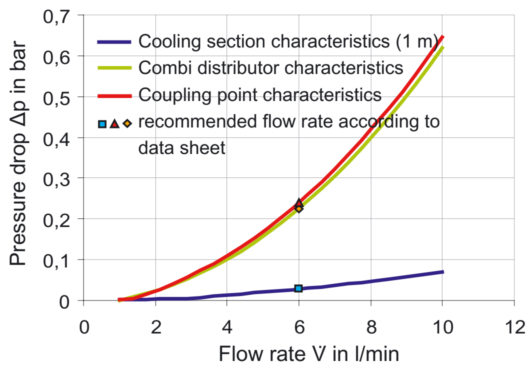
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





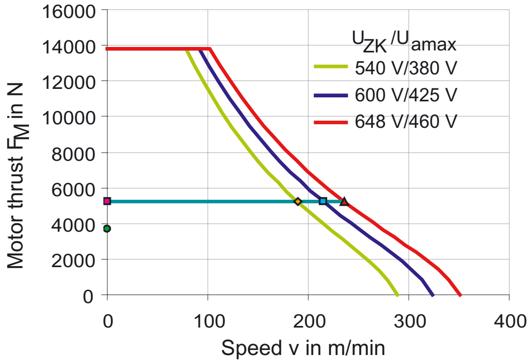
1FN3

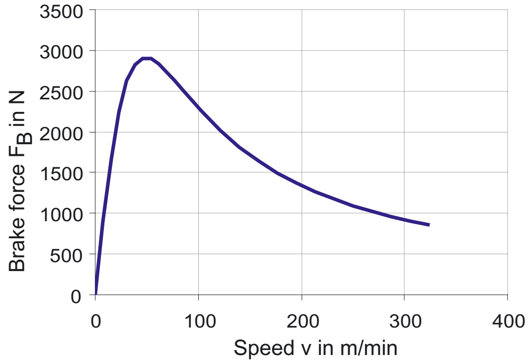
1FN3600-4WB50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	5220
Rated current	I_N	A	40.8
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	215
Rated power loss	$P_{V,N}$	W	3810
Limiting data			
Maximum thrust	F_{MAX}	N	13800
Maximum current	I_{MAX}	A	118.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	91
Maximum electric power input	$P_{EL,MAX}$	W	53200
Stall thrust	F_0*	N	3691
Stall current	I_0*	A	28.8
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	128
Voltage constant	k_E	Vs/m	42.7
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	99.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.5
Phase inductance	L_{STR}	mH	6.9
Attraction force	F_A	N	27460
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	40.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	43.3
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	3810
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6
Cooling medium temperature increase	$\Delta T_{P,H}$	K	9.1
Pressure drop	$\Delta p_{P,H}$	bar	1.55
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	90
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6
Pressure drop	$\Delta p_{P,P}$	bar	2.2
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	324
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.23
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3

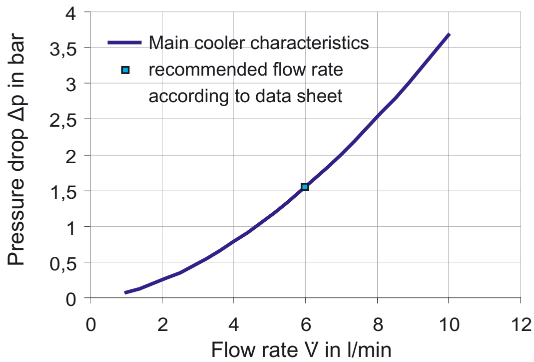
1FN3600-4WB50-0AA1 characteristics

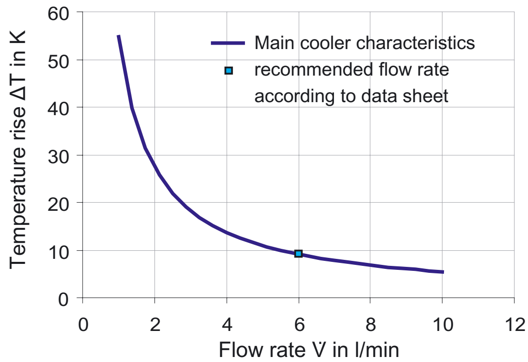
Thrust characteristics



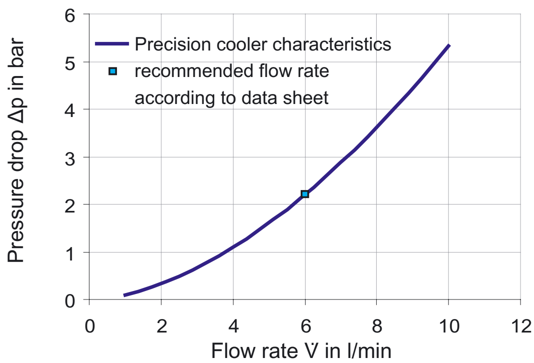


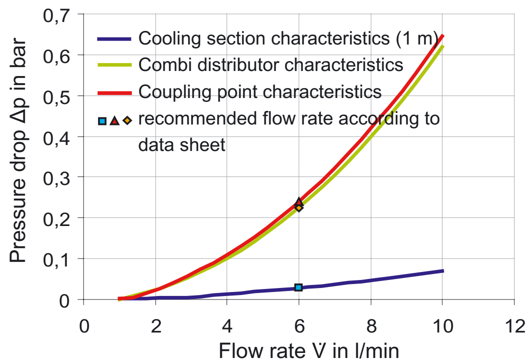
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



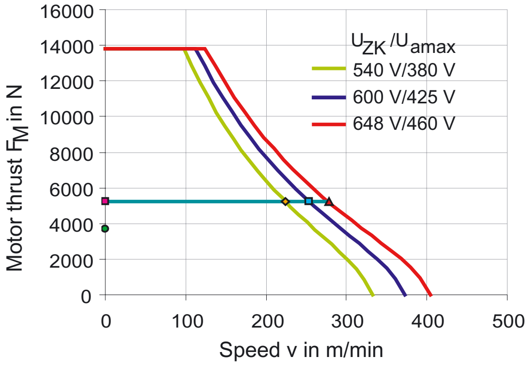


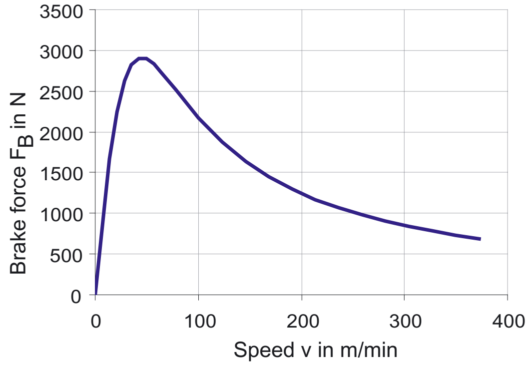
1FN3

1FN3600-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	5220
Rated current	I_N	A	46.9
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	254
Rated power loss	$P_{V,N}$	W	3510
Limiting data			
Maximum thrust	F_{MAX}	N	13800
Maximum current	I_{MAX}	A	136.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	112
Maximum electric power input	$P_{EL,MAX}$	W	55490
Stall thrust	F_0*	N	3691
Stall current	I_0*	A	33.2
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	111
Voltage constant	k_E	Vs/m	37.1
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	104
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.4
Phase inductance	L_{STR}	mH	5.2
Attraction force	F_A	N	27460
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	40.8
Mass of the primary section with precision cooler	$m_{P,P}$	kg	43.3
Mass secondary section	m_S	kg	4.6
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	5
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	3505
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6
Cooling medium temperature increase	$\Delta T_{P,H}$	K	8.4
Pressure drop	$\Delta p_{P,H}$	bar	1.55
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	90
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6
Pressure drop	$\Delta p_{P,P}$	bar	2.2
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	324
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.23
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3600-4WC00-0AA1 characteristics

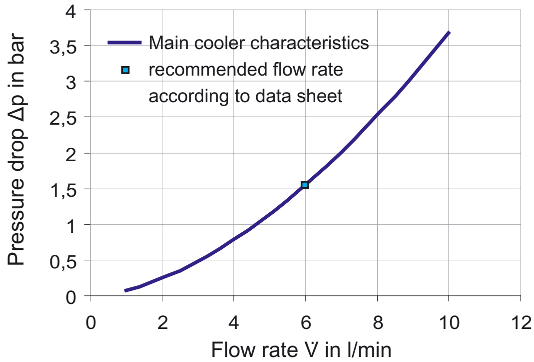
Thrust characteristics

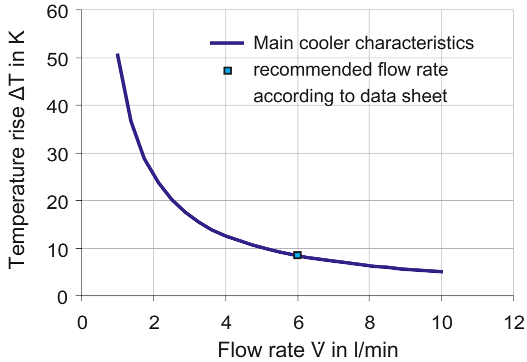




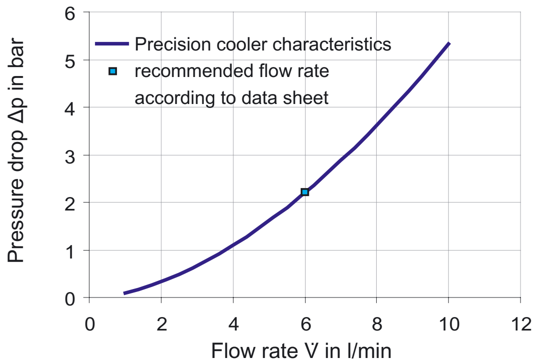
1FN3

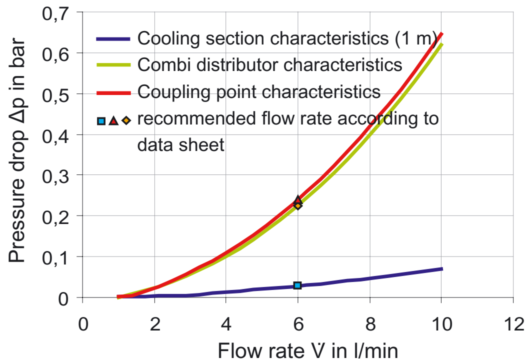
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



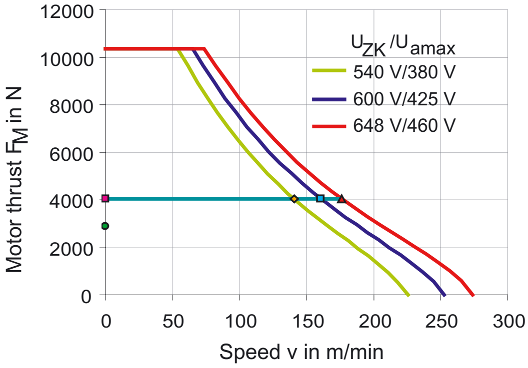


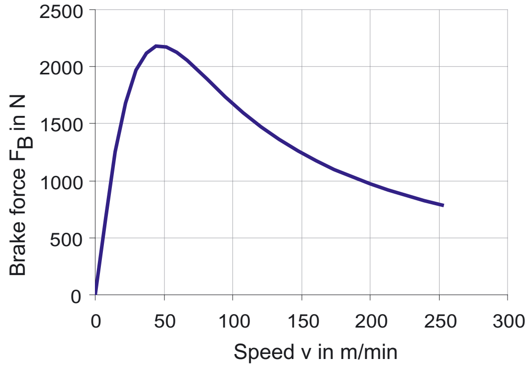
1FN3

1FN3900-2WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4050
Rated current	I_N	A	24.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	160
Rated power loss	$P_{V,N}$	W	2940
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	69.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	65
Maximum electric power input	$P_{EL,MAX}$	W	34460
Stall thrust	F_0*	N	2864
Stall current	I_0*	A	17.5
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	164
Voltage constant	k_E	Vs/m	54.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	88.1
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	1.2
Phase inductance	L_{STR}	mH	15
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	28.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	29.7
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2945
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7.7
Pressure drop	$\Delta p_{P,H}$	bar	0.88
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	60
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	1.28
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	234
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.02
Pressure drop per combi distributor	Δp_{KV}	bar	0.19
Pressure drop per coupling point	Δp_{KS}	bar	0.2

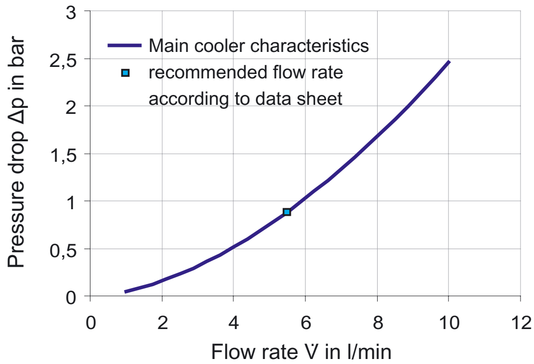
1FN3900-2WB00-0AA1 characteristics

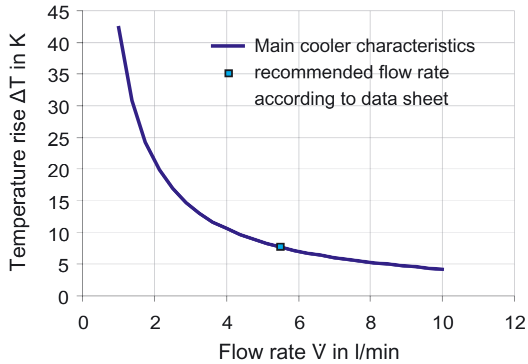
Thrust characteristics



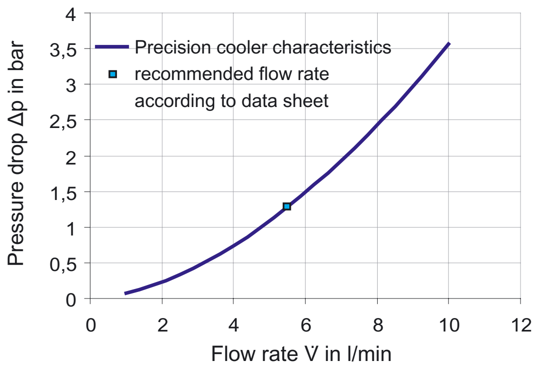


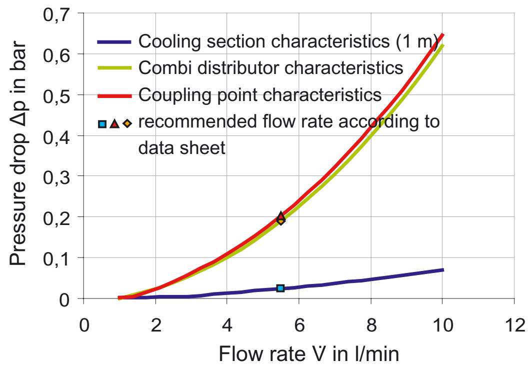
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



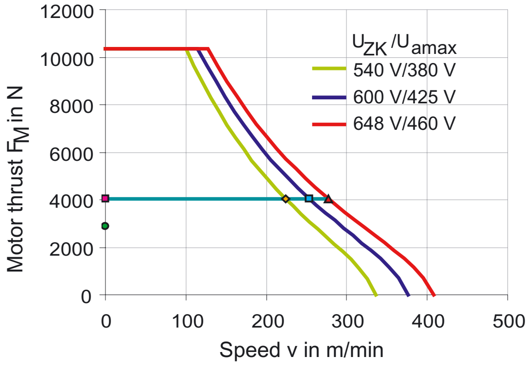


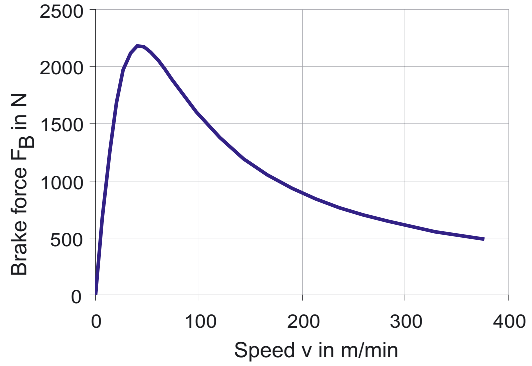
1FN3

1FN3900-2WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	4050
Rated current	I_N	A	36.7
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	253
Rated power loss	$P_{V,N}$	W	2670
Limiting data			
Maximum thrust	F_{MAX}	N	10350
Maximum current	I_{MAX}	A	103.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	115
Maximum electric power input	$P_{EL,MAX}$	W	40940
Stall thrust	F_0*	N	2864
Stall current	I_0*	A	26
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	110
Voltage constant	k_E	Vs/m	36.7
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	92.5
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.5
Phase inductance	L_{STR}	mH	6.8
Attraction force	F_A	N	20600
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	28.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	29.7
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	2670
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	5.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	7
Pressure drop	$\Delta p_{P,H}$	bar	0.88
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	60
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	5.5
Pressure drop	$\Delta p_{P,P}$	bar	1.28
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	234
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	5.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.02
Pressure drop per combi distributor	Δp_{KV}	bar	0.19
Pressure drop per coupling point	Δp_{KS}	bar	0.2

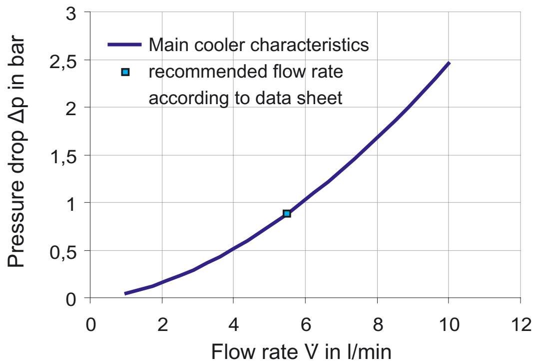
1FN3900-2WC00-0AA1 characteristics

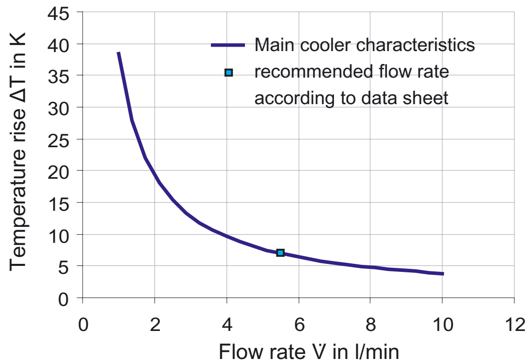
Thrust characteristics



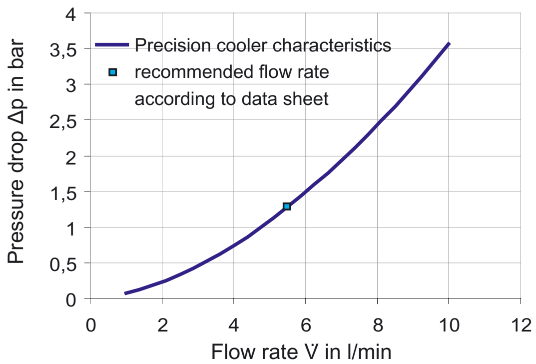


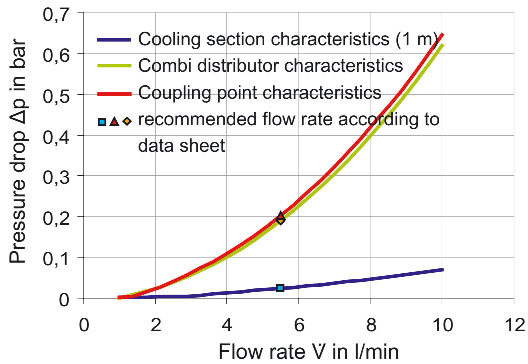
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





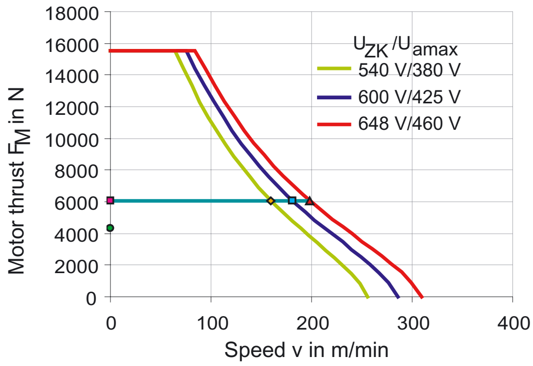
1FN3

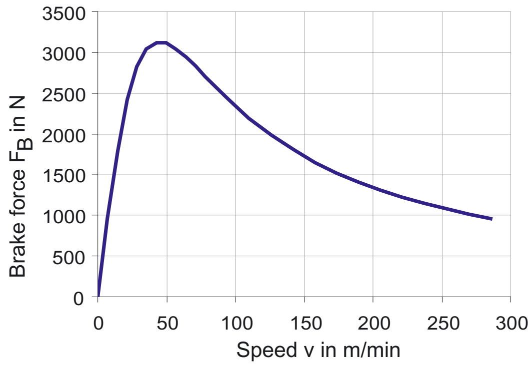
1FN3900-3WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	6075
Rated current	I_N	A	40.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	181
Rated power loss	$P_{V,N}$	W	4430
Limiting data			
Maximum thrust	F_{MAX}	N	15530
Maximum current	I_{MAX}	A	114
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	75
Maximum electric power input	$P_{EL,MAX}$	W	54470
Stall thrust	F_0^*	N	4296
Stall current	I_0^*	A	28.7
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	150
Voltage constant	k_E	Vs/m	49.9
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	107.7
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.6
Phase inductance	L_{STR}	mH	8.7
Attraction force	F_A	N	30910
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	42.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	44.3
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	4430
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6
Cooling medium temperature increase	$\Delta T_{P,H}$	K	10.6
Pressure drop	$\Delta p_{P,H}$	bar	1.49
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	85
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6
Pressure drop	$\Delta p_{P,P}$	bar	1.9
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	342
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.23
Pressure drop per coupling point	Δp_{KS}	bar	0.24

1FN3

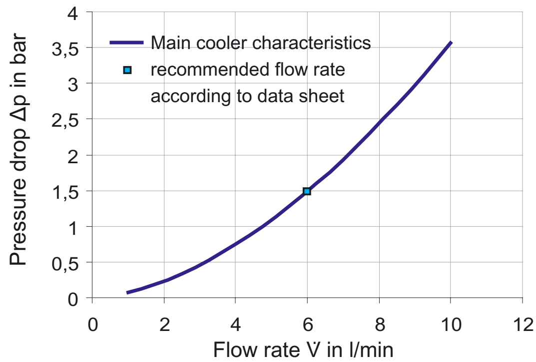
1FN3900-3WB00-0AA1 characteristics

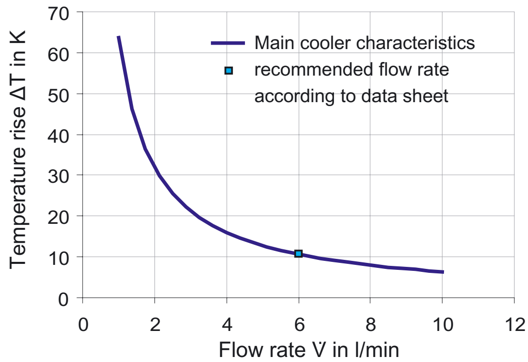
Thrust characteristics



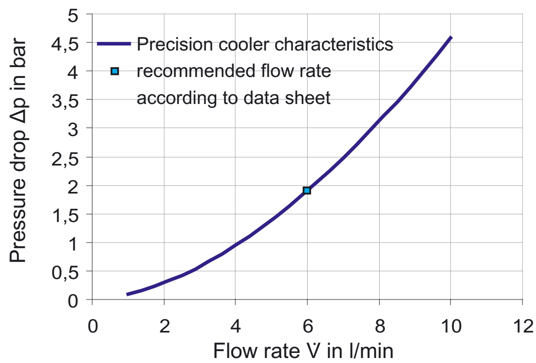


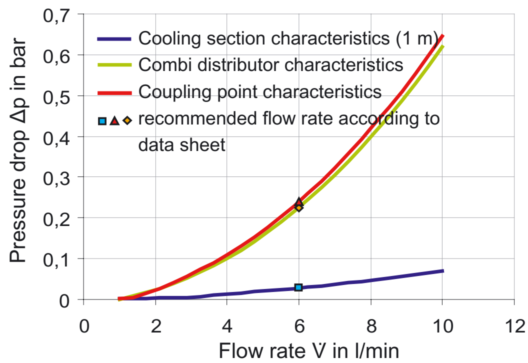
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





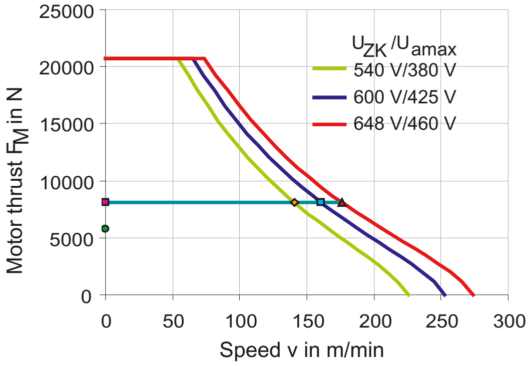
1FN3

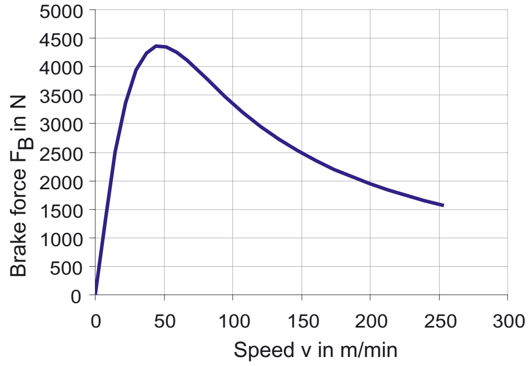
1FN3900-4WB00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	8100
Rated current	I_N	A	49.4
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	160
Rated power loss	$P_{V,N}$	W	5890
Limiting data			
Maximum thrust	F_{MAX}	N	20700
Maximum current	I_{MAX}	A	138.9
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	65
Maximum electric power input	$P_{EL,MAX}$	W	68910
Stall thrust	F_0*	N	5728
Stall current	I_0*	A	34.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	164
Voltage constant	k_E	Vs/m	54.6
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	124.6
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.6
Phase inductance	L_{STR}	mH	7.5
Attraction force	F_A	N	41210
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	56.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	58.9
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5890
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	13
Pressure drop	$\Delta p_{P,H}$	bar	2.24
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	110
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6.5
Pressure drop	$\Delta p_{P,P}$	bar	2.66
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	451
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.26
Pressure drop per coupling point	Δp_{KS}	bar	0.28

1FN3

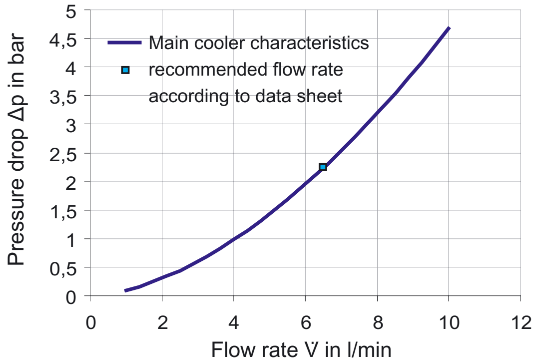
1FN3900-4WB00-0AA1 characteristics

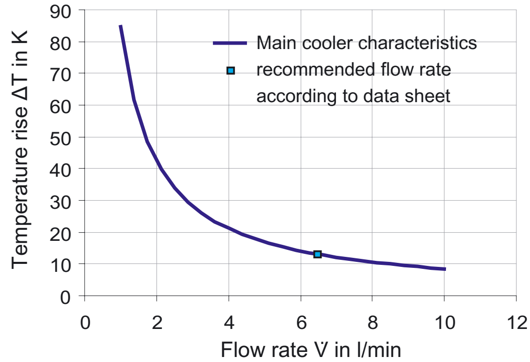
Thrust characteristics



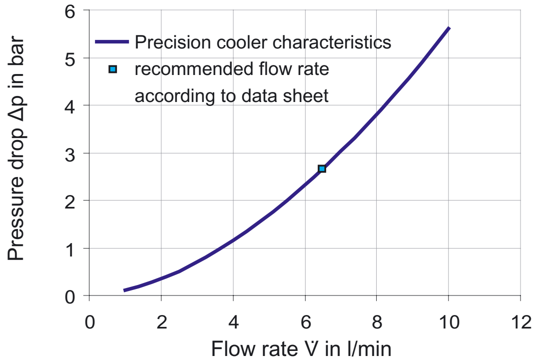


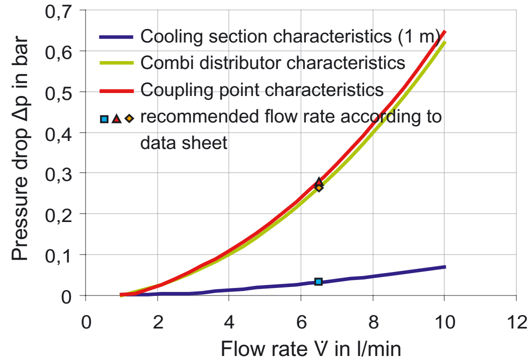
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



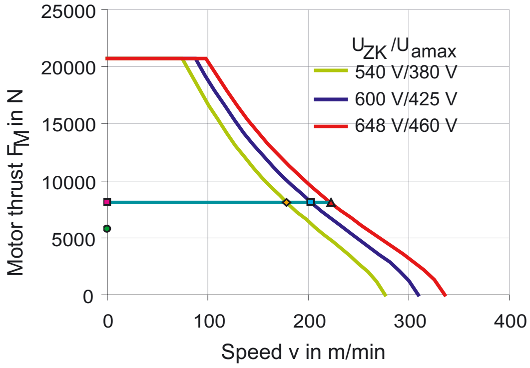


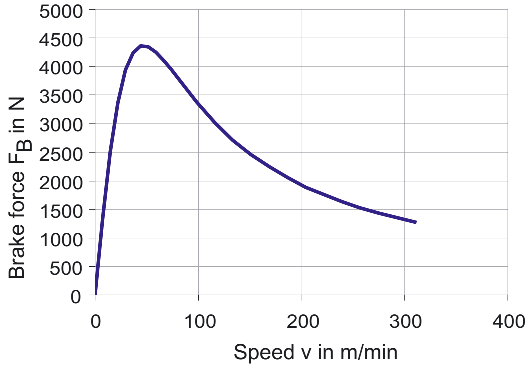
1FN3

1FN3900-4WB50-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	8100
Rated current	I_N	A	60.6
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	203
Rated power loss	$P_{V,N}$	W	5830
Limiting data			
Maximum thrust	F_{MAX}	N	20700
Maximum current	I_{MAX}	A	170.3
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	88
Maximum electric power input	$P_{EL,MAX}$	W	76280
Stall thrust	F_0*	N	5728
Stall current	I_0*	A	42.9
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	134
Voltage constant	k_E	Vs/m	44.5
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	125.2
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.4
Phase inductance	L_{STR}	mH	5
Attraction force	F_A	N	41210
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	56.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	58.9
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5830
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	12.9
Pressure drop	$\Delta p_{P,H}$	bar	2.24
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	110
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6.5
Pressure drop	$\Delta p_{P,P}$	bar	2.66
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	451
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.26
Pressure drop per coupling point	Δp_{KS}	bar	0.28

1FN3900-4WB50-0AA1 characteristics

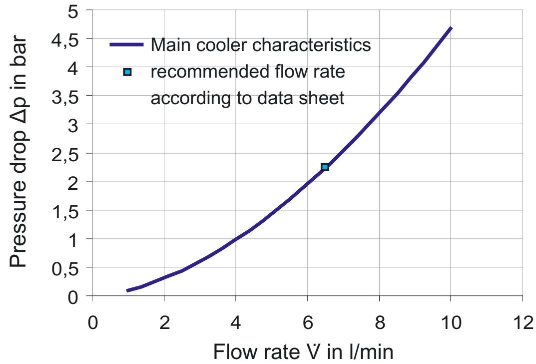
Thrust characteristics

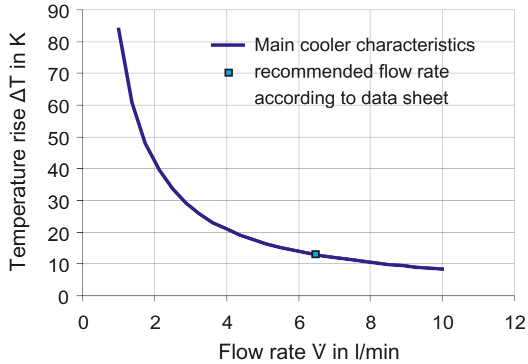




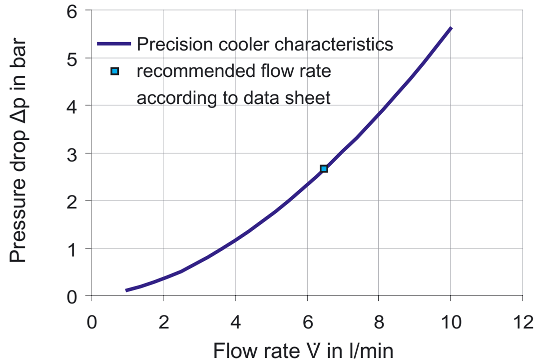
1FN3

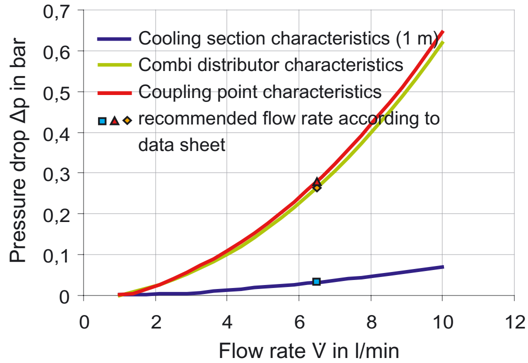
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling



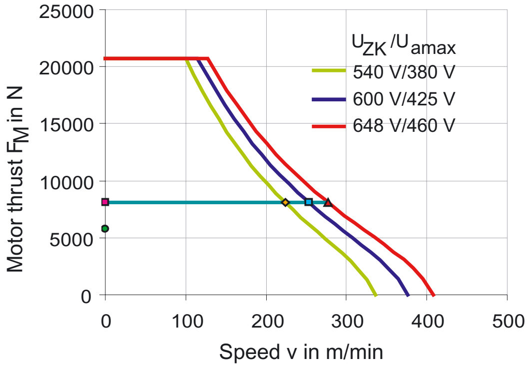


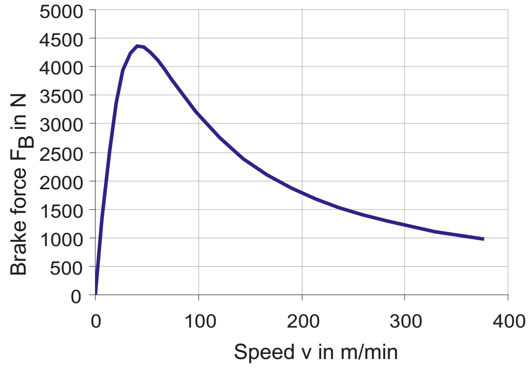
1FN3

1FN3900-4WC00-0AA1			
Technical data	**Brief designation**	**Units**	**Value**
Limitations/secondary conditions			
DC link voltage	U_{ZK}	V	600
Water cooling intake temperature	T_{VORL}	°C	35
Rated temperature	T_N	°C	120
Rated data			
Rated thrust	F_N	N	8100
Rated current	I_N	A	73.5
Maximum speed at rated thrust	$v_{MAX,FN}$	m/min	253
Rated power loss	$P_{V,N}$	W	5340
Limiting data			
Maximum thrust	F_{MAX}	N	20700
Maximum current	I_{MAX}	A	206.5
Maximum speed at maximum thrust	$v_{MAX,FMAX}$	m/min	115
Maximum electric power input	$P_{EL,MAX}$	W	81870
Stall thrust	F_0*	N	5728
Stall current	I_0*	A	52
Physical constants			
Power constant at 20° C	$k_{F,20}$	N/A	110
Voltage constant	k_E	Vs/m	36.7
Motor constant at 20° C	$k_{M,20}$	$N/\sqrt{W}$	130.8
Motor winding resistance at 20° C	$R_{STR,20}$	Ω	0.2
Phase inductance	L_{STR}	mH	3.4
Attraction force	F_A	N	41210
Thermal time constant	t_{TH}	s	120
Pole width	τ_M	mm	23
Mass primary section	m_P	kg	56.2
Mass of the primary section with precision cooler	$m_{P,P}$	kg	58.9
Mass secondary section	m_S	kg	7.5
Mass of a secondary section with cooling sections	$m_{S,P}$	kg	7.9
Primary section main cooler data			
Maximum heat output	$Q_{P,H,MAX}$	W	5345
Recommended min. flow rate	$\dot{V}_{P,H,MIN}$	l/min	6.5
Cooling medium temperature increase	$\Delta T_{P,H}$	K	11.8
Pressure drop	$\Delta p_{P,H}$	bar	2.24
Primary section precision cooler data			
Maximum heat output	$Q_{P,P,MAX}$	W	110
Recommended min. flow rate	$\dot{V}_{P,P,MIN}$	l/min	6.5
Pressure drop	$\Delta p_{P,P}$	bar	2.66
Secondary section cooling data			
Maximum heat output	$Q_{S,MAX}$	W	451
Recommended min. flow rate	$\dot{V}_{S,MIN}$	l/min	6.5
Pressure drop per meter secondary section cooling	Δp_S	bar	0.03
Pressure drop per combi distributor	Δp_{KV}	bar	0.26
Pressure drop per coupling point	Δp_{KS}	bar	0.28

1FN3900-4WC00-0AA1 characteristics

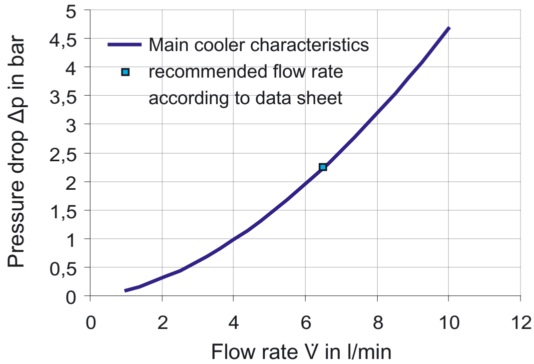
Thrust characteristics

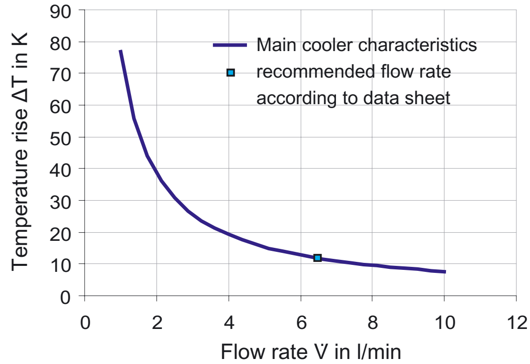




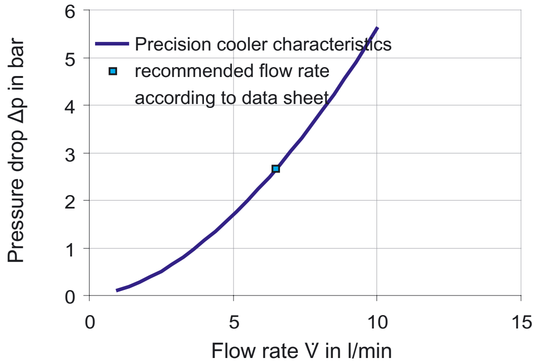
1FN3

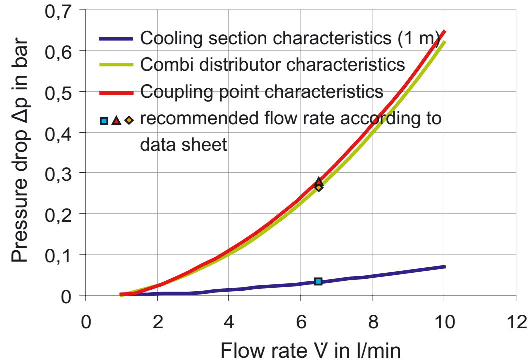
Primary section main cooler characteristics





Pressure drop characteristics for the primary section precision cooler and the secondary section cooling





1FN3

15.3 Additional characteristics

15.3.1 Continuous thrust vs. intake temperature

The motor's continuous thrust capacity F_{eff} is dependent on the intake temperature of the primary section main cooler F_{VORL}, see Figure 15-7. F_{eff} must not exceed the rated thrust of the motor if T_{VORL} = 35 °C applies.

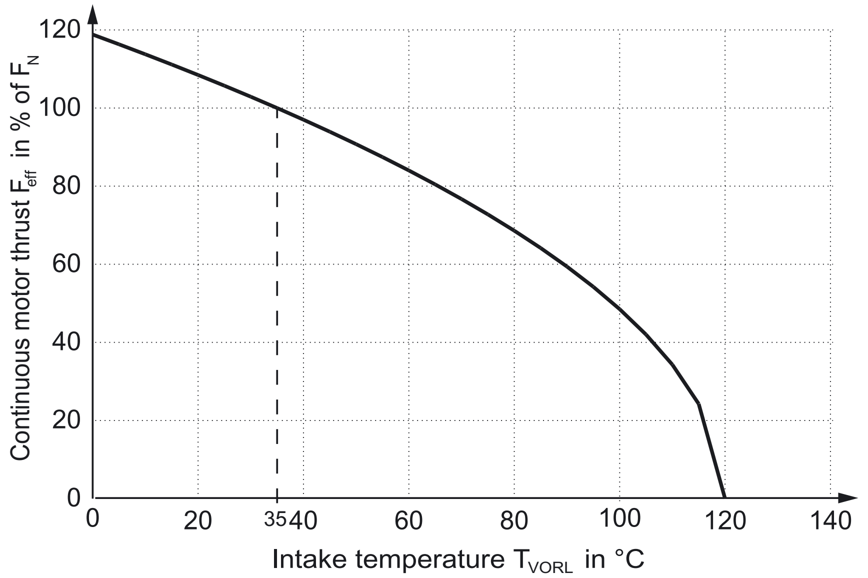


Figure 15-7 Maximum continuous thrust dependent on the intake temperature of the primary section main cooler

15.3.2 Attraction force vs. relative air gap

The attraction force F_A between the primary section and the secondary section track depends on the air gap, see Figure 15-8. The value F_A specified in the motor data sheets refers to the rated air gap.

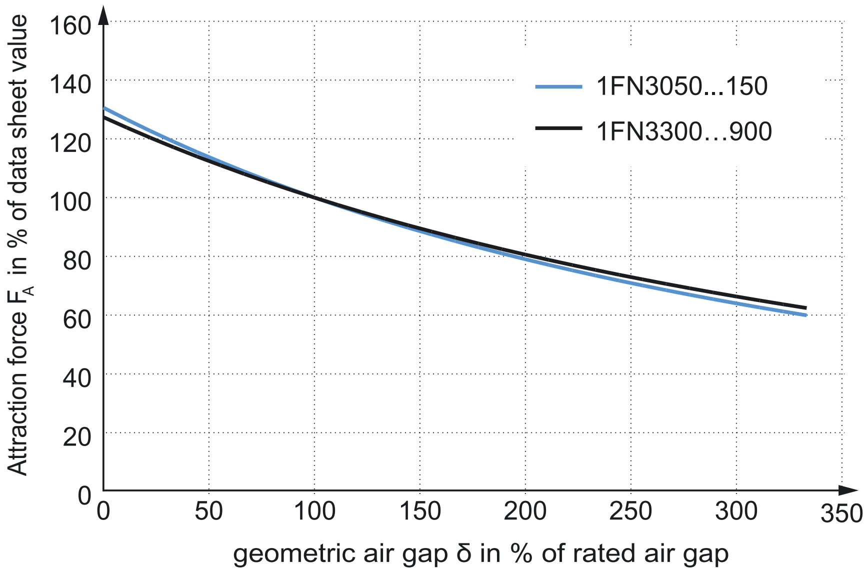


Figure 15-8 Attraction force of the 1FN3-type peak-load motors dependent on the air gap

15.3.3 Motor thrust vs. relative air gap

The motor thrust F_{MAX} depends on the air gap, see Figure 15-9. The value F_{MAX} specified in the motor data sheets refers to the rated air gap.

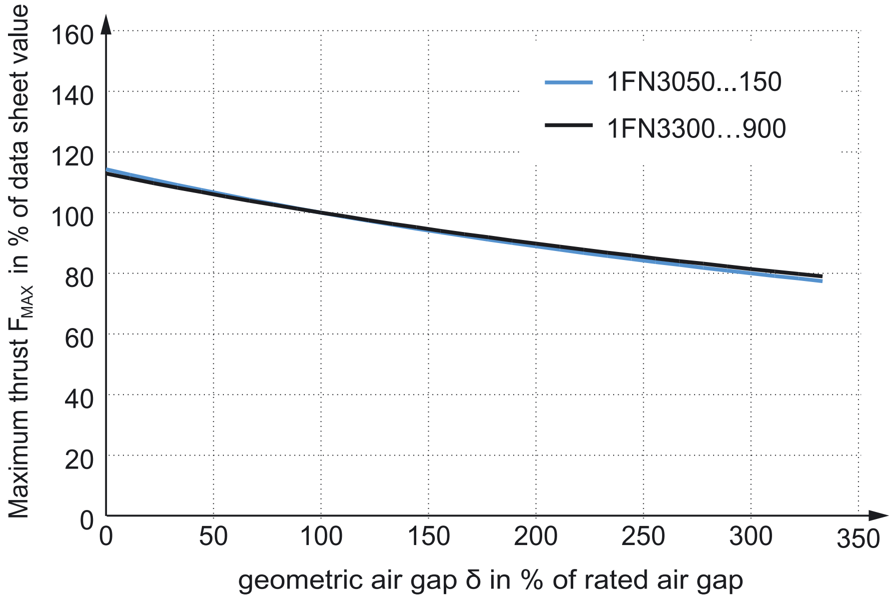


Figure 15-9 Motor thrust of the 1FN3-type peak-load motors dependent on the air gap

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1FN3

16 Mounting diagrams and dimension tables

16.1 1FN3050, 1FN3100, 1FN3150

16.1.1 Installation diagrams

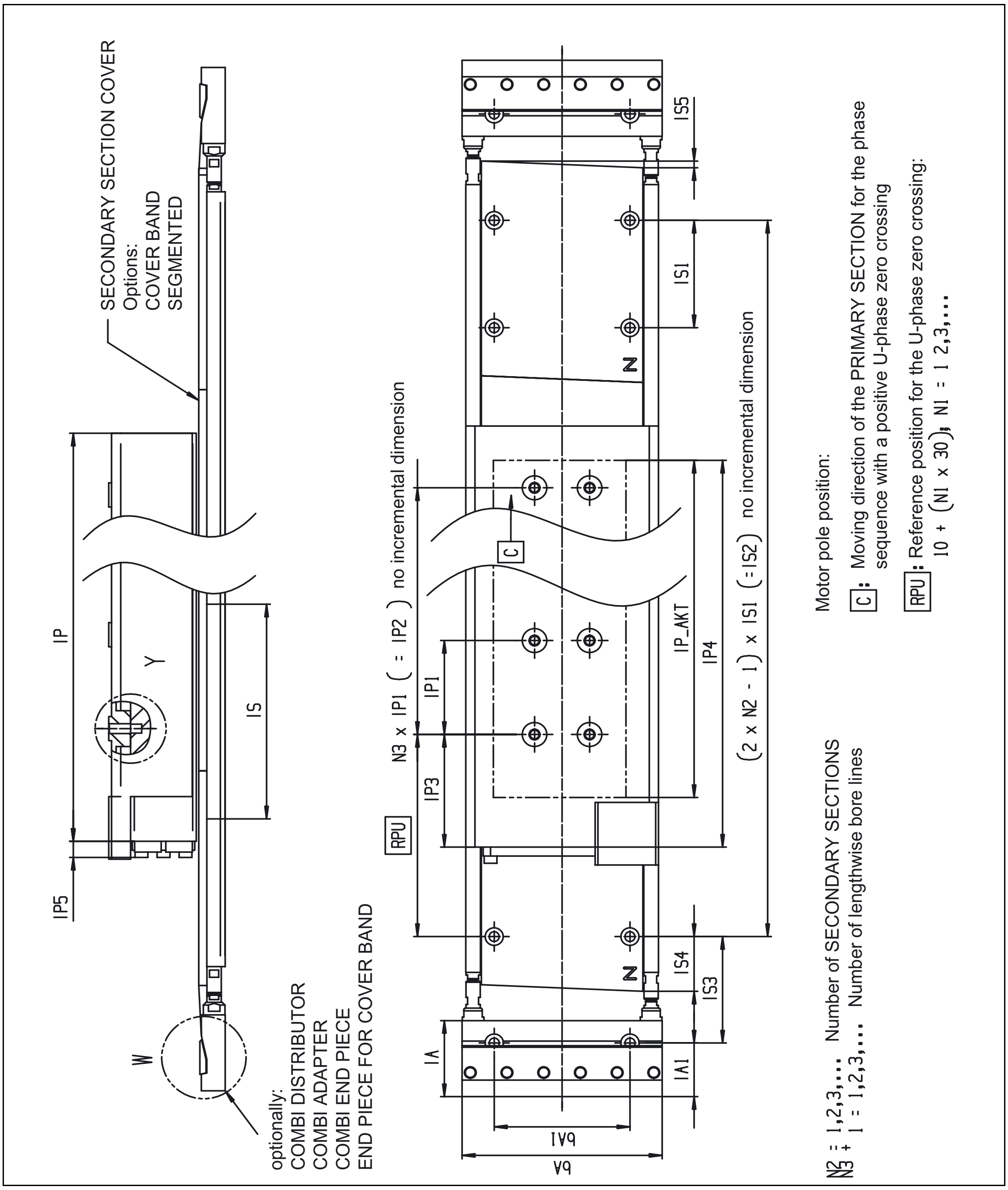


Figure 16-1 Mounting dimensions for the 1FN3050, 1FN3100 and 1FN3150 motor models

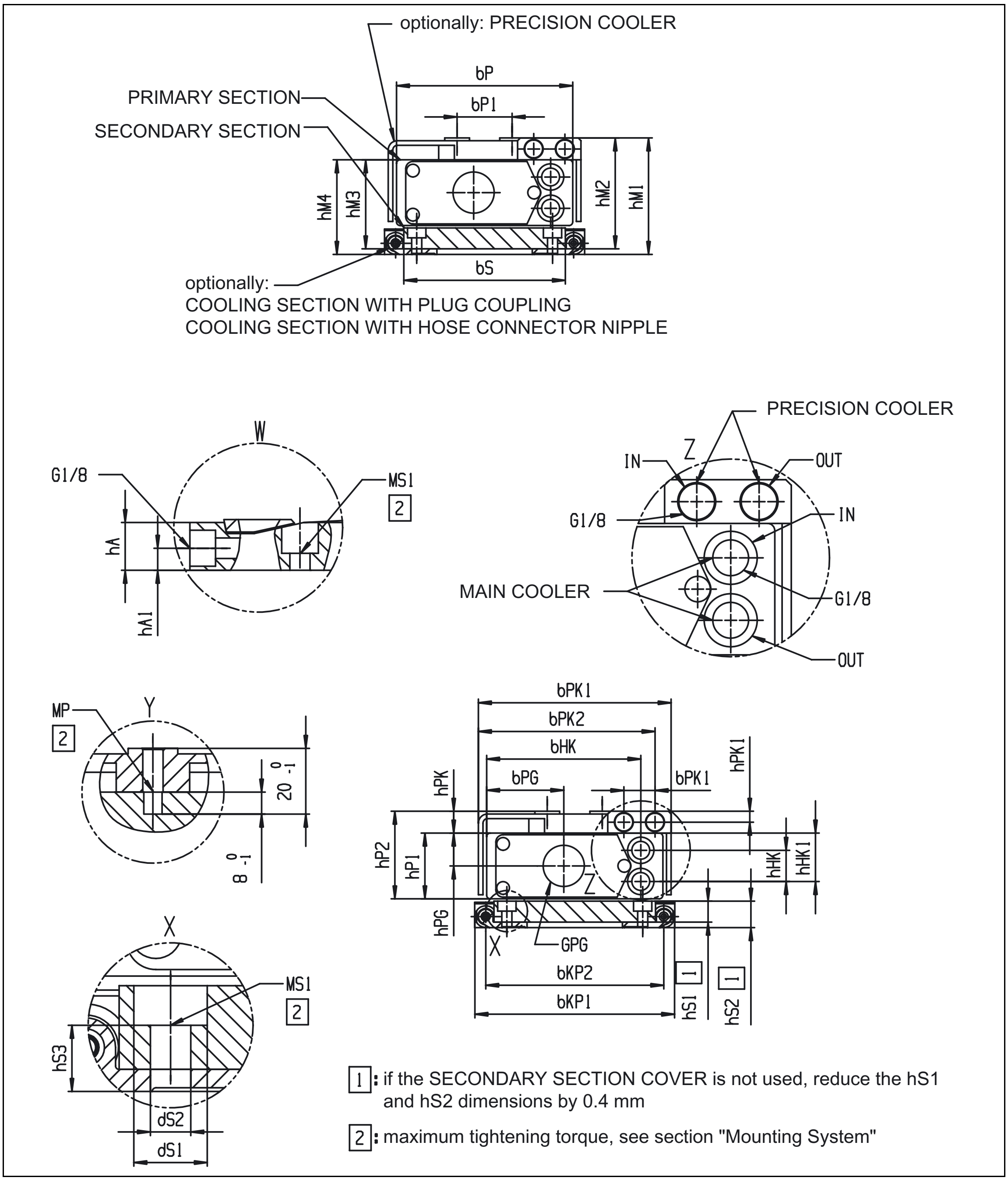


Figure 16-2 Mounting dimensions for the 1FN3050, 1FN3100 and 1FN3150 motor models: Sections and details

16.1.2 1FN3050 dimensioning tables

Primary section dimensions

1FN3

Size	Variable	Value	1FN3050-...				
			1W	2W	3W	4W	5W
Length without terminal panel	IP	mm		255			
Longitudinal bore grid	IP1	mm		52.5			
Total longitudinal bore grid	IP2	mm		157.5			
First bore hole position on longitudinal grid	IP3	mm		63			
Position of the magnetically active surface	IP4	mm		247			
Length of terminal panel cover	IP5	mm		9			
Magnetically active length	IP,AKT	mm		210			
Main cooler connector position (width)	bHK	mm		55			
Width without precision cooler	bP	mm		67			
Transversal bore grid	bP1	mm		30			
Total transversal bore grid	bP2	mm		–			
PG thread position (width)	bPG	mm		26.5			
Precision cooler connector distance	bPK	mm		17			
Precision cooler width	bPK1	mm		76			
Precision cooler connector position	bPK2	mm		68			
Main cooler connector distance	hHK	mm		17			
Main cooler connector position (height)	hHK1	mm		26.4			
Motor height with additional coolers	hM1	mm		63.4			
Motor height with precision cooler	hM2	mm		60.4			
Motor height without additional coolers	hM3	mm		48.5			
Motor height with cooling section without precision cooler	hM4	mm		51.5			
Height of primary section without precision cooler	hP1	mm		35.8			
Height of primary section with precision cooler	hP2	mm		47.7			
PG thread position (height)	hPG	mm		17.9			
Precision cooler height	hPK	mm		11.9			
Precision cooler connector positions (height)	hPK1	mm		6			
PG thread diameter	GPG			PG16			
Mounting screw thread	MP			M5			

Secondary section dimensions

Size	Variable	Value	1FN3050-4SAxx
Secondary section length	lS	mm	120
Bore grid (longitudinal)	lS1	mm	60
Total bore grid (longitudinal)	lS2	mm	lS1 x (2xN2–1)
First bore hole position on longitudinal grid	lS4	mm	31.3
Skew factor	lS5	mm	5
Width without cooling section	bS	mm	58
Bore grid (transversal)	bS1	mm	44
Width with cooling section	bKP1	mm	75
Cooling section connector distance	bKP2	mm	67
Height without cooling section with cover	hS1	mm	11.8
Height with cooling section and cover	hS2	mm	14.8
Mounting screw grip	hS3	mm	9
Screw countersink diameter (outer)	dS1	mm	10
Bore hole diameter (outer)	dS2	mm	5.5
Bore hole diameter (inner)	dS3	mm	–
Screw countersink diameter (inner)	dS4	mm	–
Secondary section mounting screws (exterior)	MS1	mm	DIN_912_M5
Secondary section mounting screws (interior)	MS2	mm	–

1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3050-0Tx00
Maximum length	lA	mm	42.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	60
Maximum width	bA	mm	79
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	44
Maximum height (block)	hA	mm	13.8

16.1.3 1FN3100 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3100-...				
			1W	2W	3W	4W	5W
Length without terminal panel	lP	mm	150	255	360	465	570
Longitudinal bore grid	lP1	mm	52.5	52.5	52.5	52.5	52.5
Total longitudinal bore grid	lP2	mm	52.5	157.5	262.5	367.5	472.5
First bore hole position on longitudinal grid	lP3	mm	63	63	63	63	63
Position of the magnetically active surface	lP4	mm	142	247	352	457	562
Length of terminal panel cover	lP5	mm	9	9	9	9	9
Magnetically active length	lP,AKT	mm	105	210	315	420	525
Main cooler terminal position (width)	bHK	mm	84	84	84	84	84
Width without precision cooler	bP	mm	96	96	96	96	96
Transversal bore grid	bP1	mm	30	30	30	30	30
Total transversal bore grid	bP2	mm	–	–	–	–	–
PG thread position (width)	bPG	mm	42	42	42	42	42
Precision cooler connector distance	bPK	mm	–	17	17	17	17
Precision cooler width	bPK1	mm	–	105	105	105	105
Precision cooler connector position	bPK2	mm	–	97	97	97	97
Main cooler connector distance	hHK	mm	17	17	17	17	17
Main cooler connector position (height)	hHK1	mm	26.4	26.4	26.4	26.4	26.4
Motor height with additional coolers	hM1	mm	–	63.4	63.4	63.4	63.4
Motor height with precision cooler	hM2	mm	–	60.4	60.4	60.4	60.4
Motor height without additional cooler	hM3	mm	48.5	48.5	48.5	48.5	48.5
Motor height with cooling section without precision cooler	hM4	mm	51.5	51.5	51.5	51.5	51.5
Height of primary section without precision cooler	hP1	mm	35.8	35.8	35.8	35.8	35.8
Height of primary section with precision cooler	hP2	mm	–	47.7	47.7	47.7	47.7
PG thread position (height)	hPG	mm	17.9	17.9	17.9	17.9	17.9
Precision cooler height	hPK	mm	–	11.9	11.9	11.9	11.9
Precision cooler connector positions (height)	hPK1	mm	–	6	6	6	6
PG thread diameter	GPG		PG16	PG16	PG16	PG16	PG16
Mounting screw thread	MP		M5	M5	M5	M5	M5

Secondary section dimensions

Size	Variable	Value	1FN3100-4SAxx
Secondary section length	lS	mm	120
Bore grid (longitudinal)	lS1	mm	60
Total bore grid (longitudinal)	lS2	mm	lS1 x (2xN2–1)
First bore hole position on longitudinal grid	lS4	mm	30.6
Skew factor	lS5	mm	3.7
Width without cooling section	bS	mm	88
Bore grid (transversal)	bS1	mm	74
Width with cooling section	bKP1	mm	105
Cooling section connector distance	bKP2	mm	97
Height without cooling section with cover	hS1	mm	11.8
Height with cooling section with cover	hS2	mm	14.8
Mounting screw grip	hS3	mm	9
Screw countersink diameter (outer)	dS1	mm	10
Bore hole diameter (outer)	dS2	mm	5.5
Bohrungsdurchmesser (innen)	dS3	mm	–
Screw countersink diameter (inner)	dS4	mm	–
Secondary section mounting screws (exterior)	MS1	mm	DIN_912_M5
Secondary section mounting screws (interior)	MS2	mm	–

1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3100-0Tx00
Maximum length	lA	mm	42.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	60
Maximum width	bA	mm	109
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	74
Maximum height (block)	hA	mm	13.8

16.1.4 1FN3150 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3150-...				
			1W	2W	3W	4W	5 W
Length without terminal panel	lP	mm		255	360	465	570
Longitudinal bore grid	lP1	mm		52.5	52.5	52.5	52.5
Total longitudinal bore grid	lP2	mm		157.5	262.5	367.5	472.5
First bore hole position on longitudinal grid	lP3	mm		63	63	63	63
Position of the magnetically active surface	lP4	mm		247	352	457	562
Length of terminal panel cover	lP5	mm		9	9	9	9
Magnetically active length	lP,AKT	mm		210	315	420	525
Main cooler terminal position (width)	bHK	mm		114	114	114	114
Width without precision cooler	bP	mm		126	126	126	126
Transversal bore grid	bP1	mm		45	45	45	45
Total transversal bore grid	bP2	mm		–	–	–	–
PG thread position (width)	bPG	mm		42	42	42	42
Precision cooler connector distance	bPK	mm		17	17	17	17
Precision cooler width	bPK1	mm		135	135	135	135
Precision cooler connector position	bPK2	mm		127	127	127	127
Main cooler connector distance	hHK	mm		17	17	17	17
Main cooler connector position (height)	hHK1	mm		26.4	26.4	26.4	26.4
Motor height with additional cooler	hM1	mm		65.4	65.4	65.4	65.4
Motor height with precision cooler	hM2	mm		62.4	62.4	62.4	62.4
Motor height without additional cooler	hM3	mm		50.5	50.5	50.5	50.5
Motor height with cooling section without precision cooler	hM4	mm		53.5	53.5	53.5	53.5
Height of primary section without precision cooler	hP1	mm		35.8	35.8	35.8	35.8
Height of primary section with precision cooler	hP2	mm		47.7	47.7	47.7	47.7
PG thread position (height)	hPG	mm		17.9	17.9	17.9	17.9
Precision cooler height	hPK	mm		11.9	11.9	11.9	11.9
Precision cooler connector positions (height)	hPK1	mm		6	6	6	6
PG thread diameter	GPG			PG16	PG16	PG16	PG16
Mounting screw thread	MP			M5	M5	M5	M5

1FN3

Secondary section dimensions

Size	Variable	Value	1FN3150-4SAxx
Secondary section length	lS	mm	120
Bore grid (longitudinal)	lS1	mm	60
Total bore grid (longitudinal)	lS2	mm	lS1 x (2xN2–1)
first bore hole position on longitudinal grid	lS4	mm	30.4
Skew factor	lS5	mm	3.3
Width without cooling section	bS	mm	118
Bore grid (transversal)	bS1	mm	104
Width with cooling section	bKP1	mm	135
Cooling section connector distance	bKP2	mm	127
Height without cooling section with cover	hS1	mm	13.8
Height with cooling section and cover	hS2	mm	16.8
Mounting screw grip	hS3	mm	11
Screw countersink diameter (outer)	dS1	mm	10
Bore hole diameter (outer)	dS2	mm	5.5
Bore hole diameter (inner)	dS3	mm	–
Screw countersink diameter (inner)	dS4	mm	–
Secondary section mounting screws (exterior)	MS1	mm	DIN_912_M5
Secondary section mounting screws (interior)	MS2	mm	–

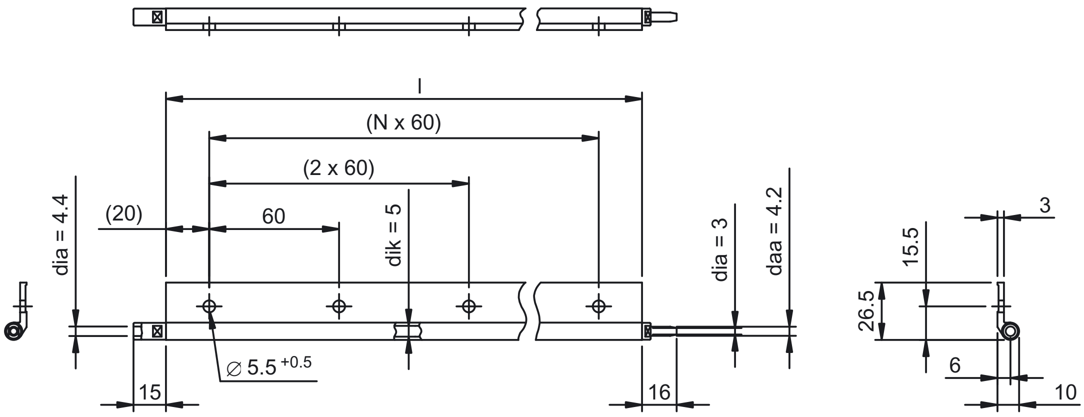
1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3150-0Tx00
Maximum length	lA	mm	42.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	60
Maximum width	bA	mm	139
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	104
Maximum height (block)	hA	mm	15.8

1FN3

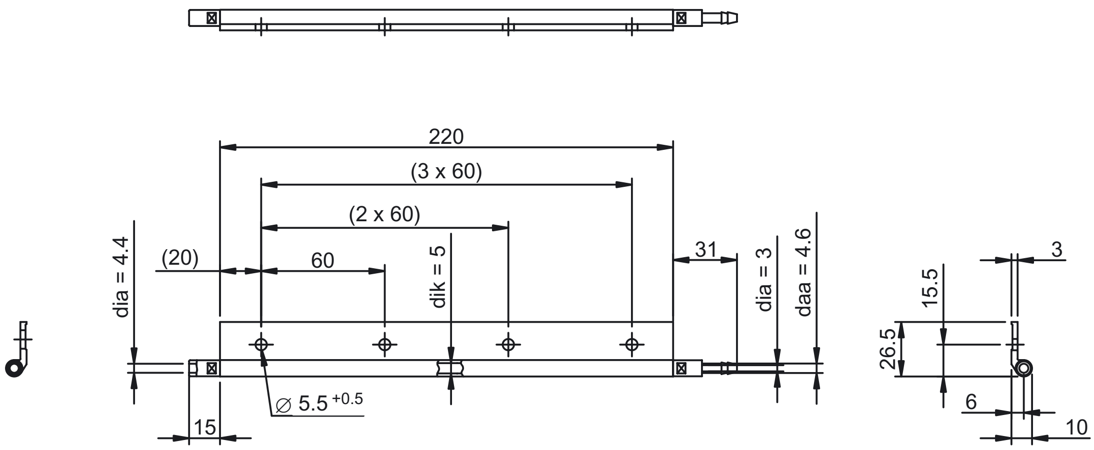
16.1.5 Cooling sections



Number of sec. sections	N	l [mm]	Ground [g]
1	2	100	30
2	3	220	60
3	5	340	90
4	7	460	110
⋮	⋮	⋮	⋮

Coupling nipple and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Figure 16-3 Cooling section with plug nipple for the 1FN3050, 1FN3100 and 1FN3150 motor models



Hose nozzle, coupling nipple, and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Mass: 60 g

Figure 16-4 Cooling section with hose connector nipple for the 1FN3050, 1FN3100 and 1FN3150 motor models

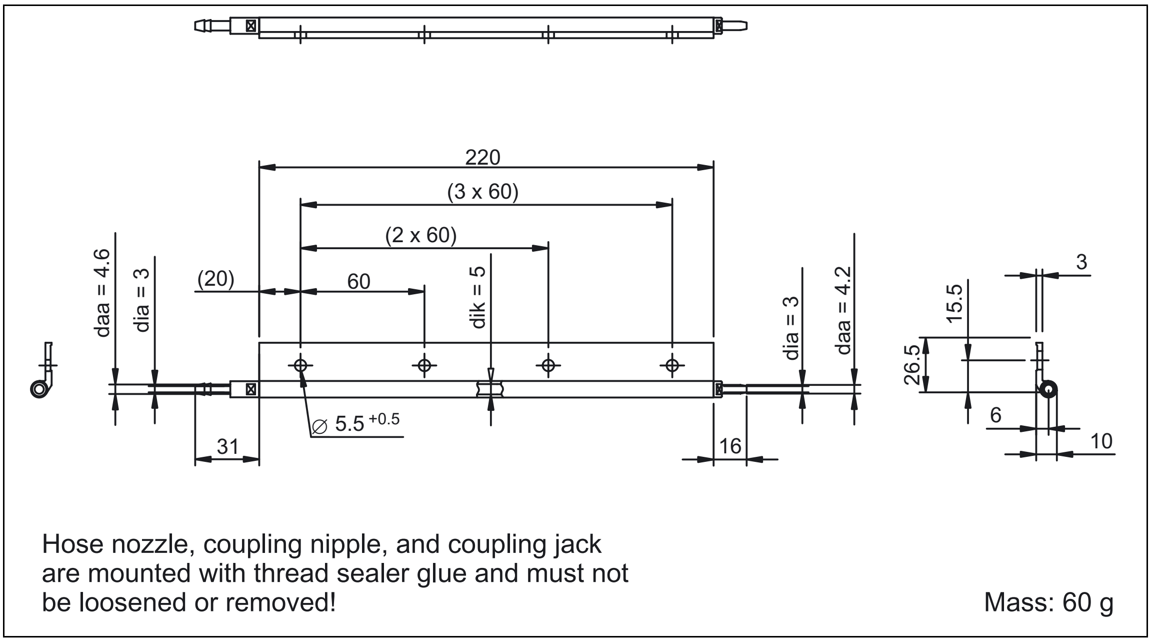


Figure 16-5 Cooling section with hose connector nipple L for the 1FN3050, 1FN3100 and 1FN3150 motor models

16.1.6 Mounting the Hall sensor box

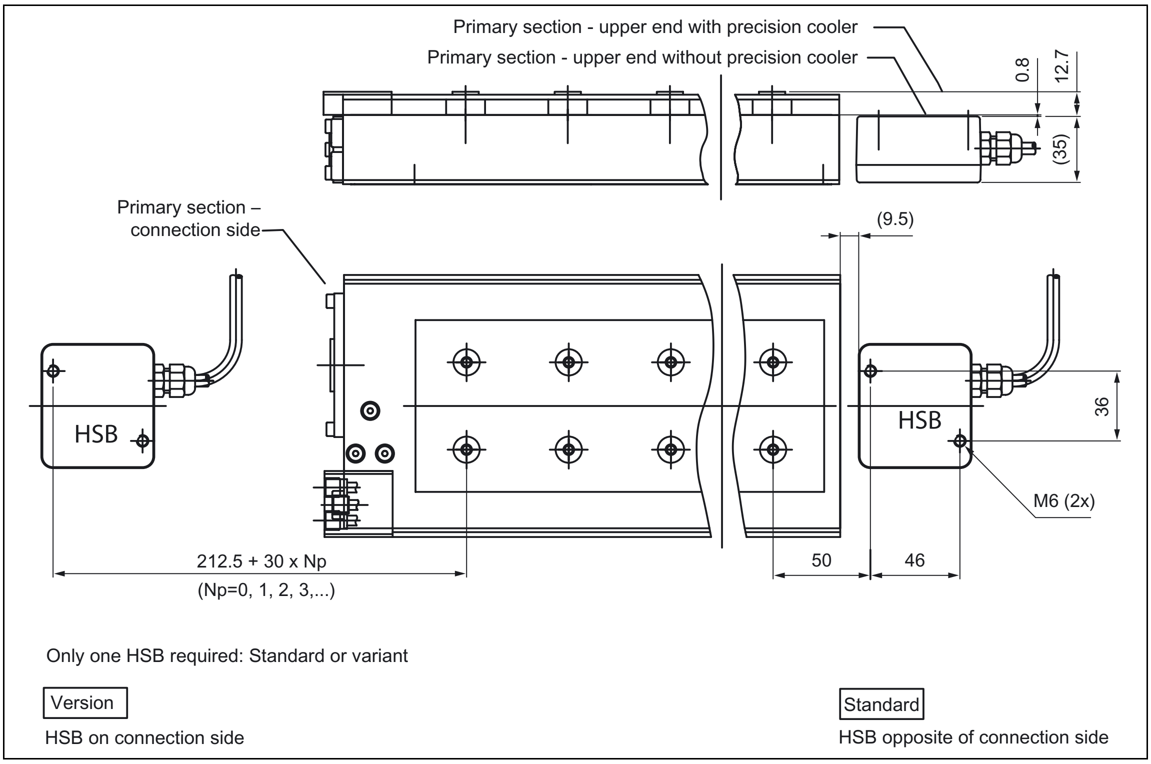


Figure 16-6 Hall sensor box (HSB) with straight cable outlet for the 1FN3050, 1FN3100, and 1FN3150 motor models

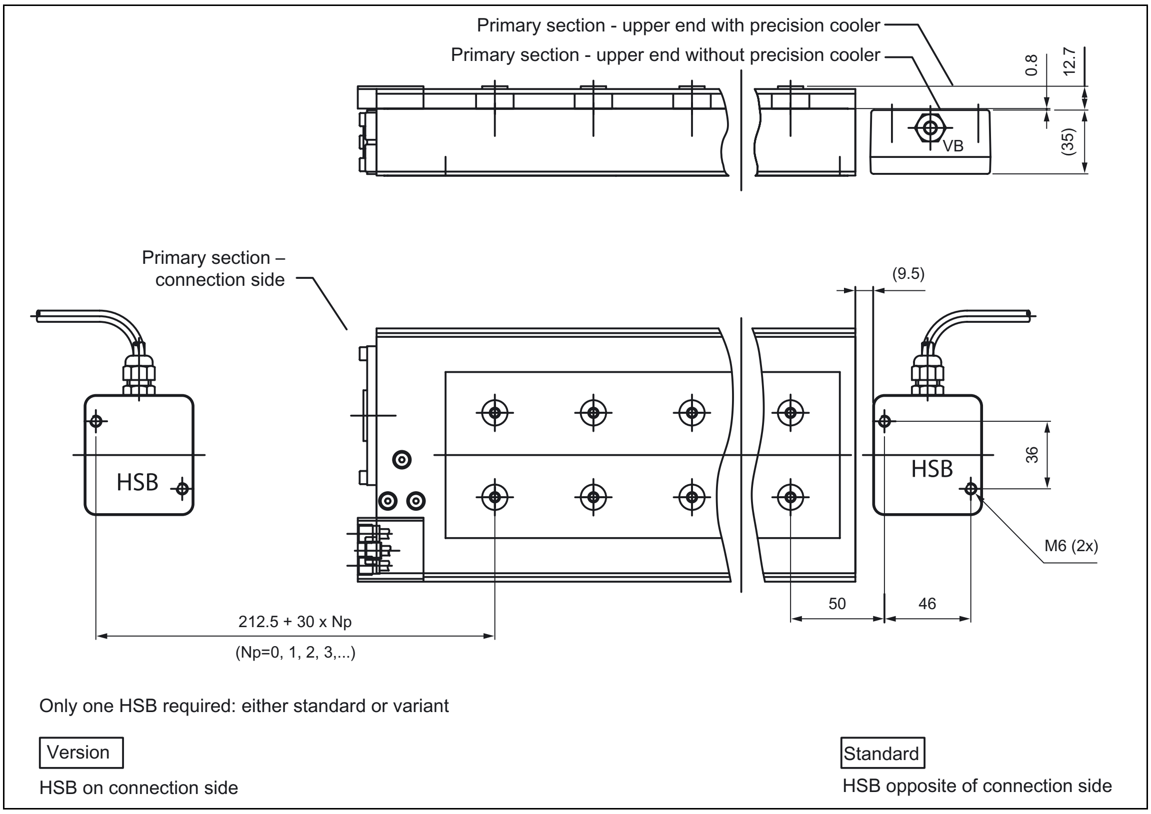


Figure 16-7 Hall sensor box (HSB) with lateral cable outlet for the 1FN3050, 1FN3100, and 1FN3150 motor models

16.2 1FN3300, 1FN3450

16.2.1 Installation diagrams

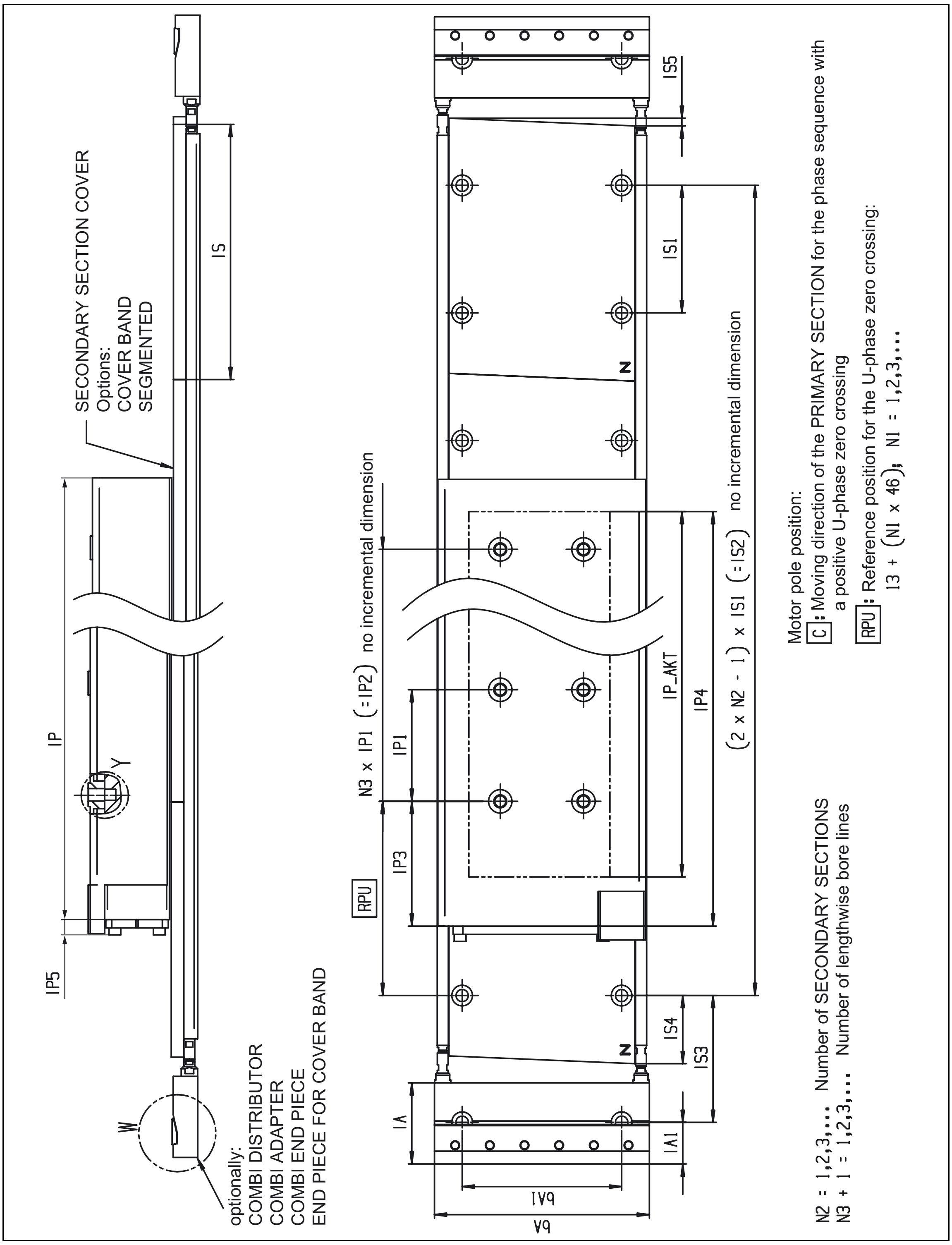


Figure 16-8 Mounting dimensions for the 1FN3300 and 1FN3450 motor models; except: 1FN3300-3WG00, 1FN3450-3WE00, 1FN3450-4WE00

1FN3

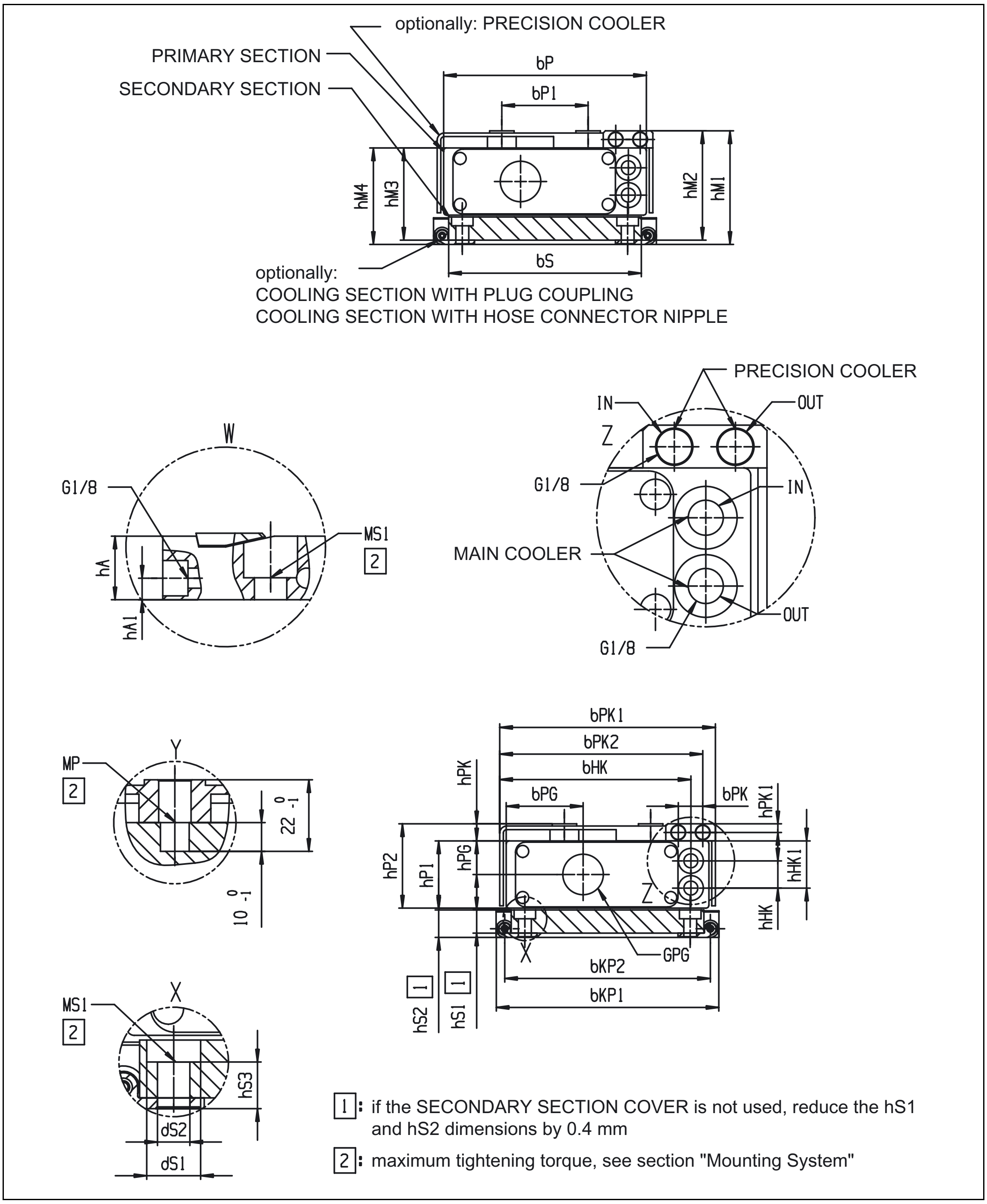


Figure 16-9 Mounting dimensions for the 1FN3300 and 1FN3450 motor models: Sections and details; except: 1FN3300-3WG00, 1FN3450-3WE00, 1FN3450-4WE00

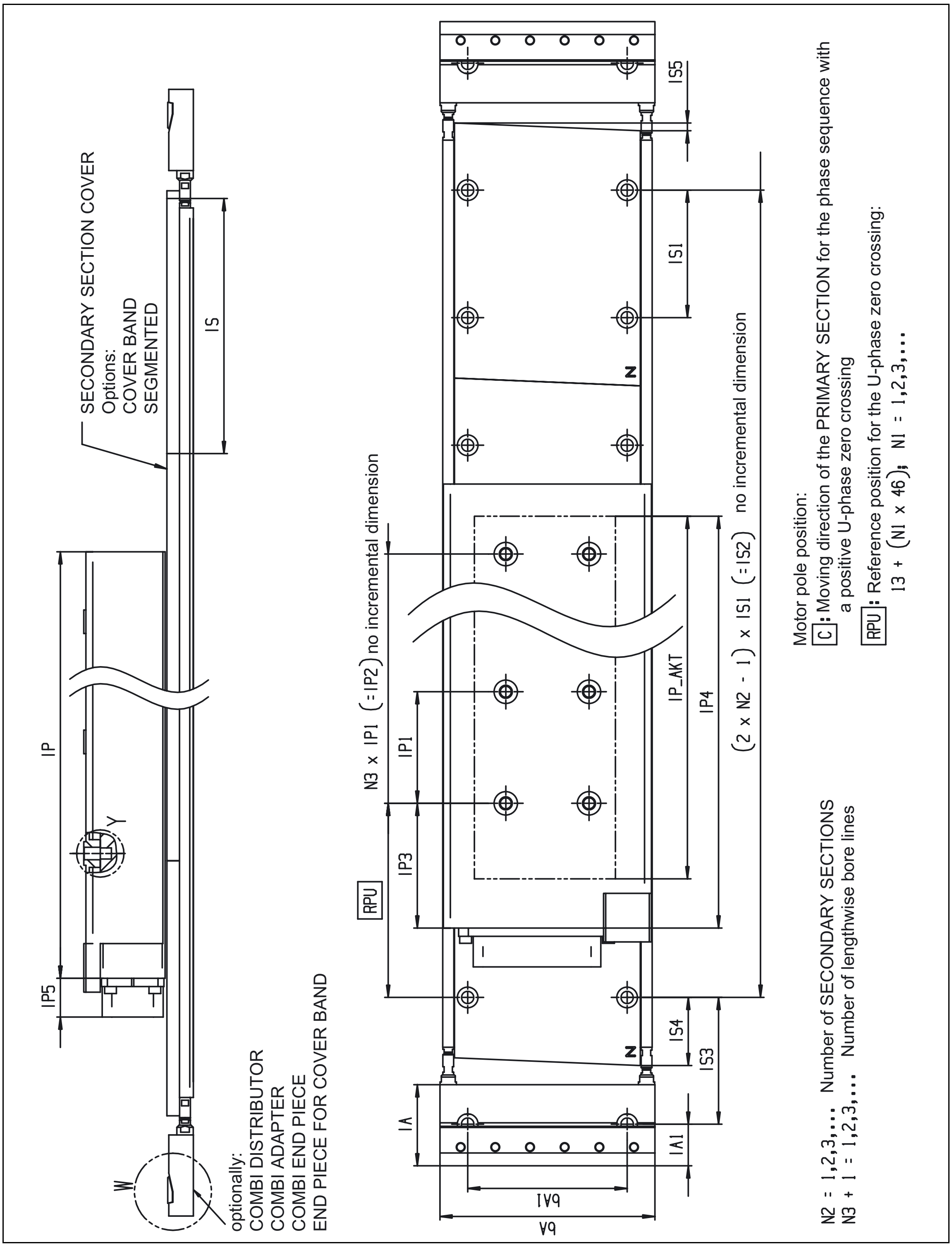


Figure 16-10 Mounting dimensions for the 1FN3300-3WG00, 1FN3450-3WE00, 1FN3450-4WE00 motor models

1FN3

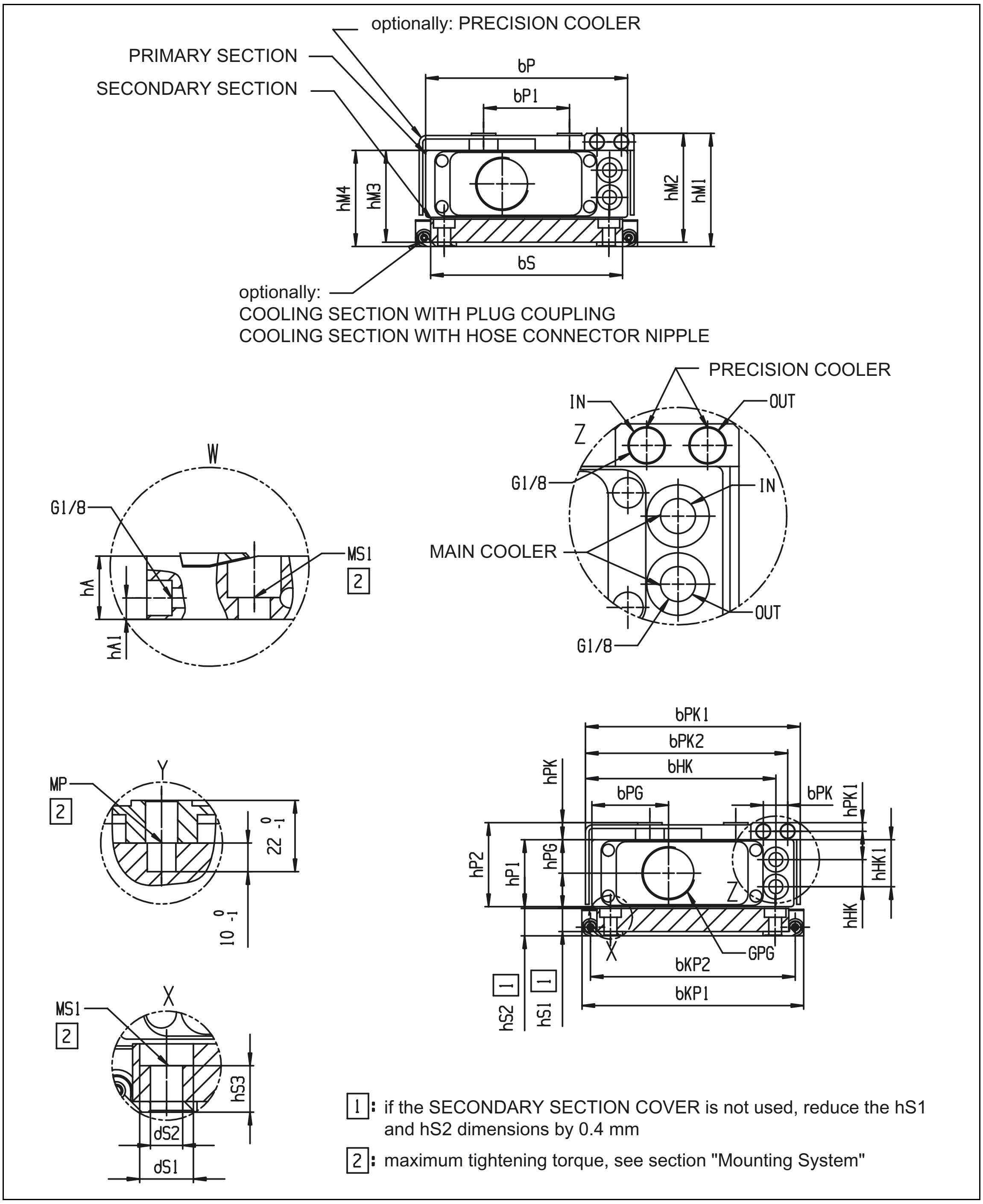


Figure 16-11 Mounting dimensions for the 1FN3300-3WG00, 1FN3450-3WE00, 1FN3450-4WE00 motor models: Sections and details

16.2.2 1FN3300 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3300-...				
			1W	2W	3W	4W	5 W
Length without terminal panel	lP	mm	221	382	543	704	
Longitudinal bore grid	lP1	mm	80.5	80.5	80.5	80.5	
Total longitudinal bore grid	lP2	mm	80.5	241.5	402.5	563.5	
First bore hole position on longitudinal grid	lP3	mm	90	90	90	90	
Position of the magnetically active surface	lP4	mm	211	372	533	694	
Length of terminal panel cover	lP5	mm	11	11	11 / 28*	11	
Magnetically active length	lP,AKT	mm	161	322	483	644	
Main cooler terminal position (width)	bHK	mm	128.5	128.5	128.5	128.5	
Width without precision cooler	bP	mm	141	141	141	141	
Transversal bore grid	bP1	mm	60	60	60	60	
Total transversal bore grid	bP2	mm	–	–	–	–	
PG thread position (width)	bPG	mm	57.5	57.5	57.5 / 53.5*	57.5	
Precision cooler connector distance	bPK	mm	–	17	17	17	
Precision cooler width	bPK1	mm	–	150	150	150	
Precision cooler connector position	bPK2	mm	–	141.5	141.5	141.5	
Main cooler connector distance	hHK	mm	19	19	19	19	
Main cooler connector position (height)	hHK1	mm	32.9	32.9	32.9	32.9	
Motor height with additional coolers	hM1	mm	–	79	79	79	
Motor height with precision cooler	hM2	mm	–	76	76	76	
Motor height without additional cooler	hM3	mm	64.1	64.1	64.1	64.1	
Motor height with cooling section without precision cooler	hM4	mm	67.1	67.1	67.1	67.1	
Height of primary section without precision cooler	hP1	mm	46.7	46.7	46.7	46.7	
Height of primary section with precision cooler	hP2	mm	–	58.6	58.6	58.6	
PG thread position (height)	hPG	mm	23.4	23.4	23.4	23.4	
Precision cooler height	hPK	mm	–	11.9	11.9	11.9	
Precision cooler connector positions (height)	hPK1	mm	–	6	6	6	
PG thread diameter	GPG		PG21	PG21	PG21 / PG29*	PG21	
Mounting screw thread	MP		M8	M8	M8	M8	

* applicable for 1FN3300-3WG00 motor models

1FN3

Secondary section dimensions

Size	Variable	Value	1FN3300-4SAxx
Secondary section length	lS	mm	184
Bore grid (longitudinal)	lS1	mm	92
Total bore grid (longitudinal)	lS2	mm	lS1 x (2xN2–1)
First bore hole position on longitudinal grid	lS4	mm	49.2
Skew factor	lS5	mm	5.6
Width without cooling section	bS	mm	134
Bore grid (transversal)	bS1	mm	115
Width with cooling section	bKP1	mm	151
Cooling section connector distance	bKP2	mm	143
Height without cooling section with cover	hS1	mm	16.5
Height with cooling section and cover	hS2	mm	19.5
Mounting screw grip	hS3	mm	13
Screw countersink diameter (outer)	dS1	mm	15
Bore hole diameter (outer)	dS2	mm	9
Bore hole diameter (inner)	dS3	mm	–
Screw countersink diameter (inner)	dS4	mm	–
Secondary section mounting screws (exterior)	MS1	mm	DIN 6912-M8
Secondary section mounting screws (interior)	MS2	mm	–

1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3300-0Tx00
Maximum length	lA	mm	58.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	92
Maximum width	bA	mm	155
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	115
Maximum height (block)	hA	mm	18.5

16.2.3 1FN3450 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3450-...				
			1W	2W	3W	4W	5 W
Length without terminal panel	lP	mm		382	543	704	
Longitudinal bore grid	lP1	mm		80.5	80.5	80.5	
Total longitudinal bore grid	lP2	mm		241.5	402.5	563.5	
First bore hole position on longitudinal grid	lP3	mm		90	90	90	
Position of the magnetically active surface	lP4	mm		372	533	694	
Length of terminal panel cover	lP5	mm		11	11 / 28*	11 / 28*	
Magnetically active length	lP,AKT	mm		322	483	644	
Main cooler connector position (width)	bHK	mm		175.5	175.5	175.5	
Width without precision cooler	bP	mm		188	188	188	
Transversal bore grid	bP1	mm		80	80	80	
Total transversal bore grid	bP2	mm		–	–	–	
PG thread position (width)	bPG	mm		57.5	57.5 / 53.5*	57.5 / 53.5*	
Precision cooler connector distance	bPK	mm		17	17	17	
Precision cooler width	bPK1	mm		197	197	197	
Precision cooler connector position	bPK2	mm		188.5	188.5	188.5	
Main cooler connector distance	hHK	mm		19	19	19	
Main cooler connector position (height)	hHK1	mm		32.9	32.9	32.9	
Motor height with additional coolers	hM1	mm		81	81	81	
Motor height with precision cooler	hM2	mm		76	76	76	
Motor height without additional cooler	hM3	mm		66.1	66.1	66.1	
Motor height with cooling section without precision cooler	hM4	mm		69.1	69.1	69.1	
Height of primary section without precision cooler	hP1	mm		46.7	46.7	46.7	
Height of primary section with precision cooler	hP2	mm		58.6	58.6	58.6	
PG thread position (height)	hPG	mm		23.4	23.4	23.4	
Precision cooler height	hPK	mm		11.9	11.9	11.9	
Precision cooler connector positions (height)	hPK1	mm		6	6	6	
PG thread diameter	GPG			PG21	PG21 / PG29*	PG21 / PG29*	
Mounting screw thread	MP			M8	M8	M8	

* applicable for 1FN3450-3WE00 and 1FN3450-4WE00 motor models

1FN3

Secondary section dimensions

Size	Variable	Value	1FN3450-4SAxx
Secondary section length	lS	mm	184
Bore grid (longitudinal)	lS1	mm	92
Total bore grid (longitudinal)	lS2	mm	lS1 x (2xN2–1)
First bore hole position on longitudinal grid	lS4	mm	48.9
Skew factor	lS5	mm	5
Width without cooling section	bS	mm	180
Bore grid (transversal)	bS1	mm	161
Width with cooling section	bKP1	mm	197
Cooling section connector distance	bKP2	mm	189
Height without cooling section with cover	hS1	mm	18.5
Height with cooling section and cover	hS2	mm	21.5
Mounting screw grip	hS3	mm	15
Screw countersink diameter (outer)	dS1	mm	15
Bore hole diameter (outer)	dS2	mm	9
Bore hole diameter (inner)	dS3	mm	–
Screw countersink diameter (inner)	dS4	mm	–
Secondary section mounting screws (exterior)	MS1	mm	DIN 6912-M8
Secondary section mounting screws (interior)	MS2	mm	–

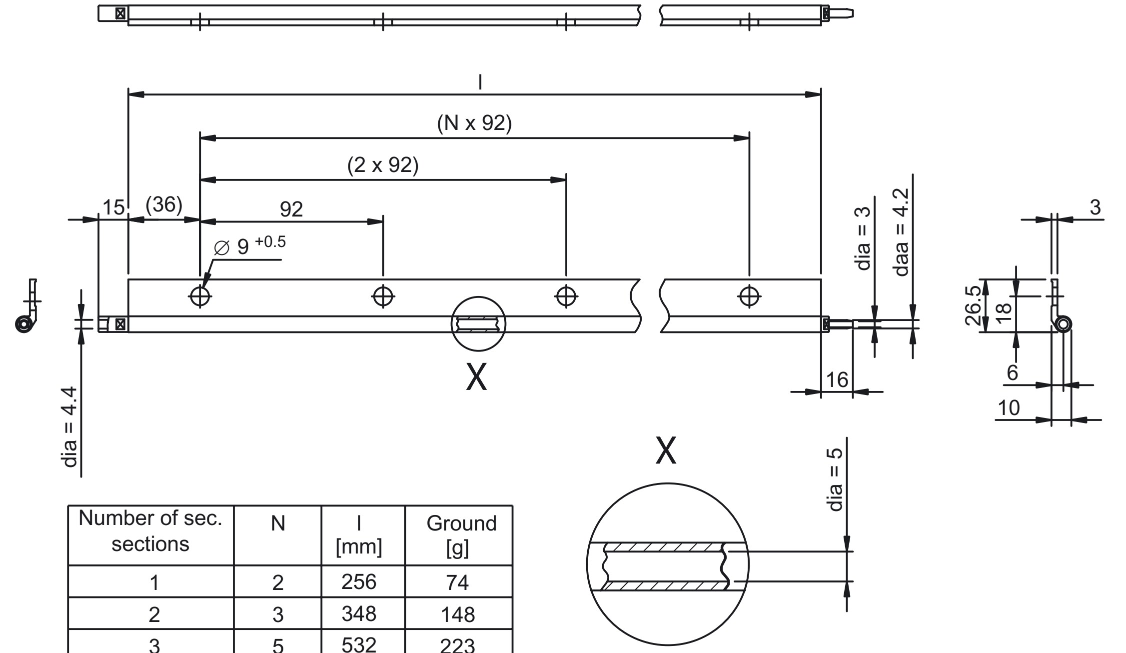
1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3450-0Tx00
Maximum length	lA	mm	58.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	92
Maximum width	bA	mm	201
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	161
Maximum height (block)	hA	mm	20.5

1FN3

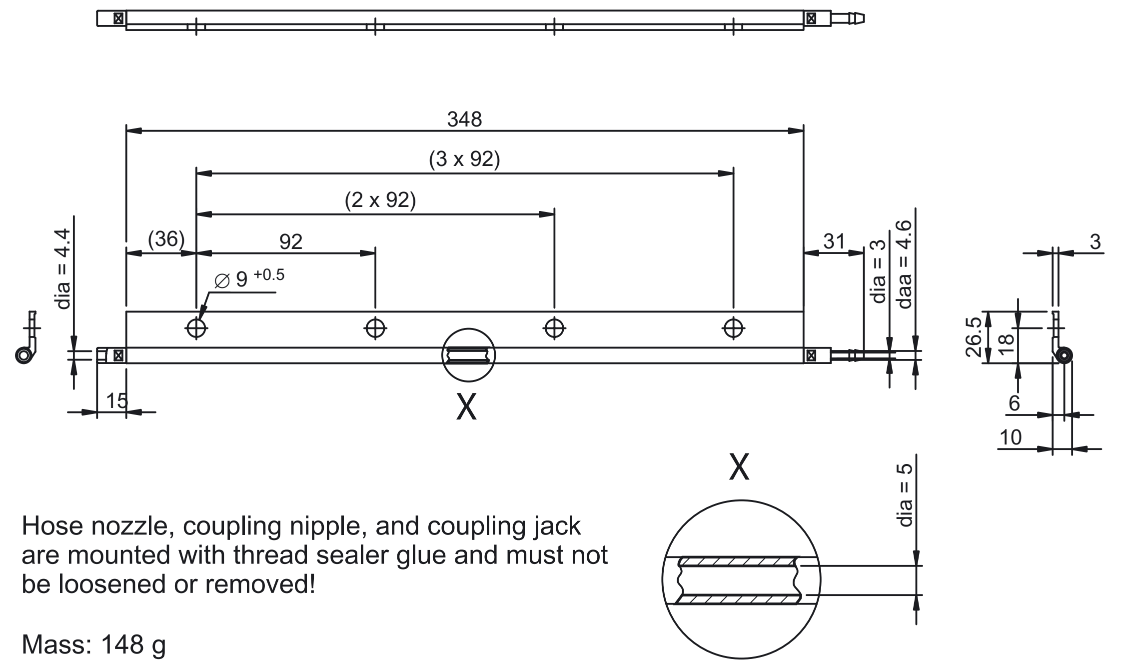
16.2.4 Cooling sections



Number of sec. sections	N	l [mm]	Ground [g]
1	2	256	74
2	3	348	148
3	5	532	223
4	7	716	298
5	9	900	373
⋮	⋮	⋮	⋮

Coupling nipple and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Figure 16-12 Cooling section with plug nipples for the 1FN3300 and 1FN3450 motor models



Hose nozzle, coupling nipple, and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Mass: 148 g

Figure 16-13 Cooling section with hose connector nipple R for the 1FN3300 and 1FN3450 motor models

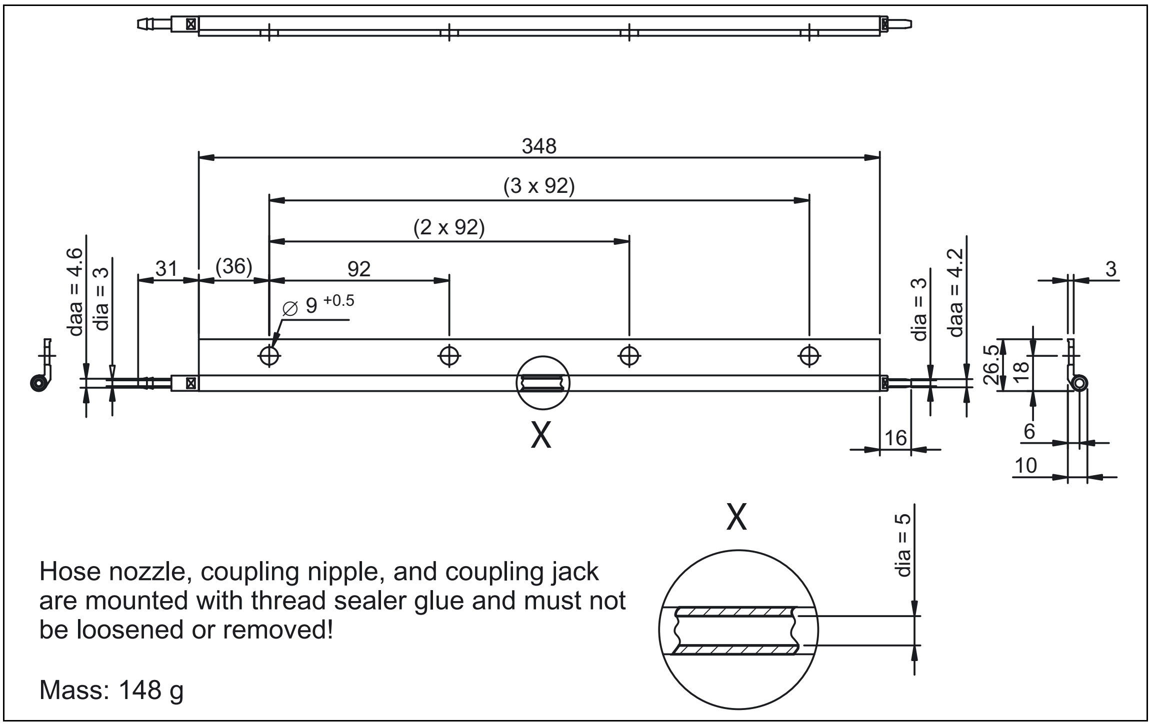


Figure 16-14 Cooling section with hose connector nipple L for the 1FN3300 and 1FN3450 motor models

16.2.5 Mounting the Hall sensor box

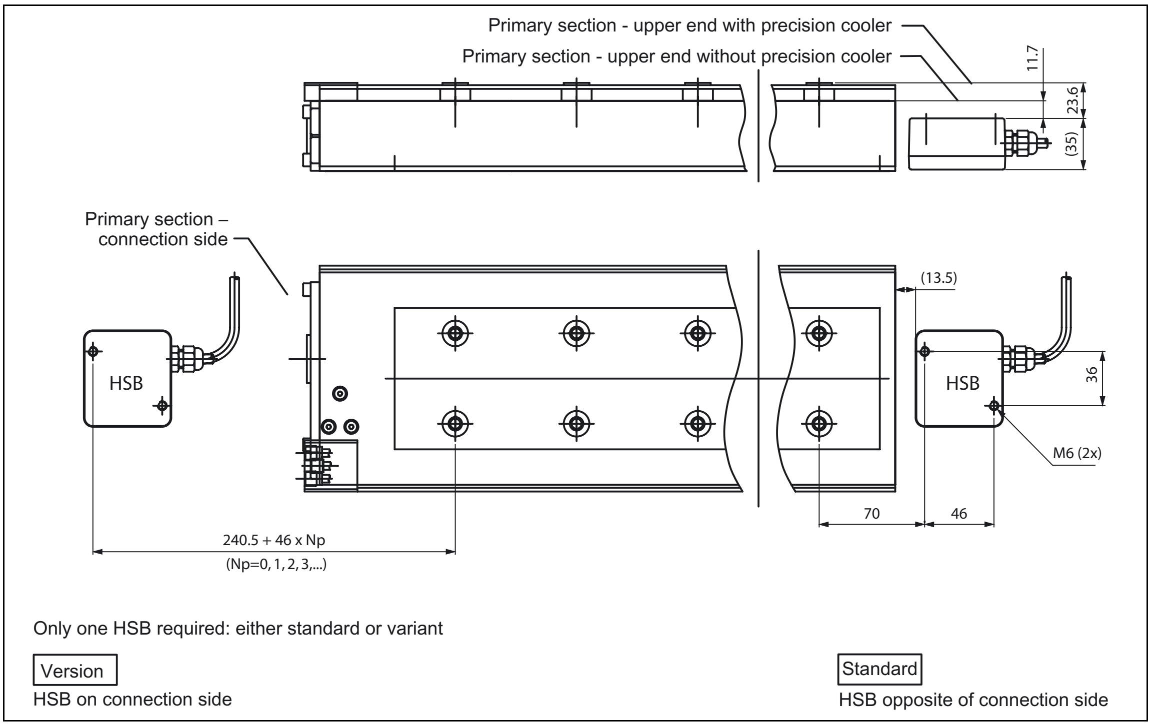


Figure 16-15 Hall sensor box (HSB) with straight cable outlet for the 1FN3300 and 1FN3450 motor models

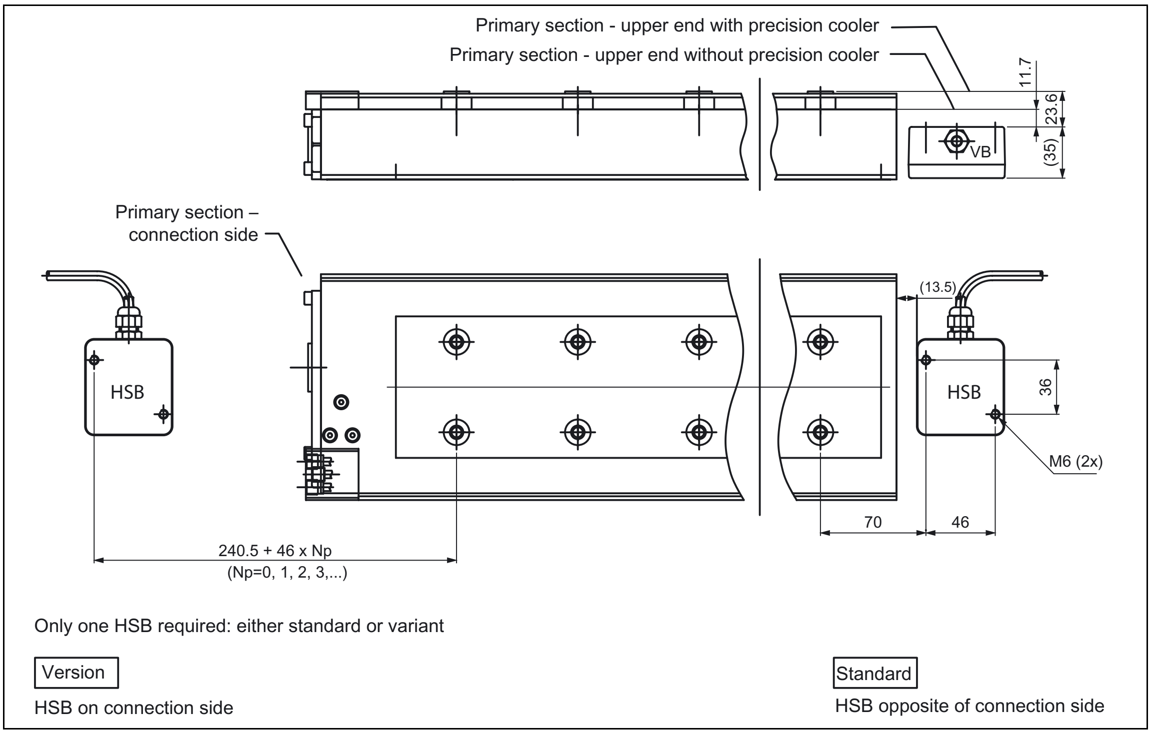


Figure 16-16 Hall sensor box (HSB) with lateral cable outlet for the 1FN3300 and 1FN3450 motor models

1FN3

1FN3

16.3 1FN3600

16.3.1 Installation diagrams

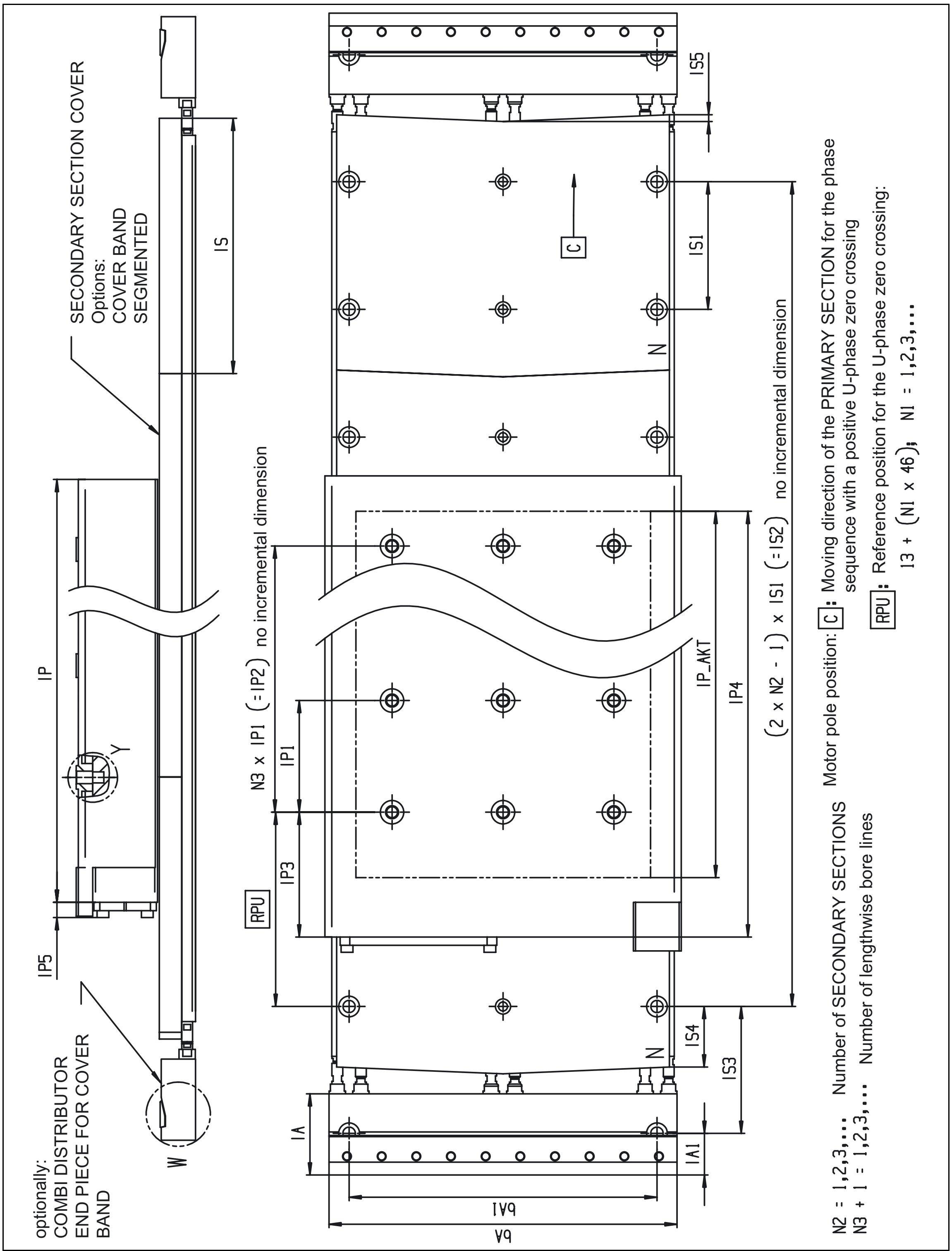


Figure 16-17 Mounting dimensions for the 1FN3600 motor models

1FN3

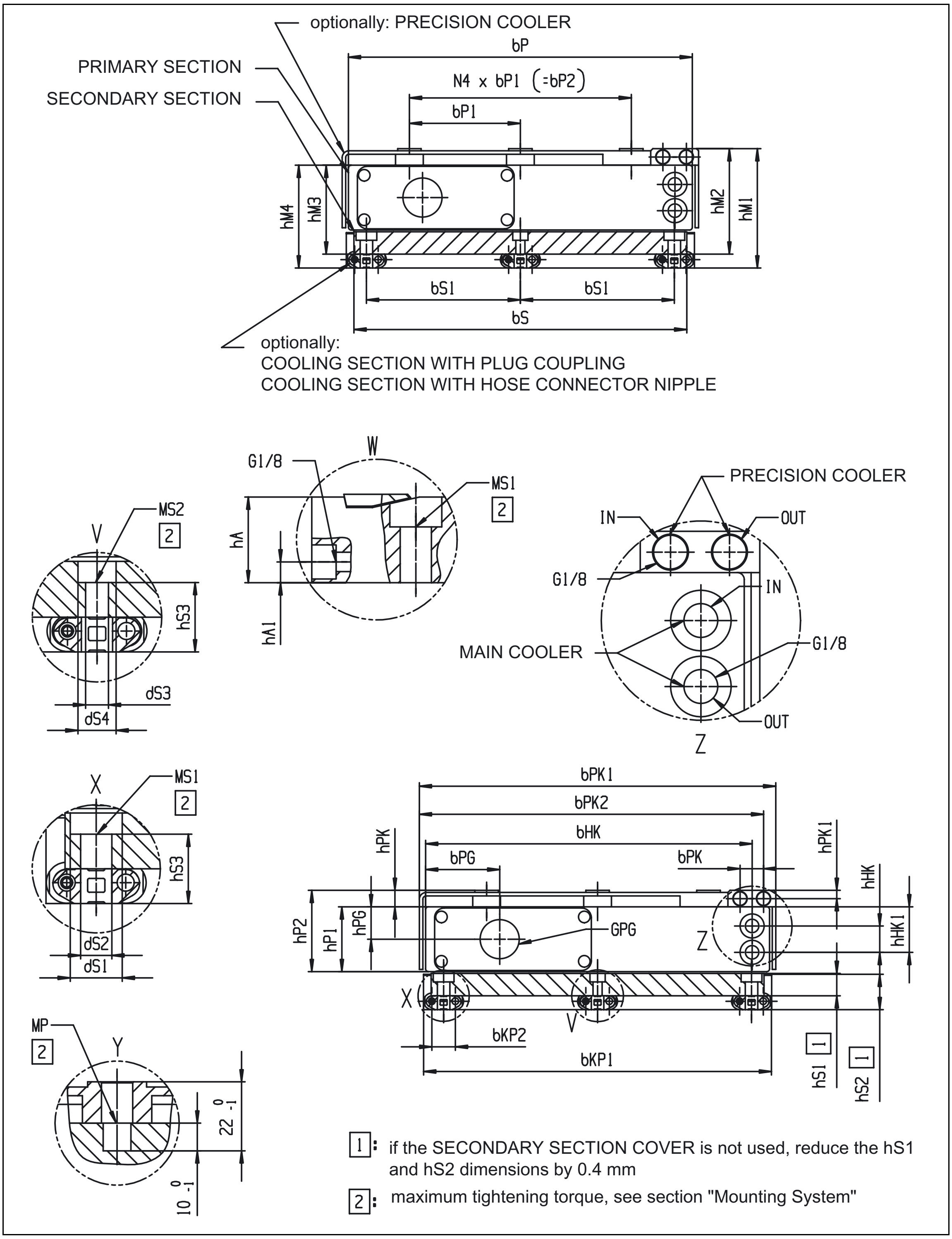


Figure 16-18 Mounting dimensions for the 1FN3600 motor models: Sections and details

1FN3

16.3.2 1FN3600 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3600-...				
			1W	2W	3W	4W	5 W
Length without terminal panel	lP	mm		382	543	704	
Longitudinal bore grid	lP1	mm		80.5	80.5	80.5	
Total longitudinal bore grid	lP2	mm		241.5	402.5	563.5	
First bore hole position on longitudinal grid	lP3	mm		90	90	90	
Position of the magnetically active surface	lP4	mm		372	533	694	
Length of terminal panel cover	lP5	mm		11	11	11	
Magnetically active length	lP,AKT	mm		322	483	644	
Main cooler connector position (width)	bHK	mm		235.5	235.5	235.5	
Width without precision cooler	bP	mm		248	248	248	
Transversal bore grid	bP1	mm		80	80	80	
Total transversal bore grid	bP2	mm		160	160	160	
PG thread position (width)	bPG	mm		57.5	57.5	57.5	
Precision cooler connection distance	bPK	mm		17	17	17	
Precision cooler width	bPK1	mm		257	257	257	
Precision cooler connector position	bPK2	mm		248.5	248.5	248.5	
Main cooler connector distance	hHK	mm		19	19	19	
Main cooler connector position (height)	hHK1	mm		32.9	32.9	32.9	
Motor height with additional coolers	hM1	mm		86	86	86	
Motor height with precision cooler	hM2	mm		76	76	76	
Motor height without additional cooler	hM3	mm		64.1	64.1	64.1	
Motor height with cooling section without precision cooler	hM4	mm		74.1	74.1	74.1	
Height of primary section without precision cooler	hP1	mm		46.7	46.7	46.7	
Height of primary section with precision cooler	hP2	mm		58.6	58.6	58.6	
PG thread position (height)	hPG	mm		23.4	23.4	23.4	
Precision cooler height	hPK	mm		11.9	11.9	11.9	
Precision cooler connector positions (height)	hPK1	mm		6	6	6	
PG thread diameter	GPG			PG21	PG21	PG21	
Mounting screw thread	MP			M8	M8	M8	

1FN3

Secondary section dimensions

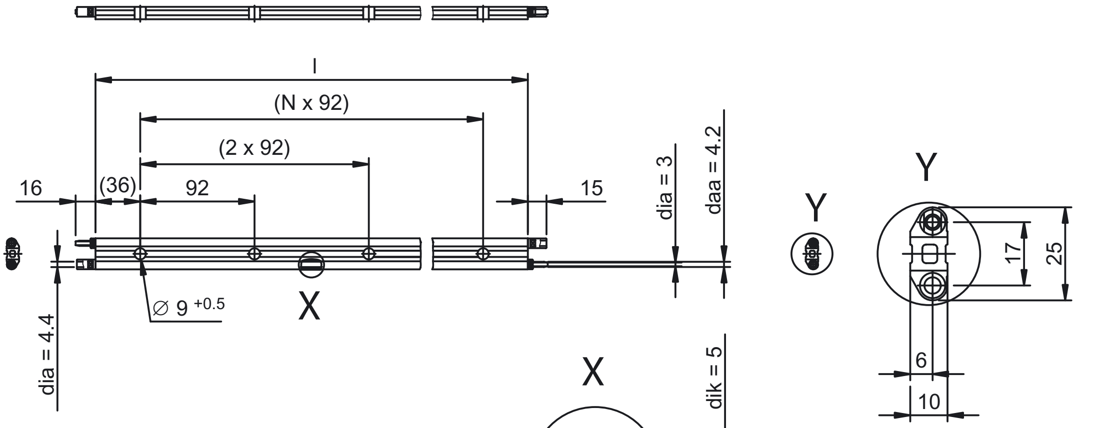
Size	Variable	Value	1FN3600-4SAxx
Secondary section length	IS	mm	184
Bore grid (longitudinal)	IS1	mm	92
Total bore grid (longitudinal)	IS2	mm	IS1 x (2xN2–1)
First bore hole position on longitudinal grid	IS4	mm	43.7
Skew factor	IS5	mm	4.9
Width without cooling section	bS	mm	240
Bore grid (transversal)	bS1	mm	111
Width with cooling section	bKP1	mm	247
Cooling section connector distance	bKP2	mm	17
Height without cooling section with cover	hS1	mm	16.5
Height with cooling section with cover	hS2	mm	26.5
Mounting screw grip	hS3	mm	20
Screw countersink diameter (outer)	dS1	mm	15
Bore hole diameter (outer)	dS2	mm	9
Bore hole diameter (inner)	dS3	mm	6.6
Screw countersink diameter (inner)	dS4	mm	11
Secondary section mounting screws (exterior)	MS1	mm	DIN 6912-M8
Secondary section mounting screws (interior)	MS2	mm	DIN 6912-M6

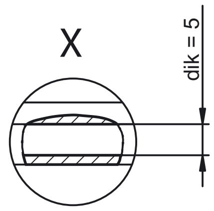
Secondary section end piece dimensions

Size	Variable	Value	1FN3600-0Tx00
Maximum length	IA	mm	58.5
Bore hole position (right)	IA1	mm	30
Bore hole distance to secondary section bore hole	IS3	mm	92
Maximum width	bA	mm	251
G 1/8 cooler connector position (height)	hA1	mm	66
Bore grid (transversal)	bA1	mm	222
Maximum height (block)	hA	mm	25.5

1FN3

16.3.3 Cooling sections

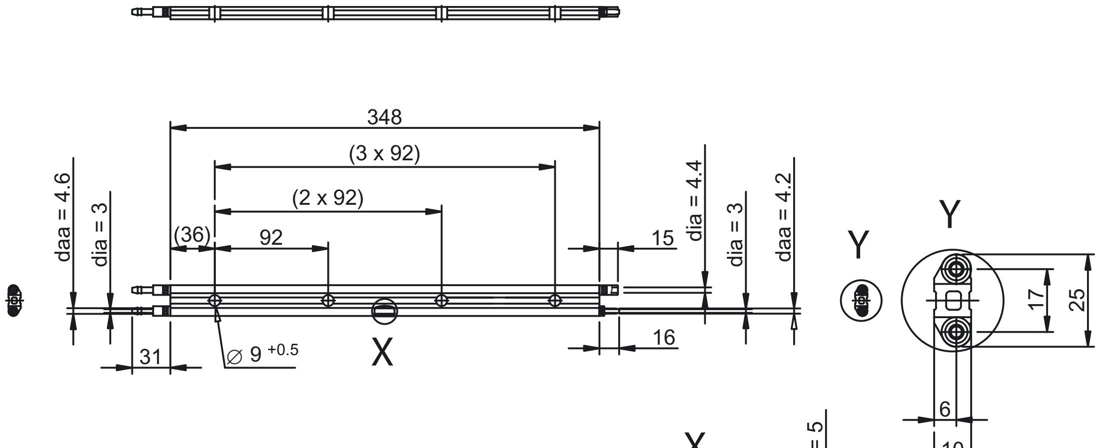


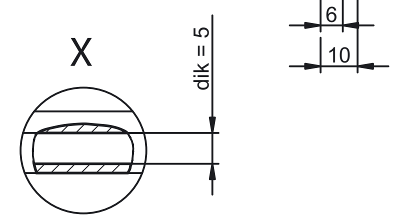


Number of sec. sections	N	l [mm]	Ground [g]
1	2	256	74
2	3	348	148
3	5	532	223
4	7	716	298
5	9	900	373
⋮	⋮	⋮	⋮

Coupling nipple and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Figure 16-19 Cooling section with plug nipples for the 1FN3600 motor models





Hose nozzle, coupling nipple, and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Mass: 148 g

Figure 16-20 Cooling section with hose connector nipple R/L for the 1FN3600 motor models

16.3.4 Mounting the Hall sensor box

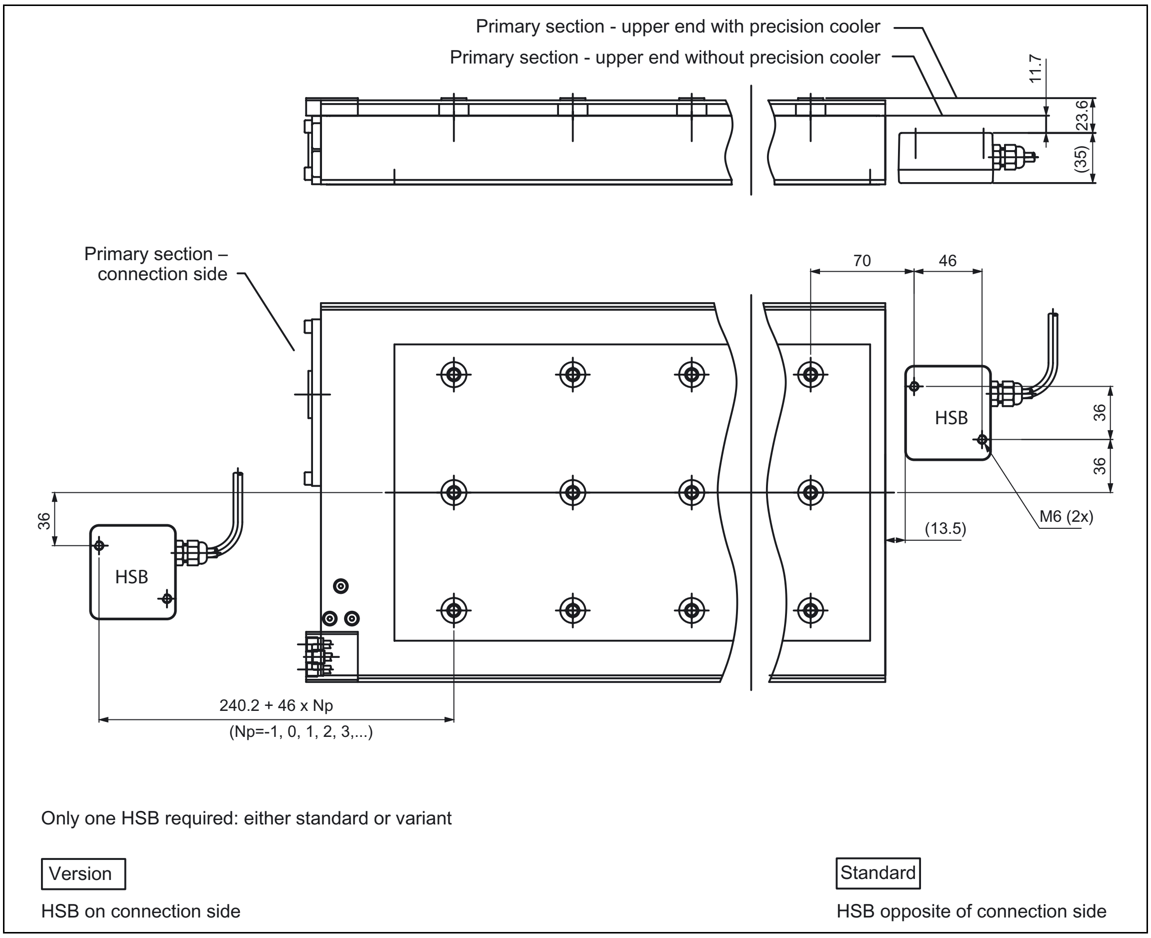


Figure 16-21 Hall sensor box (HSB) with straight cable outlet for the 1FN3600 motor models

1FN3

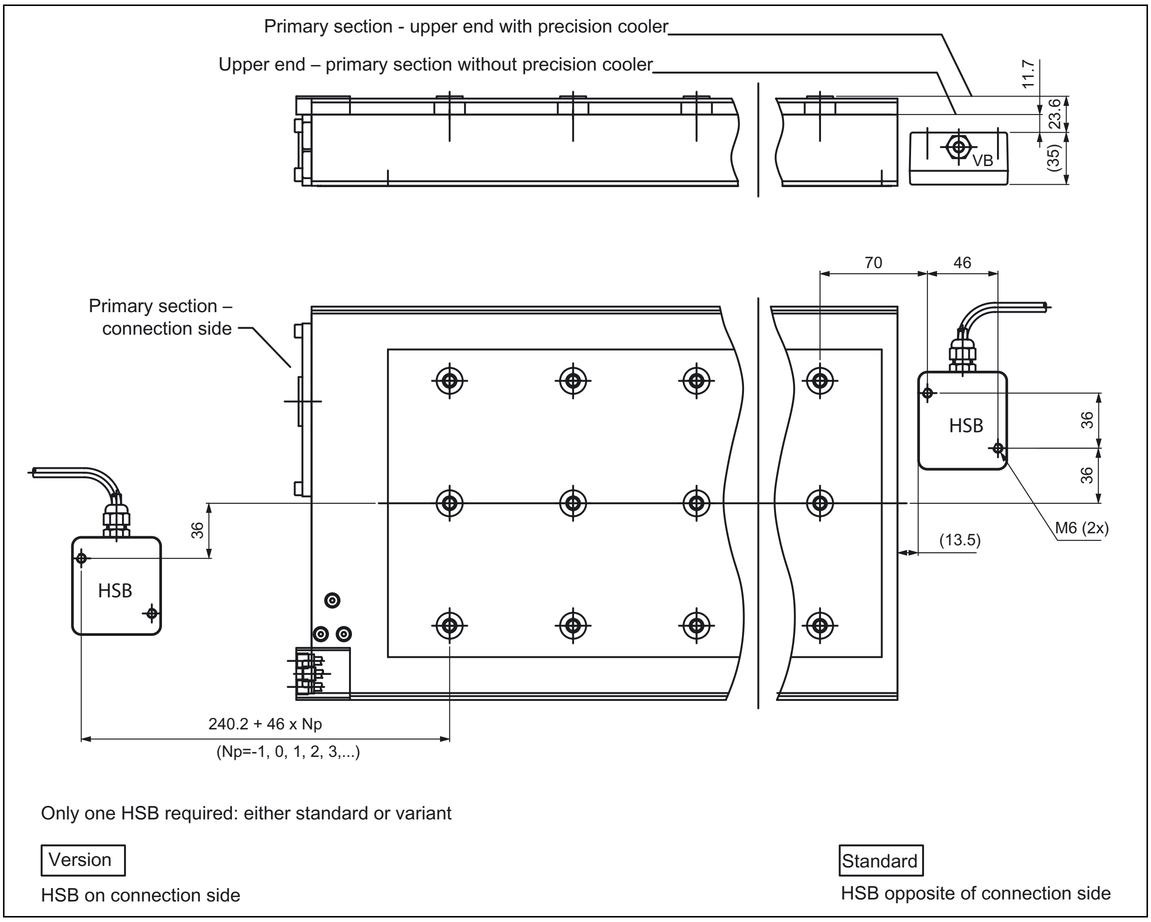


Figure 16-22 Hall sensor box (HSB) with lateral cable outlet for the 1FN3600 motor models

16.4 1FN3900

16.4.1 Installation diagrams

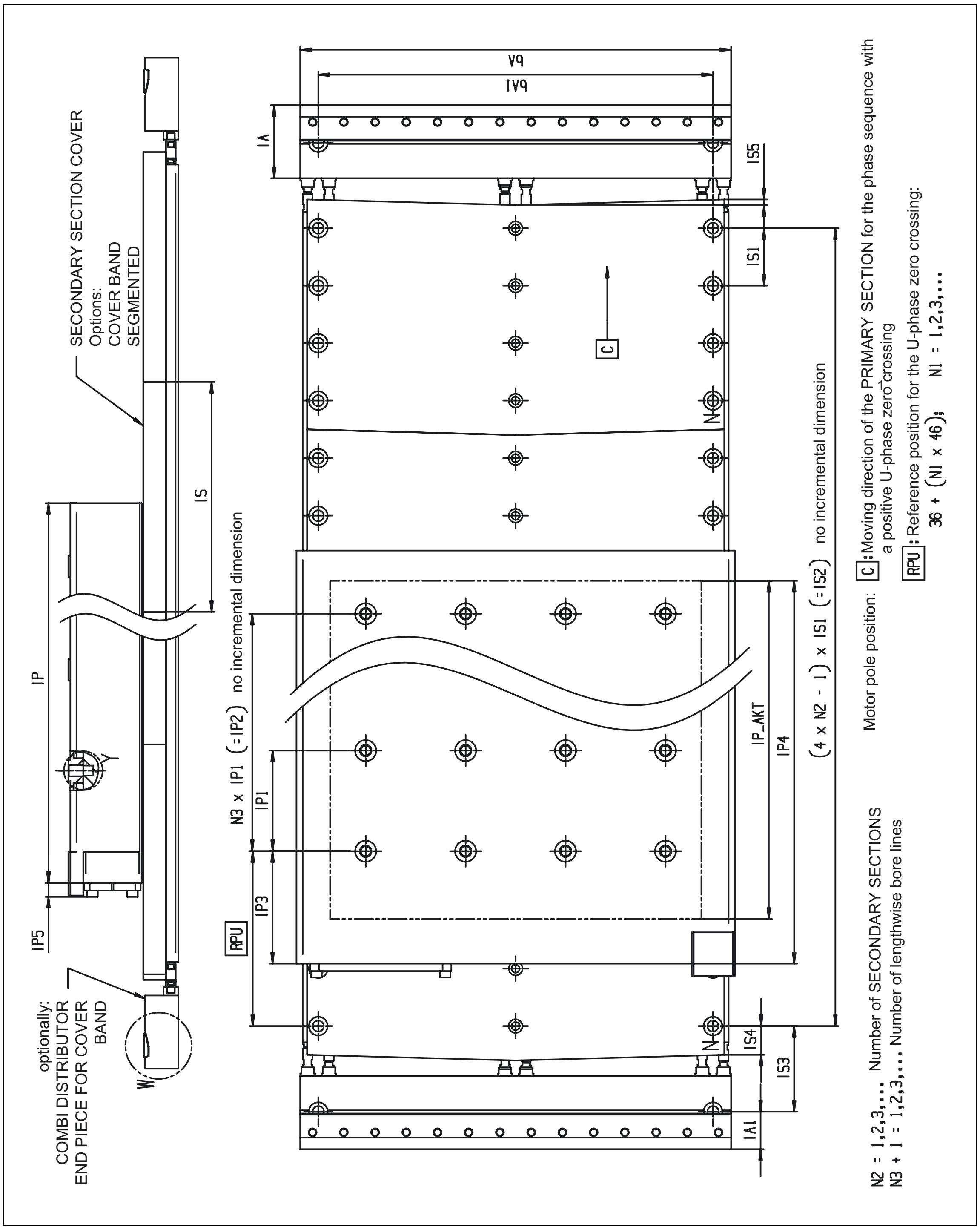


Figure 16-23 Mounting dimensions for the 1FN3900 motor models; except: 1FN3900-4WB00 and 1FN3900-4WC00

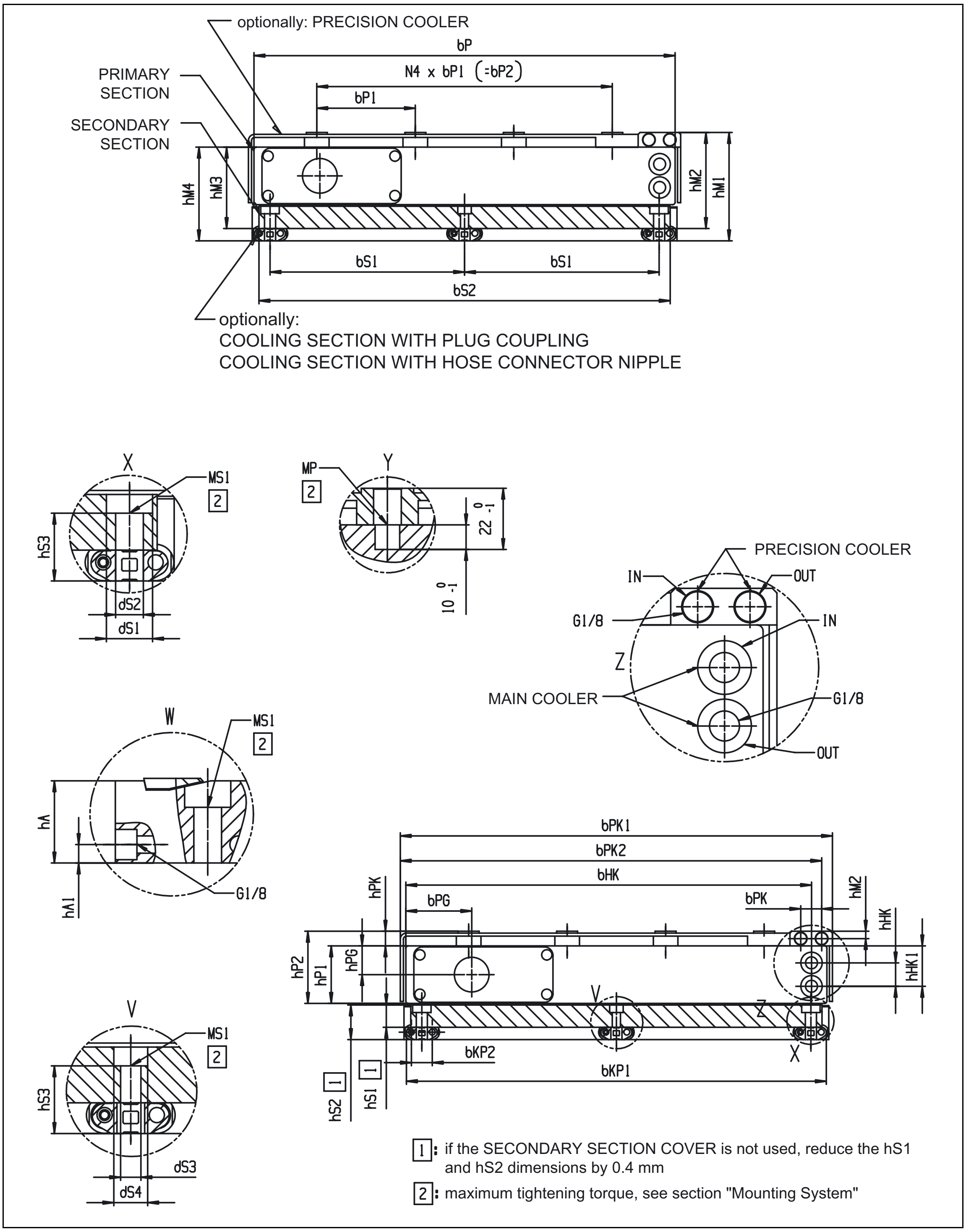


Figure 16-24 Mounting dimensions for the 1FN3900 motor models: Sections and details; except: 1FN3900-4WB00 and 1FN3900-4WC00

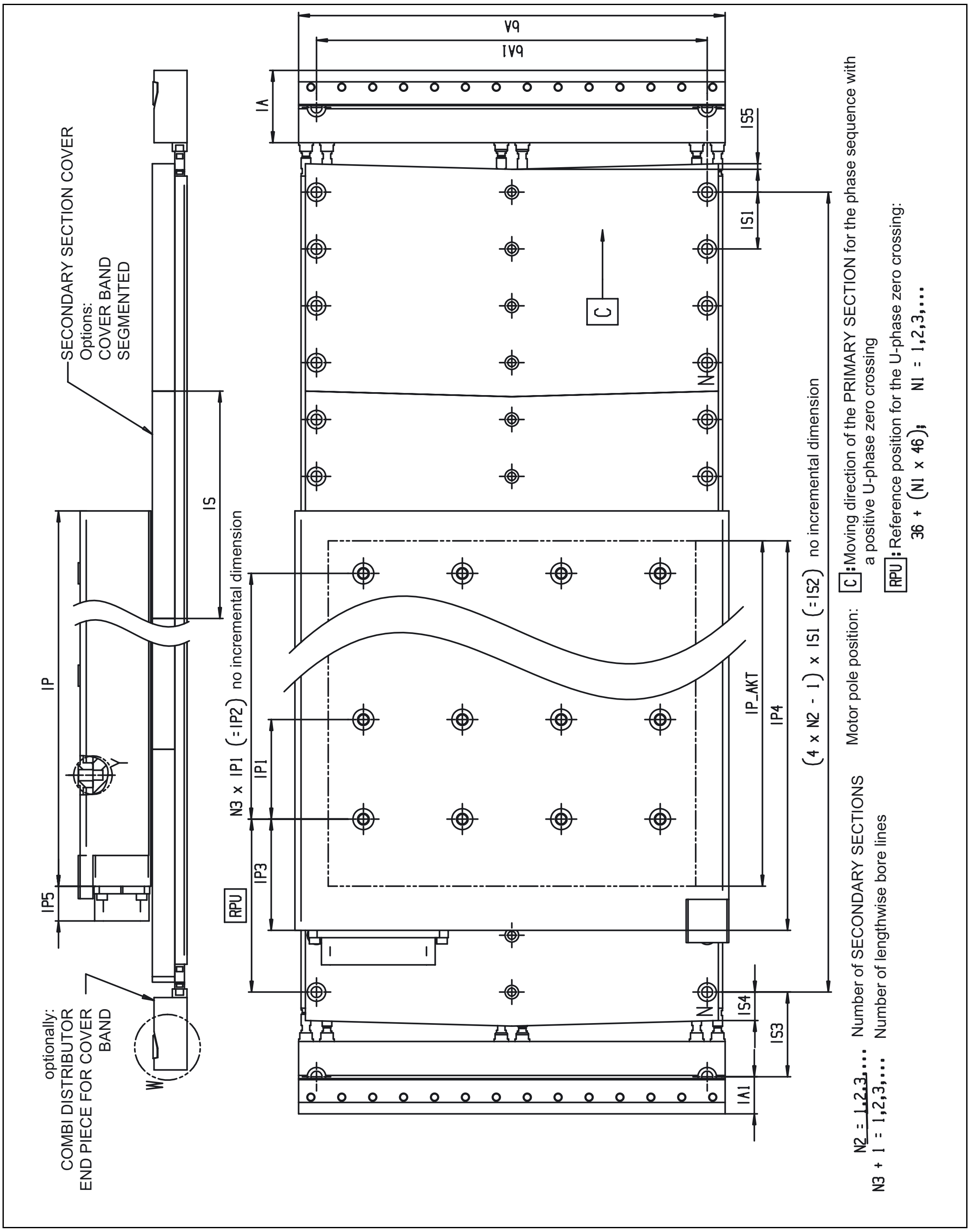


Figure 16-25 Mounting dimensions for the 1FN3900-4WB00 and 1FN3900-4WC00 motor models

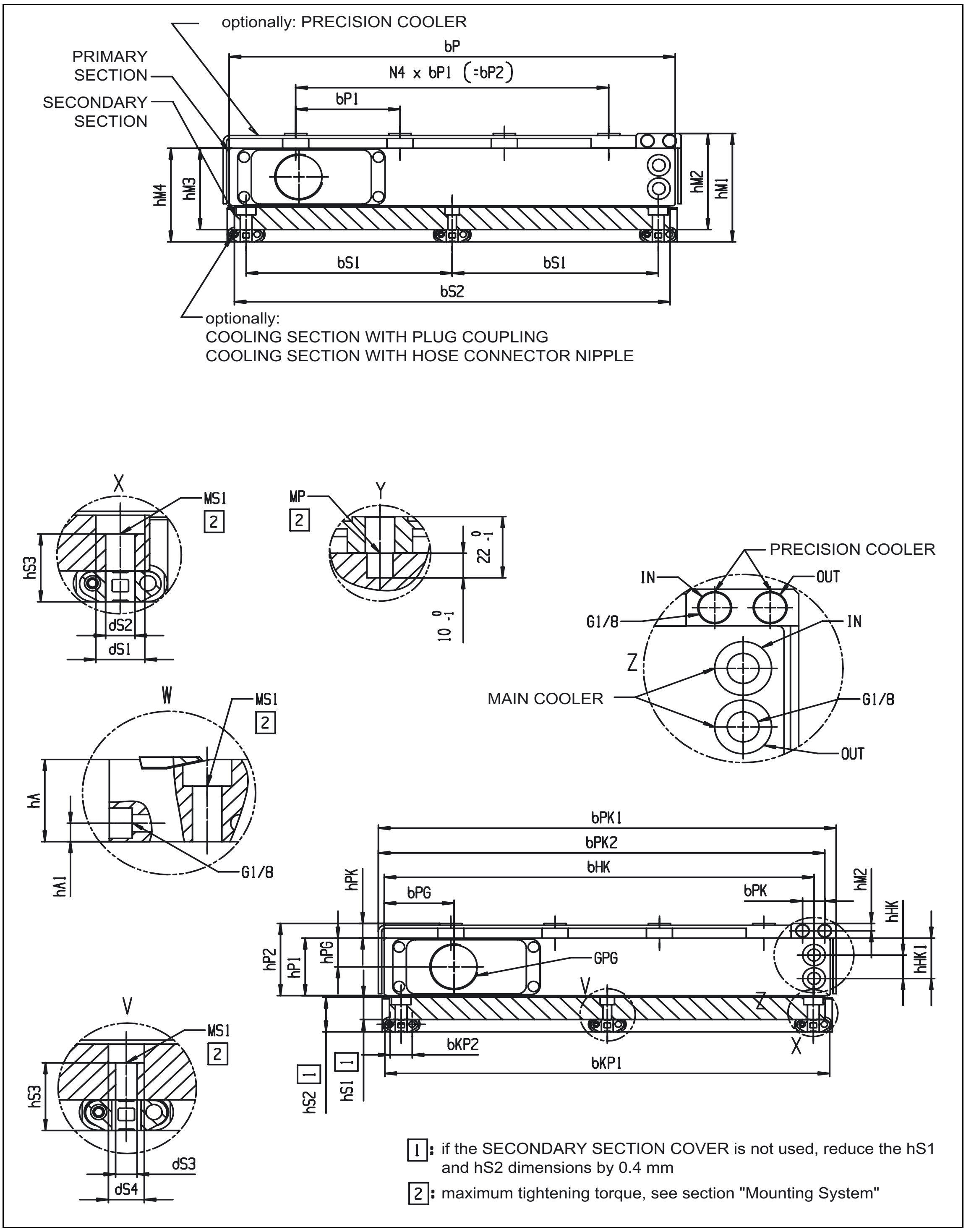


Figure 16-26 Mounting dimensions for the 1FN3900-4WB00 and 1FN3900-4WC00 motor models: Sections and details

16.4.2 1FN3900 dimensioning tables

Primary section dimensions

Size	Variable	Value	1FN3900-...				
			1W	2W	3W	4W	5 W
Length without terminal panel	lP	mm		382	543	704	
Longitudinal bore grid	lP1	mm		80.5	80.5	80.5	
Total longitudinal bore grid	lP2	mm		241.5	402.5	563.5	
First bore hole position on longitudinal grid	lP3	mm		90	90	90	
Position of the magnetically active surface	lP4	mm		372	533	694	
Length of terminal panel cover	lP5	mm		11	11	11 / 28*	
Magnetically active length	lP,AKT	mm		322	483	644	
Main cooler connector position (width)	bHK	mm		329.5	329.5	329.5	
Width without precision cooler	bP	mm		342	342	342	
Transversal bore grid	bP1	mm		80	80	80	
Total transversal bore grid	bP2	mm		240	240	240	
PG thread position (width)	bPG	mm		57.5	57.5	57.5 / 53.5*	
Precision cooler connector distance	bPK	mm		17	17	17	
Precision cooler width	bPK1	mm		351	351	351	
Precision cooler connector position	bPK2	mm		342.5	342.5	342.5	
Main cooler connector distance	hHK	mm		19	19	19	
Main cooler connector position (height)	hHK1	mm		32.9	32.9	32.9	
Motor height with additional coolers	hM1	mm		88	88	88	
Motor height with precision cooler	hM2	mm		78	78	78	
Motor height without additional coolers	hM3	mm		66.1	66.1	66.1	
Motor height with cooling section without precision cooler	hM4	mm		76.1	76.1	76.1	
Height of primary section without precision cooler	hP1	mm		46.7	46.7	46.7	
Height of primary section with precision cooler	hP2	mm		58.6	58.6	58.6	
PG thread position (height)	hPG	mm		23.4	23.4	23.4	
Precision cooler height	hPK	mm		11.9	11.9	11.9	
Precision cooler connector positions (height)	hPK1	mm		6	6	6	
PG thread diameter	GPG			PG21	PG21	PG21 / PG29*	
Mounting screw thread	MP			M8	M8	M8	

*applicable for 1FN3900-4WB00 and 1FN3900-4WC00 motor models

1FN3

Secondary section dimensions

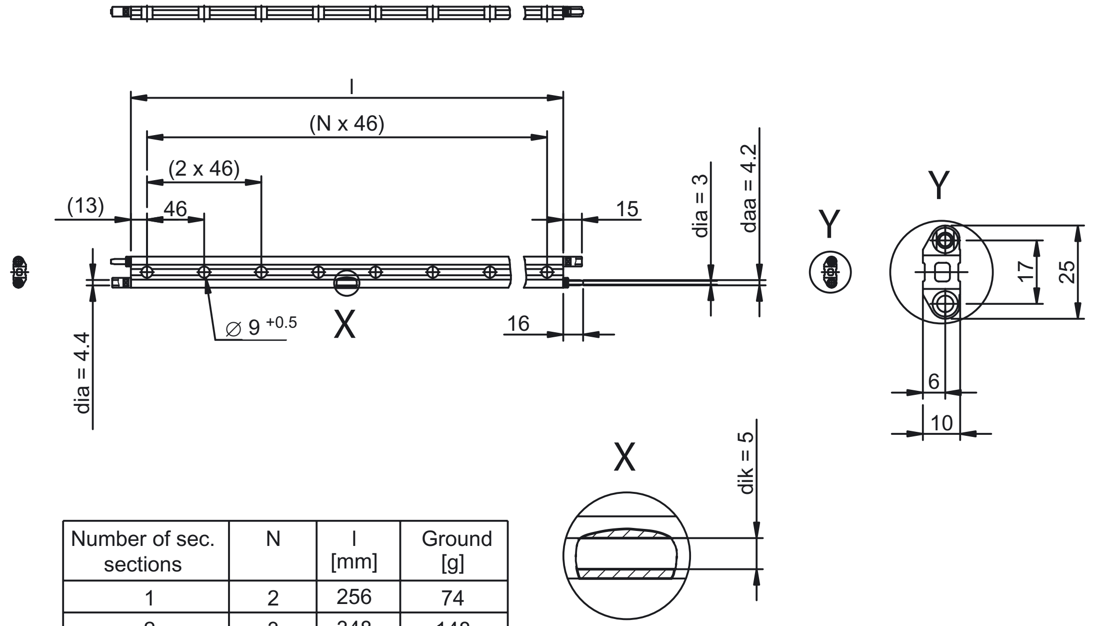
Size	Variable	Value	1FN3900-4SAxx
Secondary section length	lS	mm	184
Bore grid (longitudinal)	lS1	mm	46
Total bore grid (longitudinal)	lS2	mm	lS1 x (4xN2–1)
First bore hole position on longitudinal grid	lS4	mm	23
Skew factor	lS5	mm	4.5
Width without cooling section	bS	mm	334
Bore grid (transversal)	bS1	mm	158
Width with cooling section	bKP1	mm	341
Cooling section connector distance	bKP2	mm	17
Height without cooling section with cover	hS1	mm	18.5
Height with cooling section with cover	hS2	mm	28.5
Mounting screw grip	hS3	mm	22
Screw countersink diameter (outer)	dS1	mm	15
Bore hole diameter (outer)	dS2	mm	9
Bore hole diameter (inner)	dS3	mm	6.6
Screw countersink diameter (inner)	dS4	mm	11
Secondary section mounting screws (exterior)	MS1	mm	DIN 6912-M8
Secondary section mounting screws (interior)	MS2	mm	DIN 6912-M6

1FN3

Secondary section end piece dimensions

Size	Variable	Value	1FN3900-0Tx00
Maximum length	lA	mm	58.5
Bore hole position (right)	lA1	mm	30
Bore hole distance to secondary section bore hole	lS3	mm	69
Maximum width	bA	mm	345
G 1/8 cooler connector position (height)	hA1	mm	6
Bore grid (transversal)	bA1	mm	316
Maximum height (block)	hA	mm	27.5

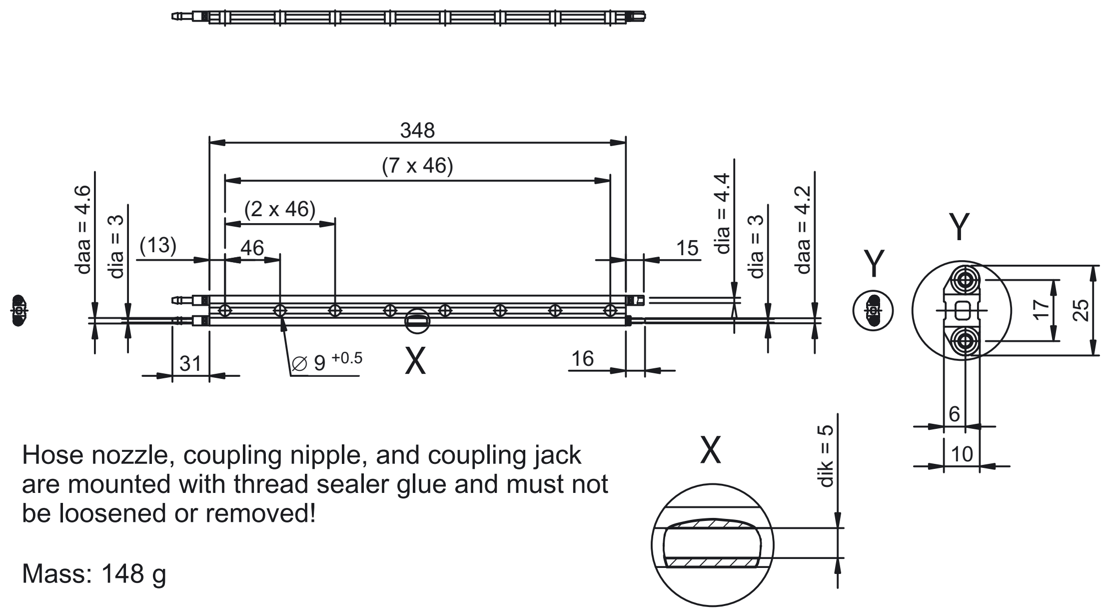
16.4.3 Cooling sections



Number of sec. sections	N	l [mm]	Ground [g]
1	2	256	74
2	3	348	148
3	5	532	223
4	7	716	298
5	9	900	373
⋮	⋮	⋮	⋮

Coupling nipple and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Figure 16-27 Cooling section with plug nipples for the 1FN3900 motor models



Hose nozzle, coupling nipple, and coupling jack are mounted with thread sealer glue and must not be loosened or removed!

Mass: 148 g

Figure 16-28 Cooling section with hose connector nipple R/L for the 1FN3900 motor models

1FN3

1FN3

16.4.4 Mounting the Hall sensor box

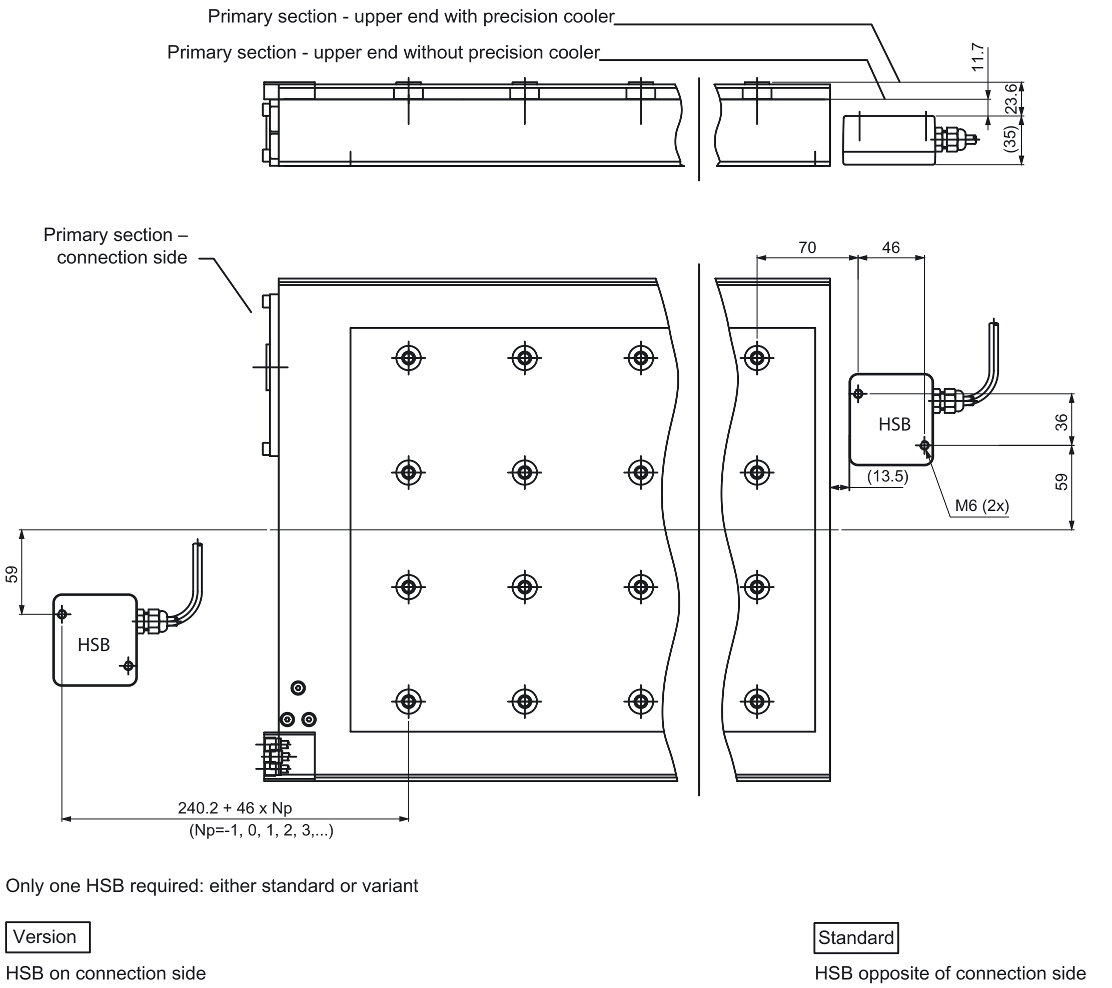


Figure 16-29 Hall sensor box (HSB) with straight cable outlet for the 1FN3900 motor models

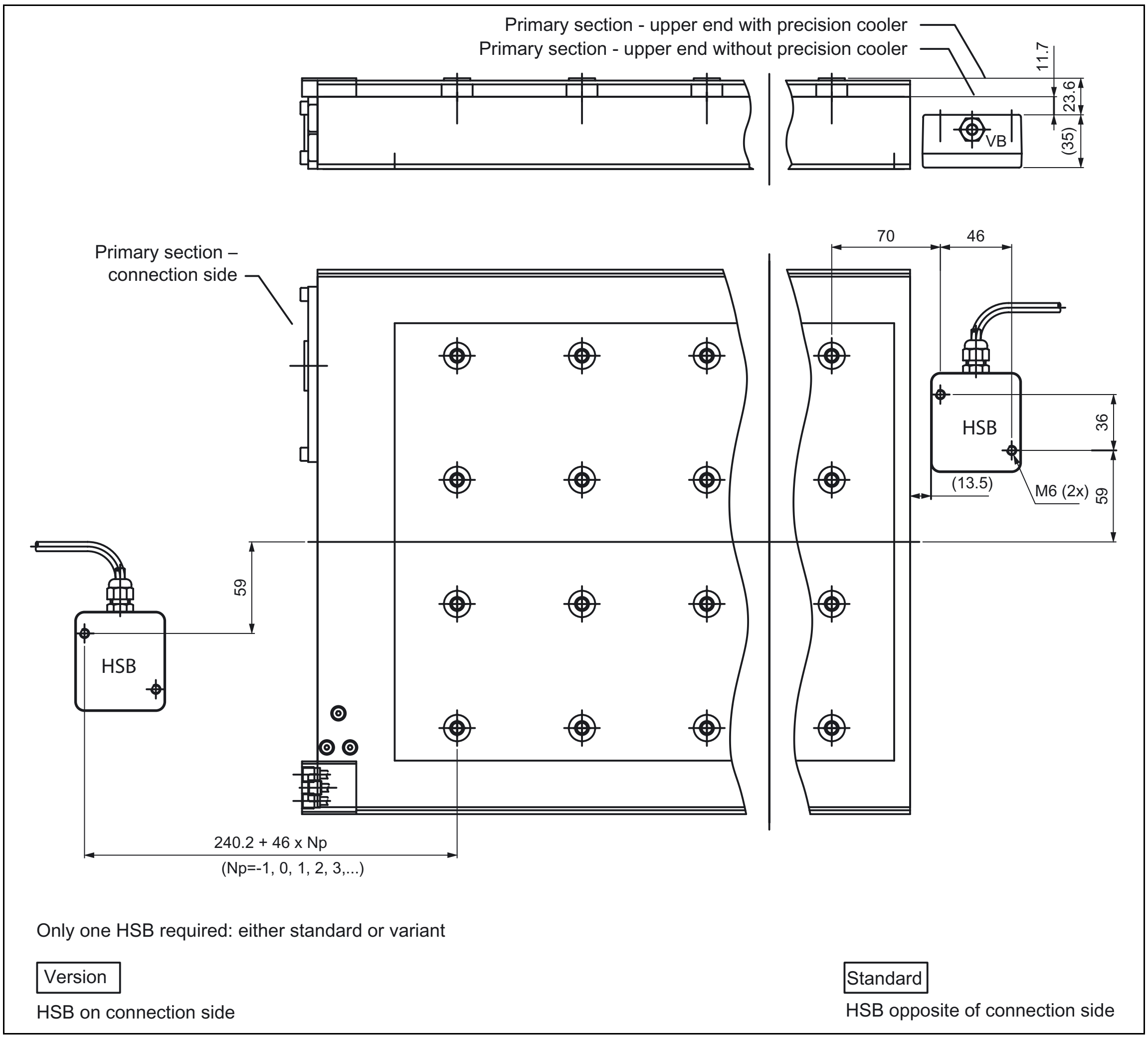


Figure 16-30 Hall sensor box (HSB) with lateral cable outlet for the 1FN3900 motor models

■

1FN3

Notes

General Information about Connection Systems

Notes

CON

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Notes

CON

17 System Integration

For system requirements, see chapter 4.1. Figure 17-1 includes a diagram illustrating the standard connections to these systems using assembled MOTION-CONNECT® cables.

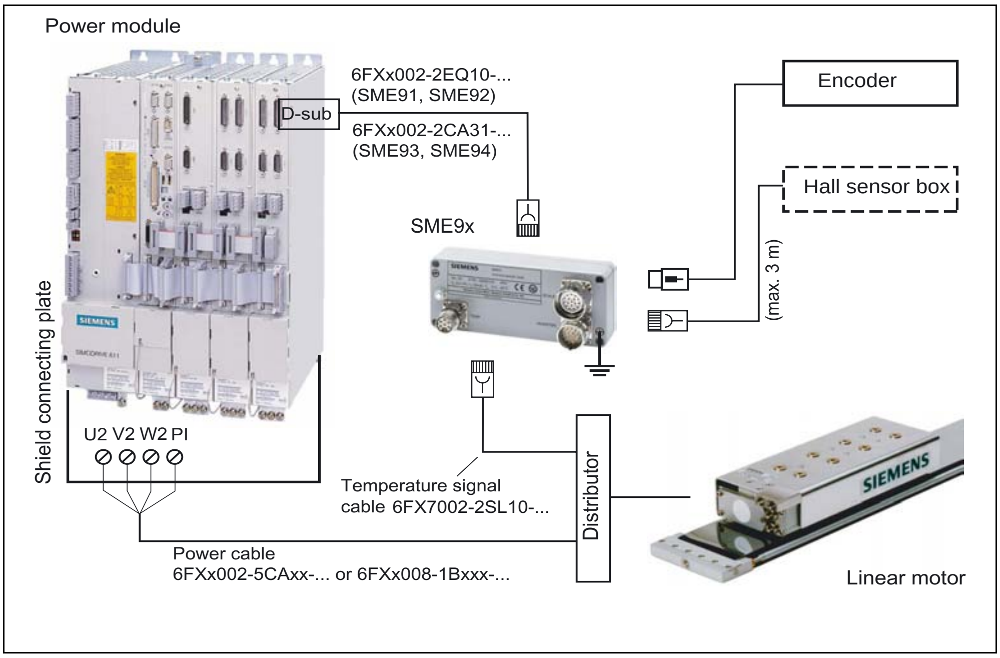

Figure 17-1 Standard connections for 1FN1- and 1FN3- type (peak-load) motors

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Danger
Improper connections of three-phase linear motors can result in death, serious injury (electrical shock), and/or damage to property.

Three-phase linear motors must be connected according to the operating instructions. Connecting the motor directly to the three-phase mains is not permitted or safe.

Please follow the operating instructions of the converter system you are using!

Assembled cables guarantee safety, proper function and cost advantages versus self-made cables. The specifications (such as conductor cross-section, outer diameter, maximum current load) for MOTION-CONNECT® power cables are listed in the catalog /NC60/.

■

18 Connecting the Primary Section

1FN1-type primary sections are supplied with a flange-mounted socket or an already mounted, assembled cable, see chapter 9.3.3. The 1FN3-type primary sections for peak-load motors are connected to a built-in terminal by means of angled cable lugs, see chapter 13.3.2.

CON

For all models, signal conductors and power conductors are routed in one cable. A distributor must be used to separate these conductors. The distributor (e. g. terminal box) must be provided by the operator. For 1FN3-type peak-load motors a distributor box with plug type connections is currently being developed.

Note

With the EN 60034-8 norm the terminal markings have changed. For the old terminal markings, see appendix C.

18.1 Connecting the Power Cables

The power cables are connected directly or via intermediate connector to the designated terminals on the power unit. Ensure proper shielding and grounding; see chapter 21!

18.2 Connecting the Temperature Monitoring Circuits

CON

18.2.1 Guidelines about Protective Separation

When connecting the temperature monitoring circuits, the regulations relating to *protective separation* in compliance with VDE 0160 /EN 50178 must be carefully observed.

Danger

The temperature monitoring circuits constitute a risk of electrical shock!

The circuits of Temp-F and Temp-S neither have "protective separation" between each other nor to the power circuits in accordance with VDE 0160/EN 50178. A connection to the X411/X412 plug of the SIMODRIVE control board without a suitable protective module (e.g. SME9x) is not permitted.

Please note that the power cables have to comply with the *protective separation* requirements according to VDE 0160/EN 50178 as well!

For SIMODRIVE 611, the X411 plug inputs do not guarantee *protective separation* to the SIMODRIVE and SINUMERIK low voltage circuits!

Note

If the motor and power cables do not meet the *protective separation* requirements, the Temp-F and Temp-S circuits cannot be implemented as SELV/PELV circuits according to VDE 0160/EN 50178. Connecting directly to SELV/PELV circuits is not permissible!

Table 18-1 Motor and cable qualification with regards to *protective separation*

	1FN1 motor and 1FN3 motor	MOTION-CONNECT power cable
Protective separation ensured?*	No	Yes

*Temp-F and Temp-S control cable connections with respect to the motor phase cables

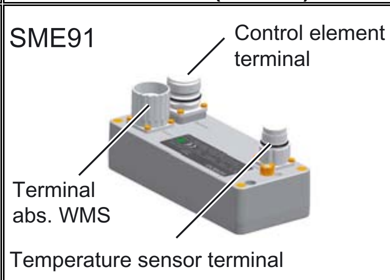
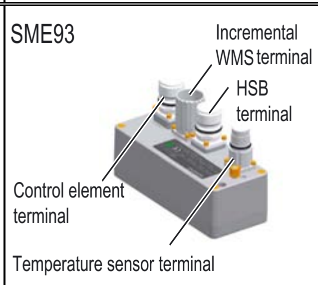
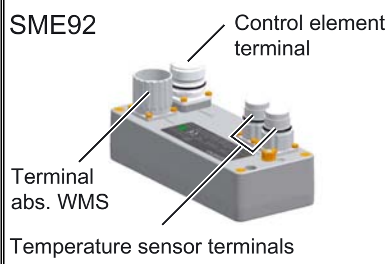
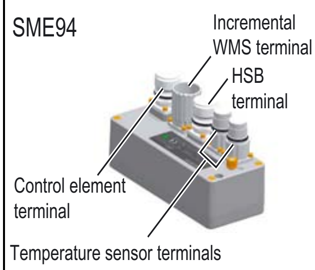
18.2.2 Connection via SME9x

The SME9x (Sensor Module External) is a plug-type connection unit to which all motor signal cables of a direct drive can be connected in close vicinity of the motor. The SME9x output can be connected to the X411 transmitter interface of the SIMODRIVE product line converter. Thus it meets the *protective separation* requirements in accordance with VDE 0160/EN 50178.

Variants

Four variants of the SME9x are provided with different inputs for the length measuring system (WMS) and signal cables, see Table 18-2.

Table 18-2 SME9x variants

	absolute WMS (EnDat)	incremental WMS
one signal cable input	 Order No.: 1FN1910-0AA20-1AA0	 Order No.: 1FN1910-0AA20-3AA0
two signal cable inputs	 Order No.: 1FN1910-0AA20-2AA0	 Order No.: 1FN1910-0AA20-4AA0

In order to operate two motors in parallel on one converter, all signal cables of the two motors – Temp-S and Temp-F – can be connected to the SME9x. For this purpose, SME92 and SME94 should be used.

Technical Data and Interfaces

For technical data and a more detailed description of the interfaces, see the operating instructions /SME9x/.

Special Note

For 1FN3xxx-…-0AA0-type primary sections, a Temp-F temperature monitoring circuit cannot be connected to the SME9x. As a substitute, a resistance of 560 Ω can be used, see Figure 18-1. In this case, an approximate value of 20 °C will always be displayed for the Temp-F evaluation.

CON

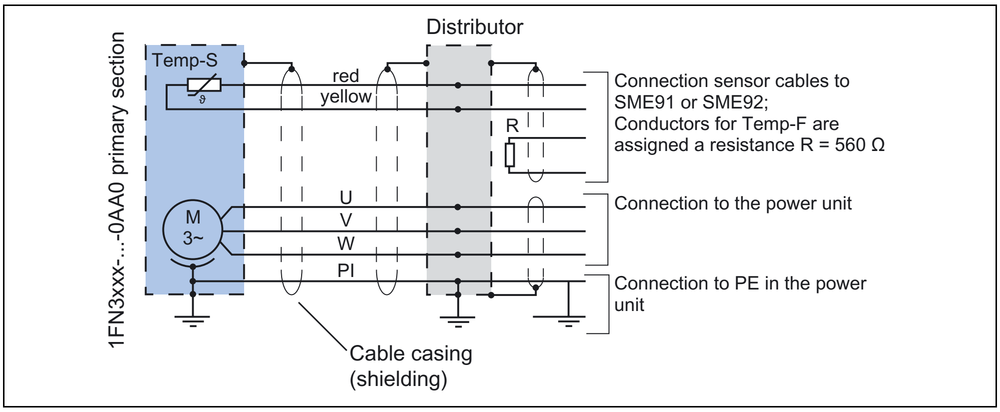


Figure 18-1 Connecting the 1FN3xxx-…-0AA0 primary section (without Temp-F)

18.2.3 Connection via a Motor Protection Device

The evaluation of the temperature sensors via the SME9x is the default temperature evaluation. As an alternative and in compliance with Figure 18-2 and Figure 18-3 Temp-S can be connected to SELV/PELV circuits.

CON

Note

Connecting Temp-S to the 3RN1013-1GW10 thermistor motor protection device according to Figure 18-2 and Figure 18-3 involves some disadvantages, such as:

- Temp-F is not connected and can only be evaluated via an external measuring device
- the Temp-S evaluation is slower than when using the SME9x

Therefore we recommend using the SME9x whenever possible to evaluate the temperature monitoring circuits!

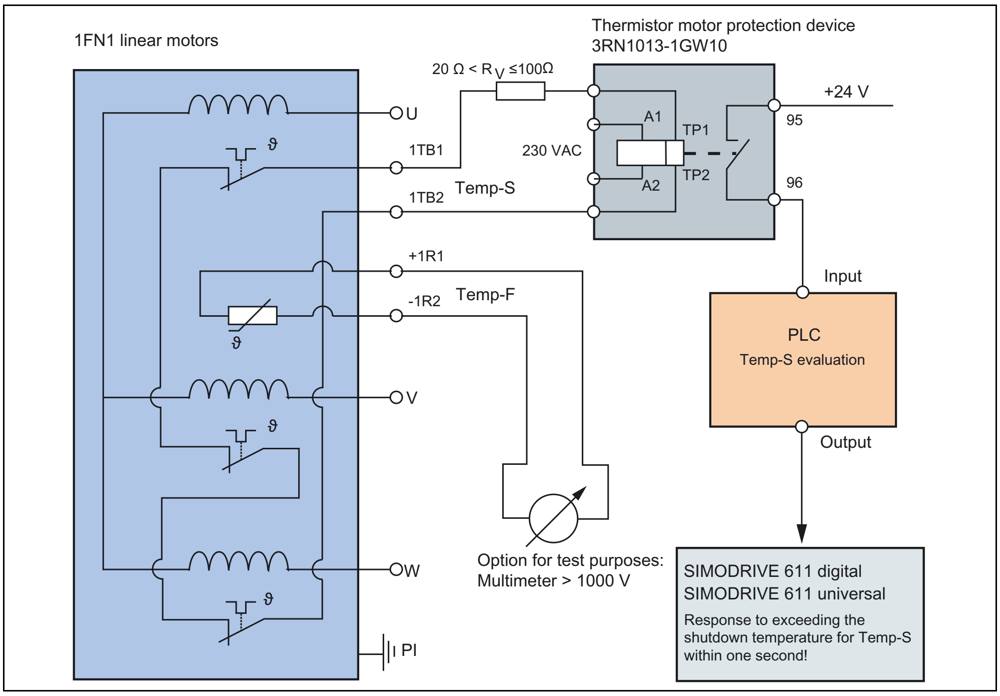


Figure 18-2 Temp-S evaluation via motor protection device and PLC for 1FN1 models

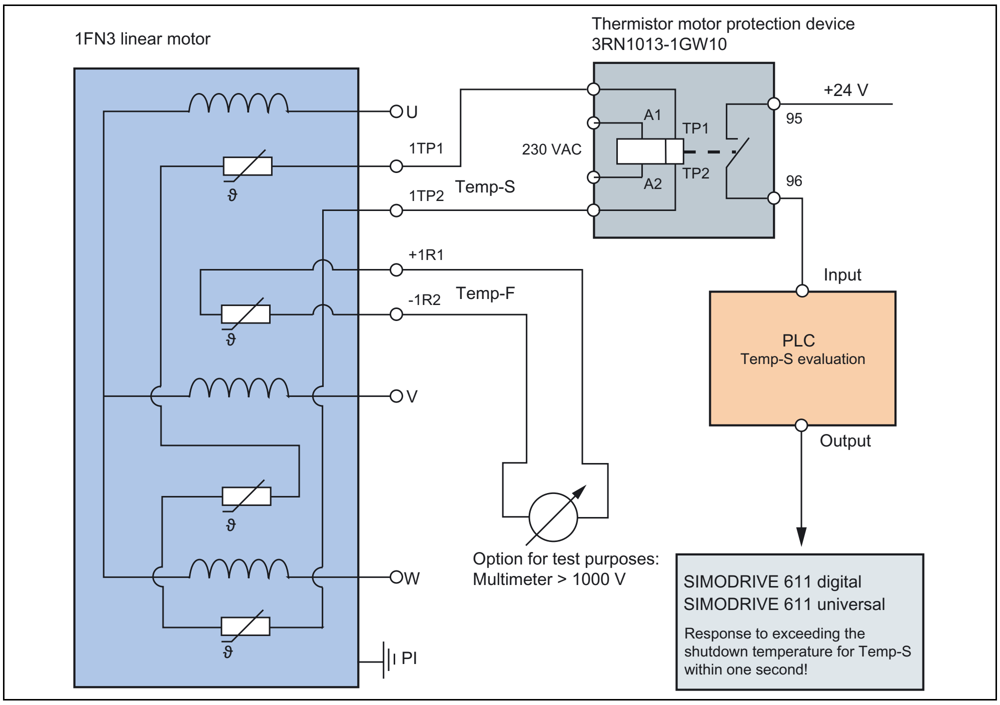


Figure 18-3 Temp-S evaluation via motor protection device and PLC for 1FN3 models

CON

Temp-S Evaluation

Temp-S is evaluated via a PLC with an upstream 3RN1013-1GW10 thermistor motor protection device. Temperature monitoring is not done directly via the converter! Therefore, it has to be deactivated there (MD 1608 ≤ 1 °C).

Note

The 3RN1013-1GW10 thermistor motor protection device is the only one of the 3RN1-type thermistor motor protection devices which

- guarantees protective separation
- is equipped with hard gilded contacts

The use of a 3RN1013-1GW10 is thus imperative if Temp-S is to be connected via a motor protection device.

Response Time

Please ensure that the response time between the Temp-S resistance increase and the motor shut down is less than one second!

Connecting Temp-F

For commissioning purposes – evaluating the thermal capacity of the motor and optimizing the machine cycle – Temp-F can be evaluated via an external measuring device. (ensure proper polarity!)

The measuring device must have a suitable electric strength in order to protect the operator from dangerous voltages (voltage of the intermediate converter circuit). The instrument leads and their connectors must comply with the VDE 0160/EN 50178 regulations.

After the measurements are completed and with the drive shut off, the Temp-F connection cables in the control cabinet must be connected safely to suitable free terminals or PE while ensuring the required sparking and creepage distance in compliance with VDE 0160/EN 50178.

■

19 Connecting Motors in Parallel

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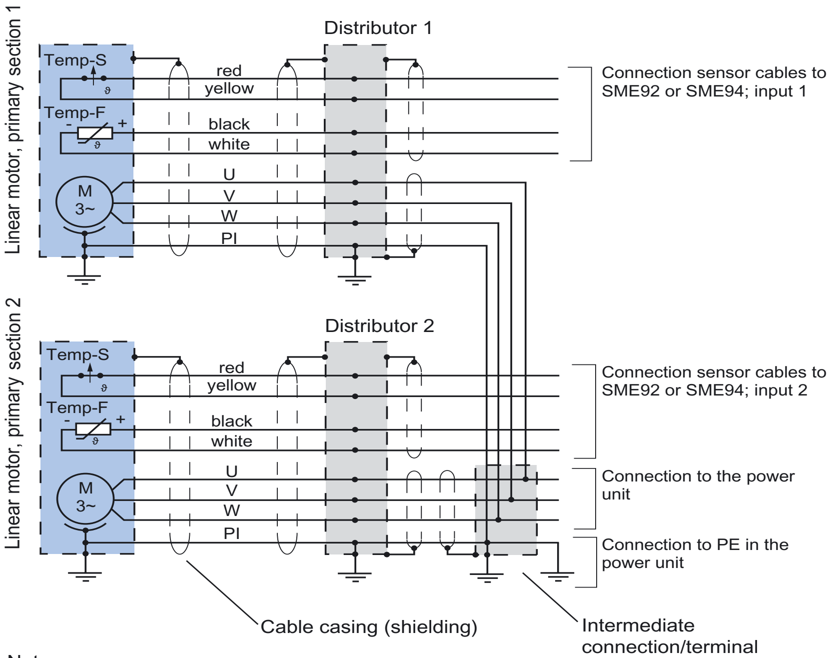
In order to operate two motors in parallel on one converter, all signal cables of the two motors – Temp-S und Temp-F – can be connected to the SME9x, see Figure 19-1.



Note:
The distributor and intermediate connectors can be combined as may be suitable.
The terminal box for intermediate connections is not required when cables are directly connected at the power unit.

Figure 19-1 Wiring diagram for two primary sections connected in parallel

The power cables for each motor are connected to the designated terminals on the power unit. An intermediate connection is possible to bring the power cables of the individual motors together before they are connected to the power unit.

Note

When connecting the motors, please follow the instructions for shielding and grounding in chapter 21!

Note

When connecting primary sections in parallel, the power cables should be of equal length in order to ensure even current distribution.

Warning

An outage of the phase current circuit of a primary section can cause excessive power surges in the connected primary sections. This may result in a demagnetization of the permanent magnets.

Be careful with all connections and wirings and replace worn power cables immediately!

■

CON

20 Encoder Connection

Encoder cables must be routed separately from the power cables.

Assembled cables guarantee safety, proper function and cost advantages versus self-made cables. The specifications (such as conductor cross-section, outer diameter, maximum current load) for MOTION-CONNECT® signal cables are listed in the catalog .

20.1 Connecting Length Measurement Systems

Proper connection systems for length measurements depend mainly on the type of scale used. Usually a SME9x connection is used, see Figure 17-1 and Table 18-2. If a Hall sensor box is not used, the WMS can be connected directly to the X411/X412 converter interface, see Figure 20-1.

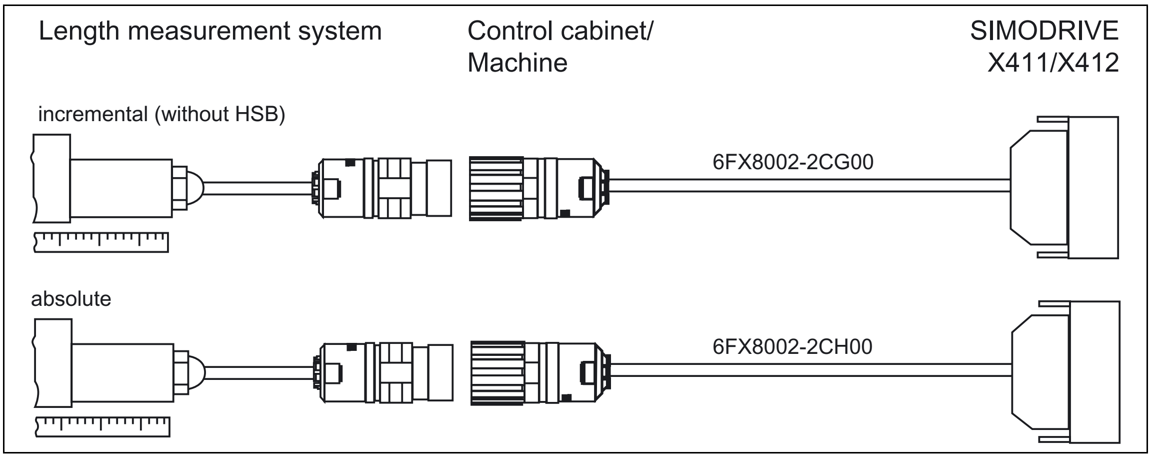


Figure 20-1 Assembled cables for a direct connection of the length measurement system (WMS) to X411/X412

20.1.1 Hall sensor box

The Hall sensor indicates the pole position inside the motor for commutation during the reference run. Its use is required for motors for which, due to technical reasons, a software-based detection of the pole position is not possible.

The Hall sensor must be adjusted to the individual motor and its pole pair length and attached in a certain position to the primary section. For details, see Mounting the Hall Sensor Box, page 9-98 in section 1FN1 and page 13-195 in section 1FN3.

20.1.2 Connector Box

The connector box is used to connect a length measuring system (WMS) with Hall sensor box to the X411/X412 interface of the converter if no SME9x unit is used, see Figure 20-2. It complies with the IP65-type protection. Opposite the side with the rating plate there are two blind holes for mounting the unit on the machine or in the control cabinet.

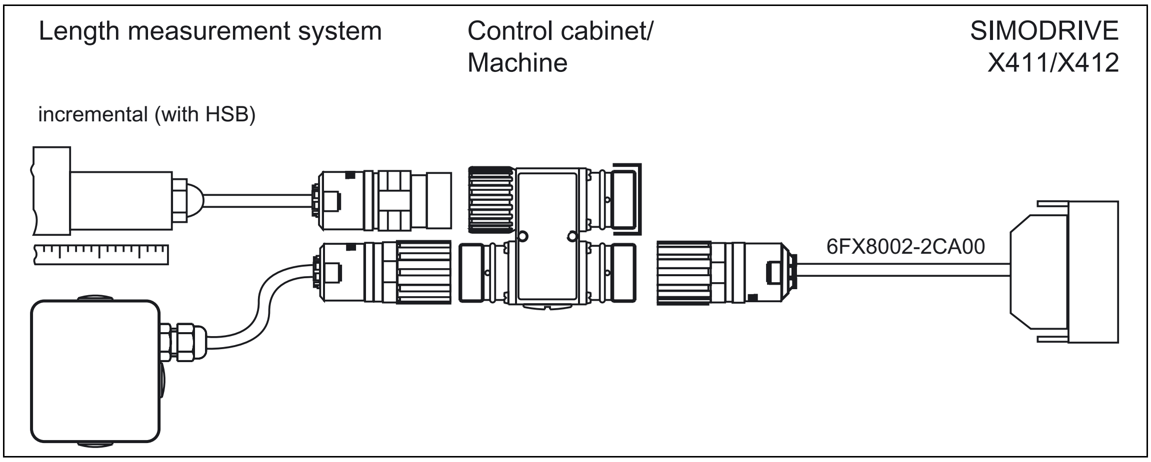


Figure 20-2 Connecting an incremental length measurement system (WMS) with Hall sensor box (HSB) to the X411/X412 interface with connector box

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Note

If the 1FN1910-0AA00-0AA0 connector box is used, free jacks are to be covered with metal caps for protection type and EMC compliance.

Figure 20-3 shows the connector box with the terminals connected according to Table 20-1 the plugs are intended for the following connections:

- X1 (17-pin plug): 611D/U X411/X412 converter
- X2 (9-pin socket): Temperature sensor
- X3 (12-pin socket): Linear scale
- X4 (9-pin socket with Y-encoding): Hall sensor box

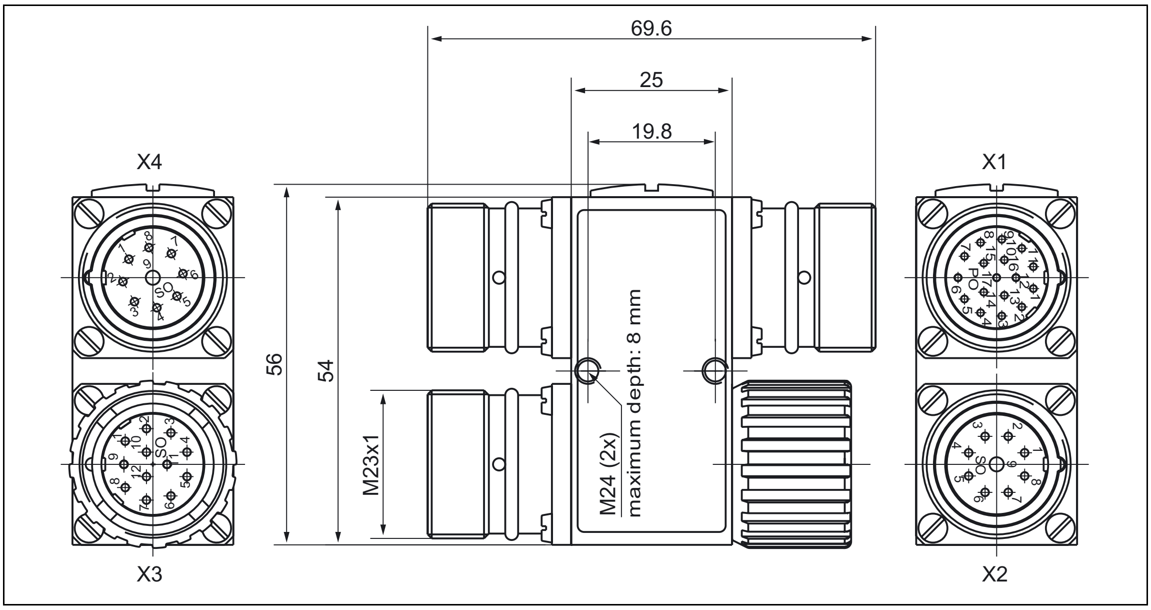

Figure 20-3 1FN1910-0AA00-0AA0 connector box for an incremental measurement system

CON

Table 20-1 Connector box plug pinout, see Figure 20-3

Signal	A+	A-	R+	D-	C+	C-	0 V	+Temp	-Temp	+5 V	B+	B-	R-	D+	0 V sense	+5 V-Sense	Inner shield
Pin X1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pin X2								7*	8*								
Pin X3	5	6	3				10			12	8	1	4		11	2	
Pin X4				6	1	2	4			3				5			9

*for *protective separation* reasons these connections cannot be made, see chapter 18.2.1.

■

21 Shielding and Grounding

The correct layout and wiring of the cable shields and ground conductors is of major significance for personnel safety as well as for interference transmission and reception. Therefore the following must be carefully observed:

- All cable shields must be connected to the respective housing via clamps or suitable terminal or screwed connectors.
- Applying only a few shield conductors or combining shield conductors in one cable is not permitted.
- For the power cable connection to the power unit, the SIMODRIVE shield attachment plates are recommended.

Note

Due to the capacitive coupling open circuits carry voltages.

Protective ground (PE) should be connected to conductors that are open-circuit or not being used, in particular electrical cables that can be touched.

The CE Declaration of Conformity applies if the above-mentioned issues are taken into consideration and the respective SIMODRIVE products are used.

Note

Unconnected or improperly connected cable shields can result in linear drive malfunctions - especially of the length measurement system – or affect third-party devices.

Note the topics mentioned above!

■

22 Wiring Guidelines

22.1 Using the Cables in the Cable Carrier

Note

For the electrical wiring carefully observe the instructions given by the cable carrier manufacturer.

To maximize the service life of the cable carrier and cables, cables in the carrier made from different materials must be installed in the cable carrier with spacers.

The chambers must be filled evenly to ensure that the position of the cables does not change during operation. The cables should be distributed as symmetrically as possible according to their mass and dimensions.

If possible, use only cables with equal diameters in one chamber. Cables with very different outer diameters should be separated by separators.

The cables must not be fixed in the carrier and must have room to move. It must be possible to move the cables without applying force, in particular in the bending radii of the carrier.

The specified bending radii must be adhered to. The cable fixings must be attached at both ends at an appropriate distance away from the end points of the moving parts in a dead zone.

At the ends of the cable carrier a tension relief must be installed (minimum requirement). Be sure to mount the cables along the casing without crushing them.

The cables are to be taken off the drum without kinks, i.e. roll the cables off the drum instead of taking them off in loops from the drum flange.

22.2 Cable Wiring in the Machine

Note

Drives with linear motors are exposed to a high dynamic load. With proper wiring and tension relief near the plug (distance < $10 \cdot d_{Kabel}$) the operator must ensure that the vibration is not transmitted to the plugs.

The actual value lines must be separated from the power lines in order to avoid cross interference.

The cables must not rub against anything and should be clamped or fastened at least every 200 mm.

■

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A Motor data overview

The tables on the following pages provide an overview of the most important technical data for the motors of type 1FN and 1FN3.

The definitions correspond to those given in the data sheets, see chapter 11.1.1 in section 1FN1 and chapter 15.1.1 in section 1FN3 respectively.

For the mass and type specifications of the 1FN3 type motors, models with and without optional cooling elements are listed.

Table A-1 Technical data – 1FN1 type motors/part 1

Order no. primary section	F_N [N]	F_{MAX} [N]	I_N [A]	I_{MAX} [A]	$v_{MAX,FN}$ [m/min]	$v_{MAX,FMAX}$ [m/min]	$P_{V,N}$ [W]
1FN1072-3AF7x-0AA0	790	1720	5.6	14	203	97	810
1FN1076-3AF7x-0AA0	1580	3450	11.2	27.9	202	96	1620
1FN1122-5xC71-0AA0	1475	3250	8.9	22.4	163	72	1350
1FN1122-5xF71-0AA0	1475	3250	11.1	28	214	105	1350
1FN1124-5xC71-0AA0	2200	4850	14.9	37.5	189	89	2010
1FN1124-5xF71-0AA0	2200	4850	16.2	40.8	208	101	2030
1FN1126-5xC71-0AA0	2950	6500	17.7	44.8	162	71	2700
1FN1126-5xF71-0AA0	2950	6500	22.2	56	213	104	2690
1FN1184-5AC71-0AA0	3600	7920	21.6	54.2	162	74	3070
1FN1184-5AF71-0AA0	3600	7920	26.2	65.6	204	100	3040
1FN1186-5AC71-0AA0	4800	10600	27.2	68	152	68	4000
1FN1186-5AD71-0AA0	4800	10600	32	80.1	185	89	4030
1FN1186-5AF71-0AA0	4800	10600	34.7	86.8	204	100	4050
1FN1244-5AC71-0AA0	4950	10900	28	69.9	149	65	4190
1FN1244-5AF71-0AA0	4950	10900	36.3	90.8	203	100	4110
1FN1246-5AC71-0AA0	6600	14500	37.7	93.7	151	67	5520
1FN1246-5AD71-0AA0	6600	14500	45.1	112.1	187	90	5530
1FN1246-5AF71-0AA0	6600	14500	48.3	119.9	201	98	5590

ABC

Table A-2 Technical data – 1FN1 type motors/part 2

Order no. primary section	h_M [mm]	b_M [mm]	l_P [mm]	m_P [kg]	l_S [mm]	m_S (short/long) [kg]
1FN1072-3AF7x-0AA0	80.7	137	320	10.1	226	3/7.5
1FN1076-3AF7x-0AA0	80.7	137	546	17.5	226	3/7.5
1FN1122-5xC71-0AA0	106.7	199	408	23.2	216	6.8/15.9
1FN1122-5xF71-0AA0	106.7	199	408	23.2	216	6.8/15.9
1FN1124-5xC71-0AA0	106.7	199	552	31.9	216	6.8/15.9
1FN1124-5xF71-0AA0	106.7	199	552	31.9	216	6.8/15.9
1FN1126-5xC71-0AA0	106.7	199	696	40.7	216	6.8/15.9
1FN1126-5xF71-0AA0	106.7	199	696	40.7	216	6.8/15.9
1FN1184-5AC71-0AA0	106.7	259	552	44.5	216	10/23.3
1FN1184-5AF71-0AA0	106.7	259	552	44.5	216	10/23.3
1FN1186-5AC71-0AA0	106,7	259	696	57.5	216	10/23.3
1FN1186-5AD71-0AA0	106,7	259	696	57.5	216	10/23.3
1FN1186-5AF71-0AA0	106,7	259	696	57,5	216	10/23.3
1FN1244-5AC71-0AA0	106.7	319	552	60.1	216	11.9/27.7
1FN1244-5AF71-0AA0	106.7	319	552	60.1	216	11.9/27.7
1FN1246-5AC71-0AA0	106,7	319	696	76	216	11.9/27.7
1FN1246-5AD71-0AA0	106.7	319	696	76	216	11.9/27.7
1FN1246-5AF71-0AA0	106.7	319	696	76	216	11.9/27.7

Table A-3 Technical data – 1FN3 type peak-load motors/part 1

Order no. primary section	F_N [N]	F_{MAX} [N]	I_N [A]	I_{MAX} [A]	$v_{MAX,FN}$ [m/min]	$v_{MAX,FMAX}$ [m/min]	$P_{V,N}$ [W]
1FN3050-2WC00-0AA0	200	550	2.7	8.2	373	146	310
1FN3100-1WC00-0AA1	200	490	2.4	6.5	322	138	280
1FN3100-2WC00-0AA1	450	1100	5.1	13.5	297	131	550
1FN3100-2WE00-0AA1	450	1100	8.1	21.5	497	237	550
1FN3100-3WC00-0AA1	675	1650	7.2	19.1	277	120	820
1FN3100-3WE00-0AA1	675	1650	12.1	32.2	497	237	830
1FN3100-4WC00-0AA1	900	2200	10.1	27	297	131	1100
1FN3100-4WE00-0AA1	900	2200	16.1	43	497	237	1110
1FN3100-5WC00-0AA1	1125	2750	11	29.5	255	109	1320
1FN3150-1WC00-0AA1	340	820	3.6	9.5	282	126	370
1FN3150-1WE00-0AA1	300	730	6.4	17	605	288	350
1FN3150-2WC00-0AA1	675	1650	7.2	19.1	282	126	730
1FN3150-3WC00-0AA1	1010	2470	10.7	28.6	282	126	1100
1FN3150-4WC00-0AA1	1350	3300	14.3	38.2	282	126	1470
1FN3150-5WC00-0AA1	1690	4120	17.9	47.7	282	126	1830
1FN3300-1WC00-0AA1	610	1720	6.5	20	309	128	520
1FN3300-2WB00-0AA1	1225	3450	8	24.7	176	63	990
1FN3300-2WC00-0AA1	1225	3450	12.6	39.2	297	125	1000
1FN3300-2WG00-0AA1	1225	3450	32.2	99.7	805	369	930
1FN3300-3WC00-0AA1	1840	5170	19	58.7	297	125	1500
1FN3300-3WG00-0AA1	1840	5170	50	154.9	836	383	1370
1FN3300-4WB00-0AA1	2450	6900	16	49.4	176	63	1990
1FN3300-4WC00-0AA1	2450	6900	25.3	78.3	297	125	1990
1FN3450-2WA50-0AA1	1930	5180	8.6	25.3	112	30	1530
1FN3450-2WB70-0AA1	1930	5170	15.2	45.1	235	102	1420
1FN3450-2WC00-0AA1	1930	5180	18.8	55.3	275	120	1470
1FN3450-2WE00-0AA1	1930	5180	33.8	99.7	519	240	1370
1FN3450-3WA50-0AA1	2895	7760	13.1	38.8	114	30	2390
1FN3450-3WB00-0AA1	2895	7760	17.9	52.7	164	62	2250
1FN3450-3WB50-0AA1	2895	7760	22.8	67.3	217	90	2230
1FN3450-3WC00-0AA1	2895	7760	28.1	83	275	120	2200
1FN3450-3WE00-0AA1	2895	7760	50.7	149.6	519	240	2060
1FN3450-4WB00-0AA1	3860	10350	23.8	70.3	164	62	3000
1FN3450-4WB50-0AA1	3860	10350	30.4	89.8	217	90	2980
1FN3450-4WC00-0AA1	3860	10350	37.5	110.6	275	120	2940
1FN3450-4WE00-0AA1	3860	10350	67.6	199.5	519	240	2740
1FN3600-2WA50-0AA1	2610	6900	12.4	36	120	36	2100
1FN3600-3WB00-0AA1	3915	10350	23.2	67.3	155	58	3000
1FN3600-3WC00-0AA1	3915	10430	35.7	105.9	279	127	2560
1FN3600-4WA30-0AA1	5220	13800	22.3	64.9	105	26	4230
1FN3600-4WB00-0AA1	5220	13800	30.9	89.8	155	58	4000
1FN3600-4WB50-0AA1	5220	13800	40.8	118.5	215	91	3810
1FN3600-4WC00-0AA1	5220	13800	46.9	136.5	254	112	3510
1FN3900-2WB00-0AA1	4050	10350	24.7	69.5	160	65	2940
1FN3900-2WC00-0AA1	4050	10350	36.7	103.3	253	115	2670
1FN3900-3WB00-0AA1	6075	15530	40.6	114	181	75	4430
1FN3900-4WB00-0AA1	8100	20700	49.4	138.9	160	65	5890
1FN3900-4WB50-0AA1	8100	20700	60.6	170.3	203	88	5830
1FN3900-4WC50-0AA1	8100	20700	73.5	206.5	253	115	5340

ABC

Table A-4 Technical data – 1FN3 type peak-load motors/part 1

Order no. primary section	$h_M/h_{M,P}$ [mm]	$b_M/b_{M,P}$ [mm]	l_P [mm]	$m_P/m_{P,P}$) [kg]	l_S [mm]	$m_S/m_{S,P}$ [kg]
1FN3050-2WC00-0AA0	48.5 / 63.4	67 / 76	255	2.4 / 2.9	120	0.4 / 0.5
1FN3100-1WC00-0AA1	48.5 / -	96 / -	150	2.2 / -	120	0.7 / 0.8
1FN3100-2WC00-0AA1	48.5 / 63.4	96 / 105	255	3.8 / 4.4	120	0.7 / 0.8
1FN3100-2WE00-0AA1	48.5 / 63.4	96 / 105	255	3.8 / 4.4	120	0.7 / 0.8
1FN3100-3WC00-0AA1	48.5 / 63.4	96 / 105	360	5.4 / 6.2	120	0.7 / 0.8
1FN3100-3WE00-0AA1	48.5 / 63.4	96 / 105	360	5.4 / 6.2	120	0.7 / 0.8
1FN3100-4WC00-0AA1	48.5 / 63.4	96 / 105	465	7.4 / 8.5	120	0.7 / 0.8
1FN3100-4WE00-0AA1	48.5 / 63.4	96 / 105	465	7.4 / 8.5	120	0.7 / 0.8
1FN3100-5WC00-0AA1	48.5 / 63.4	96 / 105	570	9.1 / 10.4	120	0.7 / 0.8
1FN3150-1WC00-0AA1	50.5 / -	126 / -	150	3 / -	120	1.2 / 1.3
1FN3150-1WE00-0AA1	50.5 / -	126 / -	150	3 / -	120	1.2 / 1.3
1FN3150-2WC00-0AA1	50.5 / 65.4	126 / 135	255	5.3 / 6	120	1.2 / 1.3
1FN3150-3WC00-0AA1	50.5 / 65.4	126 / 135	360	7.8 / 8.7	120	1.2 / 1.3
1FN3150-4WC00-0AA1	50.5 / 65.4	126 / 135	465	10.2 / 11.4	120	1.2 / 1.3
1FN3150-5WC00-0AA1	50.5 / 65.4	126 / 135	570	12.8 / 14.2	120	1.2 / 1.3
1FN3300-1WC00-0AA1	64.1 / -	141 / -	221	6.2 / -	184	2.4 / 2.6
1FN3300-2WB00-0AA1	64.1 / 79	141 / 151	382	11.4 / 12.4	184	2.4 / 2.6
1FN3300-2WC00-0AA1	64.1 / 79	141 / 151	382	11.4 / 12.4	184	2.4 / 2.6
1FN3300-2WG00-0AA1	64.1 / 79	141 / 151	382	11.4 / 12.4	184	2.4 / 2.6
1FN3300-3WC00-0AA1	64.1 / 79	141 / 151	543	17 / 18.4	184	2.4 / 2.6
1FN3300-3WG00-0AA1	64.1 / 79	141 / 151	543	17 / 18.4	184	2.4 / 2.6
1FN3300-4WB00-0AA1	64.1 / 79	141 / 151	704	22.2 / 24	184	2.4 / 2.6
1FN3300-4WC00-0AA1	64.1 / 79	141 / 151	704	22.2 / 24	184	2.4 / 2.6
1FN3450-2WA50-0AA1	66.1 / 81	188 / 197	382	15.9 / 17.1	184	3.8 / 4
1FN3450-2WB70-0AA1	66.1 / 81	188 / 197	382	15.9 / 17.1	184	3.8 / 4
1FN3450-2WC00-0AA1	66.1 / 81	188 / 197	382	15.9 / 17.1	184	3.8 / 4
1FN3450-2WE00-0AA1	66.1 / 81	188 / 197	382	15.9 / 17.1	184	3.8 / 4
1FN3450-3WA50-0AA1	66.1 / 81	188 / 197	543	22.6 / 24.3	184	3.8 / 4
1FN3450-3WB00-0AA1	66.1 / 81	188 / 197	543	22.6 / 24.3	184	3.8 / 4
1FN3450-3WB50-0AA1	66.1 / 81	188 / 197	543	22.6 / 24.3	184	3.8 / 4
1FN3450-3WC00-0AA1	66.1 / 81	188 / 197	543	22.6 / 24.3	184	3.8 / 4
1FN3450-3WE00-0AA1	66.1 / 81	188 / 197	543	22.6 / 24.3	184	3.8 / 4
1FN3450-4WB00-0AA1	66.1 / 81	188 / 197	704	30.9 / 33.1	184	3.8 / 4
1FN3450-4WB50-0AA1	66.1 / 81	188 / 197	704	30.9 / 33.1	184	3.8 / 4
1FN3450-4WC00-0AA1	66.1 / 81	188 / 197	704	30.9 / 33.1	184	3.8 / 4
1FN3450-4WE00-0AA1	66.1 / 81	188 / 197	704	30.9 / 33.1	184	3.8 / 4
1FN3600-2WA50-0AA1	64.1 / 86	248 / 257	382	22.2 / 24.7	184	4.6 / 5
1FN3600-3WB00-0AA1	64.1 / 86	248 / 257	543	31.5 / 33.4	184	4.6 / 5
1FN3600-3WC00-0AA1	64.1 / 86	248 / 257	543	31.5 / 33.4	184	4.6 / 5
1FN3600-4WA30-0AA1	64.1 / 86	248 / 257	704	40.8 / 43.3	184	4.6 / 5
1FN3600-4WB00-0AA1	64.1 / 86	248 / 257	704	40.8 / 43.3	184	4.6 / 5
1FN3600-4WB50-0AA1	64.1 / 86	248 / 257	704	40.8 / 43.3	184	4.6 / 5
1FN3600-4WC00-0AA1	64.1 / 86	248 / 257	704	40.8 / 43.3	184	4.6 / 5
1FN3900-2WB00-0AA1	66.1 / 88	342 / 351	382	28.2 / 29.7	184	7.5 / 7.9
1FN3900-2WC00-0AA1	66.1 / 88	342 / 351	382	28.2 / 29.7	184	7.5 / 7.9
1FN3900-3WB00-0AA1	66.1 / 88	342 / 351	543	42.2 / 44.3	184	7.5 / 7.9
1FN3900-4WB00-0AA1	66.1 / 88	342 / 351	704	56.2 / 58.9	184	7.5 / 7.9
1FN3900-4WB50-0AA1	66.1 / 88	342 / 351	704	56.2 / 58.9	184	7.5 / 7.9
1FN3900-4WC50-0AA1	66.1 / 88	342 / 351	704	56.2 / 58.9	184	7.5 / 7.9

B Recommended manufacturers

In this chapter we recommend products whose general suitability we know. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or dictates. We cannot accept any liability for the quality and properties/features of third-party products.

Manufacturers of corrosion protection agents (see page 4-31)

A manufacturer of corrosion protection agents is, for example, TYFOROP CHEMIE.

Table B-5 Contact information – Manufacturers of corrosion protection agents

Manufacturer/Contact information
TYFOROP CHEMIE GmbH Anton-Rée-Weg 7 D-20537 Hamburg Tel: +49 40 209497-0 http://www.tyfo.de/

ABC

Manufacturers of cold water units (see page 4-36)

Manufacturers of cold water units which may also support cooling system layouts include, for example, SCHIMPKE, BKW, RITTAL, PFANNENBERG, and HYDAC SYSTEM.

Table B-6 Contact information – Manufacturers of cold water units

Manufacturer/Contact information	Manufacturer/Contact information
Helmut Schimpke Industriekühlanlagen GmbH + Co.KG Postfach 101661 D-42760 Haan Tel: +49 2129 9438-0 http://www.schimpke.de/	BKW Kälte-Wärme-Versorgungstechnik GmbH Benzstraße 2 D-72649 Wolfschlugen Tel: +49 7022 5003-0 http://www.bkw-kuema.de/
Rittal GmbH & Co. KG Postfach 1662 D-35726 Herborn Tel: 02772/505-2063 http://www.rittal.de/	Pfannenberg GmbH Werner-Witt-Straße 1 D-21035 Hamburg Tel.: +49 40 73412-0 http://www.pfannenberg.de/
Hydac System GmbH Postfach 12 51 66273 Sulzbach/Saar Tel.: +49 (0) 68 97 - 5 09 - 7 08 www.hydac.com	

Manufacturers of brake elements (see page 4-40)

Manufacturers of brake elements include, for example, INA or Zimmer.

Table B-7 Contact information – Manufacturers of brake elements

Manufacturer/Contact information	Manufacturer/Contact information
INA-Schaeffler KG Industriestraße 1-3 91074 Herzogenaurach Tel.: +49 9132 82-0 http://www.ina.com/	Zimmer GmbH Technische Werkstätten Im Salmenkopf 5 D-77866 Rheinau Tel: +49 7844 9138-0 http://www.zimmer-gmbh.com/

Manufacturers of coupling pieces (see page 9-92)

Manufacturers of couplings without check valve include, for example, Rectus with its product line 21 KA.

Table B-8 Contact information – Manufacturers of coupling pieces

Manufacturer/Contact information
RECTUS GmbH Daimlerstraße 7 D-71735 Eberdingen-Nussdorf Tel: +49 7042 100-0 http://www.rectus.de/

ABC

Manufacturers of cooler connections for 1FN3 models (see page 13-180)

Manufacturers of cooler connections for 1FN3 type motors include, for example, Rectus:

- Plug-in nipple: Article no. 21 SF AW 10 MXX (brass)
- Set of gaskets: A10x13.5 (DIN 7603 compliant, Al or Cu)
- Quick-snap couplings for plastic hoses
  - d_{innen} x $d_{außen}$ = (5,7...6) mm x 8 mm: Article no. 21 KF KO 08 MPX (hose connector with union nut, brass)
  - d_{innen} = 6 mm:
  - Article no. 21 KF TF 06 MPX (hose connector with clamp or cable tie, brass)
  - d_{innen} = 8 mm: Article no. 21 KF TF 08 MPX (hose connector with clamp or cable tie, brass)
  - non-blocking: 21 KF series instead of 21 KA (special design)

Table B-9 Contact information – Manufacturers of cooler connections for 1FN3 models

Manufacturer/Contact information
RECTUS GmbH Daimlerstraße 7 D-71735 Eberdingen-Nussdorf Tel: +49 7042 100-0 http://www.rectus.de/

Manufacturers of plastic hoses (see page **13-181**)

Manufacturers of plastic hoses include, for example, FESTO and RECTUS.

Table B-10 Contact information – Manufacturers of plastic hoses

Manufacturer/Contact information	Manufacturer/Contact information
Festo AG & Co. KG Ruiter Straße 82 D-73734 Esslingen-Berkheim Tel: +49 711 3470 http://www.festo.com/	RECTUS GmbH Daimlerstraße 7 D-71735 Eberdingen-Nussdorf Tel: +49 7042 100-0 http://www.rectus.de/

Manufacturers of screw-in nipples and reinforcing sleeves (see page **13-182**)

Manufacturers of union pieces with screw-in nipples and reinforcing sleeves include, for example, SERTO. This company also supplies screw-in nipples for hose nozzles.

Table B-11 Contact information – Manufacturers of screw-in nipples and reinforcing sleeves

Manufacturer/Contact information
SERTO jacob GmbH Kasseler Strasse 66 DE-34271 Fuldabrück Tel: +49 561 580040 www.serto.com/

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C Terminal markings

With the norm EN 60034-8:2002 the terminal markings for electrical connections have changed. Table C-12 indicates the relevant changes regarding the 1FN1- and 1FN3-type primary sections.

Table C-12 Terminal markings according to EN 60034-8

	KTY 84 (Temp-F)	Bimetallic NC contact (Temp-S for 1FN1)	PTC (Temp-S for 1FN3)
old marking	2T1⊕/2T1⊖	1T1/1T2	1T1/1T2
new marking	+1R1/–1R2	1TB1/1TB2	1TP1/1TP2

■

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D References

Reference materials quoted in this document

/NC60/ Catalog NC 60 • 2004
SINUMERIK & SIMODRIVE, Automation Systems for Machine Tools
Order no. E86060-K4460-A101-B1

/PJU/ SIMODRIVE 611 Planning Guide Drive Converters
Edition 10.04
Order no. 6SN1197-0AA00–0BP7

/IAD/ SINUMERIK 840D/SIMODRIVE 611D Installation and Start-Up Guide
Edition 11.02
Order no. 6FC5297-7AB10–0BP2

/SME9x/ Sensor Module External SME 9x Operator's Manual
Edition 09.05

Electronic publications

CA 01 Automation & Drives Offline Mall
CD-ROM including all products listed in the NC 60 • 2004 catalog
Order number E86060-D4001-A100-C1

A&D Mall Automation & Drives Online Mall
http://www.siemens.com/automation/mall

DocOnCD Technical Documentation on CD-ROM
SINUMERIK & SIMODRIVE
Order no. 6FC5298-0CD00–0BG0

DocOnWeb Automation & Drives Online Technical Documentation
http://www.siemens.com/automation/doconweb

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Additional documentation

/EMV/ EMC Design Guidelines
SINUMERIK, SIROTECC, SIMODRIVE
Configuration Manual
Order no. 6FC5297-0AD30–0BP1

/FBA/ Description of Functions Drive Functions
SIMODRIVE 611D, SINUMERIK 840D/810D
Edition 03.04
Order no. 6SN1 197–0AA80–1BP1

/FBU/ Function description
Control Components for Closed-Loop Speed Control and Positioning
SIMODRIVE 611 universal/universal E
Edition 07.03
Order no. 6SN1197–0AB20–0BP7

/FBSI/ Description of Functions SINUMERIK Safety Integrated
SINUMERIK 840D, SIMODRIVE
Edition 11.03
Order no. 6FC5297-6AB80–0BP2

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Suggestions

Corrections

For Publication/Manual:

SIMODRIVE
1FN1- and 1FN3-SL-type linear motors

Manufacturer/service documentation

From

Name:

Address of your company/department

Address: ____

Postal/zip code: ___________ City: __

Telephone: _________ / ____

Telefax: _________ / _

Configuration Manual

Order No.: 6SN1197-0AB70-0BP6
Edition: 01.06

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Suggestions and/or corrections