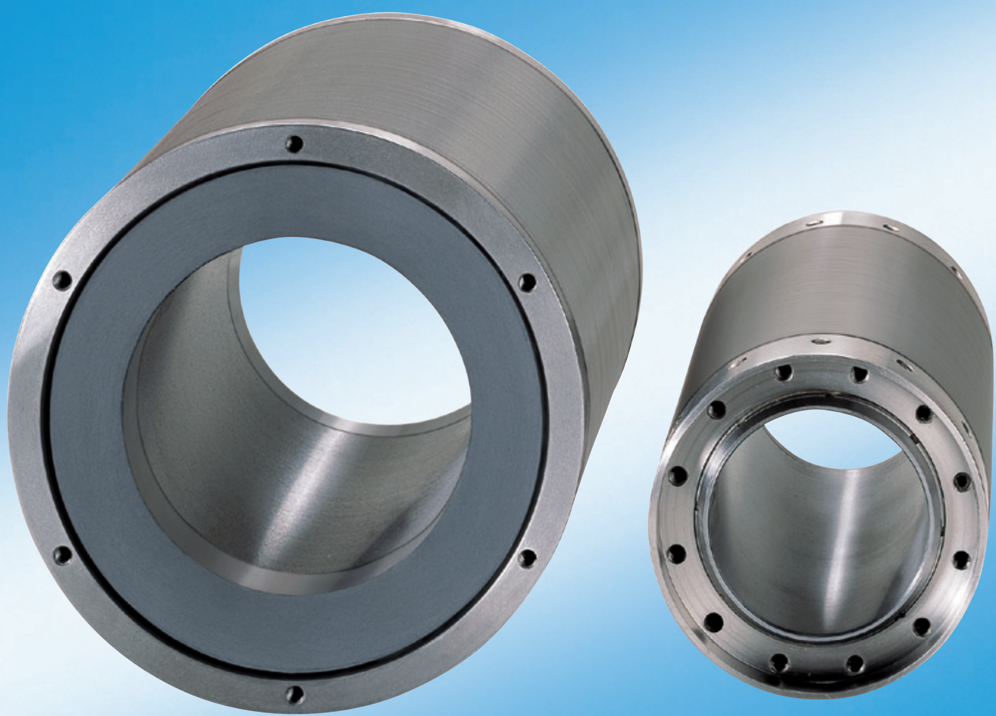
Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth
Bosch Group

Rexroth IndraDyn H
Synchronous Kit Spindle Motors

R911297895
Edition 03

Project Planning Manual



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Purpose of Documentation This documentation…

- explains product features and applications, technical data as well as conditions and limits for operation.
- provides information regarding product selection, handling and operation.

Record of Revision

Edition	Release Date	Notes
DOK-MOTOR*-MBS-H******-PR01-EN	07.2004	First edition
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1 Introduction to the Product

1.1 General

New technologies with high economic benefits are posing increasingly extreme demands on the acceleration, velocity and precision of motors.

Rexroth IndraDyn H motors are state-of-the-art, high-speed synchronous kit motors, optimized for high torques at high speeds. They consist of a stator with a three-phase winding and a rotor with permanent magnets.

Due to a wide constant-power range, the brief start-up times and the low rotor temperature, these motors are especially suitable for use in motor spindles.

The novel cooling system which is self-contained in the motor reduces expenses for the machine manufacturer and increases the cooling efficiency.

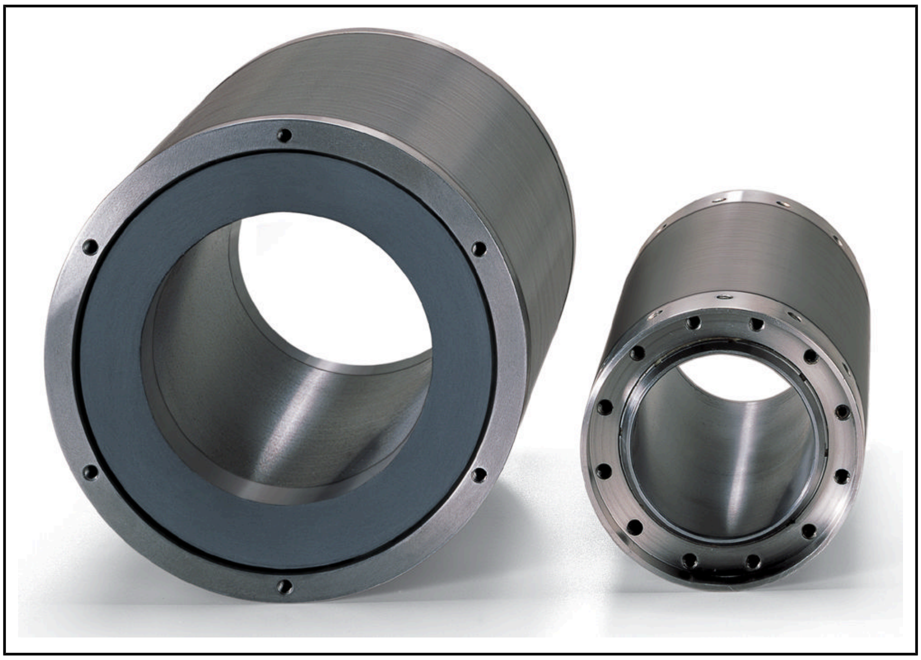

Fig. 1-1: Example of IndraDyn H stator and Rotor

Rexroth IndraDyn H motors are used mainly as direct drives in motor spindles. The position of the motor between the main spindle bearings gives the motor spindle a high rigidity. As a result, the main spindle and the C axis can be operated with only one drive in grinding machines, for example.

Motor spindles are used for turning, milling and grinding in machine tools, transfer lines, processing centers and special-purpose machines.

Performance list

The following diagram gives an overview of the performance range of the IndraDyn H motors.

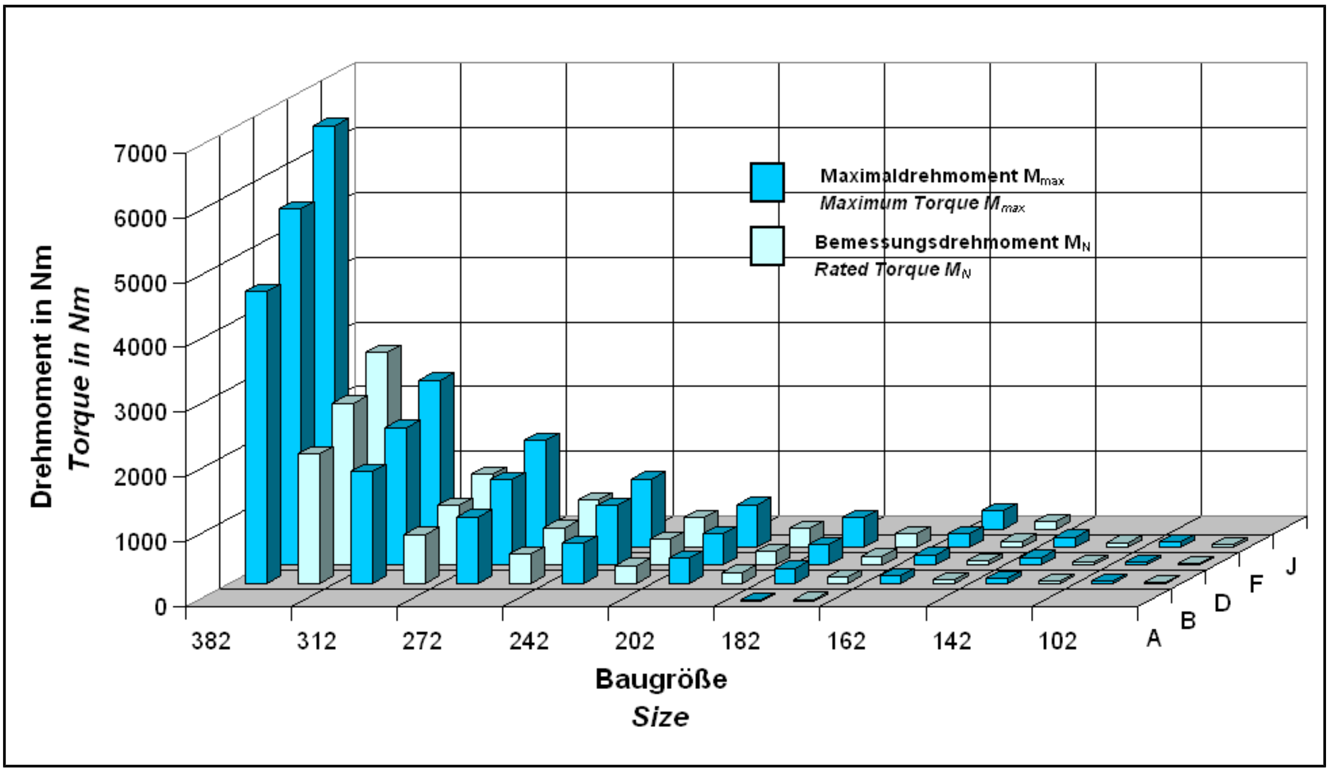

Fig. 1-2: IndraDyn H performance range

1.2 About this Documentation

1.2.1 Document Structure

This documentation includes safety regulations, technical data and operating instructions. The following table provides an overview of the contents of this documentation.

<table>
<tr><th>Sect.</th><th>Title</th><th colspan="2">Contents</th></tr>
<tr><td>1</td><td>Introduction</td><td colspan="2">Introduction to the product and notes</td></tr>
<tr><td>2</td><td>Important Instructions on Use</td><td colspan="2" rowspan="2">Important safety notes</td></tr>
<tr><td>3</td><td>Safety</td></tr>
<tr><td>4</td><td>Technical Data</td><td rowspan="3">Product descrip-tion</td><td rowspan="5">for planners and designers</td></tr>
<tr><td>5</td><td>Dimension Sheets</td></tr>
<tr><td>6</td><td>Type Codes</td></tr>
<tr><td>7</td><td>Accessories</td><td rowspan="2"></td></tr>
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Sect.	Title	Contents	
9	Application Notes	Practice	for operating and maintenance personnel
10	Handling & Transport		
11	Installation		
12	Operation		
13	Service and Support		
14	Index	Additional information	

Fig. 1-3: Chapter structure

1.2.2 Additional Documentation

To design drive systems of the Rexroth MSP motor series, you may need additional documentation corresponding to the devices used. Rexroth has made the entire product documentation available in several languages on DVD in PDF format or in the Internet under www.boschrexroth.com/BRCDoku/ (one-time registration required). You will not need all the documentation included on the DVD to project a system.

☞ All documentation is also available as printed versions which you can order from your Rexroth sales office.

MNR	Title / description
R911306531	DVD Product documentation Electric Drives and Controls Version **xx** [1)]DOK-GENERL-DRIVE*CONTR-GN**xx**-D0-*****
1) The index (e.g. ...**02**-...) identifies the version of the CD	

Fig. 1-4: Additional documentation

1.2.3 Additional Components

Documentation for external systems which are connected to Bosch Rexroth components are not included in the scope of delivery and must be ordered directly from the corresponding manufacturers.

For information on the manufacturers see chapter 9 "Application Notes" on page 131.

1.2.4 Feedback

Your experiences are an essential part of the process of improving both the product and the documentation.

Please do not hesitate to inform us of any mistakes you detect in this documentation or of any modifications you might desire. We would appreciate your feedback.

Please send your remarks to:

Bosch Rexroth Electric Drives and Controls GmbH

Dep. BRC/EDM1

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97816 Lohr, Germany

Fax +49 (0) 93 52 / 40-43 80

1.2.5 Standards

This documentation refers to German, European and international technical standards. Documents and sheets on standards are subject to the protection by copyright and may not be passed on to third parties by Rexroth. If necessary, please address the authorized sales outlets or, in Germany, directly to:

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10787 Berlin, Germany

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E-mail: postmaster@beuth.de

2 Important Instructions on Use

2.1 Appropriate Use

2.1.1 Introduction

BOSCH REXROTH products are designed and manufactured using state-of-the-art-technology. Before they are delivered, they are inspected to ensure that they operate safely.

The products may only be used in the proper manner. If they are inappropriate used, situations may arise that result in damage to material and personnel.

☞ BOSCH REXROTH provides no warranty, assumes no liability and will not pay for any damages resulting from damage caused by products not being used as intended. Any risks resulting from the products not being used as intended are the sole responsibility of the user.

Before using the products by Bosch Rexroth, the following condition precedent must be fulfilled so as to ensure that they are used as intended:

- Everyone who in any way deals with one of our products must read and understand the corresponding notes regarding safety and regarding proper use.
- If the products are hardware, they must be kept in their original state, i.e. no constructional modifications may be made. Software products may not be decompiled; their source codes may not be modified.
- Damaged or improperly working products must not be installed or put into operation.
- It must be ensured that the products are installed according to the regulations mentioned in the documentation.

2.1.2 Areas of Use and Application

Rexroth IndraDyn H motors are designed to be used as rotary main drive motors.

Unit types with different driving powers and different interfaces are available for an application-specific use of the motors.

Controlling and monitoring of the motors may require connection of additional sensors and actuators.

☞

- The motors may only be used with the accessories specified in the documentation. Components that are not explicitly mentioned may be neither attached nor connected. The same is true for cables and lines.
- Operation may be carried out only in the explicitly mentioned configurations and combinations of the component and with the software and firmware specified in the corresponding description of functions.

Any connected drive controller must be programmed before startup in order to ensure that the motor executes the functions specific to the particular application.

Rexroth IndraDyn H motors may only be operated under the assembly, mounting and installation conditions, in the normal position, and under the environmental conditions (temperature, degree of protection, humidity, EMC, and the like) specified in this documentation.

2.2 Inappropriate Use

Any use of the motors outside of the fields of application mentioned above or under operating conditions and technical data other than those specified in this documentation is considered to be ”inappropriate use”.

Rexroth IndraDyn H motors may e.g. not be used if ...

- they are subjected to operating conditions which do not comply with the ambient conditions described above. For example, they must not be operated under water, under extreme temperature fluctuations or in extreme maximum temperatures.
- the intended fields of application have not been expressly released for the motors by Rexroth. Please be absolutely sure to also observe the statements made in the general safety notes.

3 Safety Instructions for Electric Drives and Controls

3.1 Safety Instructions - General Information

3.1.1 Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.

If the device is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the device in the official language of the user's country.

WARNING

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

Observe the safety instructions!

3.1.2 How to Employ the Safety Instructions

Read these instructions before initial commissioning of the equipment in order to eliminate the risk of bodily harm and/or material damage. Follow these safety instructions at all times.

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before commissioning the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations:
  - Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the product, as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.

- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The devices have been designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturer must

  – make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  – make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only permitted if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective documentation (Project Planning Manuals of components and system).

  The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.
- Technical data, connection and installation conditions are specified in the product documentation and must be followed at all times.

National regulations which the user must take into account

- European countries: according to European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

3.1.3 Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:

Warning symbol	Signal word	Degree of hazard seriousness acc. to ANSI Z 535.4-2002
	Danger	Death or severe bodily harm will occur.
	Warning	Death or severe bodily harm may occur.
	Caution	Minor or moderate bodily harm or material damage may occur.

Fig.3-1: Hazard classification (according to ANSI Z 535)

3.1.4 Hazards by Improper Use

DANGER

High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!

Observe the safety instructions!

DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

Observe the safety instructions!

WARNING

High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!

Observe the safety instructions!

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

Observe the safety instructions!

CAUTION

Hot surfaces on device housing! Danger of injury! Danger of burns!

Observe the safety instructions!

CAUTION

Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting or improper handling of pressurized lines!

Observe the safety instructions!

CAUTION

Risk of injury by improper handling of batteries!

Observe the safety instructions!

3.2 Instructions with Regard to Specific Dangers

3.2.1 Protection Against Contact with Electrical Parts and Housings

This section concerns devices and drive components with voltages of **more than 50 Volt.**

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

DANGER

High electrical voltage! Danger to life, electric shock and severe bodily injury!

- Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
- Follow general construction and safety regulations when working on power installations.
- Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.
- Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard to prevent reconnection.
- With electrical drive and filter components, observe the following:

  Wait **30 minutes** after switching off power to allow capacitors to discharge before beginning to work. Measure the electric voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
- Never touch the electrical connection points of a component while power is turned on. Do not remove or plug in connectors when the component has been powered.
- Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
- A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.
- Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.

For electrical drive and filter components with voltages of **more than 50 volts**, observe the following additional safety instructions.

DANGER

High housing voltage and high leakage current! Risk of death or bodily injury by electric shock!

- Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
- The equipment grounding conductor of the electrical equipment and the devices must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
- Over the total length, use copper wire of a cross section of a minimum of 10 mm^2 for this equipment grounding connection!
- Before commissioning, also in trial runs, always attach the equipment grounding conductor or connect to the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

3.2.2 Protection Against Electric Shock by Protective Extra-Low Voltage

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

All connections and terminals with voltages between 5 and 50 volts at Rexroth products are PELV systems. [1] It is therefore allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections and terminals.

WARNING

High electric voltage by incorrect connection! Risk of death or bodily injury by electric shock!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g. the mains connection) are connected to Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV. [2]

3.2.3 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

1) *"Protective Extra-Low Voltage"*

2) *"Protective Extra-Low Voltage"*

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

DANGER

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

- Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation.

  These measures have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

- Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
  - use safety fences
  - use safety guards
  - use protective coverings
  - install light curtains or light barriers
- Fences and coverings must be strong enough to resist maximum possible momentum.
- Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the device if the emergency stop is not working.
- Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.
- Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.
- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example:
  - mechanically securing the vertical axes,
  - adding an external braking/ arrester/ clamping mechanism or
  - ensuring sufficient equilibration of the vertical axes.
- The standard equipment motor brake or an external brake controlled directly by the drive controller are **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
  - maintenance and repair work
  - cleaning of equipment
  - long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

3.2.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- Persons with heart pacemakers and metal implants are not permitted to enter following areas:
  - Areas in which electrical equipment and parts are mounted, being operated or commissioned.
  - Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.
- If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of present or future implanted heart pacemakers differs greatly so that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

3.2.5 Protection Against Contact with Hot Parts

CAUTION

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

- Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
- Do not touch housing surfaces of motors! Danger of burns!
- According to the operating conditions, temperatures can be **higher than 60 °C**, 140°F during or after operation.
- Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes**! Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.
- After switching drive controllers or chokes off, wait 15 minutes to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.

3.2.6 Protection During Handling and Mounting

In unfavorable conditions, handling and mounting certain parts and components in an improper way can cause injuries.

CAUTION

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!

- Observe the general construction and safety regulations on handling and mounting.
- Use suitable devices for mounting and transport.
- Avoid jamming and bruising by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids because of the danger of skidding.

3.2.7 Battery Safety

Batteries consist of active chemicals enclosed in a solid housing. Therefore, improper handling can cause injury or material damage.

CAUTION

Risk of injury by improper handling!

- Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
- Do not recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries do not damage electrical parts installed in the devices.
- Only use the battery types specified by the manufacturer.

☞ Environmental protection and disposal! The batteries contained in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separate from other waste. Observe the local regulations in the country of assembly.

3.2.8 Protection Against Pressurized Systems

According to the information given in the Project Planning Manuals, motors cooled with liquid and compressed air, as well as drive controllers, can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids and cooling lubricating agents. Improper handling of the connected supply systems, supply lines or connections can cause injuries or material damage.

CAUTION

Risk of injury by improper handling of pressurized lines!

- Do not attempt to disconnect, open or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- Immediately clean up any spilled liquids from the floor.

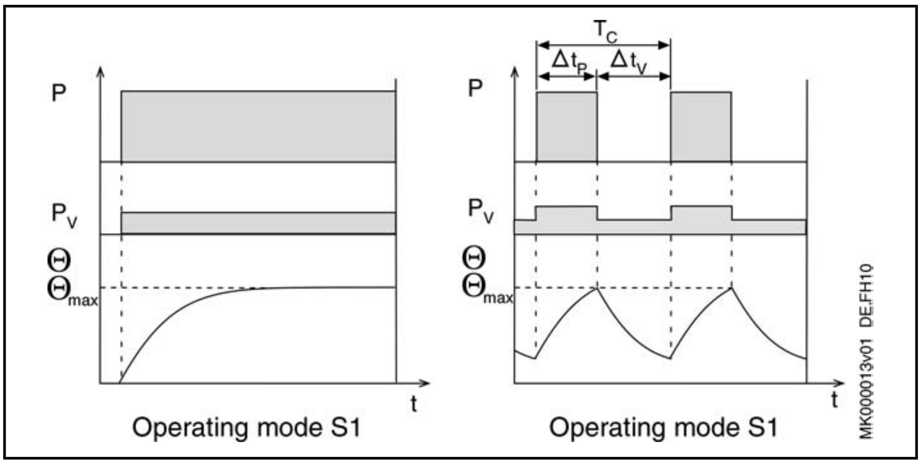
☞ Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separately from other waste. Observe the local regulations in the country of assembly.

4 Technical Data

4.1 Definitions

4.1.1 Operating Modes

Bosch Rexroth motors are documented according to the test criteria and measuring methods of EN 60034-1. Stated technical data refer to operating modes S1 (continuous operation) and S6 (periodic operation), each with liquid cooling and water as the coolant.



P	Load
P_V	Electric losses
Θ	Temperature
Θ_{max}	Highest temperature (stator)
t	Time
T_C	Cycle time
Δt_P	Operating time with constant load
Δt_V	Idling time

Fig.4-1: Operating modes according to EN 60034-1:1998

4.1.2 ON Time

The operating mode S6 is supplemented by specification of the ON time (ED) in %. The operating time is calculated as follows:

$$ED = \frac{\Delta t_P}{T_C} \cdot 100\%$$

ED	Cyclic duration factor in %
T_C	Cycle time
Δt_P	Operating time with constant load

Fig.4-2: Cyclic duration factor

4.1.3 Parameters

Rated torque M_N = Available torque that can be output at the rated speed in operating mode S1 (continuous operation). Unit = Newton meters (Nm).

Rated speed n_N = Typical working speed defined by the manufacturer. Depending on the particular application, other working speeds are possible (see speed-torque curve).

Rated power P_N = Mechanical power output of the motor while running at the rated speed and rated torque. Unit = kilowatts (kW).

Rated current I_N = Phase current of the motor while running at the rated speed and rated torque, specified as a root-mean-squared value in amps (A).

Maximum torque M_{max} = This is the maximum torque in (Nm) available using maximum current I_{max}. The achievable maximum torque depends on the drive control used.

Maximum current I_{max} = Maximum current (root mean square) of the motor at M_{max}. Unit = ampere (A).

Rotor moment of inertia J_{rot} = The moment of inertia of the rotor without bearing and encoder. Unit = kgm².

Torque constant at 20° C K_{M_N} = Relation of torque increase to the motor phase current (root mean square). Unit = Nm/A. Valid up to rated current I_{nenn}.

Voltage constant at 20°C K_{EMK_1000} = Root mean square value of the induced motor voltage depending on the motor speed. Unit (V/min^{-1}).

Winding resistance at 20°C R_{12} = Winding resistance measured between two phases in ohms (Ω).

Stator/Rotor mass The mass of the stator (m_{stat}) and rotor (m_{rot}), without bearing and encoder, stated in kilograms (kg).

Maximum torque n_{max} = Maximum allowable speed of the motor in (min^{-1}). Normally restricted by mechanical factors such as centrifugal force or bearing stress.

Power wire cross section Rated according to DIN VDE 0298-4 (2003) and laying procedure B2 according to IEC 60204-1 (1998) with conversion factor for Rexroth cables at an ambient temperature of 40°C.

The power wire cross section in (mm²) specified in the data sheets can deviate depending on the selected motor connection type - plug or terminal box. Therefore, when selecting the appropriate power cable, pay attention to the information in Chapter 8 ”Connection Techniques” and to the documentation ”Rexroth Connection Cable, MNR R911280894".

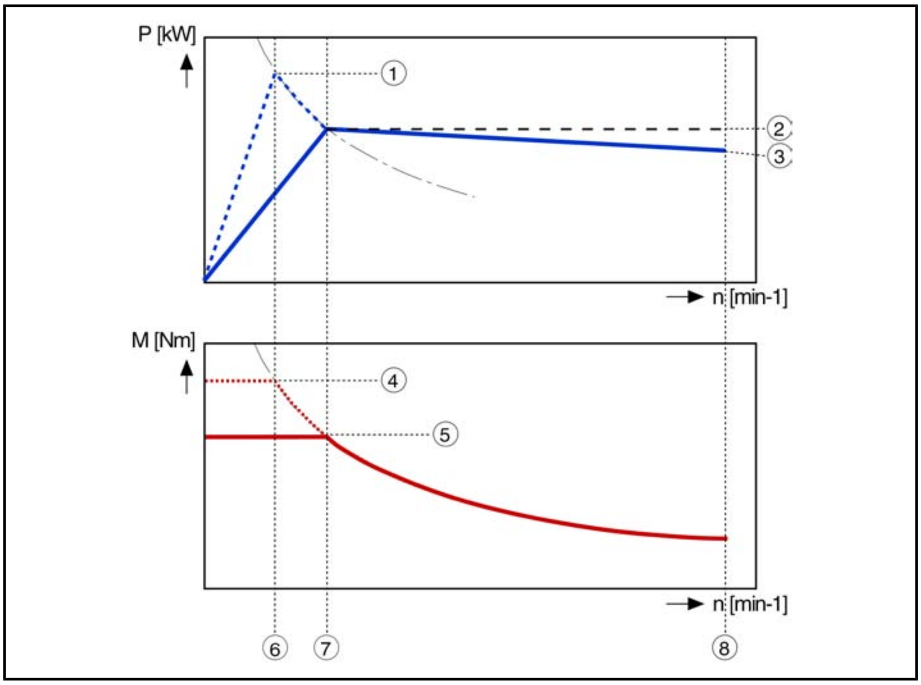
Number of pole pairs p = Number of pole pairs of the motor.

Thermal time constant T_{th} = The time it takes for the motor temperature to rise to 63% of the final temperature with the stators loaded by the rated torque in S1 operation and liquid cooling.

See also fig. 9-9 "Heating up and cooling down of an electrical machine" on page 137.

4.1.4 Operating Characteristic

The following sample characteristic curves explain the operating behavior of IndraDyn H motors, as does information found in the motor data sheet.



①	Maximum output
②	Rated output
③	real output
④	Maximum torque
⑤	Rated torque
⑥	Speed at Mmax
⑦	Rated speed
⑧	Maximum speed

Fig.4-3: Example of a motor characteristic curve

With increasing speed, the output of an IndraDyn H motor that can really be delivered is lower than the rated output specified in the data sheet as energy is required in order to weaken the field of the permanent magnets. This creates an additional power loss in the magnets reducing the deliverable output of the motor.

☞ The attainable motor torque depends on the drive controller used: it is only available for IndraDyn H motors if the drive controller is able to set the input control angle in an optimal way. This is the case for all Rexroth IndraDrive devices.

If the drive controller is not able to do this, the reluctance torque cannot be used, and about 10%-15% less rated torque will be available.

The maximum torque M_{max} is available up to the speed n_{Mmax}. When the velocity rises, the available intermediate circuit voltage is reduced by the velocity-dependent reverse voltage of the motor. This leads to a reduction of the maximum torque with rising velocity.

The specified characteristic curves can be linearly extrapolated to the existing voltages if the connection voltages or mains voltages differ.

Example:

Technical Data

$$n_{(U_{DC,neu})} = \frac{U_{DC,neu}}{540V} \cdot n_{nenn}$$

Fig.4-4: Example for conversion

Conversion to intermediate circuit voltage 750VDC

$$M_{max750V} = M_{max} = constant \qquad M_{nenn750V} = M_{nenn} = constant$$

$$n_{max750V} = \frac{750V}{540V} \cdot n_{max} \qquad n_{nenn750V} = \frac{750V}{540V} \cdot n_{nenn}$$

Fig.4-5: Conversion example to DC bus voltage 750VDC

4.2 Technical Data

4.2.1 Data Sheet Size 102 (Preliminary)

Description		Symbol	Unit	Size 102			
Motor data 1)							
Frame length				B	D	F	
Winding code				0800	0800	0300	0800
Rated torque		M_N	Nm	10,5	20	32	26
Rated speed		n_N	min^{-1}	8000		3000	8000
Rated power		P_N	KW	8,8	16,8	10,1	21,8
Rated current		I_N	A	18	24	15,3	43
Maximum torque 2)		M_{max}	Nm	30	45	75	68
Maximum current		I_{max}	A	40	69	35	100
Maximum speed		n_{max}	min^{-1}	12000	10000	18000	30000
Required power wire cross section 3)		A	mm²	2,5	4	1,5	10
Moment of inertia for rotor type 1N 6)		J_{rot}	kgm²	0,003	0,003	0,006	
Moment of inertia for rotor type 2N 7)				0,003	0,004	0,005	
Torque constant at 20° C		K_{M_N}	Nm/A	0,6	0,8	2,1	0,6
Voltage constant at 20°C 4)		K_{EMK_1000}	V/min^{-1}	57	64	156	53
Winding resistance at 20°C		R_{12}	Ohm	0,89	0,8	2,7	0,31
Winding inductivity	longitudinal	L_d	mH	1	1,28	5,67	0,64
	across	L_q	mH	4,8	4,3	16,55	1,8
Thermal time constant		T_{th}	min	7		2,2	
Mass	Rotor 6)	m_{rot}	kg	2,1	3,1	5,1	
	Stator	m_{stat}	kg	5,8	7,2	11,2	
permissible ambient temperature		T_{um}	°C	0...+40			

Description	Symbol	Unit	Size 102			
Motor data [1]						
Frame length			B	D	F	
permissible storage and transport temperature	T_{lager}	°C	-20...+80			
Insulation class			F			
Motor protection class according to IEC60050-411			IP00			
Number of pole pairs	p		3			
Liquid cooling						
Rated power loss	P_{V_H2O}	kW	1,09	1,3	1,6	2,4
Coolant inlet temperature [5]	T_{ein}	°C	+10...+40			
Coolant temperature rise at P_V [5]	ΔT_{diff}	K	10			
necessary coolant flow at ΔT_{diff} [5]	Q_{min_H2O}	l/min	3	3	2,5	4
Pressure drop at Q_{min}	Δp_{diff}	bar	1,4	1,4	0,7	
Permissible inlet pressure	p_{max}	bar	5			
Volume of coolant duct	V_{kuehl}	l	0,018	0,024	0,035	

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-6: Technical data size 102 (preliminary)

Technical Data

4.2.2 Data Sheet Size 142 (Preliminary)

Description		Symbol	Unit	Size 142		
Motor data [1]						
Frame length				B	D	F
Winding code				0700		
Rated torque		M_N	Nm	27,5	40,5	65
Rated speed		n_N	min^{-1}	7000		
Rated power		P_N	KW	20,2	29,7	47,6
Rated current		I_N	A	45	65	68
Maximum torque [2]		M_{max}	Nm	67	90	150
Maximum current		I_{max}	A	100	140	180
Maximum speed		n_{max}	min^{-1}	28000		10000
Required power wire cross section [3]		A	mm²	10	16	16
Moment of inertia for rotor type 1N [6]		J_{rot}	kgm²	0,011	0,014	0,017
Moment of inertia for rotor type 2N [7]				0,011	0,014	0,017
Torque constant at 20° C		K_{M_N}	Nm/A	0,61	0,62	0,96
Voltage constant at 20°C [4]		K_{EMK_1000}	V/min^{-1}	51	46	74
Winding resistance at 20°C		R_{12}	Ohm	0,23	0,2	0,11
Winding inductivity	longitudinal	L_d	mH	0,81	0,61	0,45
	across	L_q	mH	2,52	1,9	0,8
Thermal time constant		T_{th}	min	4,2	3,7	7
Mass	Rotor [6]	m_{rot}	kg	4,2	6,5	8,3
	Stator	m_{stat}	kg	9,6	16	25,7
permissible ambient temperature		T_{um}	°C	0...+40		
permissible storage and transport temperature		T_{lager}	°C	-20...+80		
Insulation class				F		
Motor protection class according to IEC60050-411				IP00		
Number of pole pairs		p		4		
Liquid cooling						
Rated power loss		P_{V_H2O}	kW	2,7	2,5	1,9
Coolant inlet temperature [5]		T_{ein}	°C	+10...+40		
Coolant temperature rise at P_V [5]		ΔT_{diff}	K	10		
necessary coolant flow at ΔT_{diff} [5]		Q_{min_H2O}	l/min	4	4	4
Pressure drop at Q_{min}		Δp_{diff}	bar	1,4	1,9	1,4

Description	Symbol	Unit	Size 142		
Motor data 1)					
Frame length			**B**	**D**	**F**
Permissible inlet pressure	p_{max}	bar	5		
Volume of coolant duct	V_{kuehl}	l	0,028	0,036	0,043

1) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

2) The achievable maximum torque depends on the drive controller used.

3) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

4) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

5) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

6) Values for rotor design "1N" with biggest available internal rotor diameter.

7) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-7: Technical data size 142 (preliminary)

4.2.3 Data Sheet Size 162

Description		Symbol	Unit	Size 162			
Motor data 1)							
Frame length				**B**	**D**	**F**	**J**
Winding code				0400	0400	0310	0200
Rated torque		M_N	Nm	50	70	90	120
Rated speed		n_N	min^{-1}	4000	4000	3100	2000
Rated power		P_N	KW	20,9	29,3	29,2	25,1
Rated current		I_N	A	42	64	64	64
Maximum torque 2)		M_{max}	Nm	115	160	200	275
Maximum current		I_{max}	A	110	170	170	170
Maximum speed		n_{max}	min^{-1}	16000	16000	12400	8000
Required power wire cross section 3)		A	mm²	10	16	16	16
Moment of inertia for rotor type 1N 6)		J_{rot}	kgm²	0,014	0,018	0,022	0,028
Moment of inertia for rotor type 2N 7)				0,016	0,02	0,024	0,03
Torque constant at 20° C		K_{M_N}	Nm/A	1,03	1,09	1,41	1,875
Voltage constant at 20°C 4)		K_{EMK_1000}	V/min^{-1}	90	90	110	160
Winding resistance at 20°C		R_{12}	Ohm	0,24	0,15	0,18	0,46
Winding inductivity	longitudinal	L_d	mH	1,04	1,04	1,1	2
	across	L_q	mH	3,12	2,68	3,28	5,8
Thermal time constant		T_{th}	min	i.p.	i.p.	i.p.	i.p.
Mass	Rotor 6)	m_{rot}	kg	6,9	8,8	10,6	13,4
	Stator	m_{stat}	kg	22	28,1	34,1	46,1
permissible ambient temperature		T_{um}	°C	0...+40			
permissible storage and transport temperature		T_{lager}	°C	-20...+80			
Insulation class				F			
Motor protection class according to IEC60050-411				IP00			
Number of pole pairs		p		4			
Liquid cooling							
Rated power loss		P_{V_H2O}	kW	0,55	0,9	1,1	1,5
Coolant inlet temperature 5)		T_{ein}	°C	+10...+40			
Coolant temperature rise at P_V 5)		ΔT_{diff}	K	10			
necessary coolant flow at ΔT_{diff} 5)		Q_{min_H2O}	l/min	2	3	3	4
Pressure drop at Q_{min}		Δp_{diff}	bar	1,6			

Description	Symbol	Unit	Size 162			
Motor data [1]						
Frame length			B	D	F	J
Permissible inlet pressure	p_{max}	bar	5			
Volume of coolant duct	V_{kuehl}	l	0,056	0,071	0,086	0,109

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-8: Technical data size 162

Technical Data

4.2.4 Data Sheet Size 182

Description		Symbol	Unit	Size 182				
Motor data [1]								
Frame length				A		B	D	F
Winding code				0100	0250	0280	0260	0200
Rated torque		M_N	Nm	12		100	140	200
Rated speed		n_N	min^{-1}	1000	2500	2800	2600	2000
Rated power		P_N	KW	1,25	3,1	29,3	38,1	41,9
Rated current		I_N	A	3,7	5	64	71	71
Maximum torque [2]		M_{max}	Nm	30	30	230	320	450
Maximum current		I_{max}	A	11	15	170	200	200
Maximum speed		n_{max}	min^{-1}	4000	10000	11200	10400	8000
Required power wire cross section [3]		A	mm²	1,5	1,5	10	25	25
Moment of inertia for rotor type 1N [6]		J_{rot}	kgm²	0,009		0,031	0,039	0,053
Moment of inertia for rotor type 2N [7]				0,01		0,035	0,043	0,059
Torque constant at 20° C		K_{M_N}	Nm/A	3,02	2,3	1,56	1,97	2,82
Voltage constant at 20°C [4]		$K_{EMK1000}$	V/min^{-1}	297	141	113	130	160
Winding resistance at 20°C		R_{12}	Ohm	15,47	4,1	0,17	0,15	0,21
Winding inductivity	longitudinal	L_d	mH	56,34	15,08	1	1	1,1
	across	L_q	mH	127,9	34,07	3,6	2,6	3,7
Thermal time constant		T_{th}	min	9,4	7,9	i.p.	i.p.	i.p.
Mass	Rotor [6]	m_{rot}	kg	2,7		9,6	11,8	21,3
	Stator	m_{stat}	kg	6,9		32,1	38,9	52,6
permissible ambient temperature		T_{um}	°C	0...+40				
permissible storage and transport temperature		T_{lager}	°C	-20...+80				
Insulation class				F				
Motor protection class according to IEC60050-411				IP00				
Number of pole pairs		p		4				
Liquid cooling								
Rated power loss		P_{V_H2O}	kW	0,27	0,47	1,05	1,1	1,5
Coolant inlet temperature [5]		T_{ein}	°C	+10...+40				
Coolant temperature rise at P_V [5]		ΔT_{diff}	K	10				
necessary coolant flow at ΔT_{diff} [5]		Q_{min_H2O}	l/min	3				4
Pressure drop at Q_{min}		Δp_{diff}	bar	0,36	0,2	1,6	1,6	1,6

Description	Symbol	Unit	Size 182			
Motor data [1])						
Frame length			A	B	D	F
Permissible inlet pressure	p_{max}	br	5			
Volume of coolant duct	V_{kuehl}	l	0,019	0,065	0,08	0,11

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-9: Technical data size 182

Technical Data

4.2.5 Data Sheet Size 202

Description		Symbol	Unit	Size 202				
Motor data [1]								
Frame length				A	B		D	F
Winding code				0200	0150	0210	0170	0120
Rated torque		M_N	Nm	105	140		175	245
Rated speed		n_N	min^{-1}	2000	1500	2100	1700	1200
Rated power		P_N	KW	22	22	30,8	31,2	30,8
Rated current		I_N	A	45	52	68	68	68
Maximum torque [2]		M_{max}	Nm	270	390	390	480	650
Maximum current		I_{max}	A	130	141	180	180	180
Maximum speed		n_{max}	min^{-1}	8000	6000	8400	6800	4800
Required power wire cross section [3]		A	mm²	10	10	16	16	16
Moment of inertia for rotor type 1N [6]		J_{rot}	kgm²	0,05	0,064		0,077	0,104
Moment of inertia for rotor type 2N [7]				0,055	0,07		0,084	0,114
Torque constant at 20° C		K_{M_N}	Nm/A	2,3	2,69	2,06	2,57	3,6
Voltage constant at 20°C [4]		K_{EMK_1000}	V/min^{-1}	156	250	170	185	260
Winding resistance at 20°C		R_{12}	Ohm	0,48	0,38	0,19	0,23	0,31
Winding inductivity	longitudinal	L_d	mH	1,7	2,2	1,1	1,5	1,3
	across	L_q	mH	5	6,6	3,2	4,4	3,6
Thermal time constant		T_{th}	min	i.p.	i.p.	i.p.	i.p.	i.p.
Mass	Rotor [6]	m_{rot}	kg	12,8	16,2		19,6	26,9
	Stator	m_{stat}	kg	25	40,7		48,3	63,7
permissible ambient temperature		T_{um}	°C	0...+40				
permissible storage and transport temperature		T_{lager}	°C	-20...+80				
Insulation class				F				
Motor protection class according to IEC60050-411				IP00				
Number of pole pairs		p		5				
Liquid cooling								
Rated power loss		P_{V_H2O}	kW	1,18	1,3		1,6	2,1
Coolant inlet temperature [5]		T_{ein}	°C	+10...+40				
Coolant temperature rise at P_V [5]		ΔT_{diff}	K	10				
required coolant flow at ΔT_{diff} [5]		Q_{min_H2O}	l/min	3	3		4	4
Pressure drop at Q_{min}		Δp_{diff}	bar	1,6				
Permissible inlet pressure		p_{max}	bar	5				

Description	Symbol	Unit	Size 202			
Motor data [1]						
Frame length			A	B	D	F
Volume of coolant duct	V_{kuehl}	l	0,051	0,063	0,076	0,101

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-10: Technical data size 202

4.2.6 Data Sheet Size 242

Description		Symbol	Unit	Size 242		
Motor data [1]						
Frame length				B	D	F
Winding code				0100	0070	0060
Rated torque		M_N	Nm	250	375	425
Rated speed		n_N	min^{-1}	1000	700	600
Rated power		P_N	KW	26,2	27,5	26,7
Rated current		I_N	A	68	49,5	68
Maximum torque [2]		M_{max}	Nm	575	860	970
Maximum current		I_{max}	A	180	180	180
Maximum speed		n_{max}	min^{-1}	4000	2800	2400
Required power wire cross section [3]		A	mm²	16	16	16
Moment of inertia for rotor type 1N [6]		J_{rot}	kgm²	0,119	0,167	0,193
Moment of inertia for rotor type 2N [7]				0,128	0,18	0,207
Torque constant at 20° C		K_{M_N}	Nm/A	3,68	7,17	6,25
Voltage constant at 20°C [4]		K_{EMK_1000}	V/min^{-1}	310	454	570
Winding resistance at 20°C		R_{12}	Ohm	0,65	0,48	0,41
Winding inductivity	longitudinal	L_d	mH	4,5	8,2	3
	across	L_q	mH	8,8	14,3	13,3
Thermal time constant		T_{th}	min	7,3	7,3	7,3
Mass	Rotor [6]	m_{rot}	kg	22,5	31,7	36,5
	Stator	m_{stat}	kg	66,7	92,3	105,1
permissible ambient temperature		T_{um}	°C	0...+40		
permissible storage and transport temperature		T_{lager}	°C	-20...+80		
Insulation class				F		
Motor protection class according to IEC60050-411				IP00		
Number of pole pairs		p		5		
Liquid cooling						
Rated power loss		P_{V_H2O}	kW	2,3	3,3	3,8
Coolant inlet temperature [5]		T_{ein}	°C	+10...+40		
Coolant temperature rise at P_V [5]		ΔT_{diff}	K	10		
necessary coolant flow at ΔT_{diff} [5]		Q_{min_H2O}	l/min	4	5	6
Pressure drop at Q_{min}		Δp_{diff}	bar	1,2		

Description	Symbol	Unit	Size 242		
Motor data [1])					
Frame length			**B**	**D**	**F**
Permissible inlet pressure	p_{max}	bar	5		
Volume of coolant duct	V_{kuehl}	l	0,076	0,107	0,122

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-11: Technical data size 242

4.2.7 Data Sheet Size 272

Description		Symbol	Unit	Size 272			
Motor data [1]							
Frame length				B		D	F
Winding code				0065	0080	0050	0040
Rated torque		M_N	Nm	400		525	650
Rated speed		n_N	min^{-1}	650	800	500	400
Rated power		P_N	KW	27,2	33,5	27,5	27,2
Rated current		I_N	A	71	82	71	71
Maximum torque [2]		M_{max}	Nm	900		1200	1500
Maximum current		I_{max}	A	200	250	200	200
Maximum speed		n_{max}	min^{-1}	2600	3200	2000	1600
Required power wire cross section [3]		A	mm²	25	25	25	25
Moment of inertia for rotor type 1N [6]		J_{rot}	kgm²	0,268		0,335	0,403
Moment of inertia for rotor type 2N [7]				0,287		0,36	0,433
Torque constant at 20° C		K_{M_N}	Nm/A	5,63	4,88	7,39	9,15
Voltage constant at 20°C [4]		K_{EMK_1000}	V/min^{-1}	520	465	620	775
Winding resistance at 20°C		R_{12}	Ohm	0,3	0,23	0,37	0,5
Winding inductivity	longitudinal	L_d	mH	2	1,5	4	4,4
	across	L_q	mH	10,2	7,8	13,5	16,9
Thermal time constant		T_{th}	min	i.p.	i.p.	i.p.	i.p.
Mass	Rotor [6]	m_{rot}	kg	35,5	35,5	44,5	53,5
	Stator	m_{stat}	kg	90,4		112,3	134,2
permissible ambient temperature		T_{um}	°C	0...+40			
permissible storage and transport temperature		T_{lager}	°C	-20...+80			
Insulation class				F			
Motor protection class according to IEC60050-411				IP00			
Number of pole pairs		p		6			
Liquid cooling							
Rated power loss		P_{V_H2O}	kW	3,8		4,5	4,9
Coolant inlet temperature [5]		T_{ein}	°C	+10...+40			
Coolant temperature rise at P_V [5]		ΔT_{diff}	K	10			
necessary coolant flow at ΔT_{diff} [5]		Q_{min_H2O}	l/min	6		7	7
Pressure drop at Q_{min}		Δp_{diff}	bar	1,2			

Description	Symbol	Unit	Size 272		
Motor data [1])					
Frame length			B	D	F
Permissible inlet pressure	p_{max}	bar	5		
Volume of coolant duct	V_{kuehl}	l	0,075	0,091	0,108

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-12: Technical data size 272

Technical Data

4.2.8 Data Sheet Size 312

Description		Symbol	Unit	Size 312					
Motor data [1])									
Frame length				B	D		F	H	
Winding code				0035	0028	0060	0028	0025	0085
Rated torque		M_N	Nm	650	820		975	1125	1100
Rated speed		n_N	min^{-1}	350	280	600	280	250	850
Rated power		P_N	KW	23,8	24	51,5	28,6	29,5	97,9
Rated current		I_N	A	62,5	59,5	93,2	62	62	197
Maximum torque [2])		M_{max}	Nm	1550	1950		2275	2750	
Maximum current		I_{max}	A	170	160	250	180	180	570
Maximum speed		n_{max}	min^{-1}	1400	1120	2400	1120	1000	3400
Required power wire cross section [3])		A	mm²	16	16	2x16	16	16	2x50
Moment of inertia for rotor type 1N [6])		J_{rot}	kgm²	0,617	0,751		0,885	1,064	
Moment of inertia for rotor type 2N [7])				0,664	0,809		0,953	1,146	
Torque constant at 20° C		K_{M_N}	Nm/A	10,48	12,62	8,8	15,72	20,5	5,6
Voltage constant at 20°C [4])		K_{EMK_1000}	V/min^{-1}	686	926	432	930	1250	375
Winding resistance at 20°C		R_{12}	Ohm	0,5	0,77	0,29	0,59	0,95	0,07
Winding inductivity	longitudinal	L_d	mH	5,48	8,25	3,2	15	20,8	1,8
	across	L_q	mH	11,27	10,4	7,8	18,8	26	2,25
Thermal time constant		T_{th}	min	7,5	7,8		7,8	8	
Mass	Rotor [6])	m_{rot}	kg	55	67,4		79,5	95,6	
	Stator	m_{stat}	kg	128,7	154,1		179,5	215	
permissible ambient temperature		T_{um}	°C	0...+40					
permissible storage and transport temperature		T_{lager}	°C	-20...+80					
Insulation class				F					
Motor protection class according to IEC60050-411				IP00					
Number of pole pairs		p		7					
Liquid cooling									
Rated power loss		P_V	kW	4,1	5	5,2	5,3	5,6	6
Coolant inlet temperature [5])		T_{ein}	°C	+10...+40					
Coolant temperature rise at P_V [5])		ΔT_{diff}	K	10					
necessary coolant flow at ΔT_{diff} [5])		Q_{min}	l/min	7	7,3	7,6	7,7	8,3	8,7
Pressure drop at Q_{min}		Δp_{diff}	bar	0,5					

Description	Symbol	Unit	Size 312			
Motor data [1]						
Frame length			B	D	F	H
Permissible inlet pressure	p_{max}	bar	5			
Volume of coolant duct	V_{kuehl}	l	0,126	0,152	0,179	0,207

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-13: Technical data size 312

4.2.9 Data Sheet Size 382

Description		Symbol	Unit	Size 382		
Motor data 1)						
Frame length				B	D	F
Winding code				0025	0020	0018
Rated torque		M_N	Nm	1375	1775	2170
Rated speed		n_N	min^{-1}	250	200	180
Rated power		P_N	KW	36	37,2	40,9
Rated current		I_N	A	85	101	83,6
Maximum torque 2)		M_{max}	Nm	2875	3700	4500
Maximum current		I_{max}	A	250	250	250
Maximum speed		n_{max}	min^{-1}	1000	800	720
Required power wire cross section 3)		A	mm²	25	2x16	25
Moment of inertia for rotor type 1N 6)		J_{rot}	kgm²	1,525	1,911	2,296
Moment of inertia for rotor type 2N 7)				1,682	2,108	2,533
Torque constant at 20° C		K_{M_N}	Nm/A	16,18	17,57	26,15
Voltage constant at 20°C 4)		K_{EMK_1000}	V/min^{-1}	1250	1250	1842
Winding resistance at 20°C		R_{12}	Ohm	0,48	0,46	0,9
Winding inductivity	longitudinal	L_d	mH	6,1	5,48	13
	across	L_q	mH	19,8	10,28	17,5
Thermal time constant		T_{th}	min	9,8	6,6	8,7
Mass	Rotor 6)	m_{rot}	kg	77,6	97,2	120
	Stator	m_{stat}	kg	178,5	142,7	262
permissible ambient temperature		T_{um}	°C	0...+40		
permissible storage and transport temperature		T_{lager}	°C	-20...+80		
Insulation class				F		
Motor protection class according to IEC60050-411				IP00		
Number of pole pairs		p		9		
Liquid cooling						
Rated power loss		P_{V_H2O}	kW	6,4	9,4	10
Coolant inlet temperature 5)		T_{ein}	°C	+10...+40		
Coolant temperature rise at P_V 5)		ΔT_{diff}	K	10		
necessary coolant flow at ΔT_{diff} 5)		Q_{min_H2O}	l/min	9,2	13,5	14,4
Pressure drop at Q_{min}		Δp_{diff}	bar	1		

Description	Symbol	Unit	Size 382		
Motor data [1]					
Frame length			B	D	F
Permissible inlet pressure	p_{max}	bar	5		
Volume of coolant duct	V_{kuehl}	l	0,73	0,91	1,09

i.p. = in preparation.

[1]) The determined values are root mean square values according to IEC 60034-1, if not otherwise indicated. Reference value 540 V_{DC}.

[2]) The achievable maximum torque depends on the drive controller used.

[3]) Note the explanations on the power wire cross section in the section "Power wire cross section" on page 18. For notes regarding the cable harness on the motor see chapter 8.2 "Power Connection" on page 120.

[4]) EMV = electromagnetic force. Root mean square applying to 1000 min^{-1}.

[5]) The data refers to operation with liquid cooling, cooling medium water. For additional notes regarding the coolant inlet temperature see chapter 9.6.3 "Coolant Inlet Temperature " on page 136.

[6]) Values for rotor design "1N" with biggest available internal rotor diameter.

[7]) Values for rotor design "2N" with biggest available internal rotor diameter.

Fig.4-14: Technical data size 382

5 Dimensional Sheets IndraDyn H

5.1 For your Orientation:

The dimensioned drawings in this chapter are combined according to the sizes. The drawings for each size always follow in this order:

- Dimension sheet of the complete motor with axial cooling connection and rotor design "1N".
- Dimension sheet of the complete motor with axial cooling connection and rotor design "2N".
- Dimension sheet of the complete motor with radial cooling connection and rotor design "1N" (only for sizes 182 and 312)
- Dimension sheet of the complete motor with radial cooling connection and rotor design "2N" (only for sizes 182 and 312)
- Single part drawing of the stator with axial cooling connection
- Single part drawing of the stator with radial cooling connection (only for size 182)
- Single part drawing of the rotor in design "1N"
- Single part drawing of the rotor in design "2N"

The dimensions and tolerances shown in the drawings underlie the following standards:

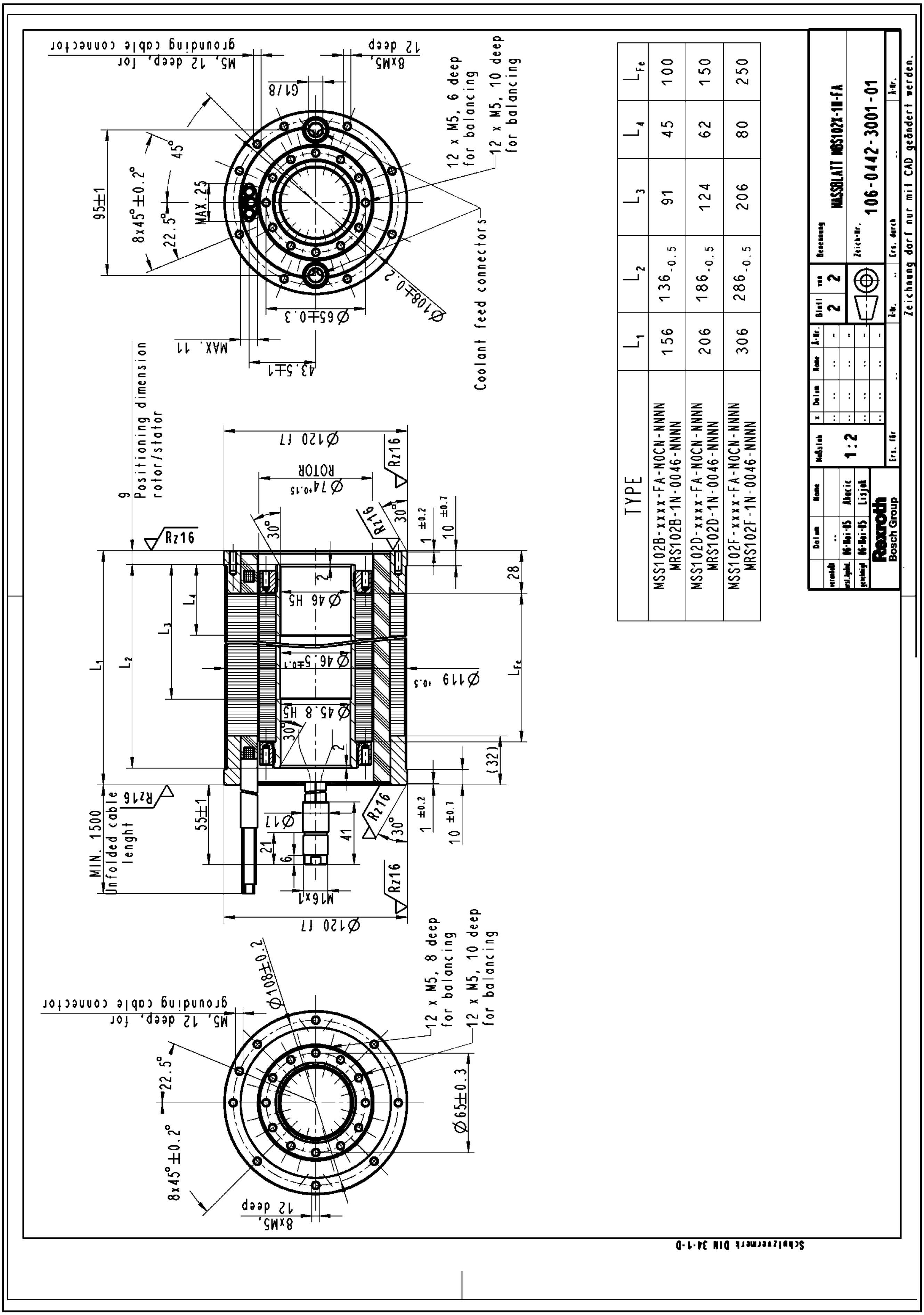
Longitudinal dimensions: DIN ISO 2768, part 1

Angular dimension: DIN 7168, avg.

Form and position tolerance: DIN ISO 1101

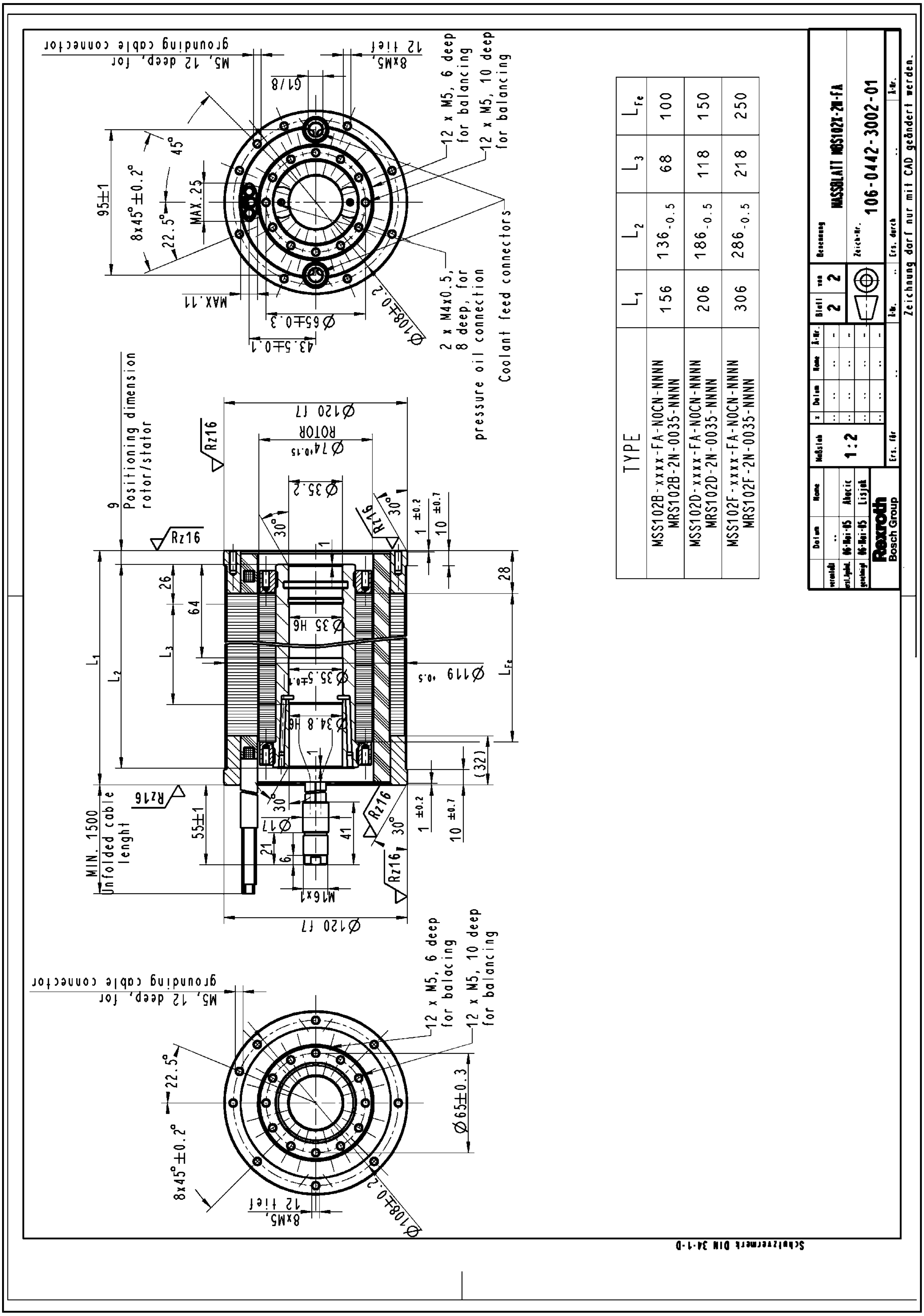
5.2 Size 102

5.2.1 MBS102 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS102B-xxxx-FA-N0CN-NNNN MRS102B-1N-0046-NNNN	156	$136_{-0.5}$	91	45	100
MSS102D-xxxx-FA-N0CN-NNNN MRS102D-1N-0046-NNNN	206	$186_{-0.5}$	124	62	150
MSS102F-xxxx-FA-N0CN-NNNN MRS102F-1N-0046-NNNN	306	$286_{-0.5}$	206	80	250

5.2.2 MBS102 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}
MSS102B-xxxx-FA-NOCN-NNNN MRS102B-2N-0035-NNNN	156	$136_{-0.5}$	68	100
MSS102D-xxxx-FA-NOCN-NNNN MRS102D-2N-0035-NNNN	206	$186_{-0.5}$	118	150
MSS102F-xxxx-FA-NOCN-NNNN MRS102F-2N-0035-NNNN	306	$286_{-0.5}$	218	250

Fig.5-2: MBS102 with axial cooling connection and rotor design "2N"

5.2.3 MSS102, Axial Cooling Connection

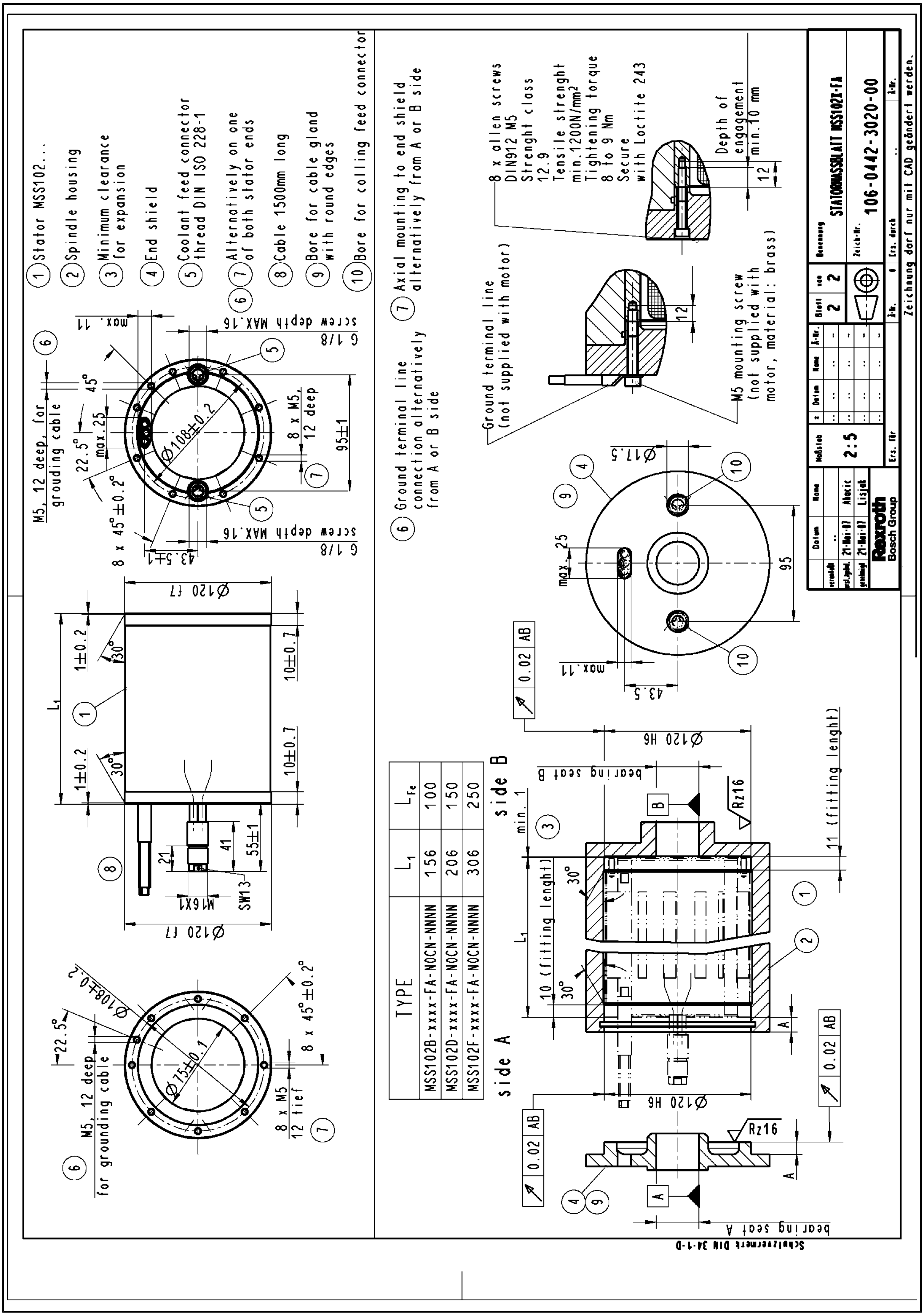
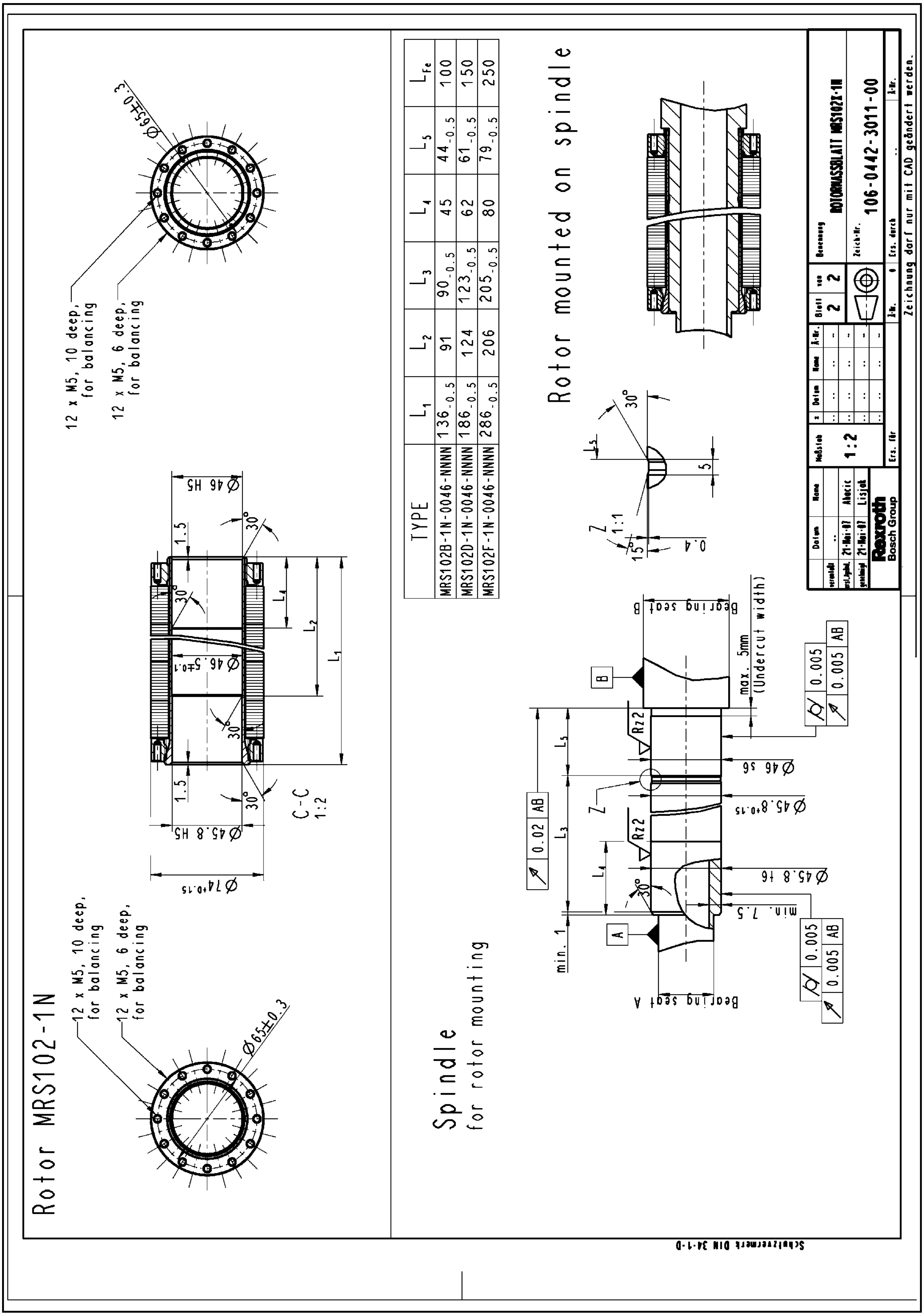


Fig.5-3: MSS102 with axial cooling connection

5.2.4 MRS102 with "1N" Design (Smooth Hole)



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MRS102B-1N-0046-NNNN	$136_{-0.5}$	91	$90_{-0.5}$	45	$44_{-0.5}$	100
MRS102D-1N-0046-NNNN	$186_{-0.5}$	124	$123_{-0.5}$	62	$61_{-0.5}$	150
MRS102F-1N-0046-NNNN	$286_{-0.5}$	206	$205_{-0.5}$	80	$79_{-0.5}$	250

Fig.5-4: MRS102 in "1N" design

Dimensional Sheets IndraDyn H

5.2.5 MRS102 with "2N" Design (Step Interference Fit)

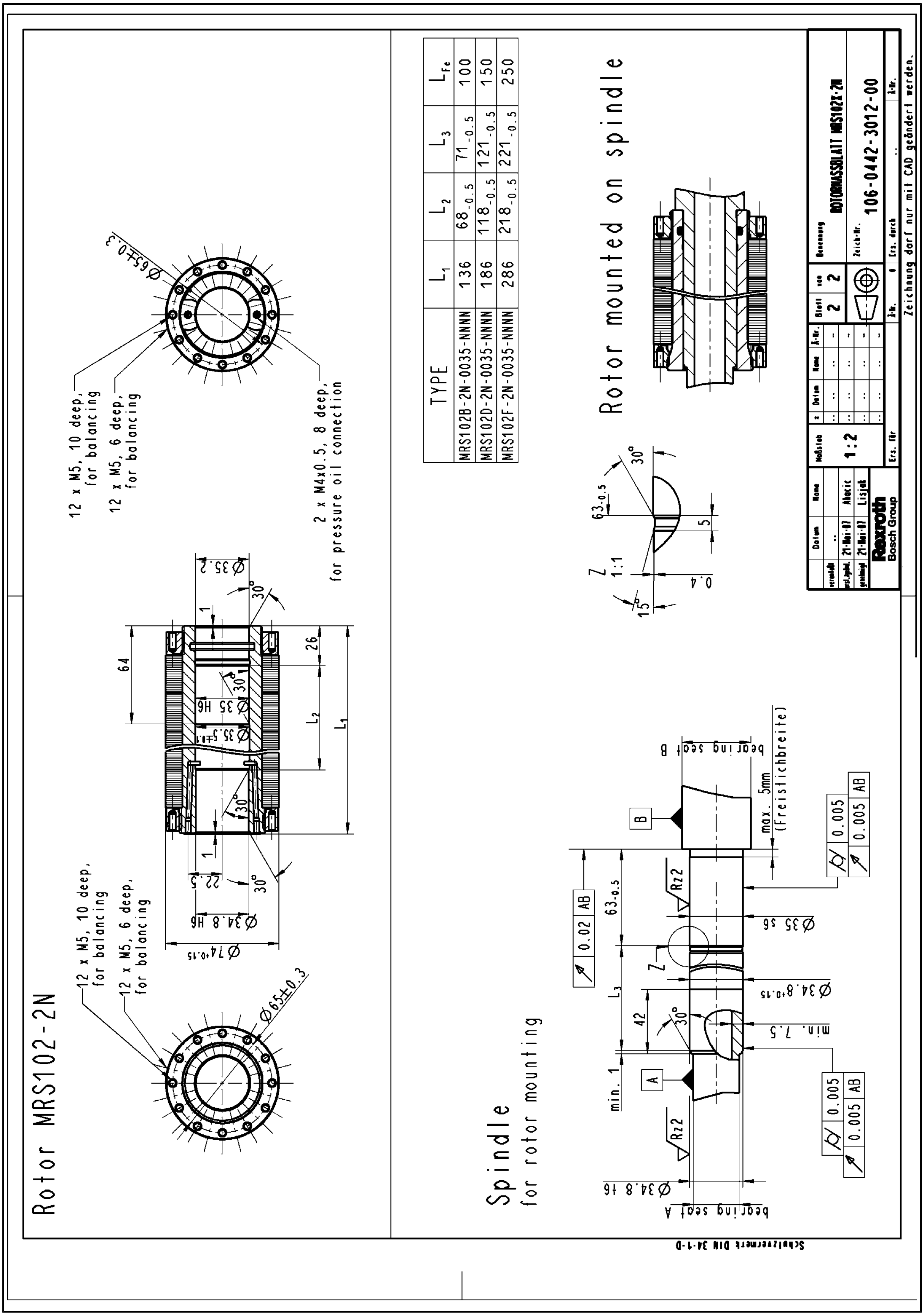
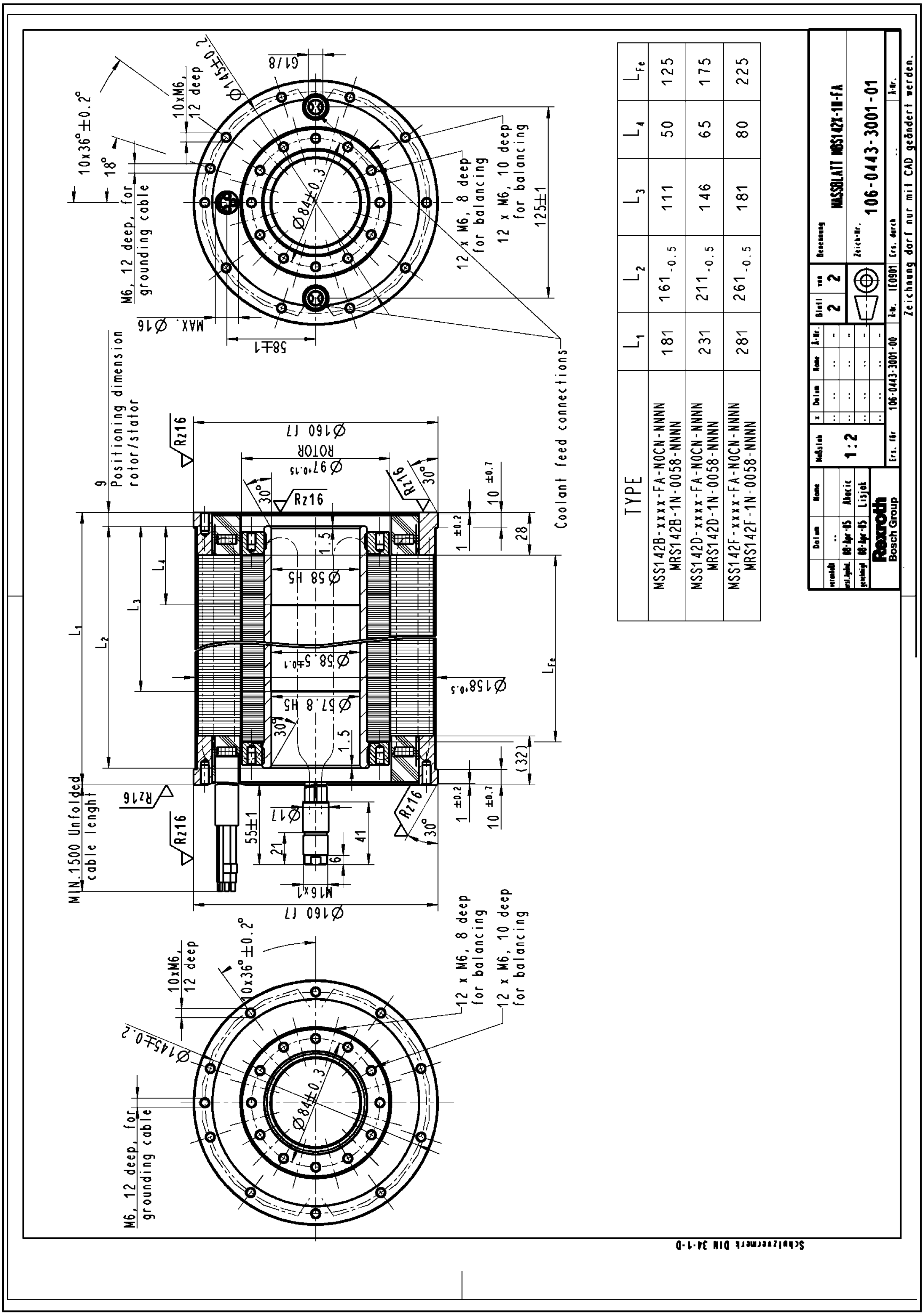


Fig.5-5: MRS102 in "2N" design

5.3 Size 142

5.3.1 MBS142 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS142B-xxxx-FA-N0CN-NNNN MRS142B-1N-0058-NNNN	181	$161_{-0.5}$	111	50	125
MSS142D-xxxx-FA-N0CN-NNNN MRS142D-1N-0058-NNNN	231	$211_{-0.5}$	146	65	175
MSS142F-xxxx-FA-N0CN-NNNN MRS142F-1N-0058-NNNN	281	$261_{-0.5}$	181	80	225

5.3.2 MBS142 with Axial Cooling Connection and Rotor Design "2N"

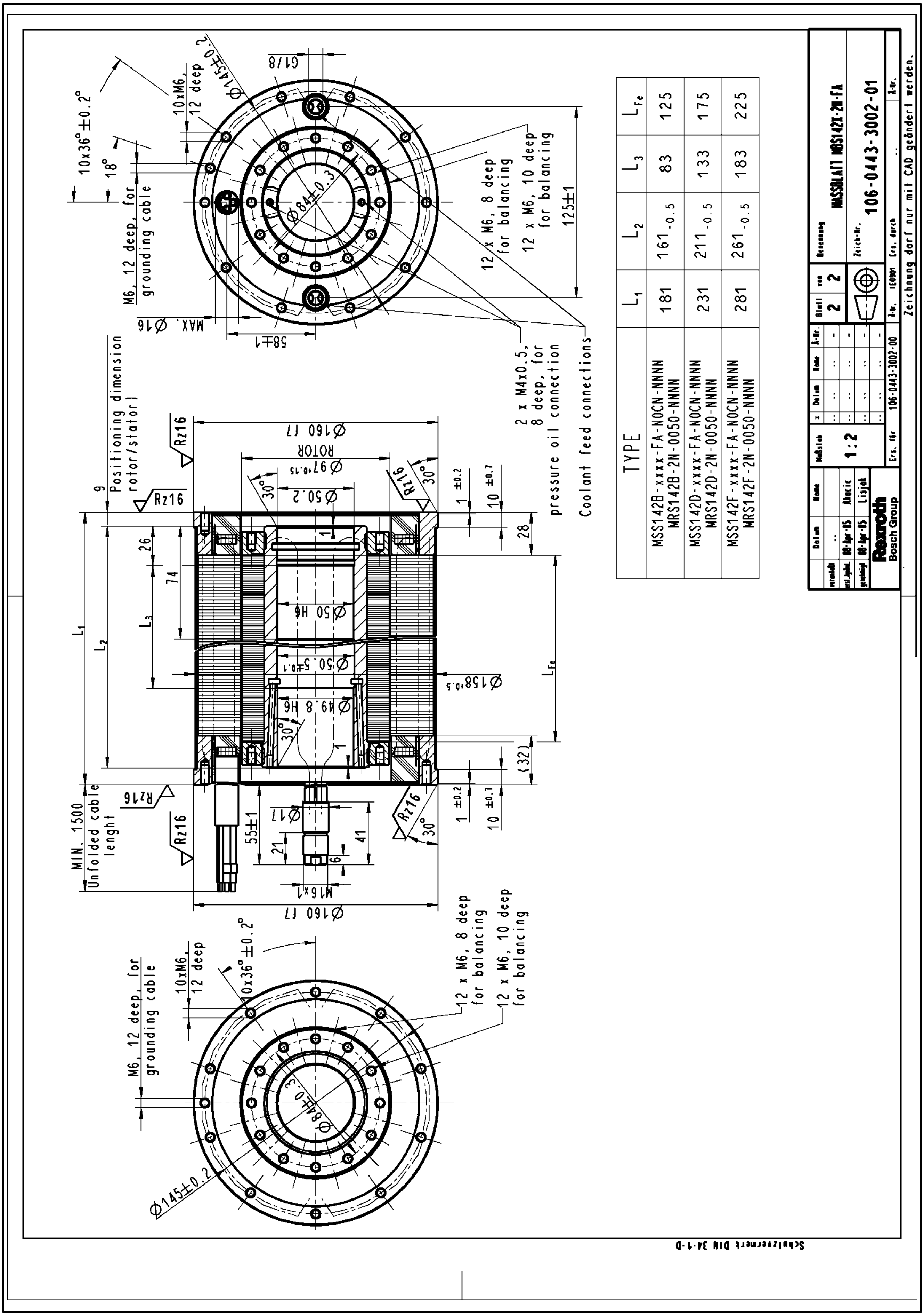


Fig.5-7: MBS142 with axial cooling connection and rotor design "2N"

5.3.3 MSS142, Axial Cooling Connection

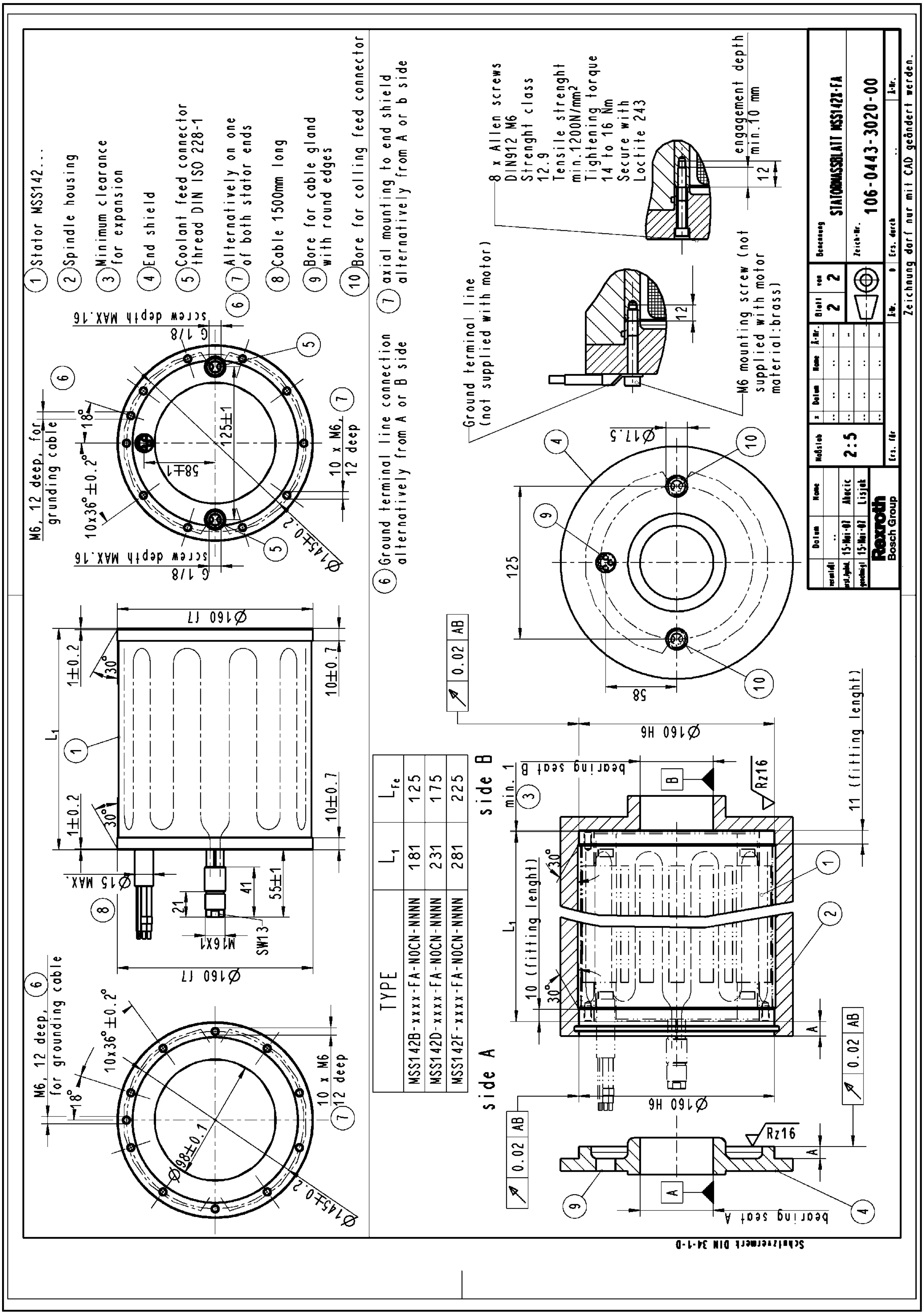
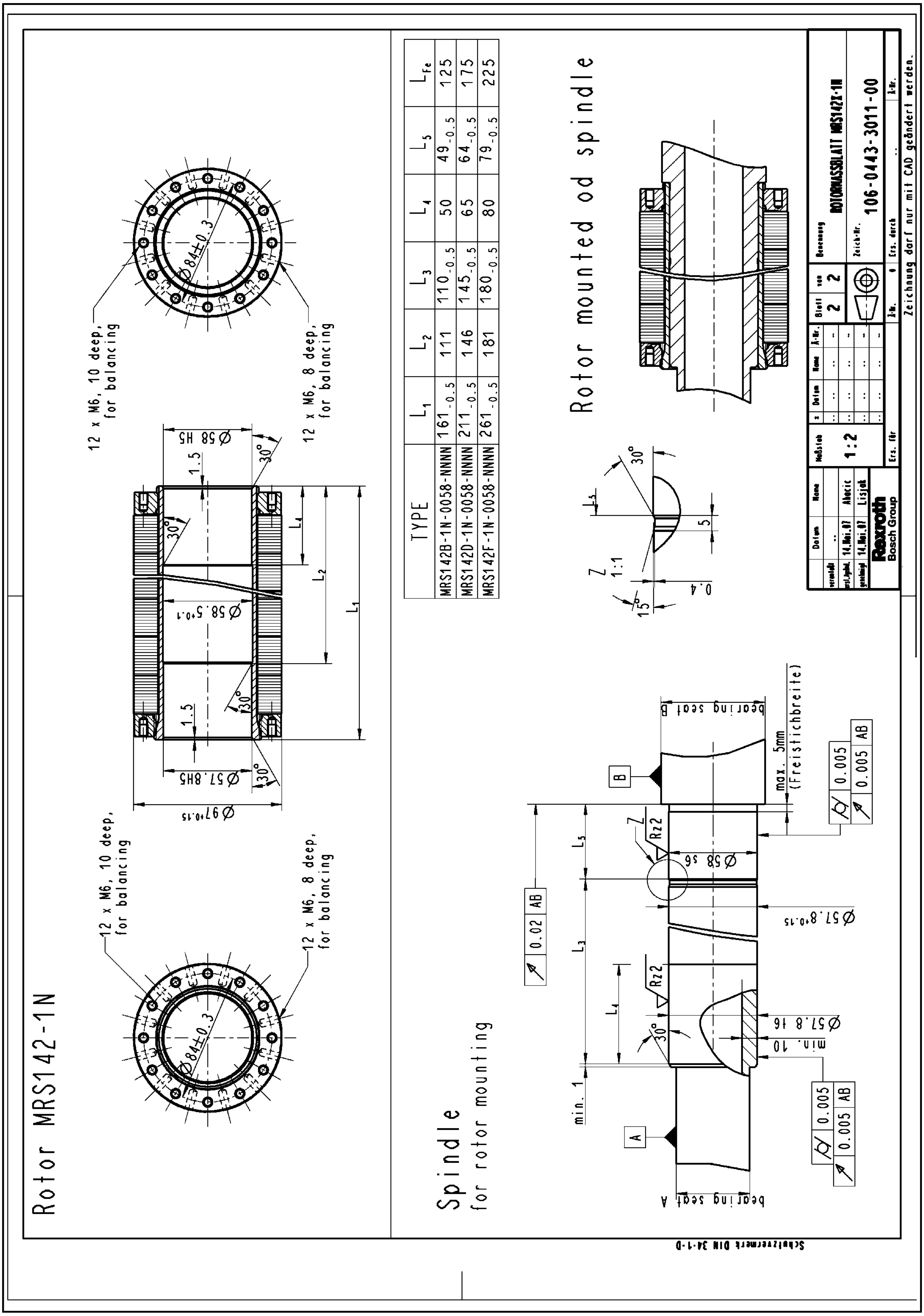


Fig.5-8: MSS142 with axial cooling connection

Dimensional Sheets IndraDyn H

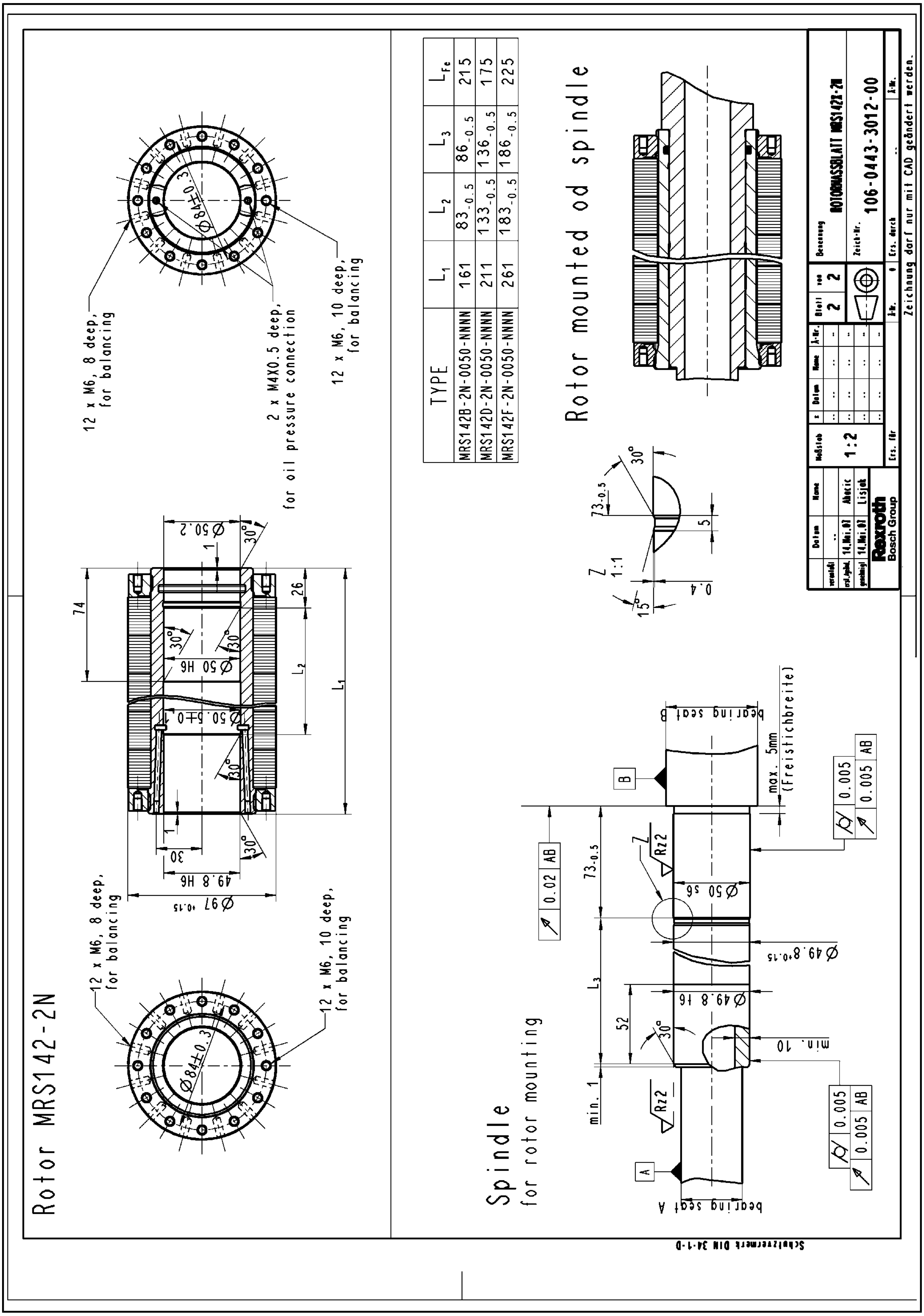
5.3.4 MRS142 with 1N Design (Smooth Hole)



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MRS142B-1N-0058-NNNN	$161_{-0.5}$	111	$110_{-0.5}$	50	$49_{-0.5}$	125
MRS142D-1N-0058-NNNN	$211_{-0.5}$	146	$145_{-0.5}$	65	$64_{-0.5}$	175
MRS142F-1N-0058-NNNN	$261_{-0.5}$	181	$180_{-0.5}$	80	$79_{-0.5}$	225

Fig.5-9: MRS142 in "1N" design

5.3.5 MRS142 with "2N" Design (Step Interference Fit)

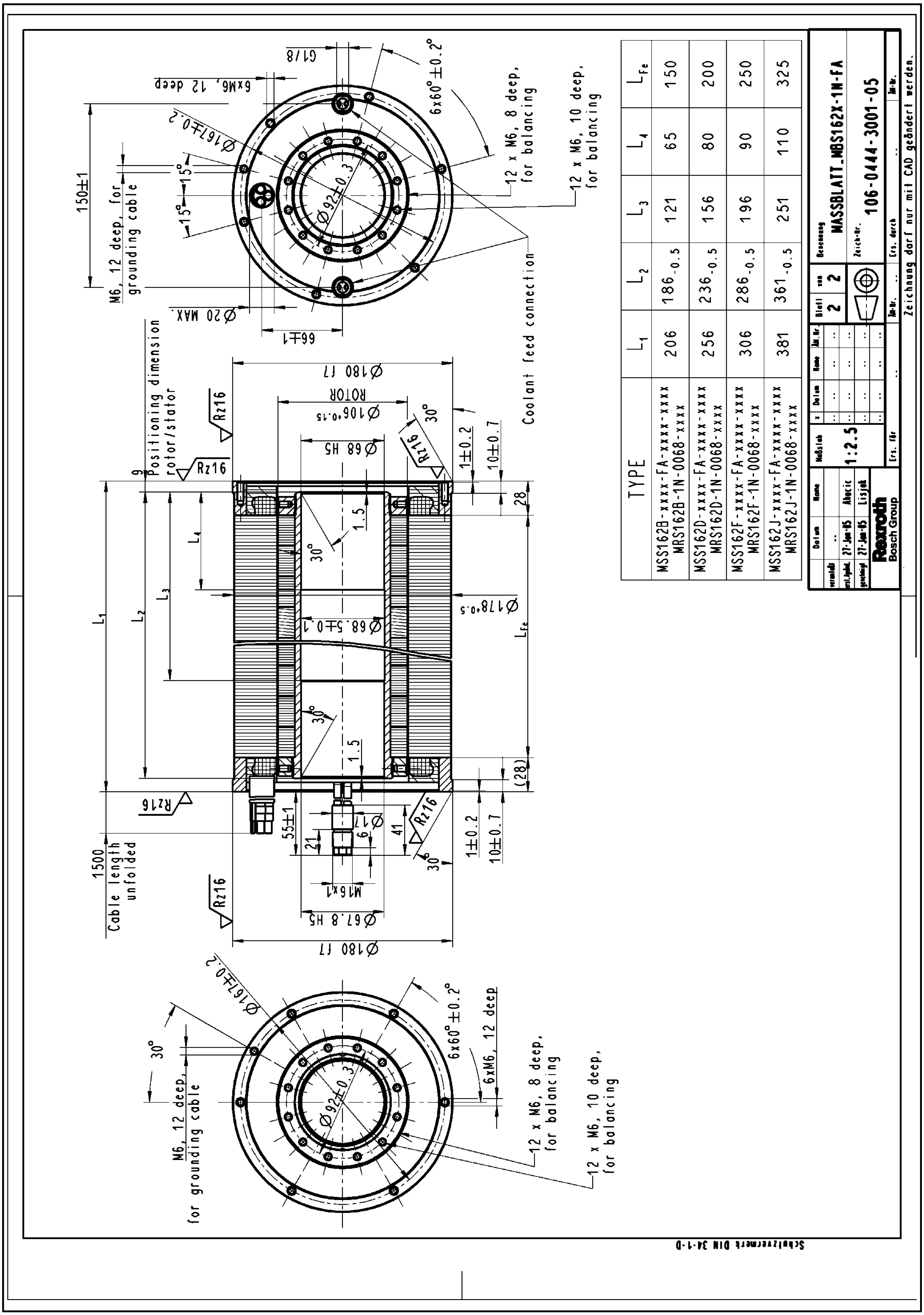


TYPE	L_1	L_2	L_3	L_{Fe}
MRS142B-2N-0050-NNNN	161	$83_{-0.5}$	$86_{-0.5}$	215
MRS142D-2N-0050-NNNN	211	$133_{-0.5}$	$136_{-0.5}$	175
MRS142F-2N-0050-NNNN	261	$183_{-0.5}$	$186_{-0.5}$	225

Fig.5-10: MRS142 in "2N" design

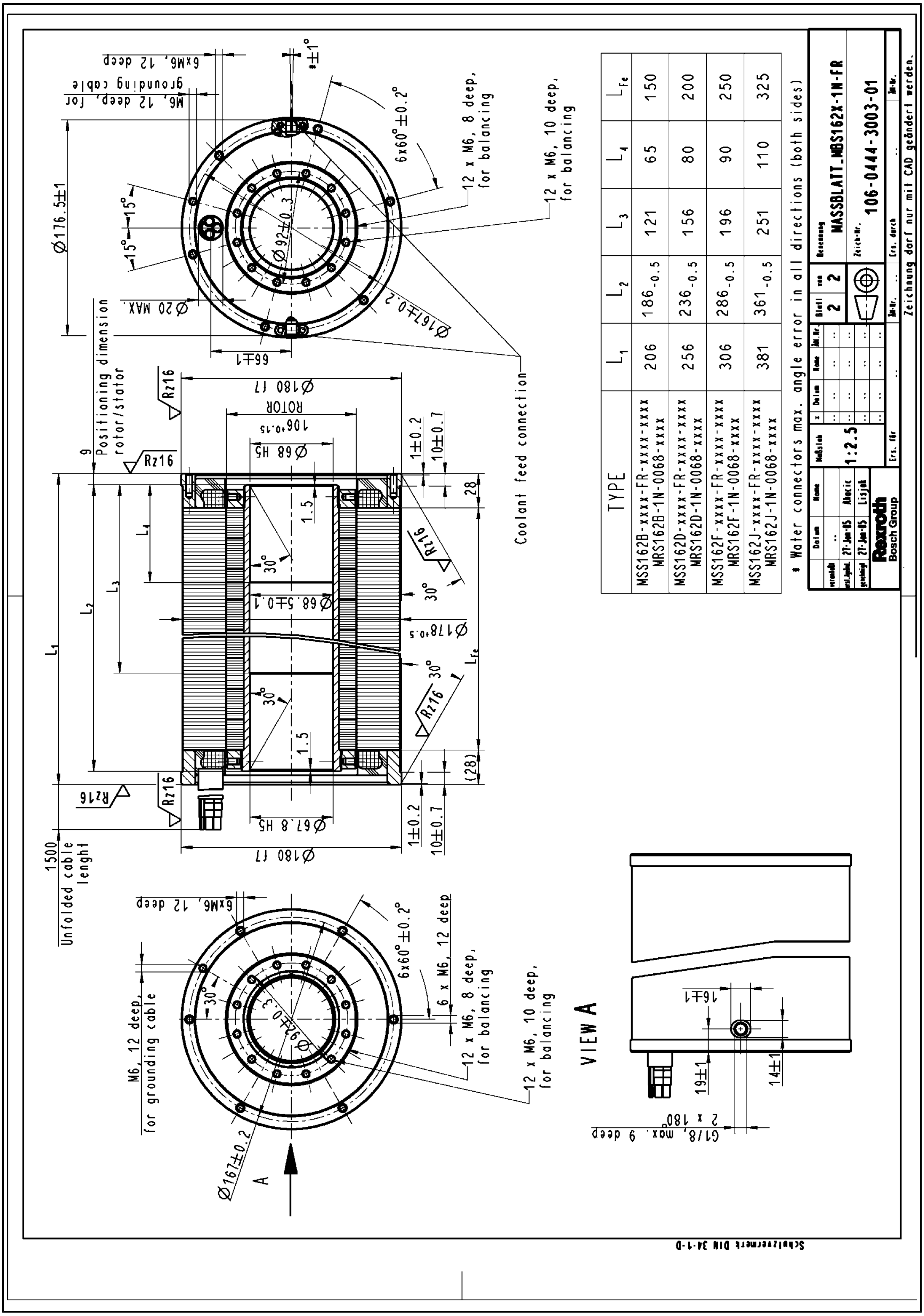
5.4 Size 162

5.4.1 MBS162 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS162B-xxxx-FA-xxxx-xxxx MRS162B-1N-0068-xxxx	206	$186_{-0.5}$	121	65	150
MSS162D-xxxx-FA-xxxx-xxxx MRS162D-1N-0068-xxxx	256	$236_{-0.5}$	156	80	200
MSS162F-xxxx-FA-xxxx-xxxx MRS162F-1N-0068-xxxx	306	$286_{-0.5}$	196	90	250
MSS162J-xxxx-FA-xxxx-xxxx MRS162J-1N-0068-xxxx	381	$361_{-0.5}$	251	110	325

5.4.2 MBS162 with Radial Cooling Connection and Rotor Design 1N

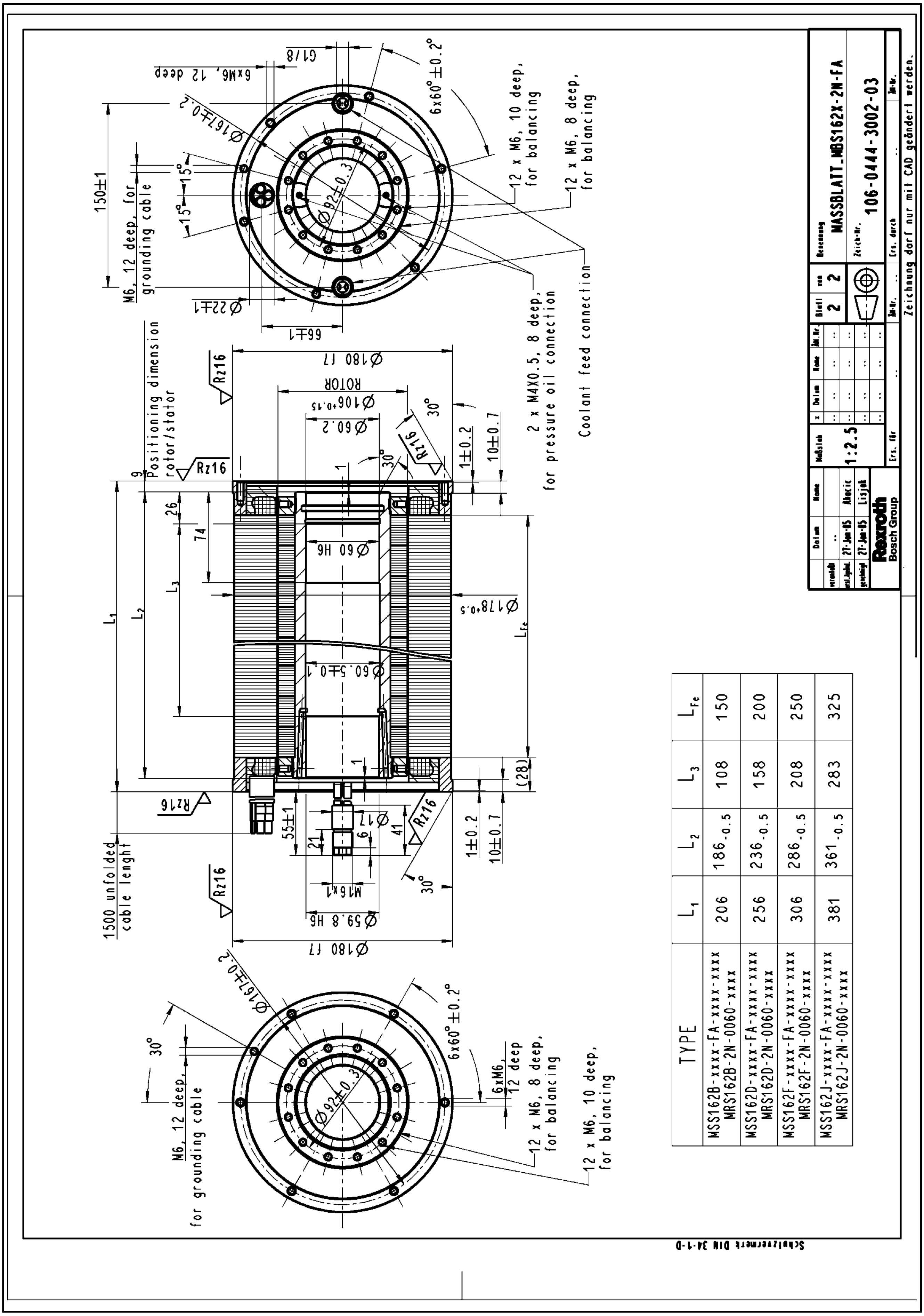


TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS162B-xxxx-FR-xxxx-xxxx MRS162B-1N-0068-xxxx	206	$186_{-0.5}$	121	65	150
MSS162D-xxxx-FR-xxxx-xxxx MRS162D-1N-0068-xxxx	256	$236_{-0.5}$	156	80	200
MSS162F-xxxx-FR-xxxx-xxxx MRS162F-1N-0068-xxxx	306	$286_{-0.5}$	196	90	250
MSS162J-xxxx-FR-xxxx-xxxx MRS162J-1N-0068-xxxx	381	$361_{-0.5}$	251	110	325

Fig.5-12: Size 162 with radial cooling connection and rotor design "1N"

Dimensional Sheets IndraDyn H

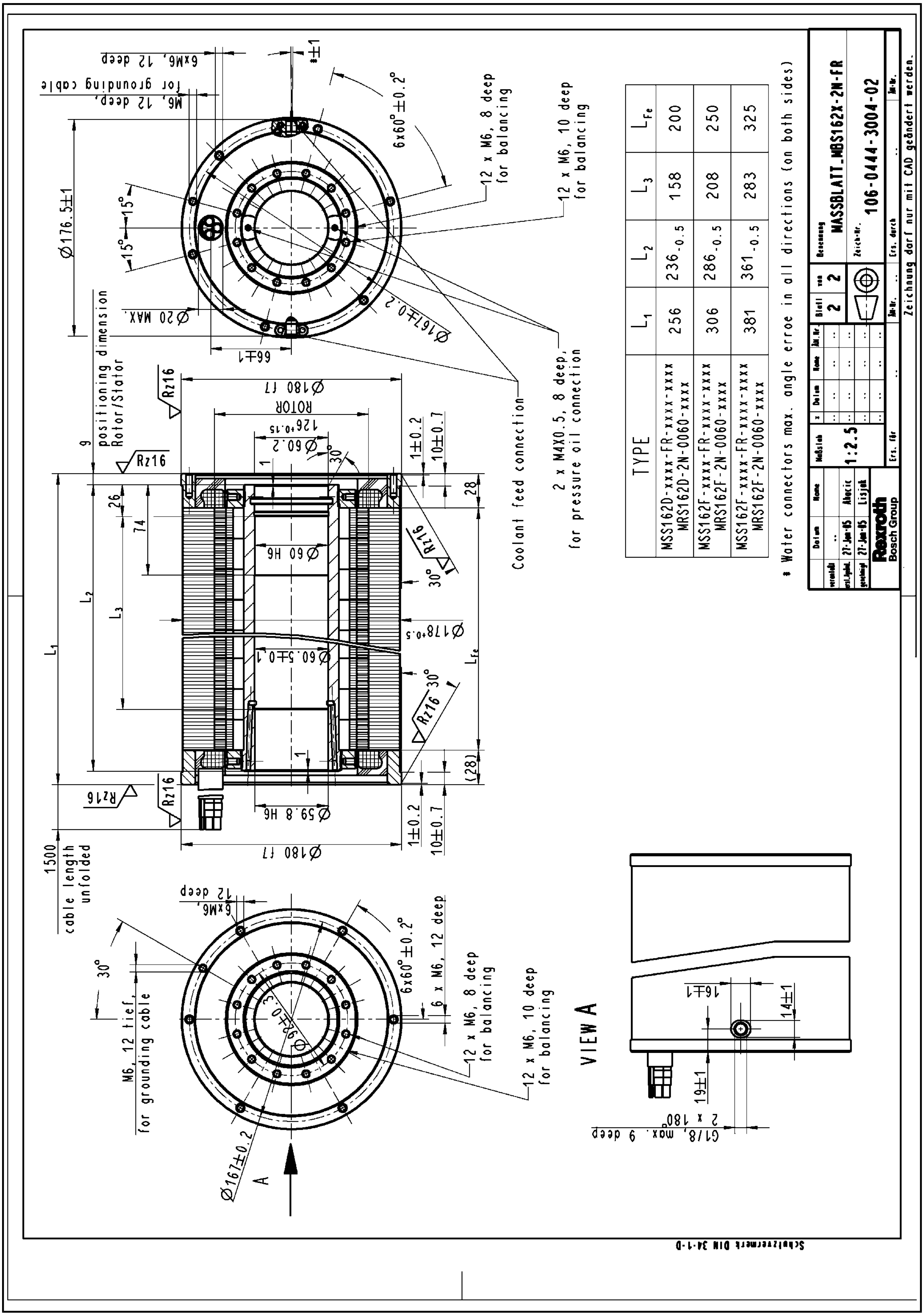
5.4.3 MBS162 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}
MSS162B-xxxx-FA-xxxx-xxxx MRS162B-2N-0060-xxxx	206	$186_{-0.5}$	108	150
MSS162D-xxxx-FA-xxxx-xxxx MRS162D-2N-0060-xxxx	256	$236_{-0.5}$	158	200
MSS162F-xxxx-FA-xxxx-xxxx MRS162F-2N-0060-xxxx	306	$286_{-0.5}$	208	250
MSS162J-xxxx-FA-xxxx-xxxx MRS162J-2N-0060-xxxx	381	$361_{-0.5}$	283	325

Fig.5-13: Size 162 with axial cooling connection and rotor design "2N"

5.4.4 MBS162 with Radial Cooling Connection and Rotor Design 2N

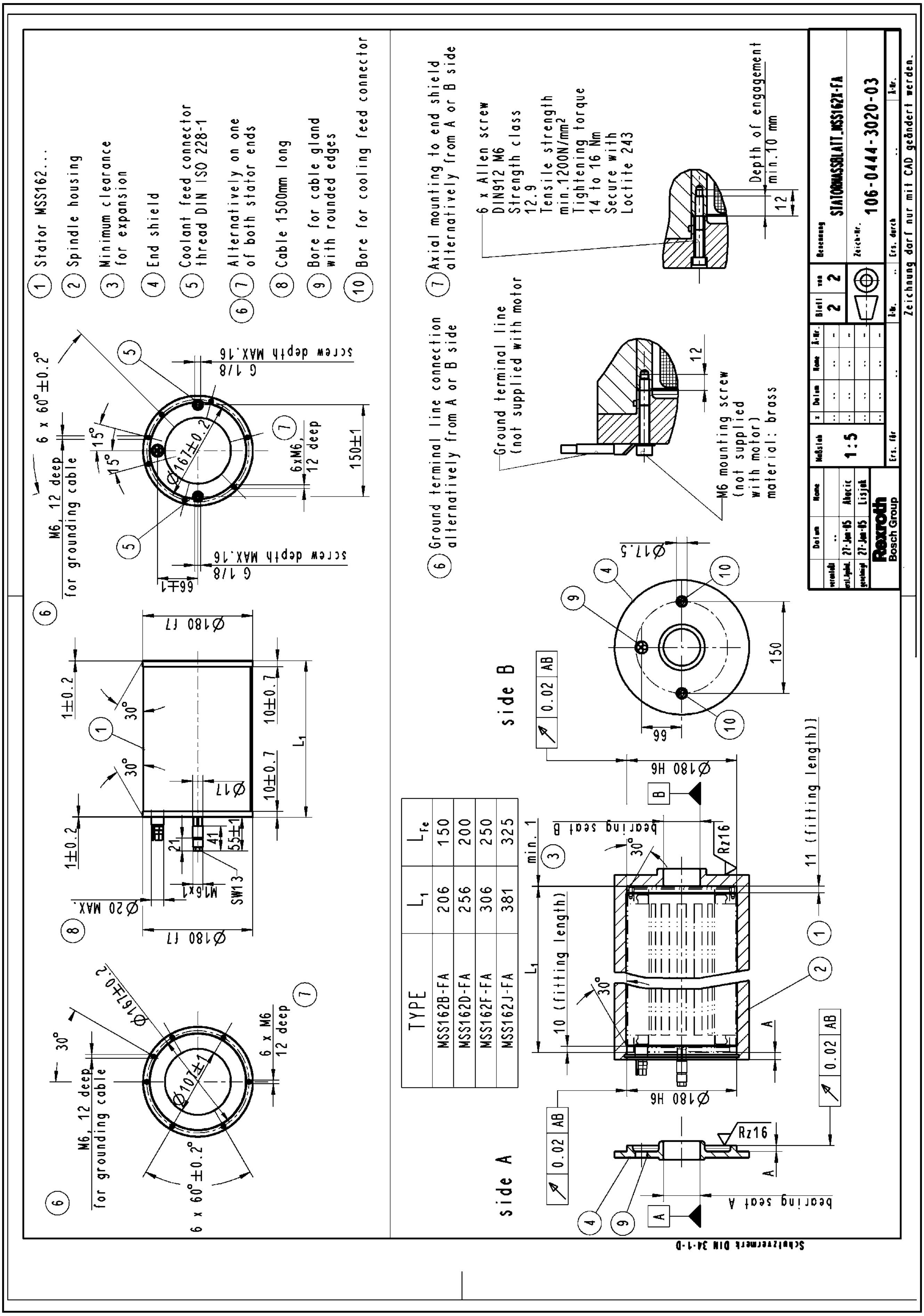


TYPE	L_1	L_2	L_3	L_{Fe}
MSS162D-xxxx-FR-xxxx-xxxx MRS162D-2N-0060-xxxx	256	$236_{-0.5}$	158	200
MSS162F-xxxx-FR-xxxx-xxxx MRS162F-2N-0060-xxxx	306	$286_{-0.5}$	208	250
MSS162F-xxxx-FR-xxxx-xxxx MRS162F-2N-0060-xxxx	381	$361_{-0.5}$	283	325

Fig.5-14: Size 162 with radial cooling connection and rotor design "2N"

Dimensional Sheets IndraDyn H

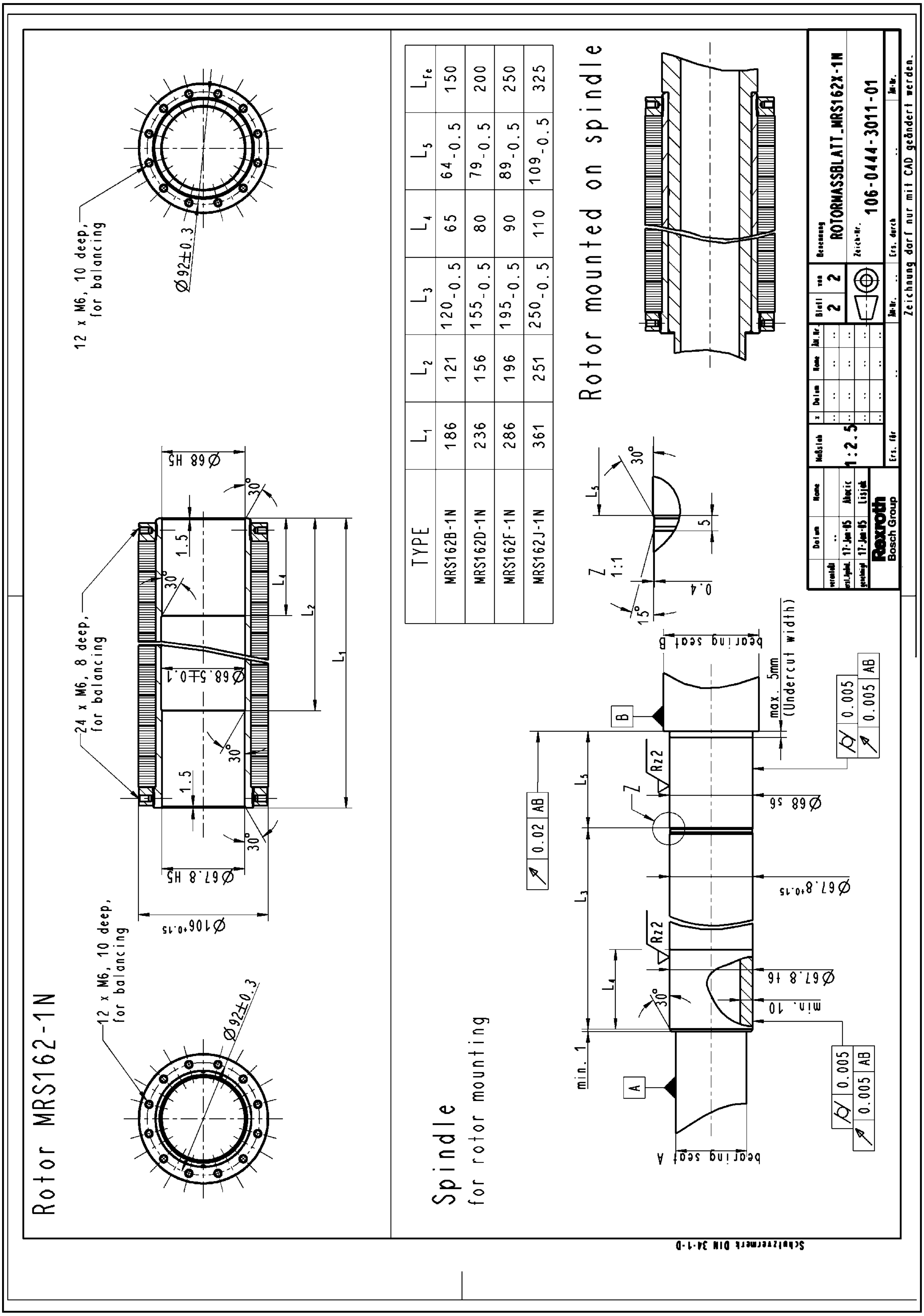
5.4.5 MSS162, Axial Cooling Connection



TYPE	L_1	L_{Fe}
MSS162B-FA	206	150
MSS162D-FA	256	200
MSS162F-FA	306	250
MSS162J-FA	381	325

Fig.5-15: MSS162, axial cooling connection

5.4.6 MRS162 with 1N Design (Smooth Hole)



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MRS162B-1N	186	121	$120_{-0.5}$	65	$64_{-0.5}$	150
MRS162D-1N	236	156	$155_{-0.5}$	80	$79_{-0.5}$	200
MRS162F-1N	286	196	$195_{-0.5}$	90	$89_{-0.5}$	250
MRS162J-1N	361	251	$250_{-0.5}$	110	$109_{-0.5}$	325

Fig.5-16: MRS162 with 1N design

Dimensional Sheets IndraDyn H

5.4.7 MRS162 with 2N Design (Step Interference Fit)

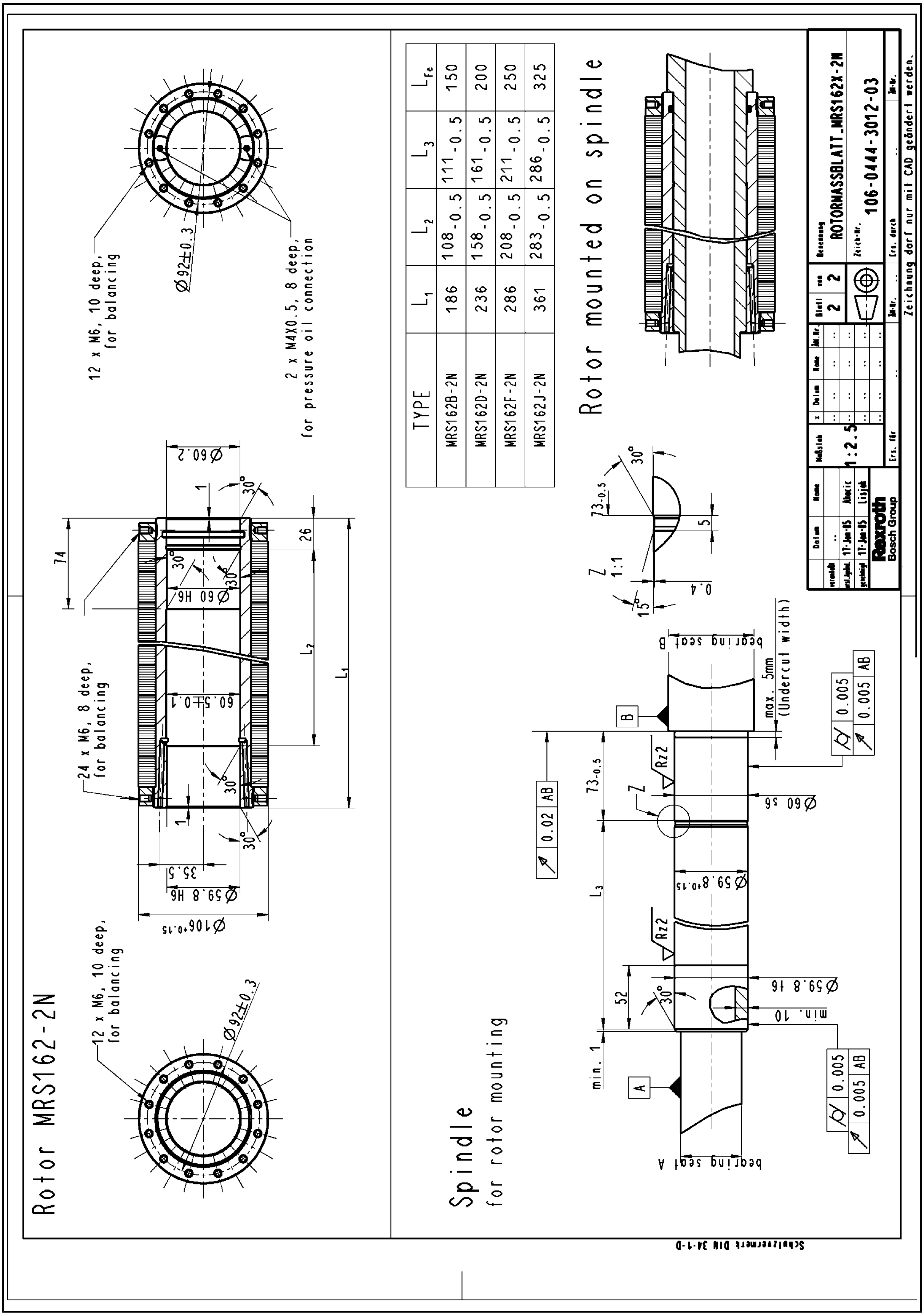
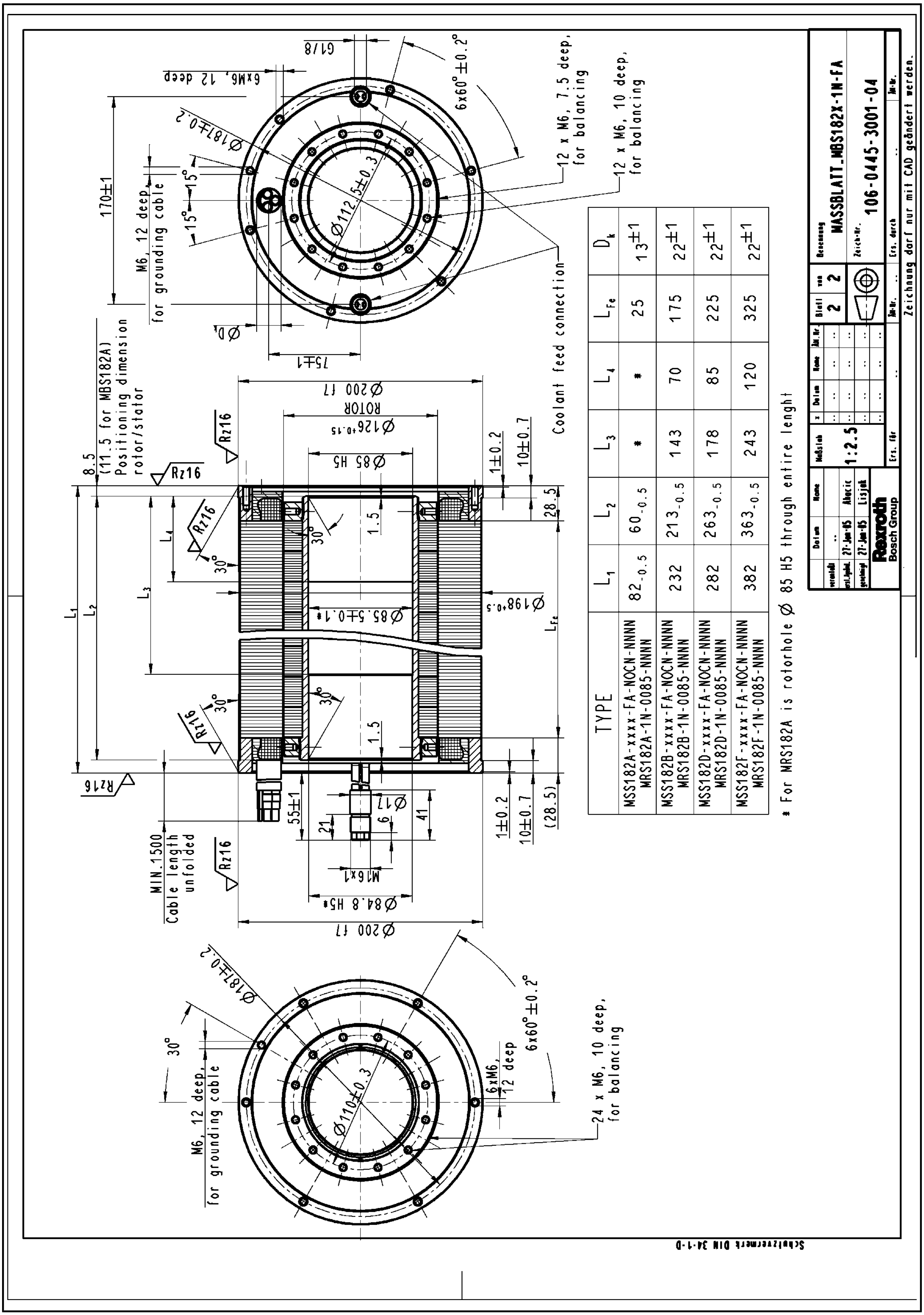


Fig.5-17: MRS162 with 2N design

5.5 Size 182

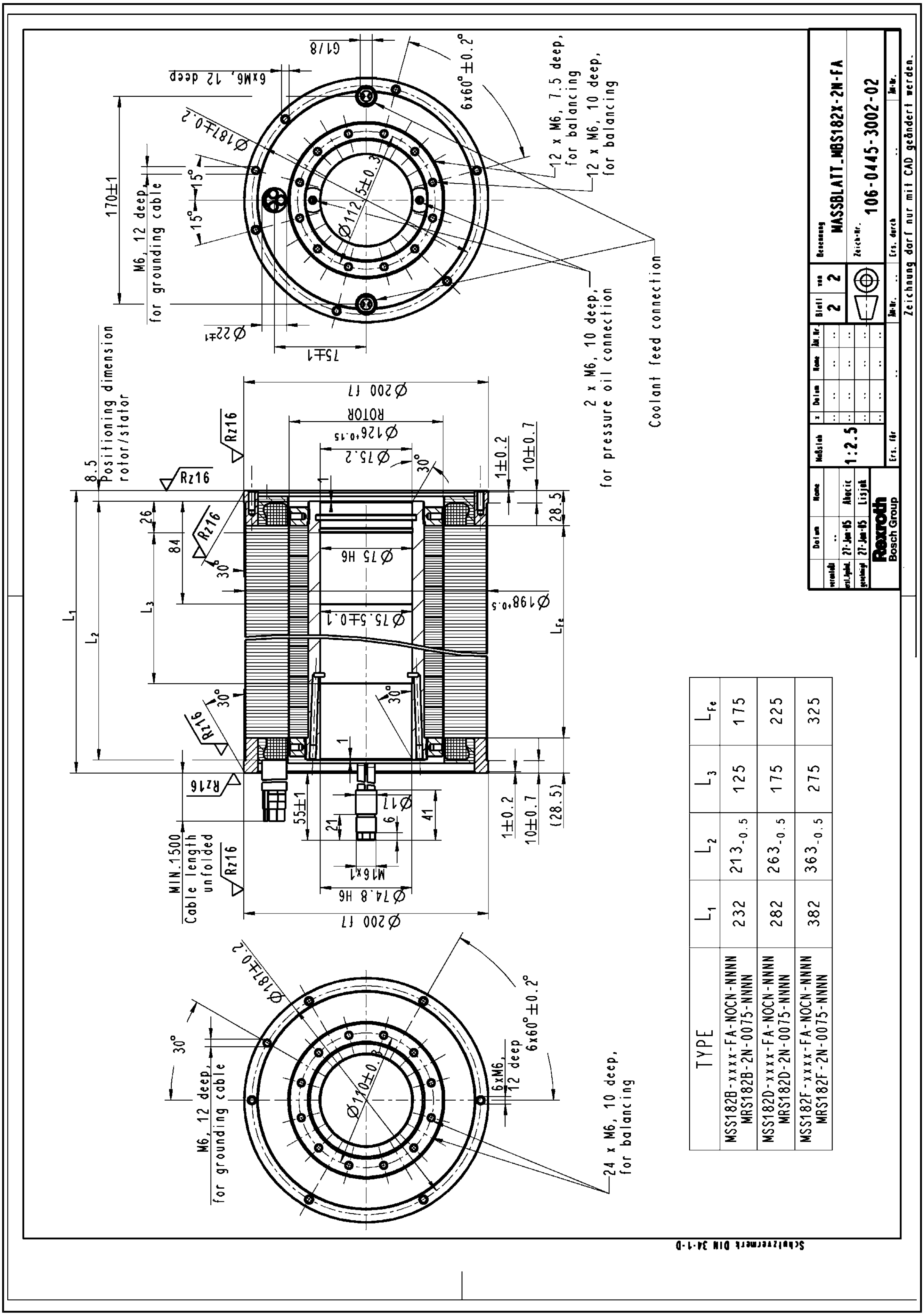
5.5.1 MBS182 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}	D_k
MSS182A-xxxx-FA-NOCN-NNNN MRS182A-1N-0085-NNNN	$82_{-0.5}$	$60_{-0.5}$	*	*	25	$13^{\pm1}$
MSS182B-xxxx-FA-NOCN-NNNN MRS182B-1N-0085-NNNN	232	$213_{-0.5}$	143	70	175	$22^{\pm1}$
MSS182D-xxxx-FA-NOCN-NNNN MRS182D-1N-0085-NNNN	282	$263_{-0.5}$	178	85	225	$22^{\pm1}$
MSS182F-xxxx-FA-NOCN-NNNN MRS182F-1N-0085-NNNN	382	$363_{-0.5}$	243	120	325	$22^{\pm1}$

* For MRS182A is rotorhole Ø 85 H5 through entire lenght

5.5.2 MBS182 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}
MSS182B-xxxx-FA-NOCN-NNNN MRS182B-2N-0075-NNNN	232	$213_{-0.5}$	125	175
MSS182D-xxxx-FA-NOCN-NNNN MRS182D-2N-0075-NNNN	282	$263_{-0.5}$	175	225
MSS182F-xxxx-FA-NOCN-NNNN MRS182F-2N-0075-NNNN	382	$363_{-0.5}$	275	325

Fig.5-19: MBS182 with axial cooling connection and rotor design "2N"

5.5.3 MBS182A with Radial Cooling Connection and Rotor Design "1N"

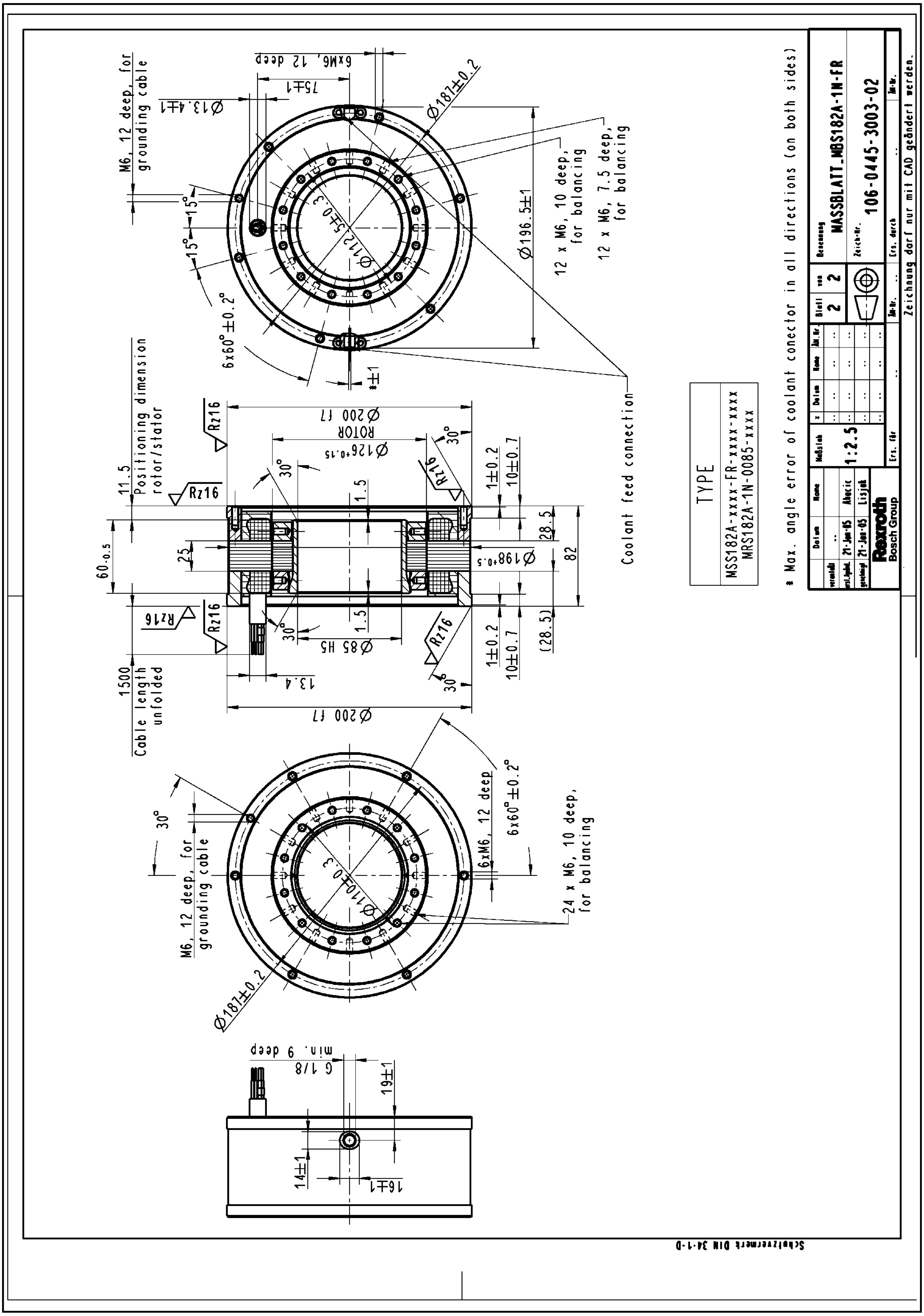
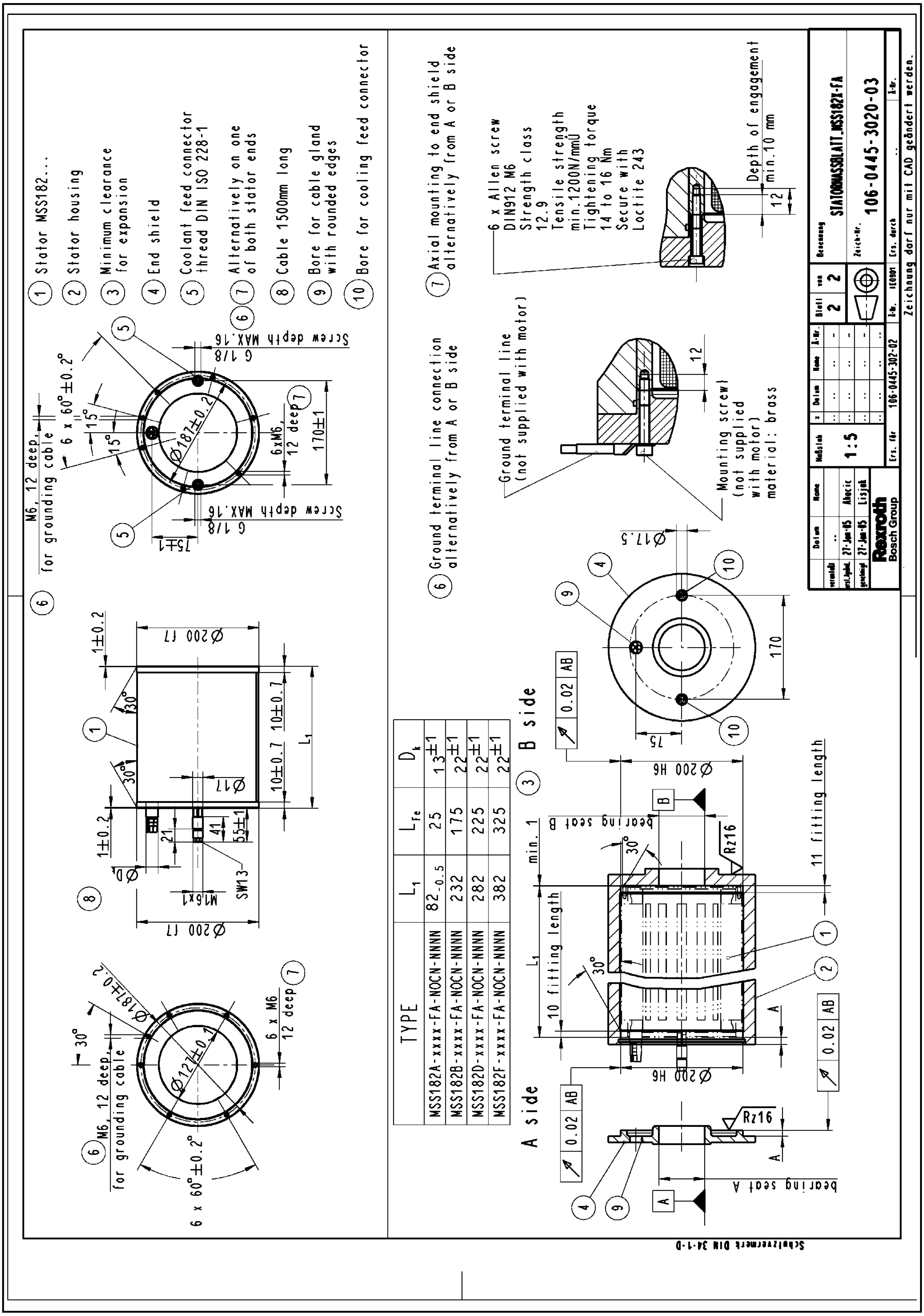


Fig.5-20: MBS182A with radial cooling connection and rotor design "1N"

Dimensional Sheets IndraDyn H

5.5.4 MSS182 with Axial Cooling Connection



TYPE	L_1	L_{Fe}	D_k
MSS182A-xxxx-FA-NOCN-NNNN	$82_{-0.5}$	25	13±1
MSS182B-xxxx-FA-NOCN-NNNN	232	175	22±1
MSS182D-xxxx-FA-NOCN-NNNN	282	225	22±1
MSS182F-xxxx-FA-NOCN-NNNN	382	325	22±1

Fig.5-21: MSS182 with axial cooling connection

5.5.5 MSS182A with Radial Cooling Connection

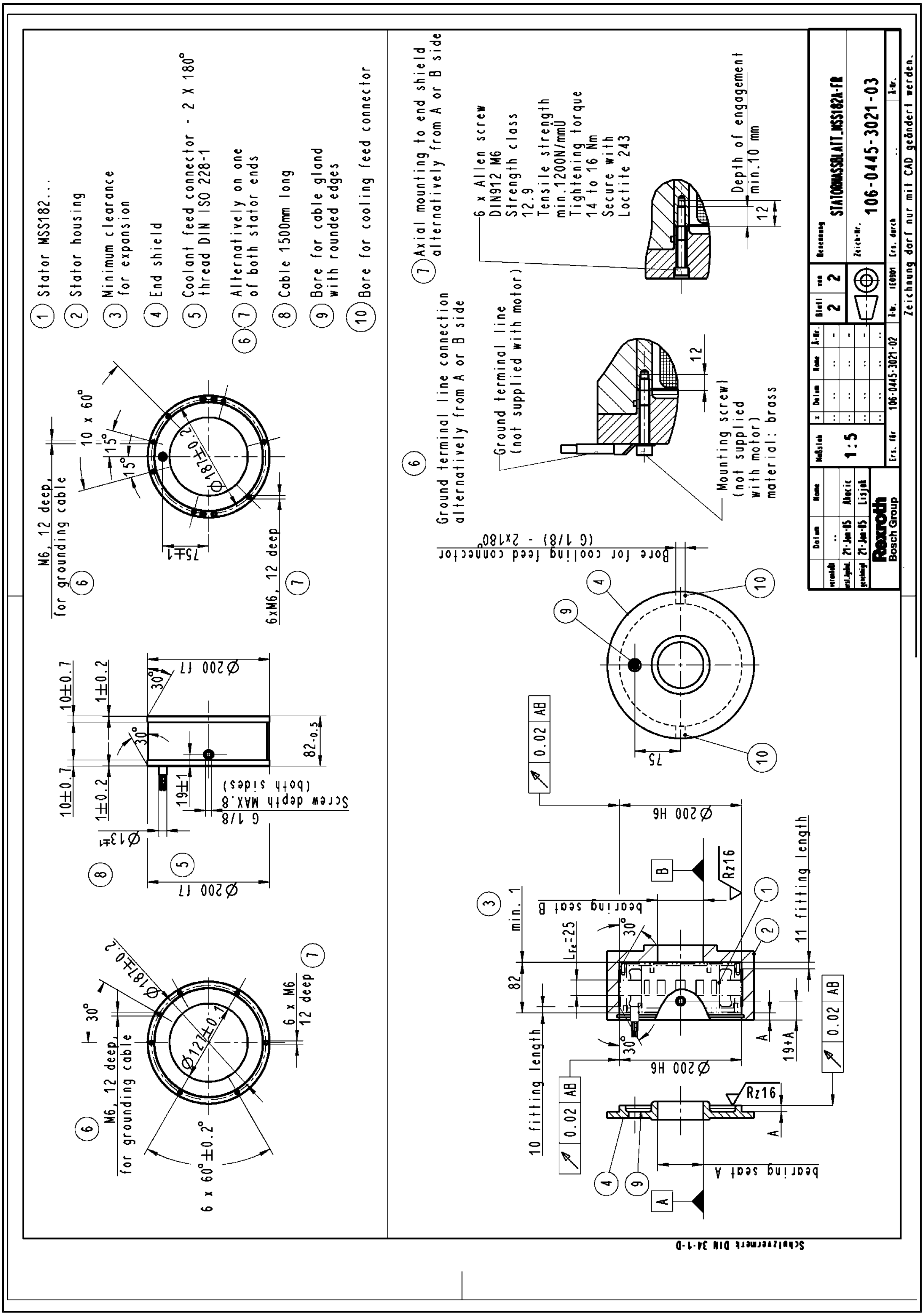


Fig.5-22: MSS182A with radial cooling connection

Dimensional Sheets IndraDyn H

5.5.6 MRS182 with "1N" Design (Smooth Hole)

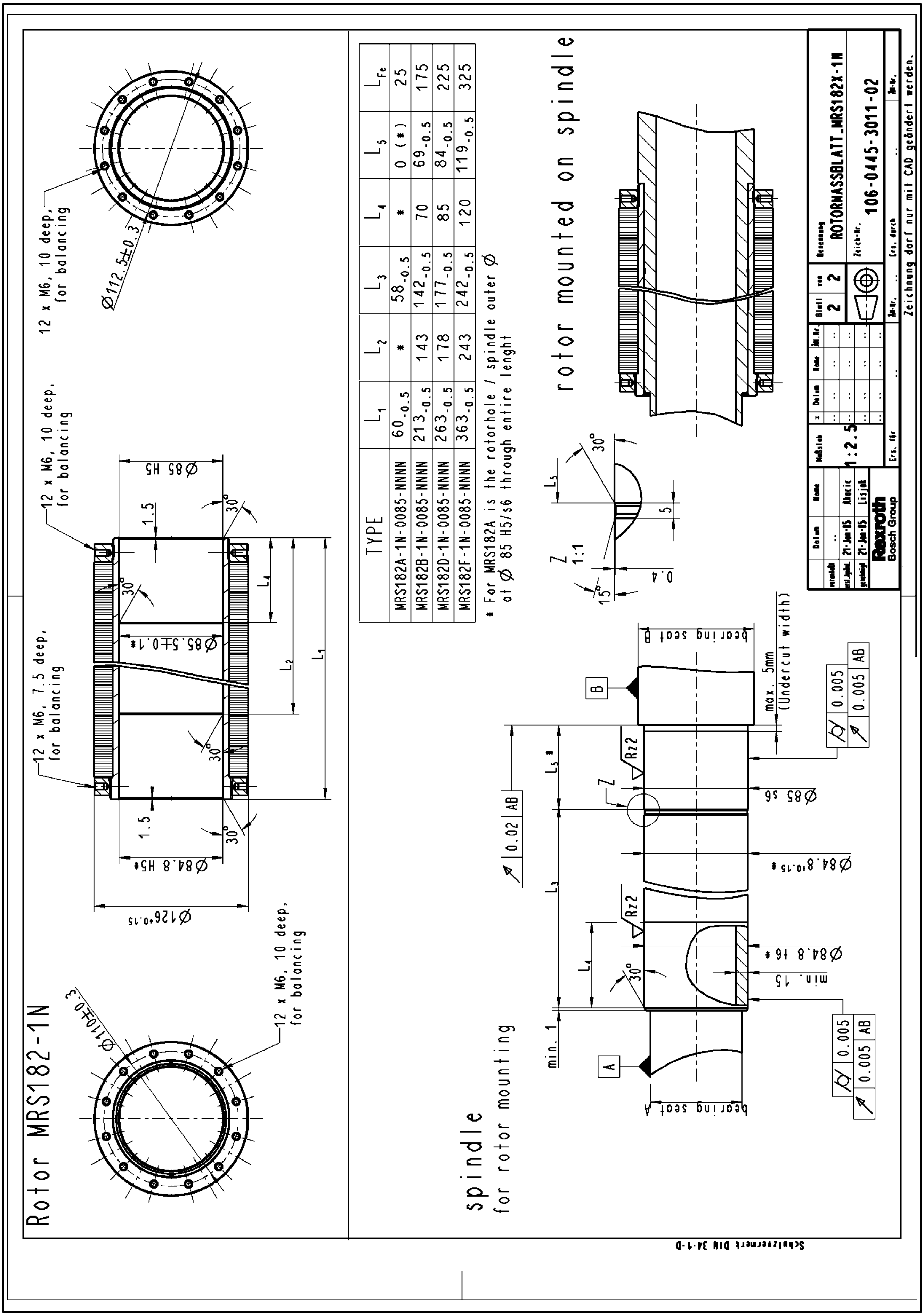
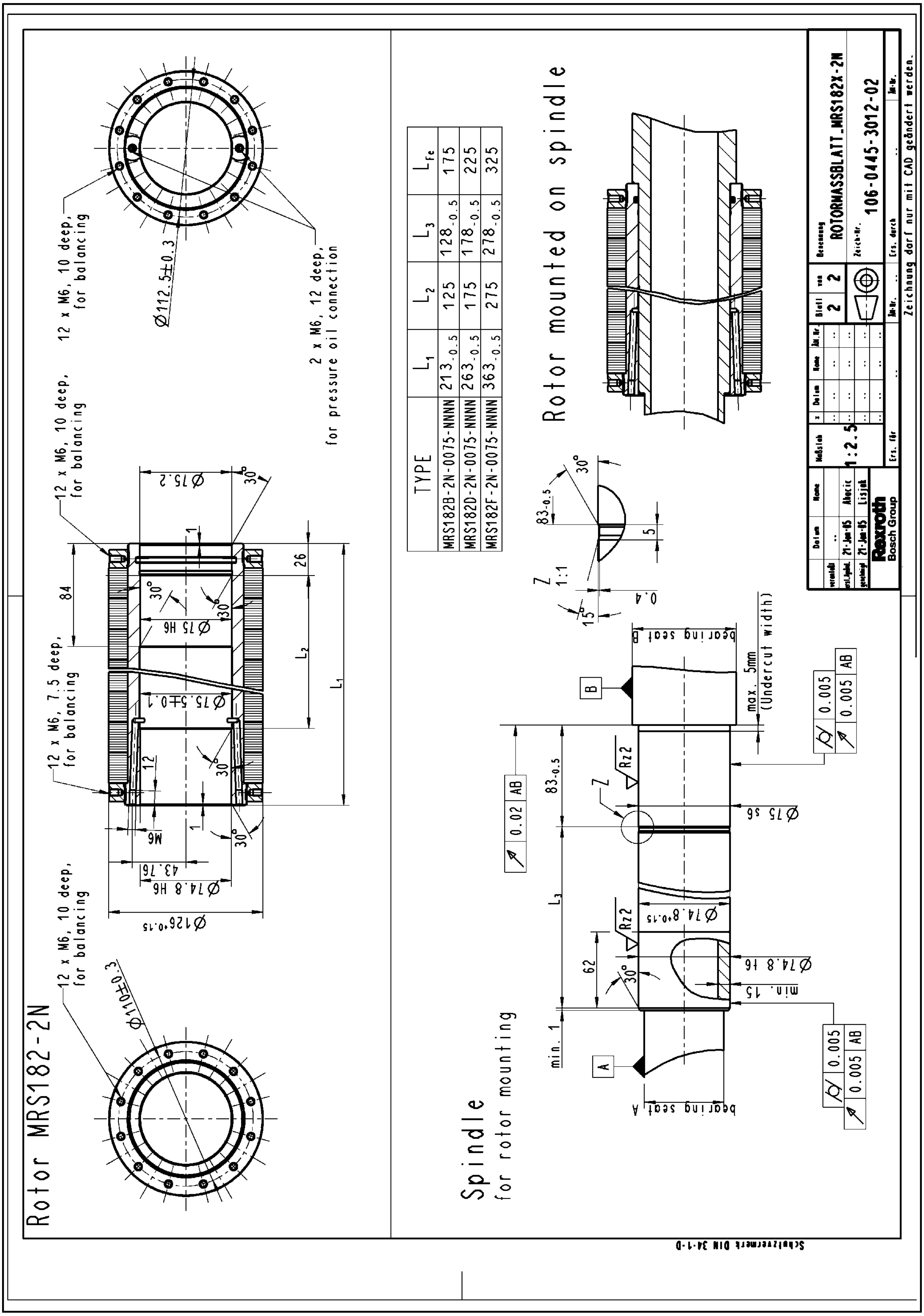


Fig.5-23: MRS182 with "1N" design

5.5.7 MRS182 with "2N" Design (Step Interference Fit)

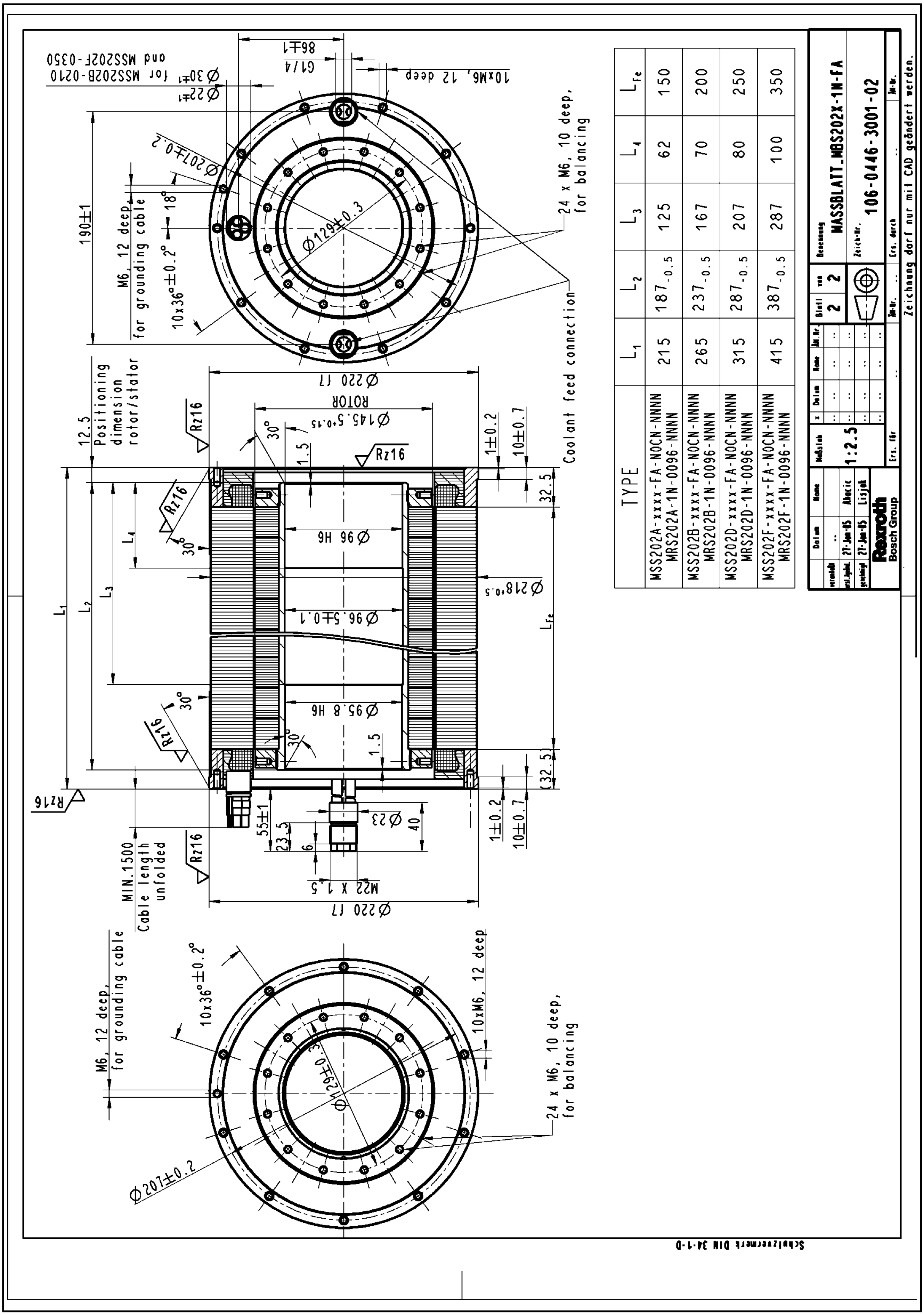


TYPE	L_1	L_2	L_3	L_{Fe}
MRS182B-2N-0075-NNNN	$213_{-0.5}$	125	$128_{-0.5}$	175
MRS182D-2N-0075-NNNN	$263_{-0.5}$	175	$178_{-0.5}$	225
MRS182F-2N-0075-NNNN	$363_{-0.5}$	275	$278_{-0.5}$	325

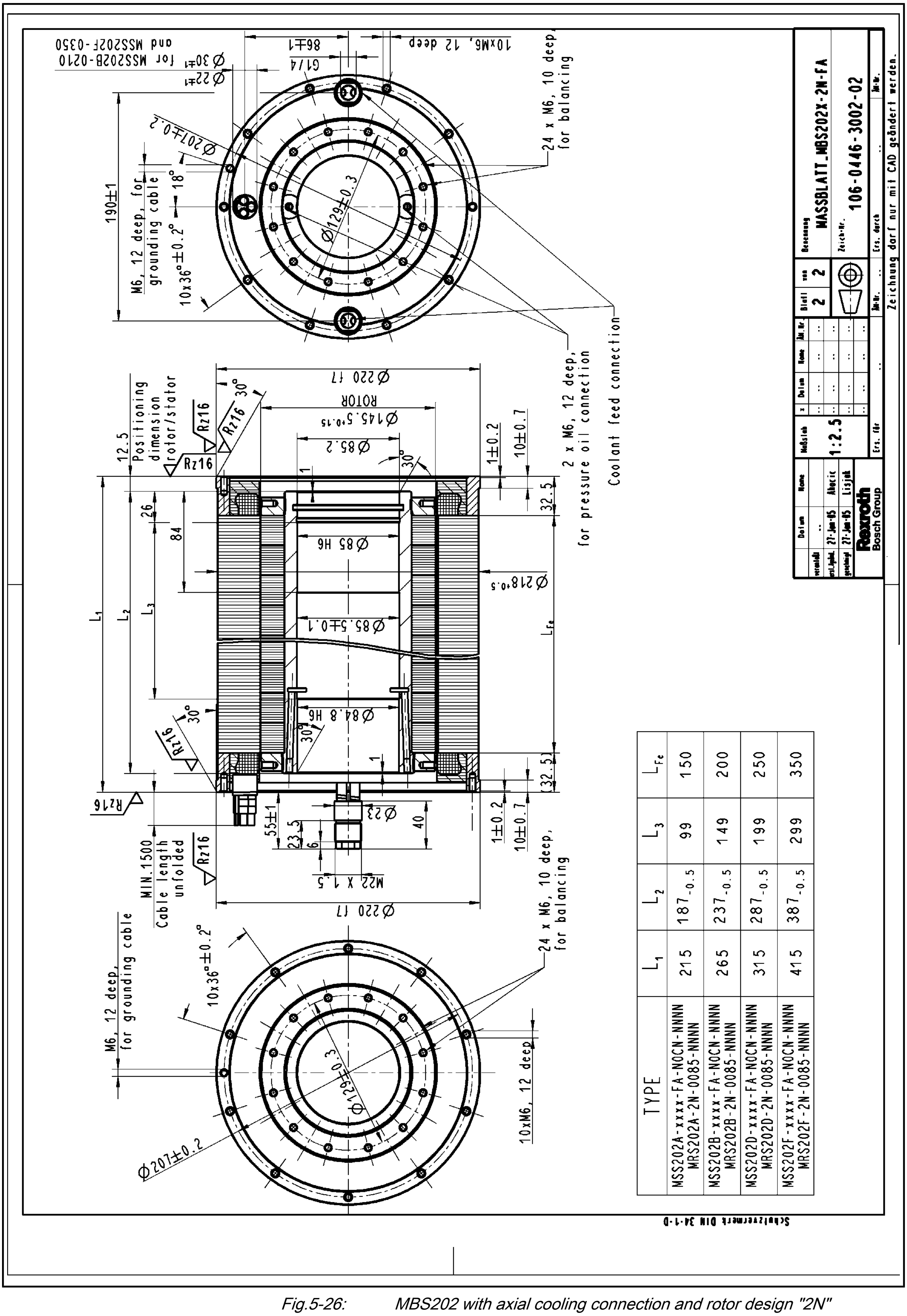
Fig.5-24: MRS182 with "2N" design

5.6 Size 202

5.6.1 MBS202 with Axial Cooling Connection and Rotor Design "1N"



5.6.2 MBS202 with Axial Cooling Connection and Rotor Design "2N"

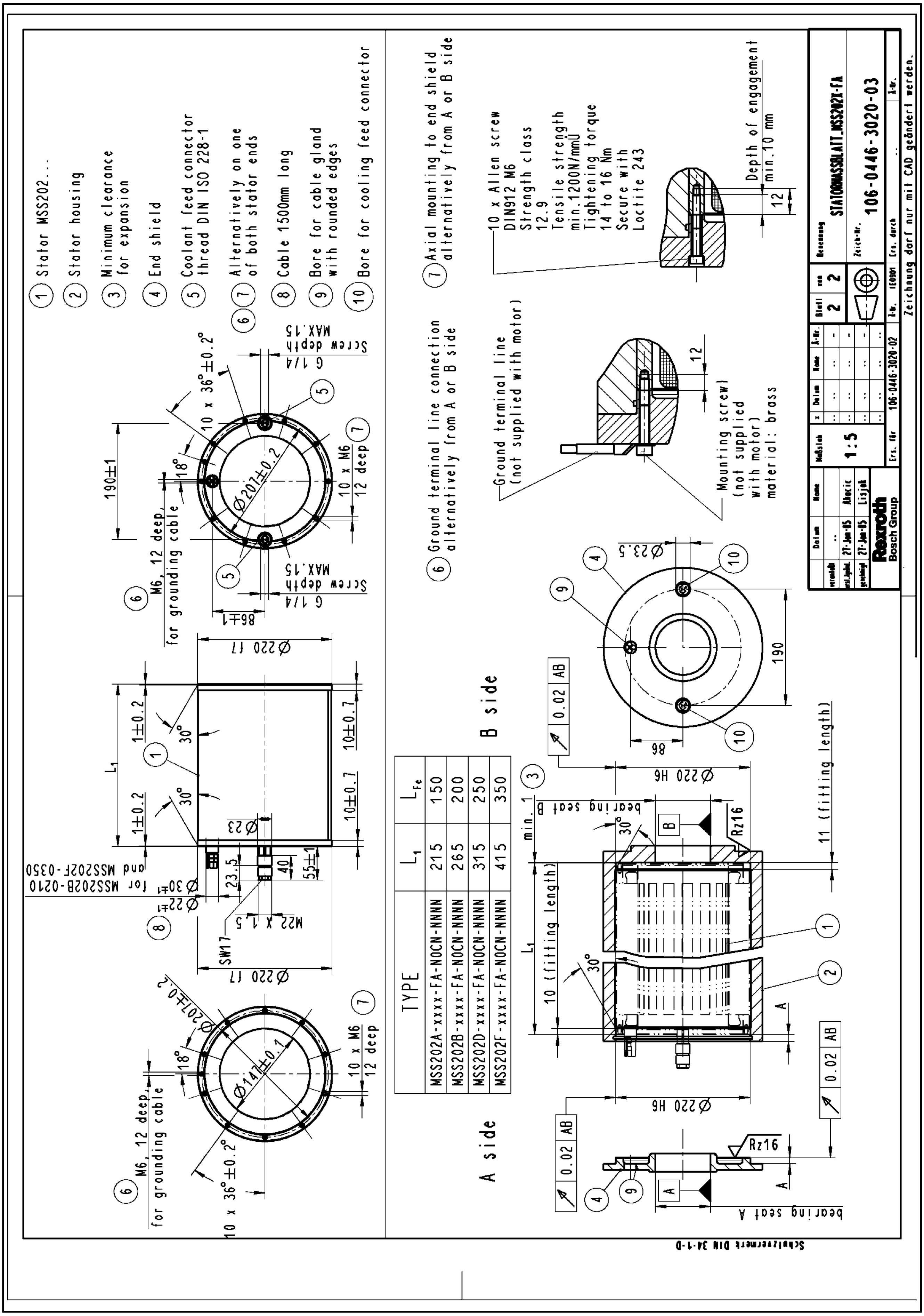


TYPE	L_1	L_2	L_3	L_{Fe}
MSS202A-xxxx-FA-NOCN-NNNN MRS202A-2N-0085-NNNN	215	$187_{-0.5}$	99	150
MSS202B-xxxx-FA-NOCN-NNNN MRS202B-2N-0085-NNNN	265	$237_{-0.5}$	149	200
MSS202D-xxxx-FA-NOCN-NNNN MRS202D-2N-0085-NNNN	315	$287_{-0.5}$	199	250
MSS202F-xxxx-FA-NOCN-NNNN MRS202F-2N-0085-NNNN	415	$387_{-0.5}$	299	350

Fig.5-26: MBS202 with axial cooling connection and rotor design "2N"

Dimensional Sheets IndraDyn H

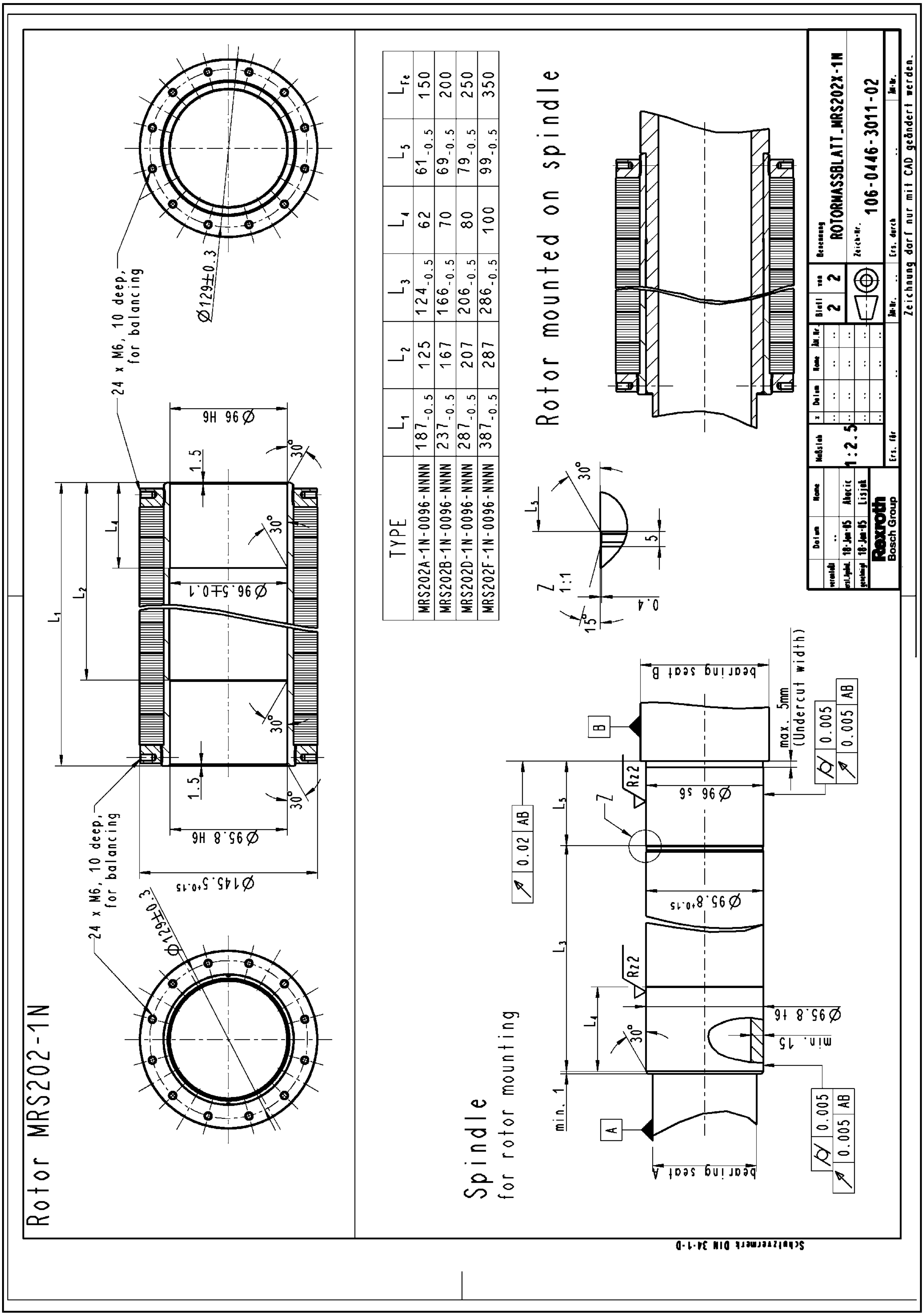
5.6.3 MSS202 with Axial Cooling Connection



TYPE	L_1	L_{Fe}
MSS202A-xxxx-FA-NOCN-NNNN	215	150
MSS202B-xxxx-FA-NOCN-NNNN	265	200
MSS202D-xxxx-FA-NOCN-NNNN	315	250
MSS202F-xxxx-FA-NOCN-NNNN	415	350

Fig.5-27: MSS202 with axial cooling connection

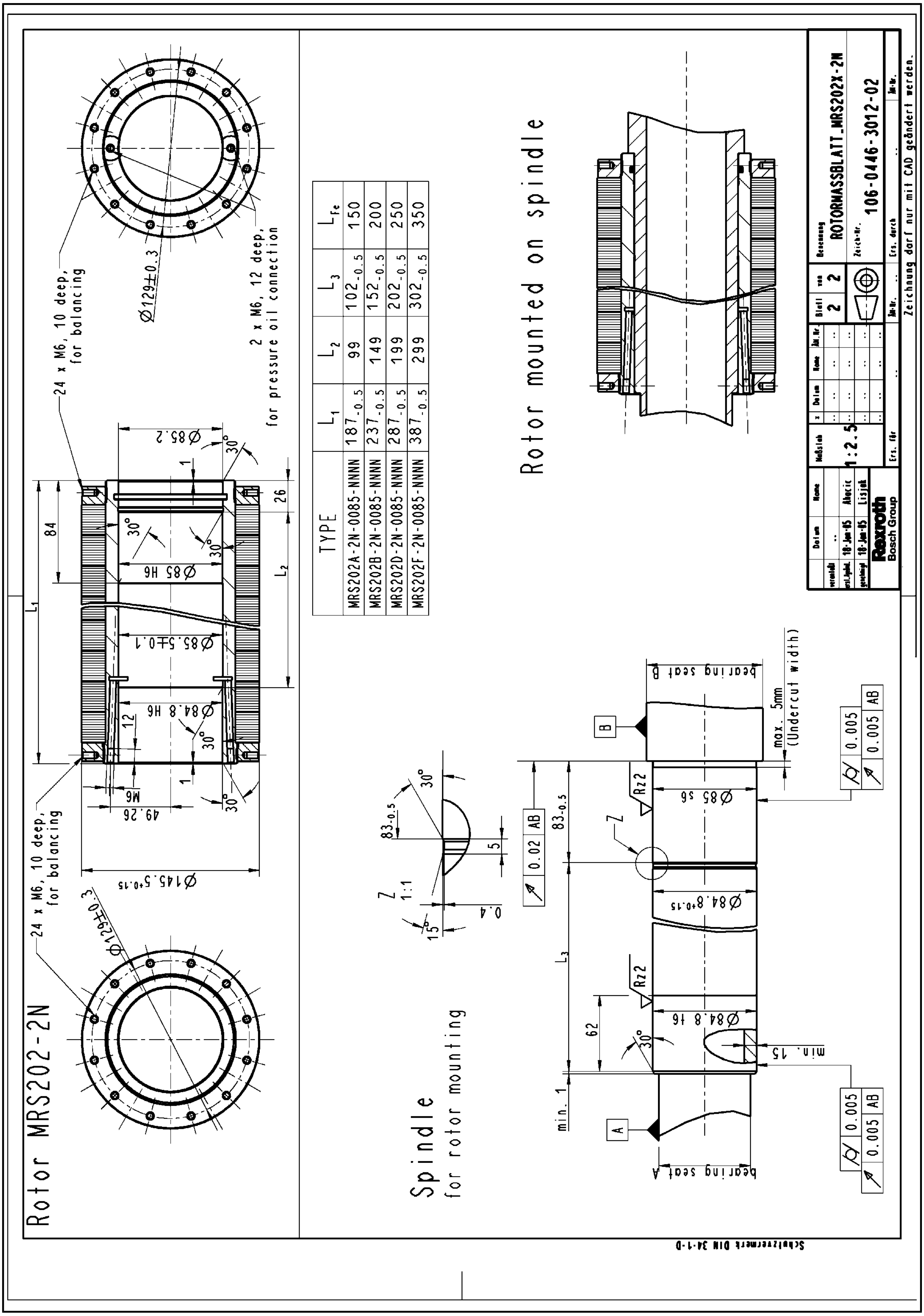
5.6.4 MRS202 with "1N" Design (Smooth Hole)



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MRS202A-1N-0096-NNNN	$187_{-0.5}$	125	$124_{-0.5}$	62	$61_{-0.5}$	150
MRS202B-1N-0096-NNNN	$237_{-0.5}$	167	$166_{-0.5}$	70	$69_{-0.5}$	200
MRS202D-1N-0096-NNNN	$287_{-0.5}$	207	$206_{-0.5}$	80	$79_{-0.5}$	250
MRS202F-1N-0096-NNNN	$387_{-0.5}$	287	$286_{-0.5}$	100	$99_{-0.5}$	350

Fig.5-28: MRS202 with "1N" design

5.6.5 MRS202 with "2N" Design (Step Interference Fit)

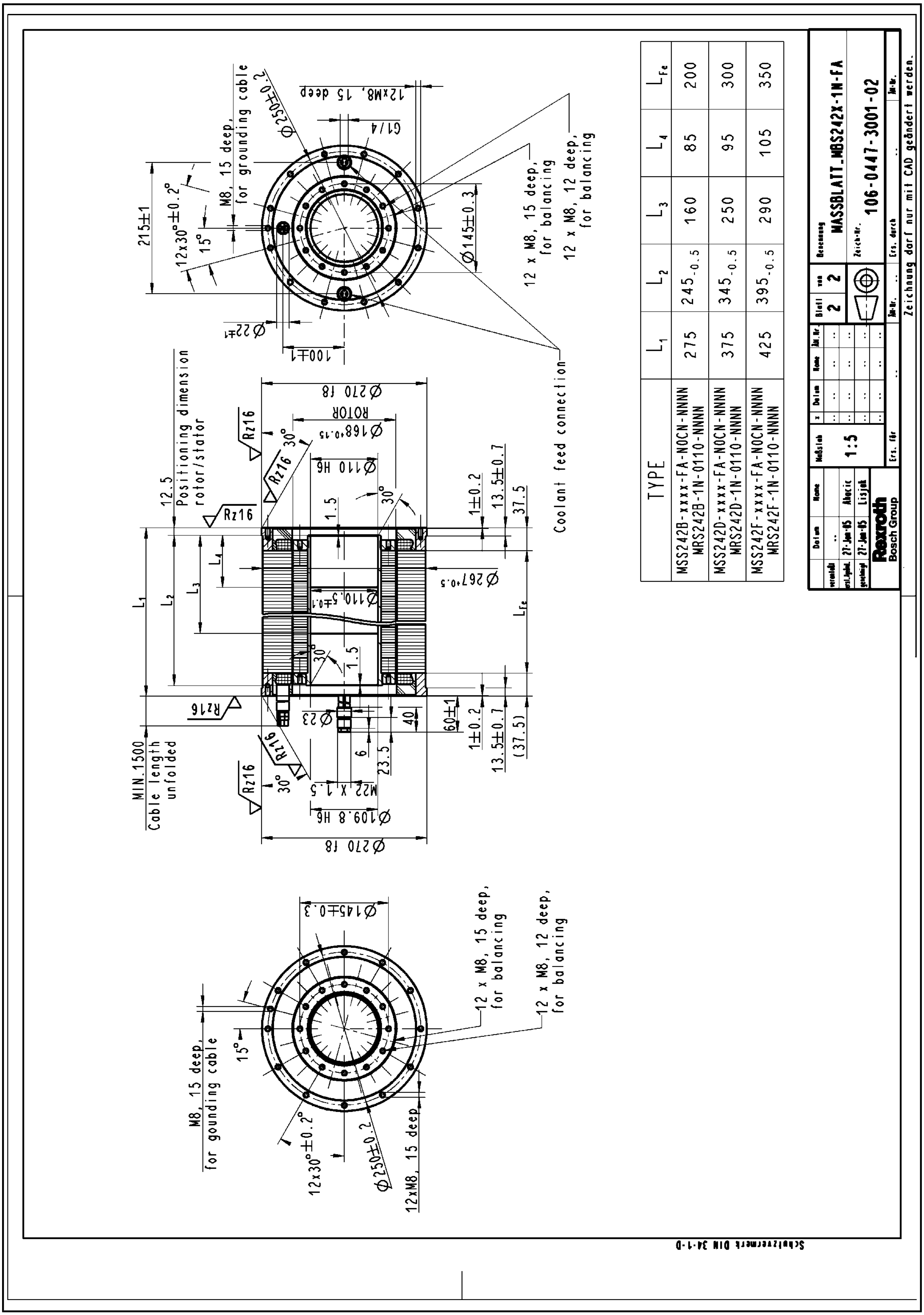


TYPE	L_1	L_2	L_3	L_{fe}
MRS202A-2N-0085-NNNN	$187_{-0.5}$	99	$102_{-0.5}$	150
MRS202B-2N-0085-NNNN	$237_{-0.5}$	149	$152_{-0.5}$	200
MRS202D-2N-0085-NNNN	$287_{-0.5}$	199	$202_{-0.5}$	250
MRS202F-2N-0085-NNNN	$387_{-0.5}$	299	$302_{-0.5}$	350

Fig.5-29: MRS202 with "2N" design

5.7 Size 242

5.7.1 MBS242 with Axial Cooling Connection and Rotor Design "1N"



5.7.2 MBS242 with Axial Cooling Connection and Rotor Design "2N"

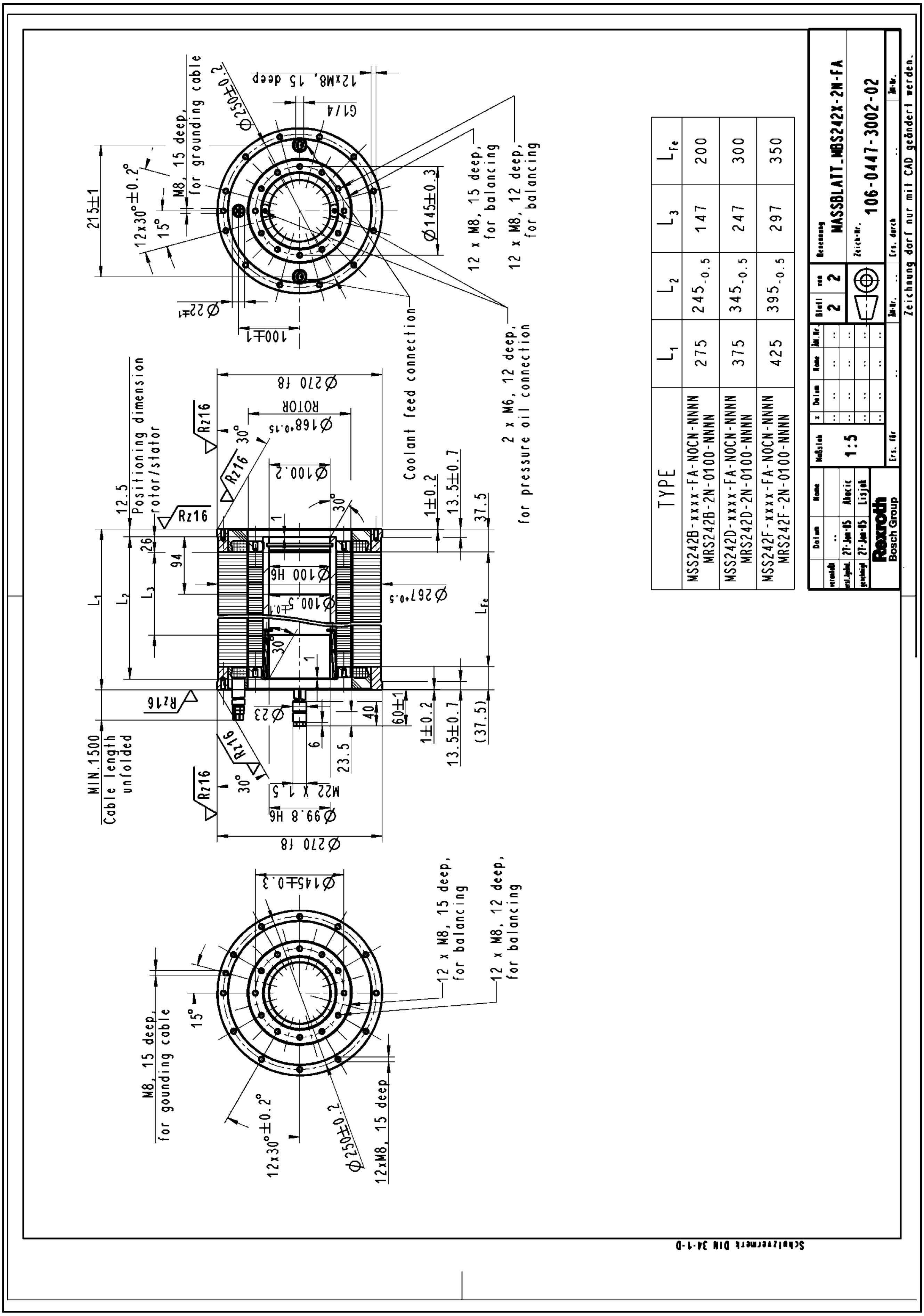


Fig.5-31: MBS242 with axial cooling connection and rotor design "2N"

5.7.3 MSS242 with Axial Cooling Connection

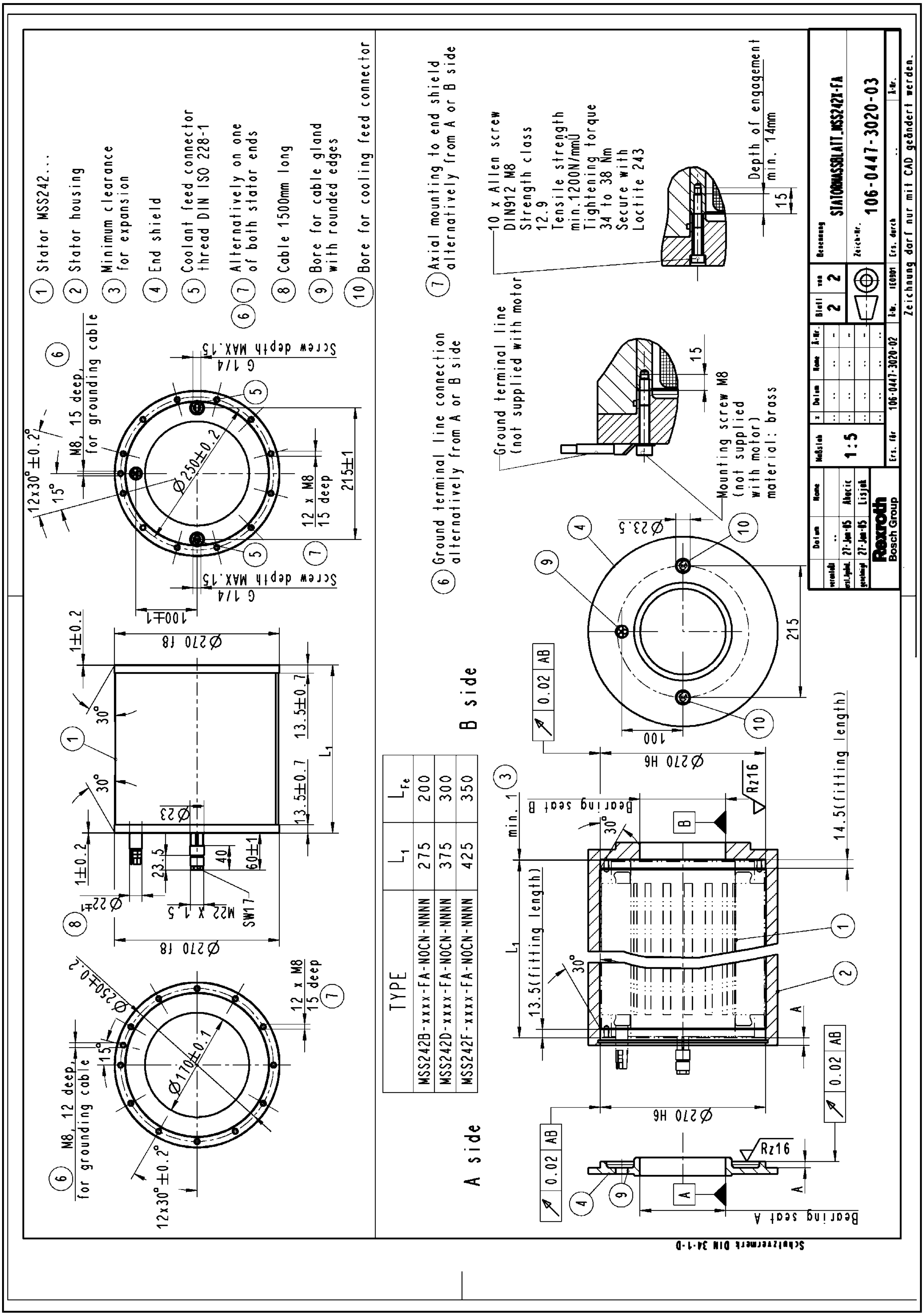
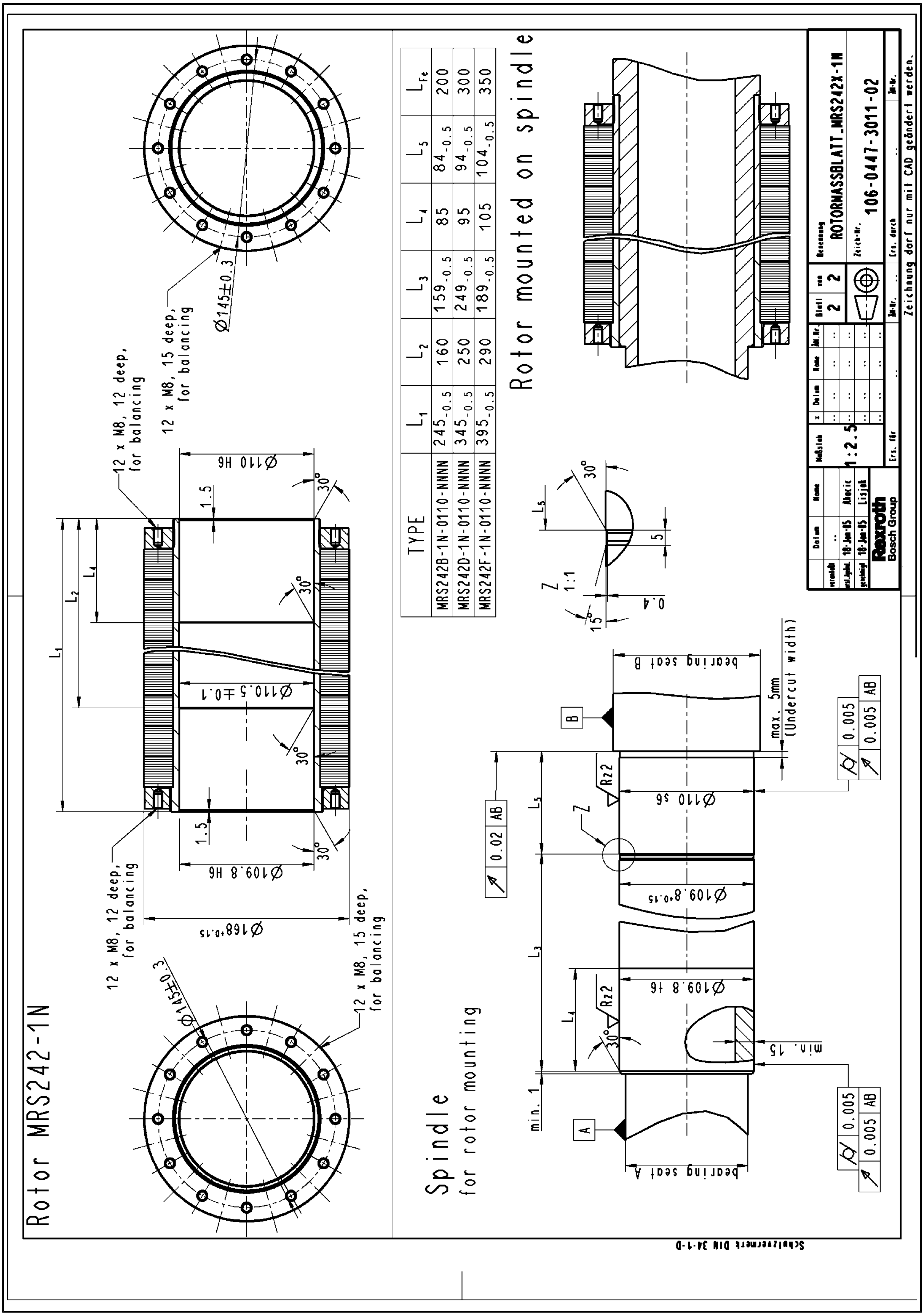


Fig.5-32: MSS242 with axial cooling connection

Dimensional Sheets IndraDyn H

5.7.4 MRS242 with "1N" Design



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MRS242B-1N-0110-NNNN	$245_{-0.5}$	160	$159_{-0.5}$	85	$84_{-0.5}$	200
MRS242D-1N-0110-NNNN	$345_{-0.5}$	250	$249_{-0.5}$	95	$94_{-0.5}$	300
MRS242F-1N-0110-NNNN	$395_{-0.5}$	290	$189_{-0.5}$	105	$104_{-0.5}$	350

Fig.5-33: MRS242 with "1N" design

5.7.5 MRS242 with "2N" Design

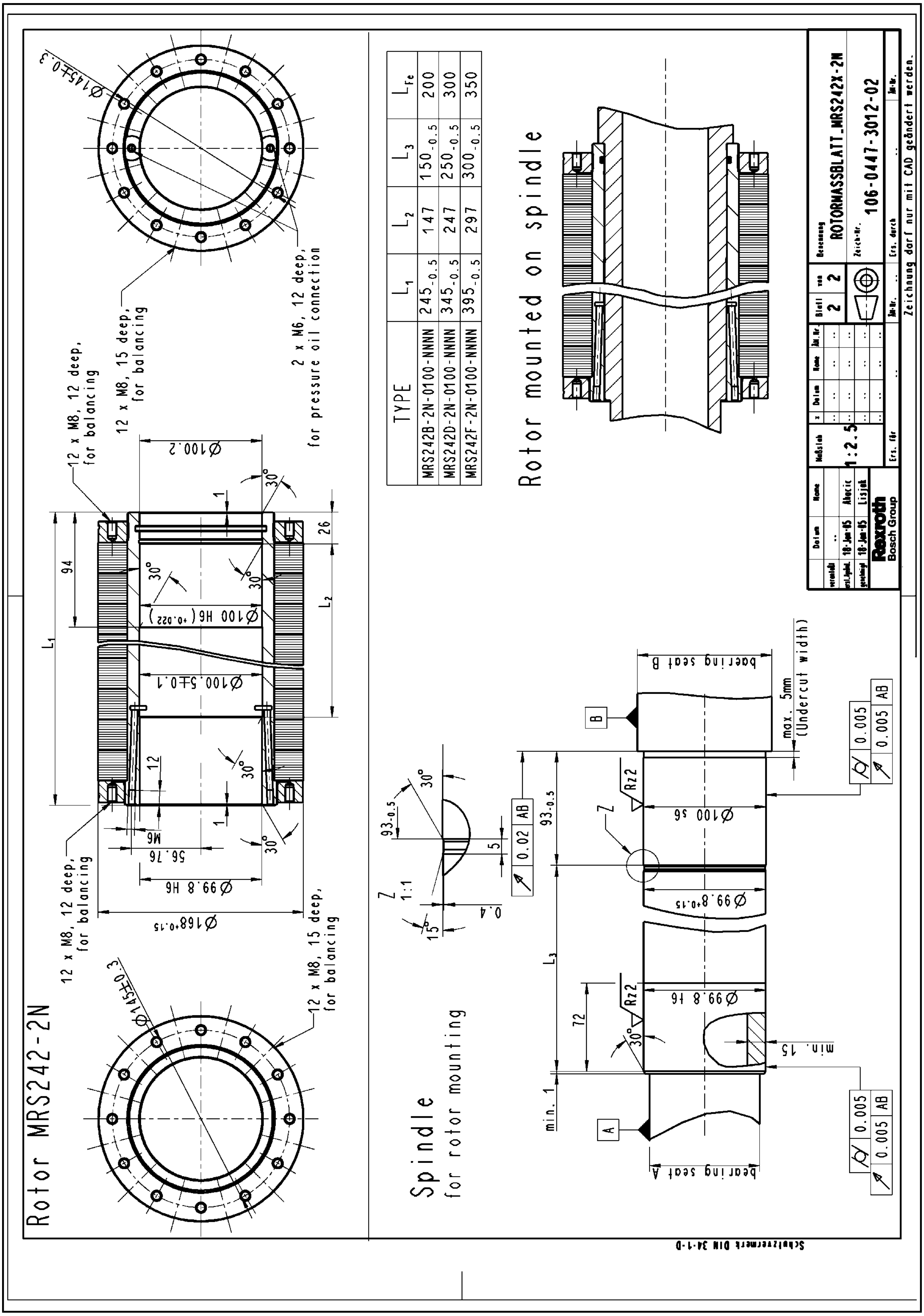
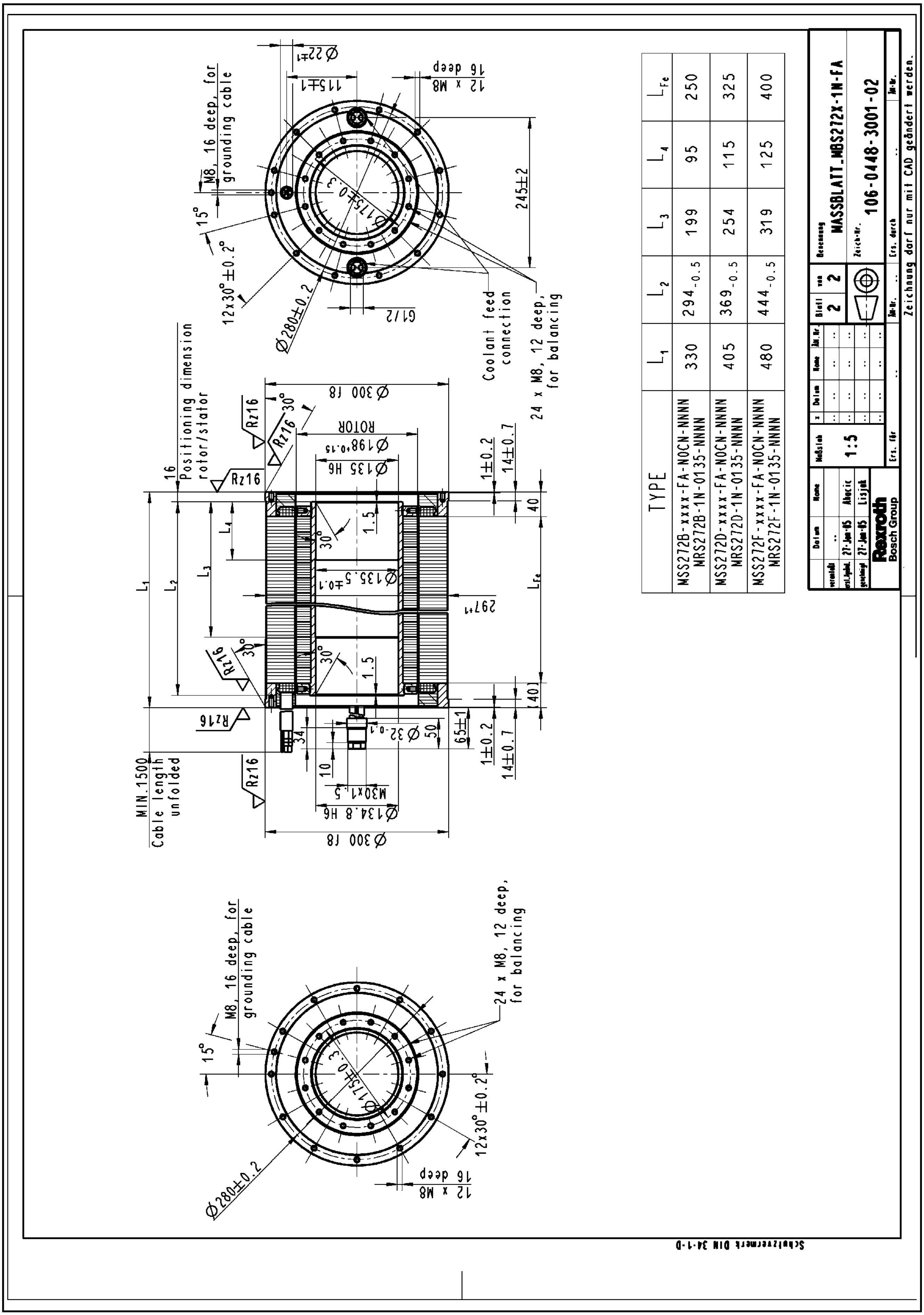


Fig.5-34: MRS242 with "2N" design

Dimensional Sheets IndraDyn H

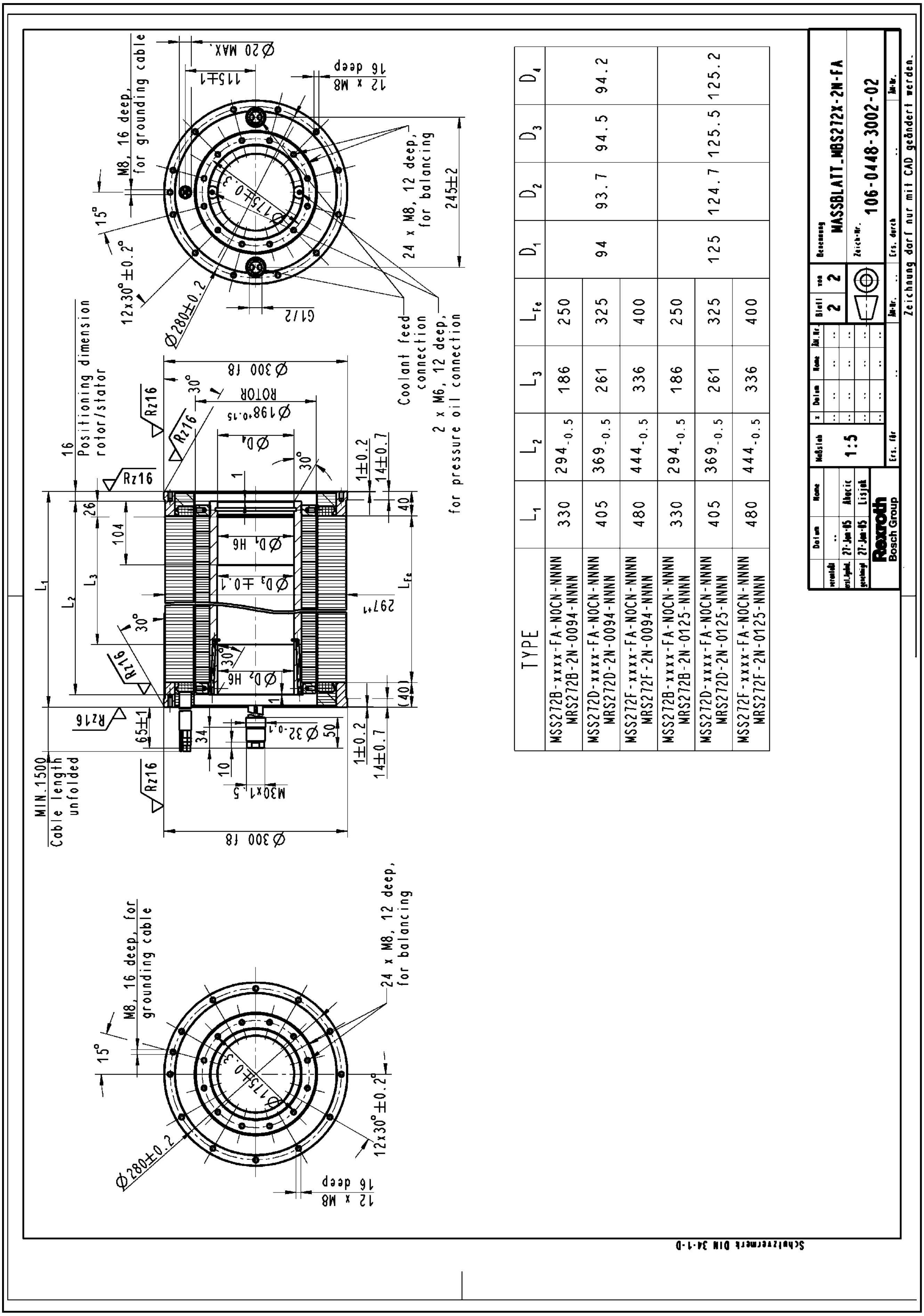
5.8 Size 272

5.8.1 MBS272 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS272B-xxxx-FA-NOCN-NNNN NRS272B-1N-0135-NNNN	330	$294_{-0.5}$	199	95	250
MSS272D-xxxx-FA-NOCN-NNNN NRS272D-1N-0135-NNNN	405	$369_{-0.5}$	254	115	325
MSS272F-xxxx-FA-NOCN-NNNN NRS272F-1N-0135-NNNN	480	$444_{-0.5}$	319	125	400

5.8.2 MBS272 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}	D_1	D_2	D_3	D_4
MSS272B-xxxx-FA-NOCN-NNNN MRS272B-2N-0094-NNNN	330	$294_{-0.5}$	186	250				
MSS272D-xxxx-FA-NOCN-NNNN MRS272D-2N-0094-NNNN	405	$369_{-0.5}$	261	325	94	93.7	94.5	94.2
MSS272F-xxxx-FA-NOCN-NNNN MRS272F-2N-0094-NNNN	480	$444_{-0.5}$	336	400				
MSS272B-xxxx-FA-NOCN-NNNN MRS272B-2N-0125-NNNN	330	$294_{-0.5}$	186	250				
MSS272D-xxxx-FA-NOCN-NNNN MRS272D-2N-0125-NNNN	405	$369_{-0.5}$	261	325	125	124.7	125.5	125.2
MSS272F-xxxx-FA-NOCN-NNNN MRS272F-2N-0125-NNNN	480	$444_{-0.5}$	336	400				

Fig.5-36: MBS272 with axial cooling connection and rotor design "2N"

5.8.3 MSS272 with Axial Cooling Connection

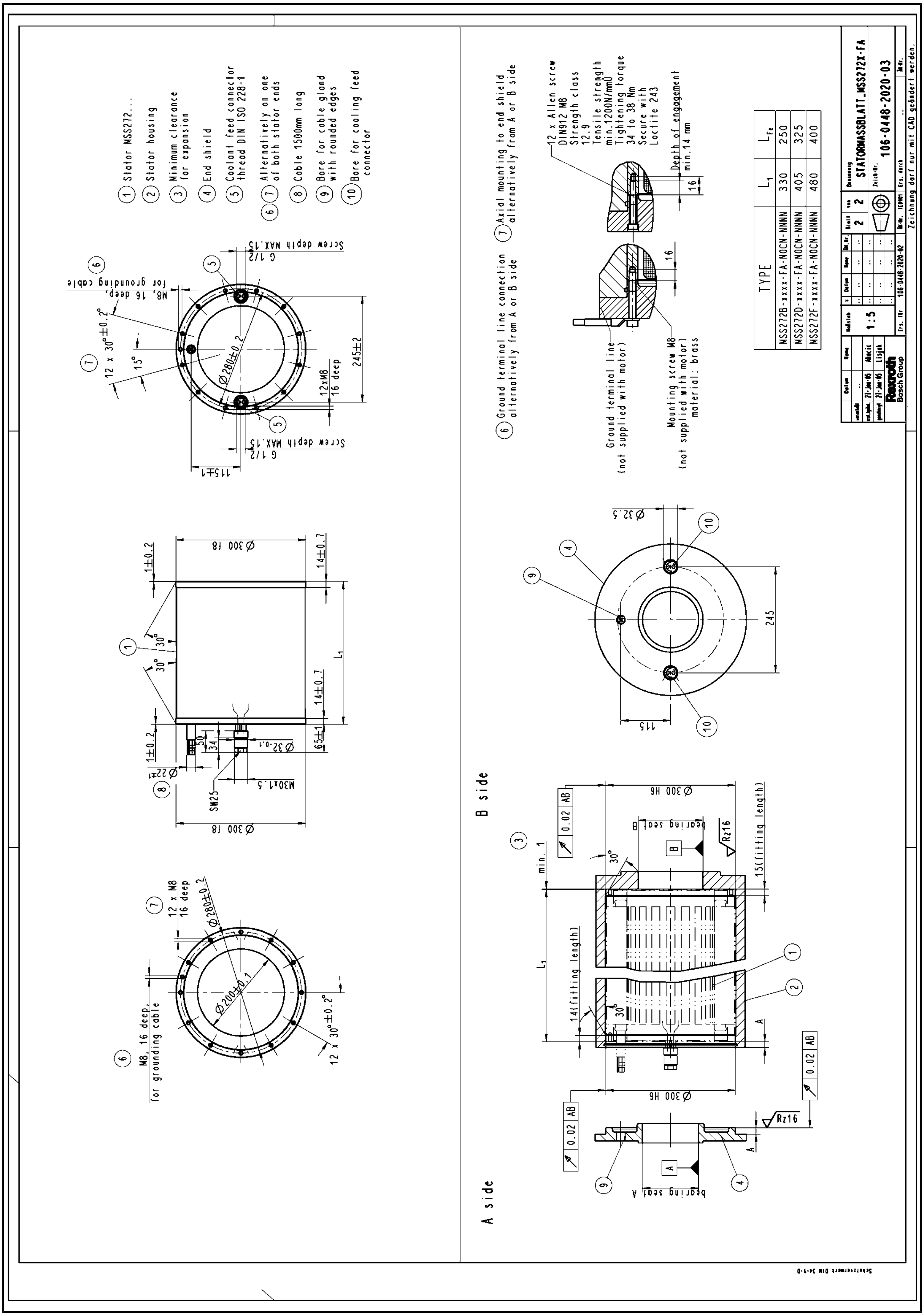
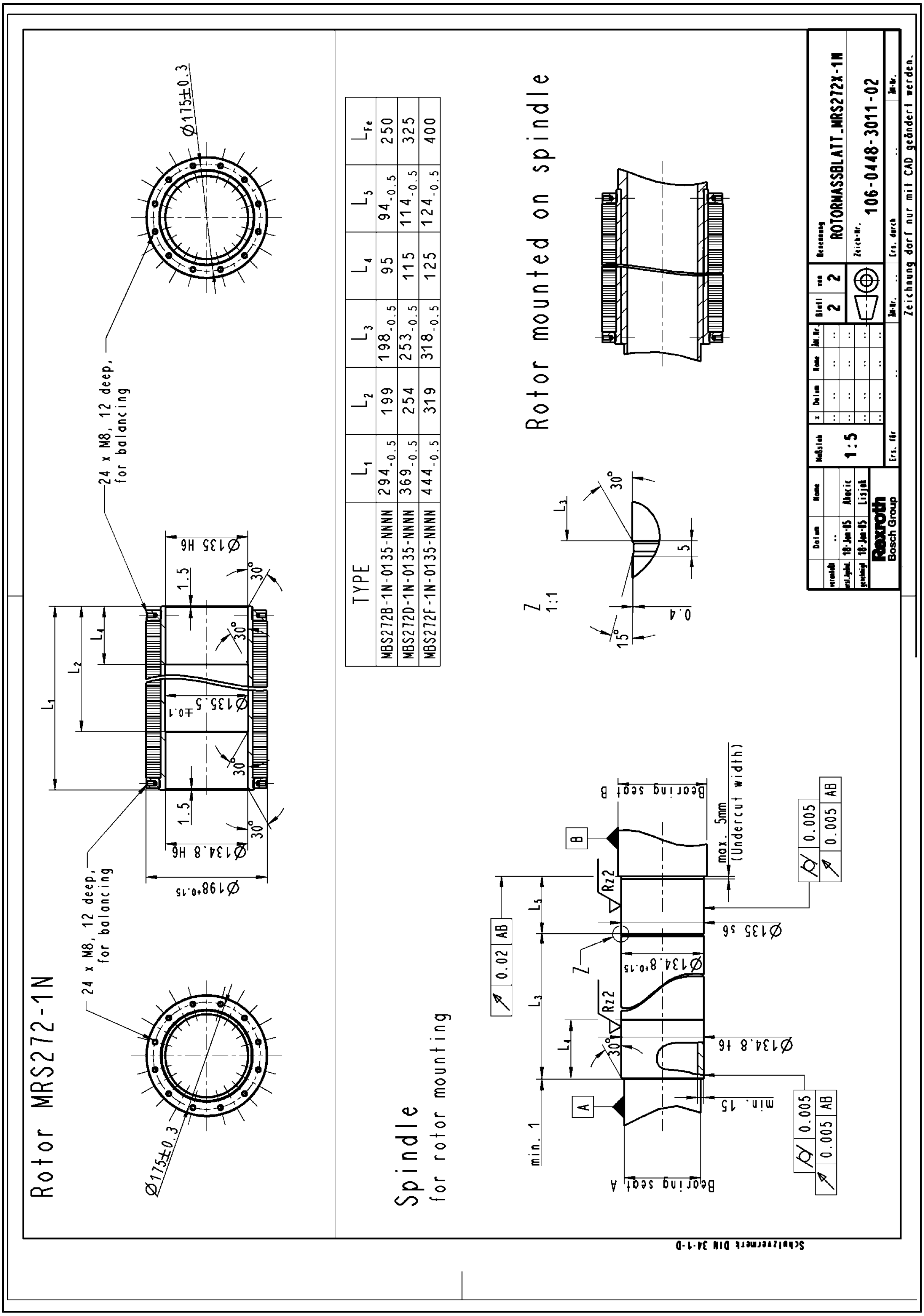


Fig.5-37: MSS272 with axial cooling connection

5.8.4 MRS272 with "1N" Design

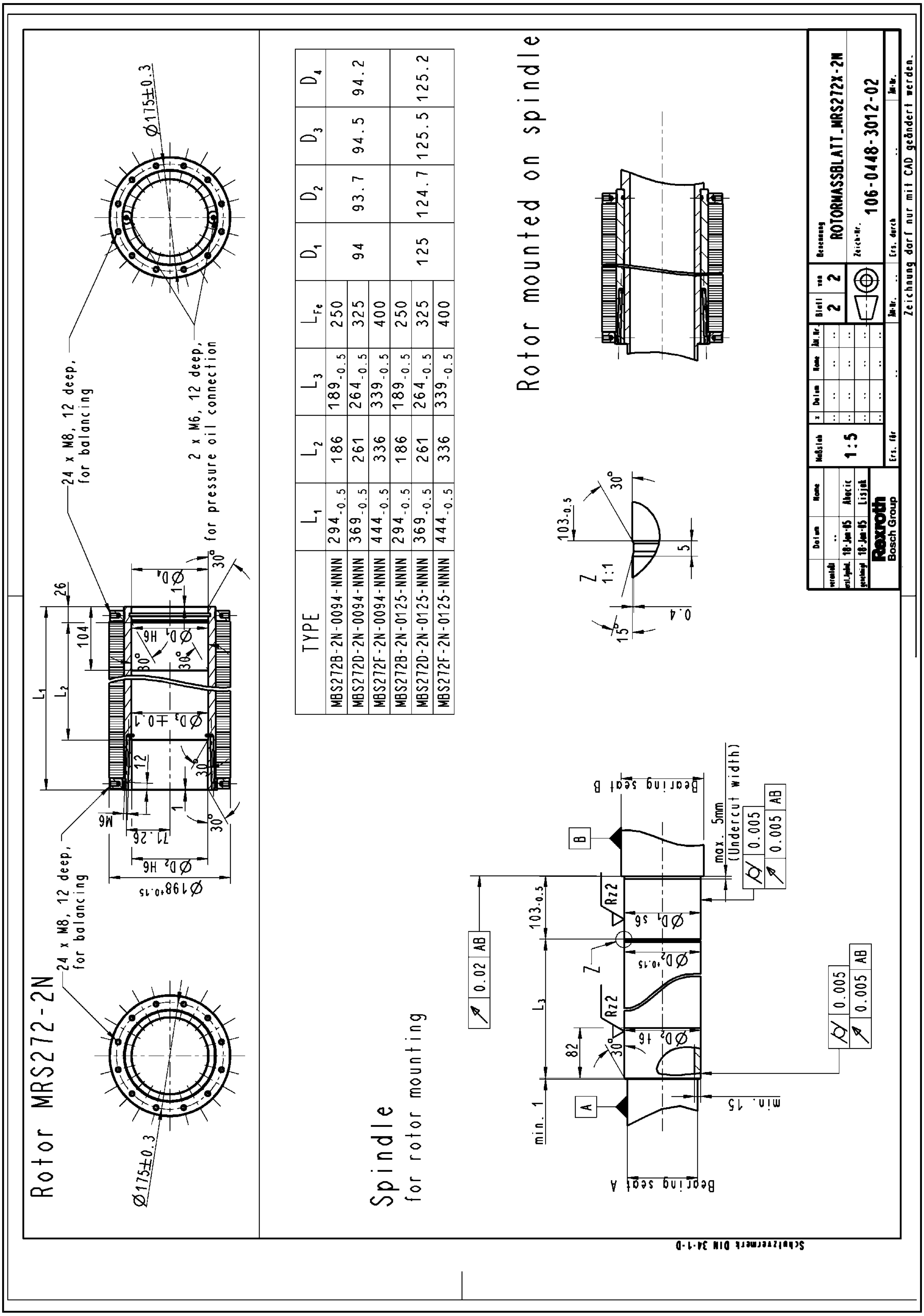


TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MBS272B-1N-0135-NNNN	$294_{-0.5}$	199	$198_{-0.5}$	95	$94_{-0.5}$	250
MBS272D-1N-0135-NNNN	$369_{-0.5}$	254	$253_{-0.5}$	115	$114_{-0.5}$	325
MBS272F-1N-0135-NNNN	$444_{-0.5}$	319	$318_{-0.5}$	125	$124_{-0.5}$	400

Fig.5-38: MRS272 with "1N" design

Dimensional Sheets IndraDyn H

5.8.5 MRS272 with "2N" Design

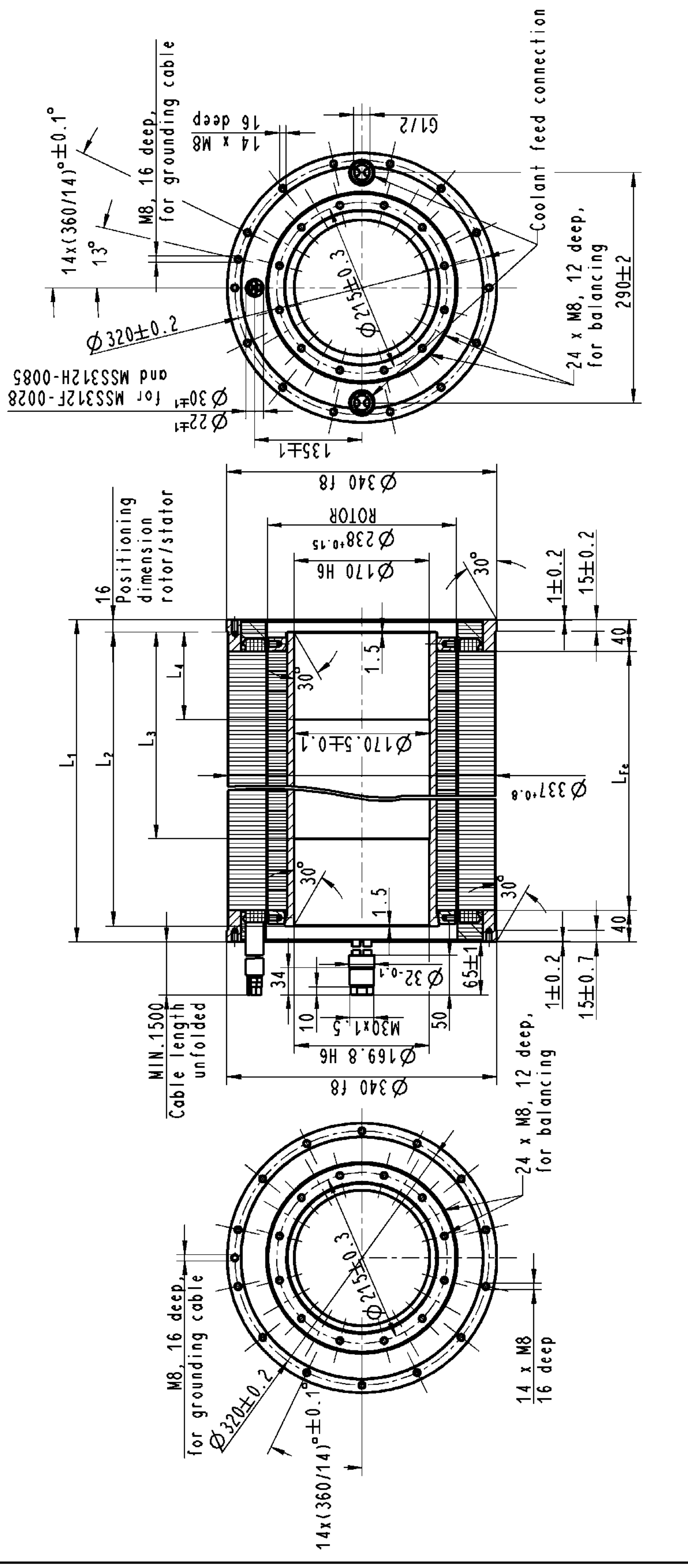


TYPE	L_1	L_2	L_3	L_{Fe}	D_1	D_2	D_3	D_4
MBS272B-2N-0094-NNNN	$294_{-0.5}$	186	$189_{-0.5}$	250	94	93.7	94.5	94.2
MBS272D-2N-0094-NNNN	$369_{-0.5}$	261	$264_{-0.5}$	325				
MBS272F-2N-0094-NNNN	$444_{-0.5}$	336	$339_{-0.5}$	400				
MBS272B-2N-0125-NNNN	$294_{-0.5}$	186	$189_{-0.5}$	250	125	124.7	125.5	125.2
MBS272D-2N-0125-NNNN	$369_{-0.5}$	261	$264_{-0.5}$	325				
MBS272F-2N-0125-NNNN	$444_{-0.5}$	336	$339_{-0.5}$	400				

Fig.5-39: MRS272 with "2N" design

5.9 Dimension Sheet Size 312

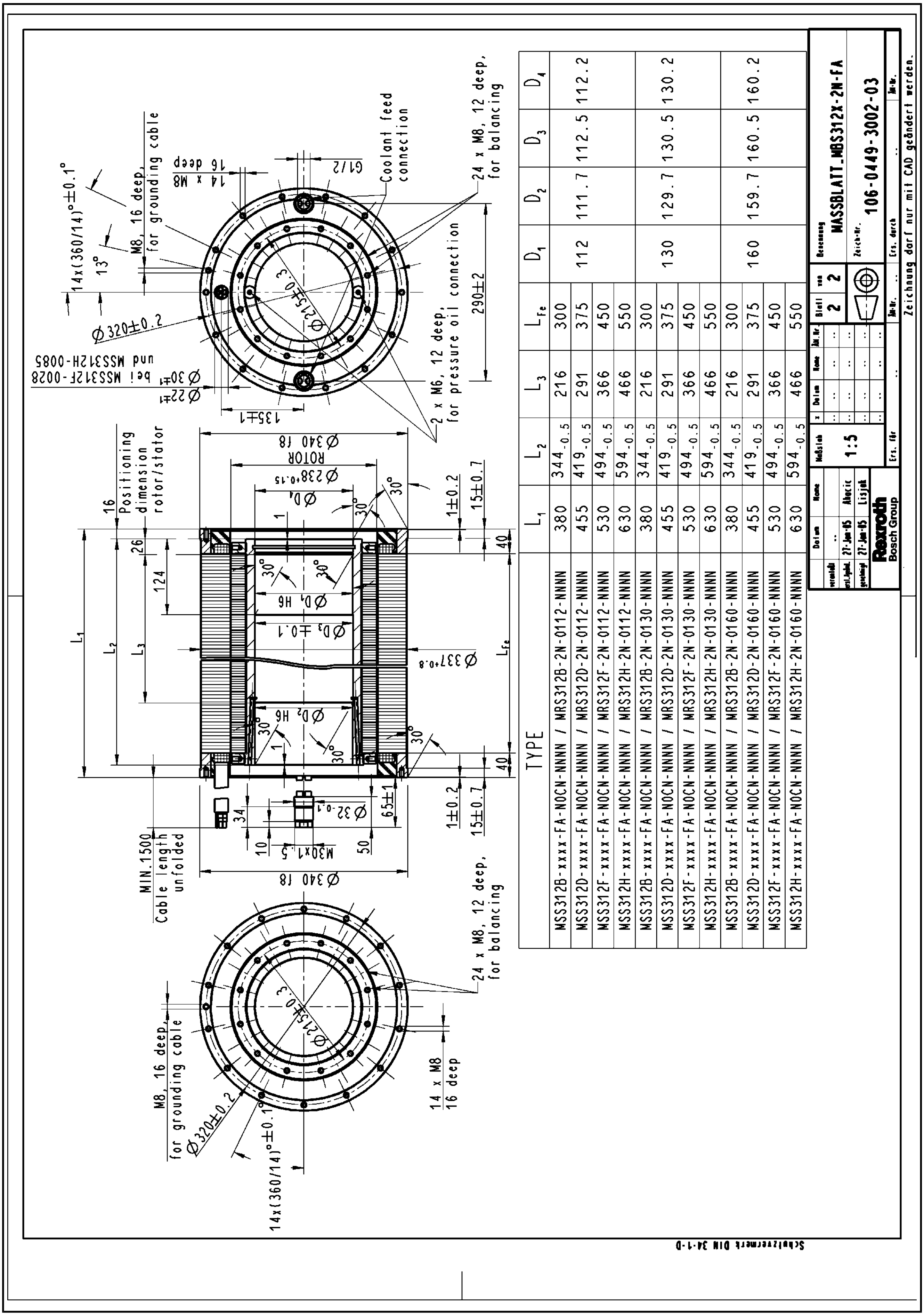
5.9.1 MBS312 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS312B-xxxx-FA-N0CN-NNNN MRS312B-1N-0170-NNNN	380	$344_{-0.5}$	234	110	300
MSS312D-xxxx-FA-N0CN-NNNN MRS312D-1N-0170-NNNN	455	$419_{-0.5}$	289	130	375
MSS312F-xxxx-FA-N0CN-NNNN MRS312F-1N-0170-NNNN	530	$494_{-0.5}$	344	150	450
MSS312H-xxxx-FA-N0CN-NNNN MRS312H-1N-0170-NNNN	630	$594_{-0.5}$	424	170	550

Maßstab 1:5 | Blatt 2 von 2 | Benennung MASSBLATT_MBS312X-1N-FA | Zeich-Nr. 106-0449-3001-03
erst./gepr. 27-Jan-05 Abacic | genehmigt 27-Jan-05 Lisjak | Rexroth Bosch Group
Zeichnung darf nur mit CAD geändert werden.
Schutzvermerk DIN 34-1-D

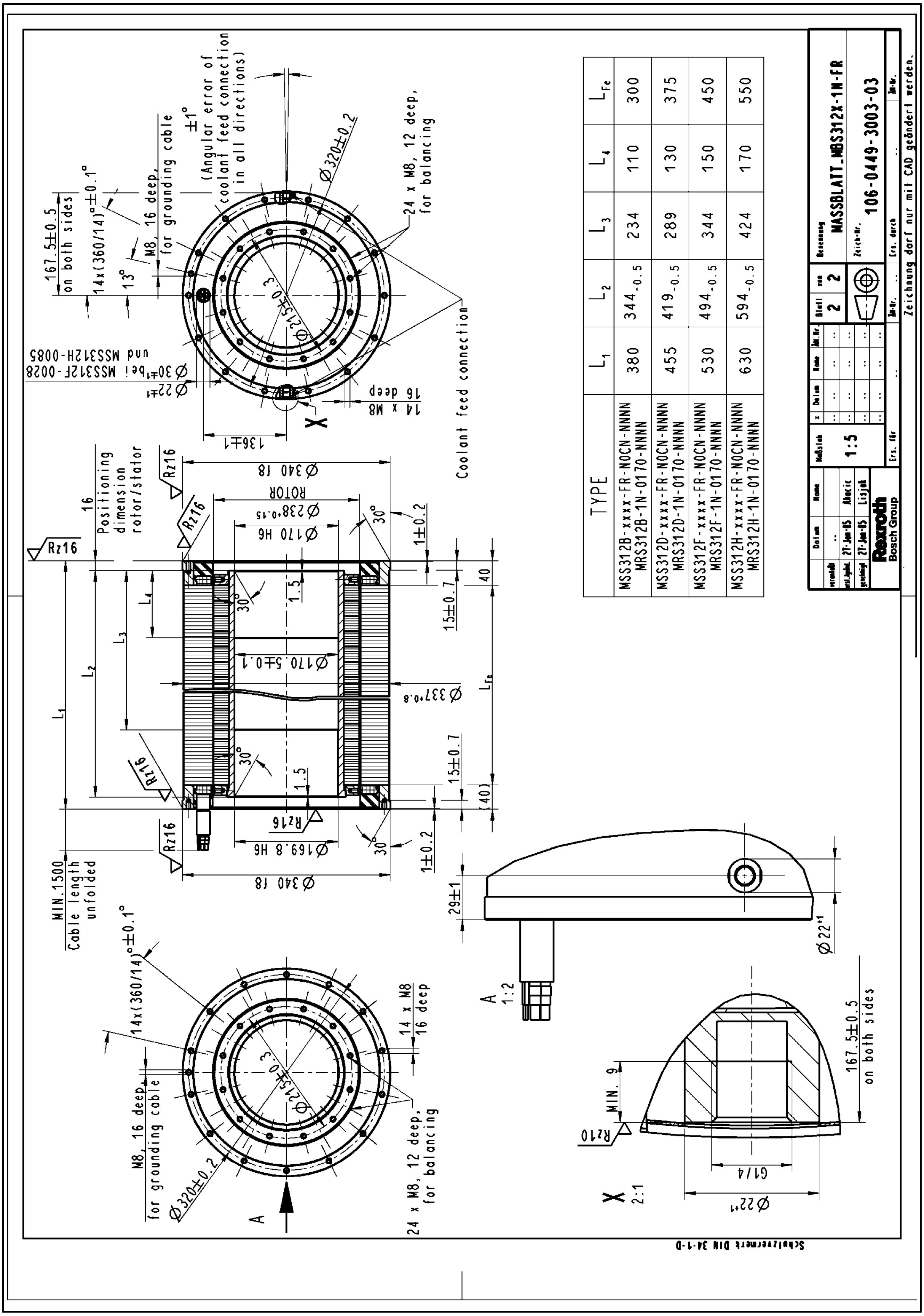
5.9.2 MBS312 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}	D_1	D_2	D_3	D_4
MSS312B-xxxx-FA-NOCN-NNNN / MRS312B-2N-0112-NNNN	380	$344_{-0.5}$	216	300	112	111.7	112.5	112.2
MSS312D-xxxx-FA-NOCN-NNNN / MRS312D-2N-0112-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FA-NOCN-NNNN / MRS312F-2N-0112-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FA-NOCN-NNNN / MRS312H-2N-0112-NNNN	630	$594_{-0.5}$	466	550				
MSS312B-xxxx-FA-NOCN-NNNN / MRS312B-2N-0130-NNNN	380	$344_{-0.5}$	216	300	130	129.7	130.5	130.2
MSS312D-xxxx-FA-NOCN-NNNN / MRS312D-2N-0130-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FA-NOCN-NNNN / MRS312F-2N-0130-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FA-NOCN-NNNN / MRS312H-2N-0130-NNNN	630	$594_{-0.5}$	466	550				
MSS312B-xxxx-FA-NOCN-NNNN / MRS312B-2N-0160-NNNN	380	$344_{-0.5}$	216	300	160	159.7	160.5	160.2
MSS312D-xxxx-FA-NOCN-NNNN / MRS312D-2N-0160-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FA-NOCN-NNNN / MRS312F-2N-0160-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FA-NOCN-NNNN / MRS312H-2N-0160-NNNN	630	$594_{-0.5}$	466	550				

Fig.5-41: MBS312 with axial cooling connection and rotor design "2N"

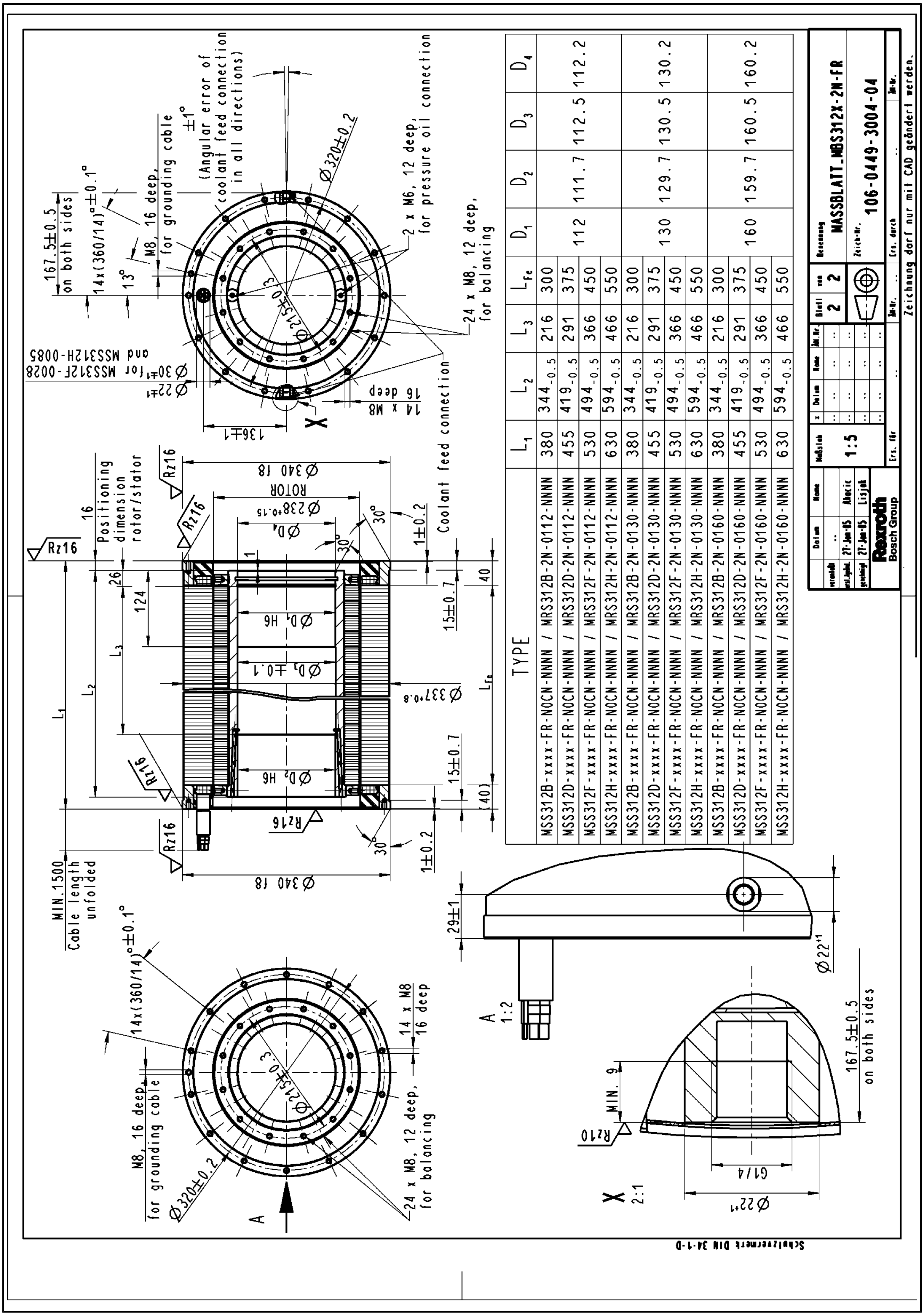
5.9.3 MBS312 with Radial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
MSS312B-xxxx-FR-N0CN-NNNN MRS312B-1N-0170-NNNN	380	$344_{-0.5}$	234	110	300
MSS312D-xxxx-FR-N0CN-NNNN MRS312D-1N-0170-NNNN	455	$419_{-0.5}$	289	130	375
MSS312F-xxxx-FR-N0CN-NNNN MRS312F-1N-0170-NNNN	530	$494_{-0.5}$	344	150	450
MSS312H-xxxx-FR-N0CN-NNNN MRS312H-1N-0170-NNNN	630	$594_{-0.5}$	424	170	550

Fig.5-42: MBS312 with radial cooling connection and rotor design "1N"

5.9.4 MBS312 with Radial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}	D_1	D_2	D_3	D_4
MSS312B-xxxx-FR-N0CN-NNNN / MRS312B-2N-0112-NNNN	380	$344_{-0.5}$	216	300	112	111.7	112.5	112.2
MSS312D-xxxx-FR-N0CN-NNNN / MRS312D-2N-0112-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FR-N0CN-NNNN / MRS312F-2N-0112-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FR-N0CN-NNNN / MRS312H-2N-0112-NNNN	630	$594_{-0.5}$	466	550				
MSS312B-xxxx-FR-N0CN-NNNN / MRS312B-2N-0130-NNNN	380	$344_{-0.5}$	216	300	130	129.7	130.5	130.2
MSS312D-xxxx-FR-N0CN-NNNN / MRS312D-2N-0130-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FR-N0CN-NNNN / MRS312F-2N-0130-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FR-N0CN-NNNN / MRS312H-2N-0130-NNNN	630	$594_{-0.5}$	466	550				
MSS312B-xxxx-FR-N0CN-NNNN / MRS312B-2N-0160-NNNN	380	$344_{-0.5}$	216	300	160	159.7	160.5	160.2
MSS312D-xxxx-FR-N0CN-NNNN / MRS312D-2N-0160-NNNN	455	$419_{-0.5}$	291	375				
MSS312F-xxxx-FR-N0CN-NNNN / MRS312F-2N-0160-NNNN	530	$494_{-0.5}$	366	450				
MSS312H-xxxx-FR-N0CN-NNNN / MRS312H-2N-0160-NNNN	630	$594_{-0.5}$	466	550				

Fig.5-43: MBS312 with radial cooling connection and rotor design "2N"

5.9.5 MSS312 with Axial Cooling Connection

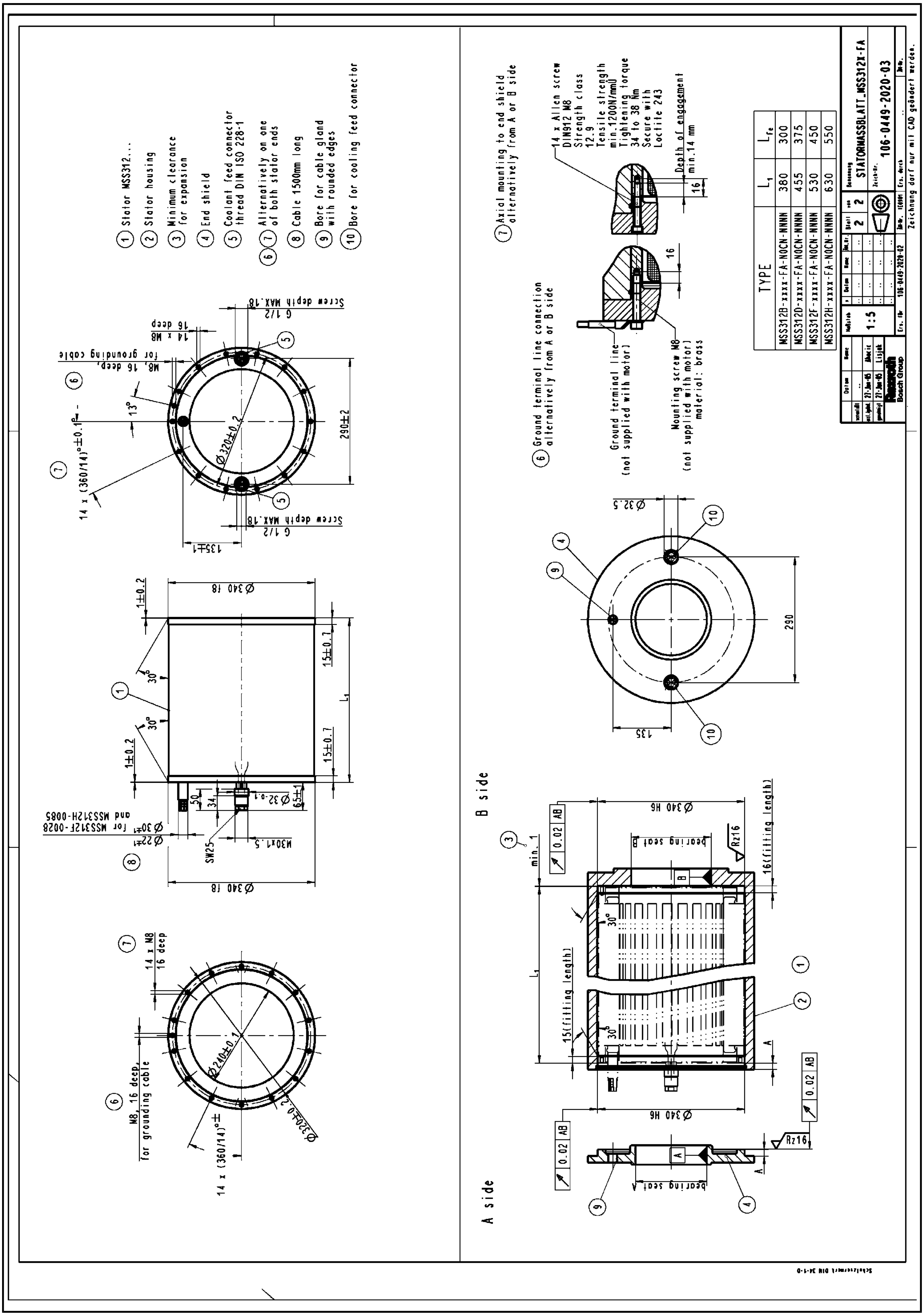


Fig.5-44: MSS312 with axial cooling connection

5.9.6 MSS312 with Radial Cooling Connection

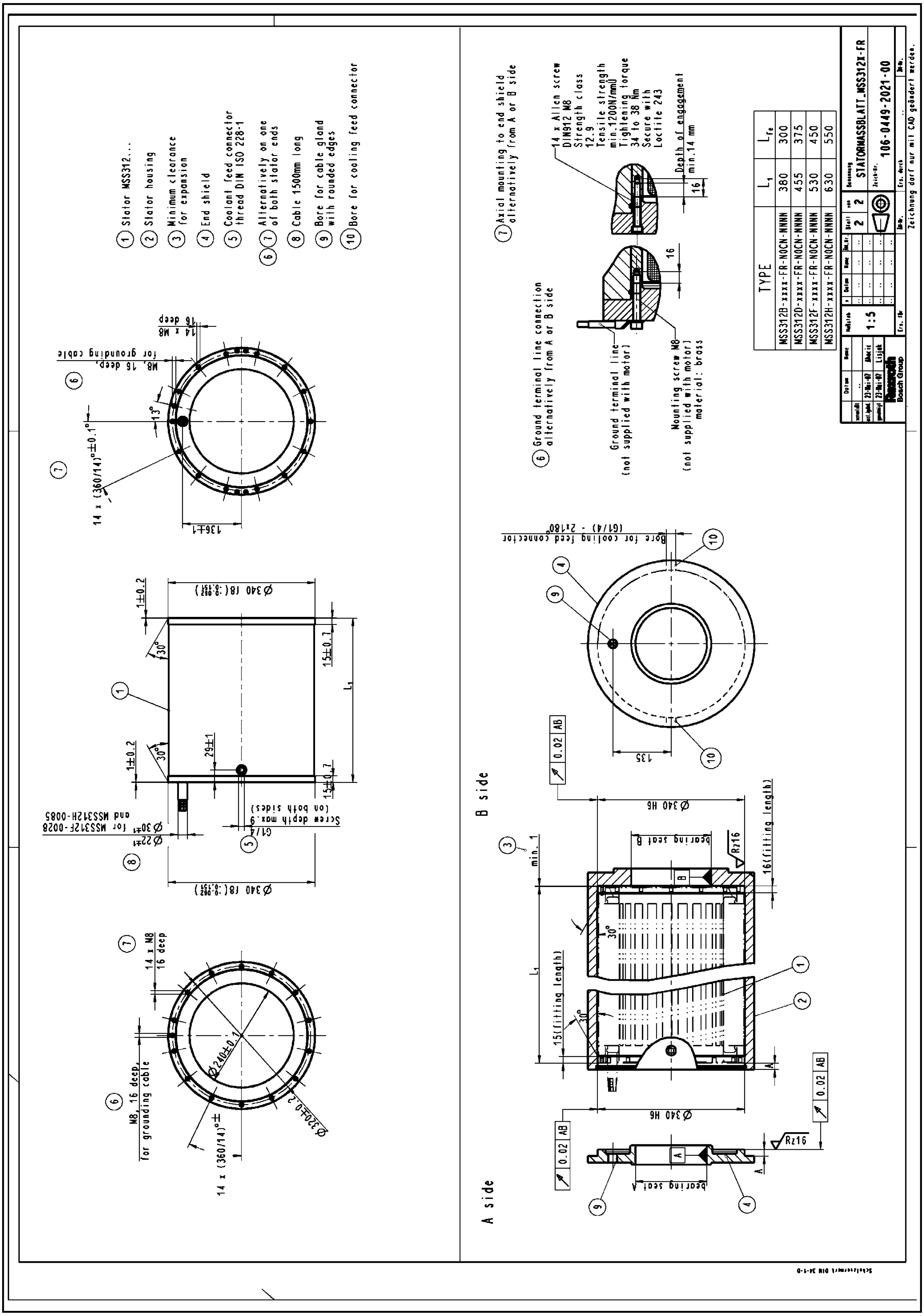
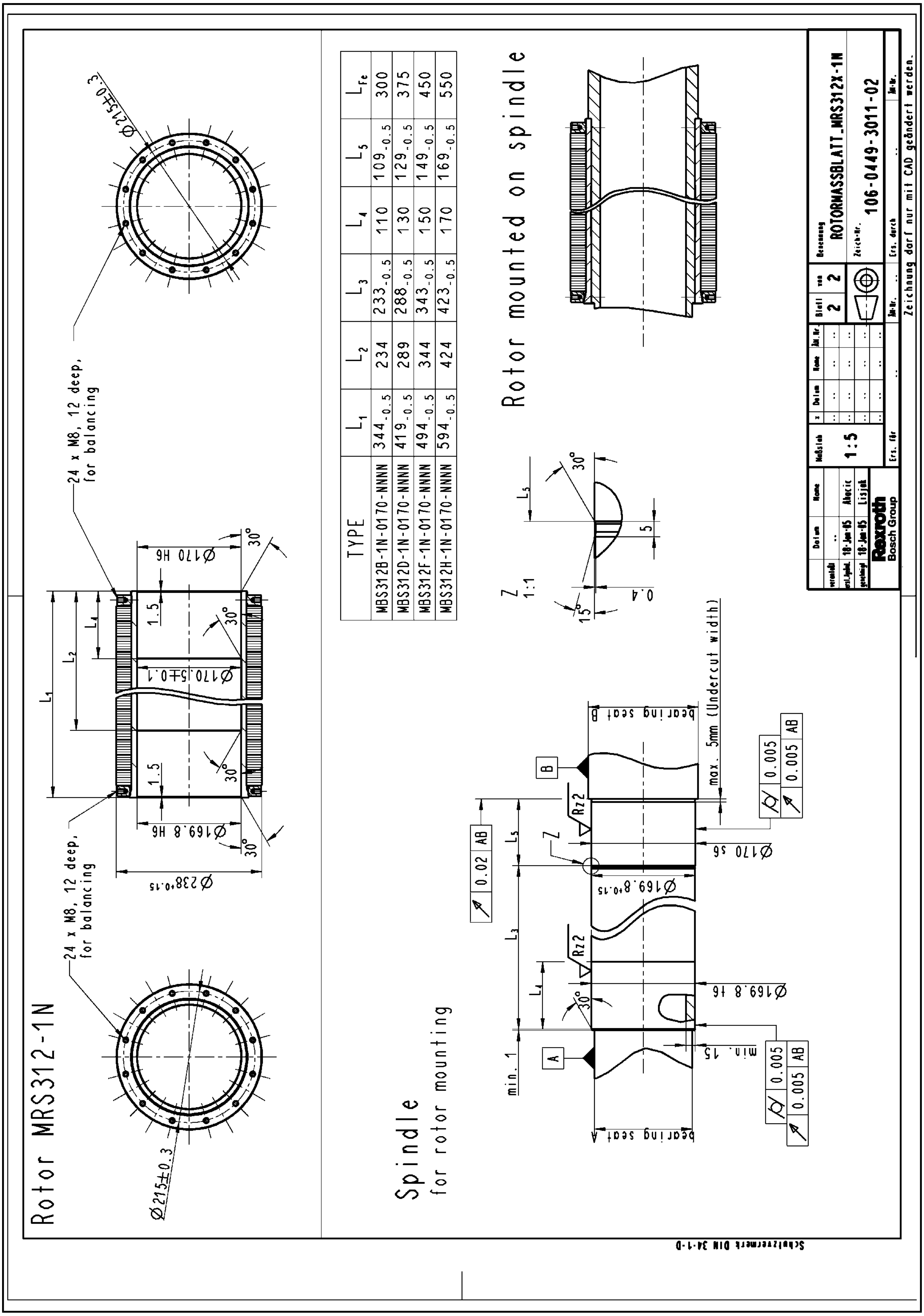


Fig.5-45: MSS312 with radial cooling connection

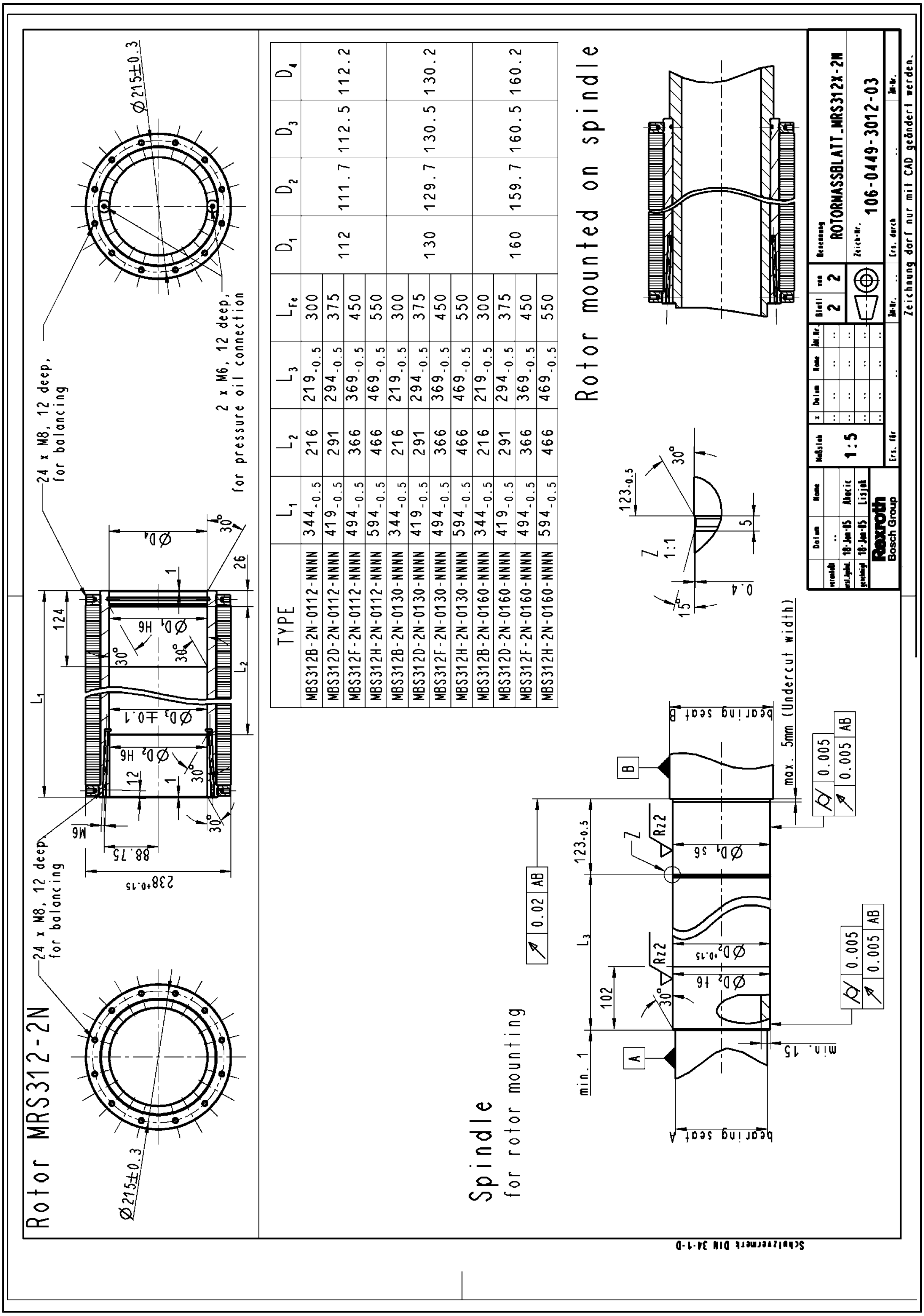
5.9.7 MRS312 with "1N" Design



TYPE	L_1	L_2	L_3	L_4	L_5	L_{Fe}
MBS312B-1N-0170-NNNN	$344_{-0.5}$	234	$233_{-0.5}$	110	$109_{-0.5}$	300
MBS312D-1N-0170-NNNN	$419_{-0.5}$	289	$288_{-0.5}$	130	$129_{-0.5}$	375
MBS312F-1N-0170-NNNN	$494_{-0.5}$	344	$343_{-0.5}$	150	$149_{-0.5}$	450
MBS312H-1N-0170-NNNN	$594_{-0.5}$	424	$423_{-0.5}$	170	$169_{-0.5}$	550

Fig.5-46: MRS312 with "1N" design

5.9.8 MRS312 with "2N" Design

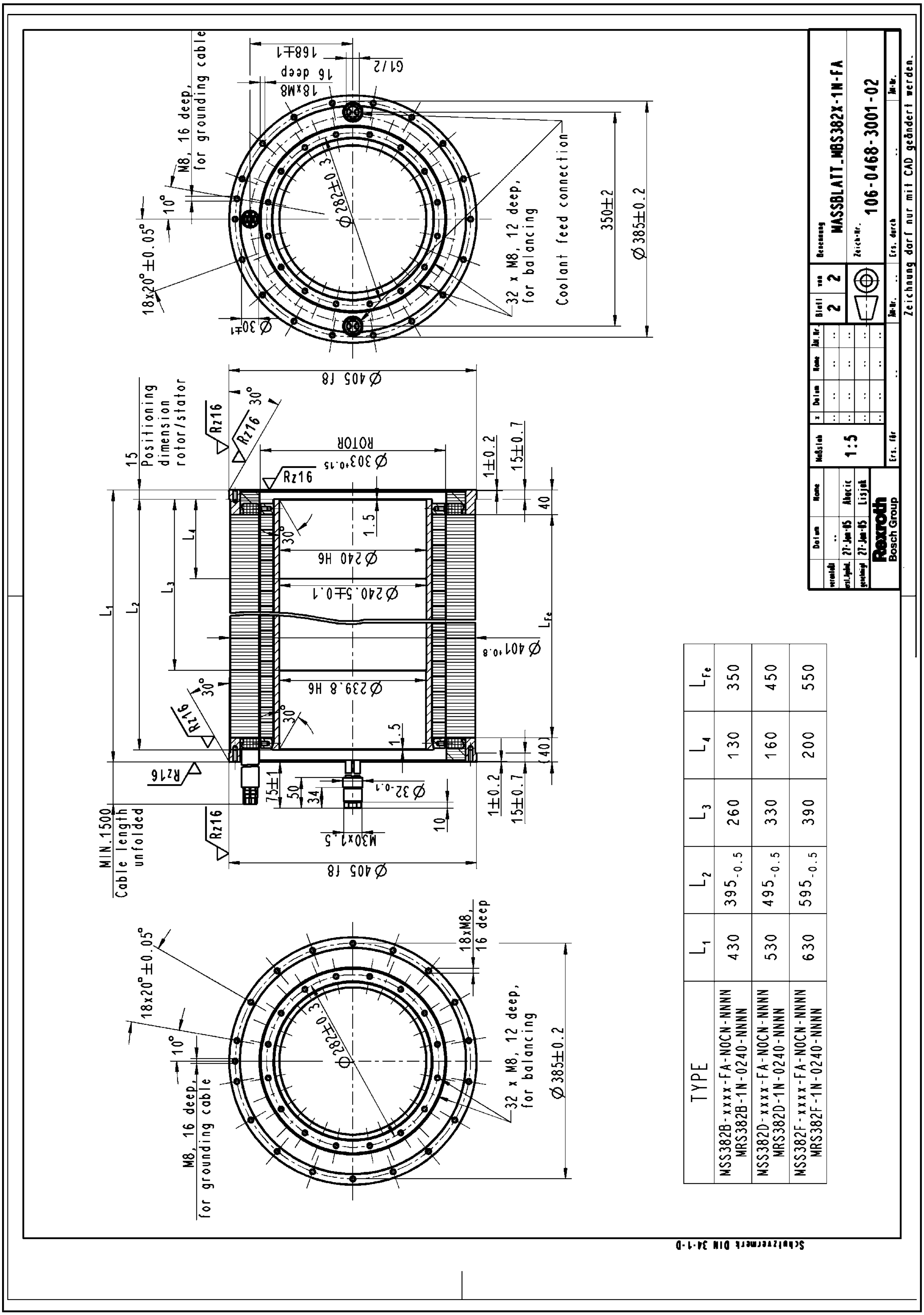


TYPE	L_1	L_2	L_3	L_{Fe}	D_1	D_2	D_3	D_4
MBS312B-2N-0112-NNNN	$344_{-0.5}$	216	$219_{-0.5}$	300	112	111.7	112.5	112.2
MBS312D-2N-0112-NNNN	$419_{-0.5}$	291	$294_{-0.5}$	375				
MBS312F-2N-0112-NNNN	$494_{-0.5}$	366	$369_{-0.5}$	450				
MBS312H-2N-0112-NNNN	$594_{-0.5}$	466	$469_{-0.5}$	550				
MBS312B-2N-0130-NNNN	$344_{-0.5}$	216	$219_{-0.5}$	300	130	129.7	130.5	130.2
MBS312D-2N-0130-NNNN	$419_{-0.5}$	291	$294_{-0.5}$	375				
MBS312F-2N-0130-NNNN	$494_{-0.5}$	366	$369_{-0.5}$	450				
MBS312H-2N-0130-NNNN	$594_{-0.5}$	466	$469_{-0.5}$	550				
MBS312B-2N-0160-NNNN	$344_{-0.5}$	216	$219_{-0.5}$	300	160	159.7	160.5	160.2
MBS312D-2N-0160-NNNN	$419_{-0.5}$	291	$294_{-0.5}$	375				
MBS312F-2N-0160-NNNN	$494_{-0.5}$	366	$369_{-0.5}$	450				
MBS312H-2N-0160-NNNN	$594_{-0.5}$	466	$469_{-0.5}$	550				

Fig.5-47: MRS312 with "2N" design

5.10 Size 382

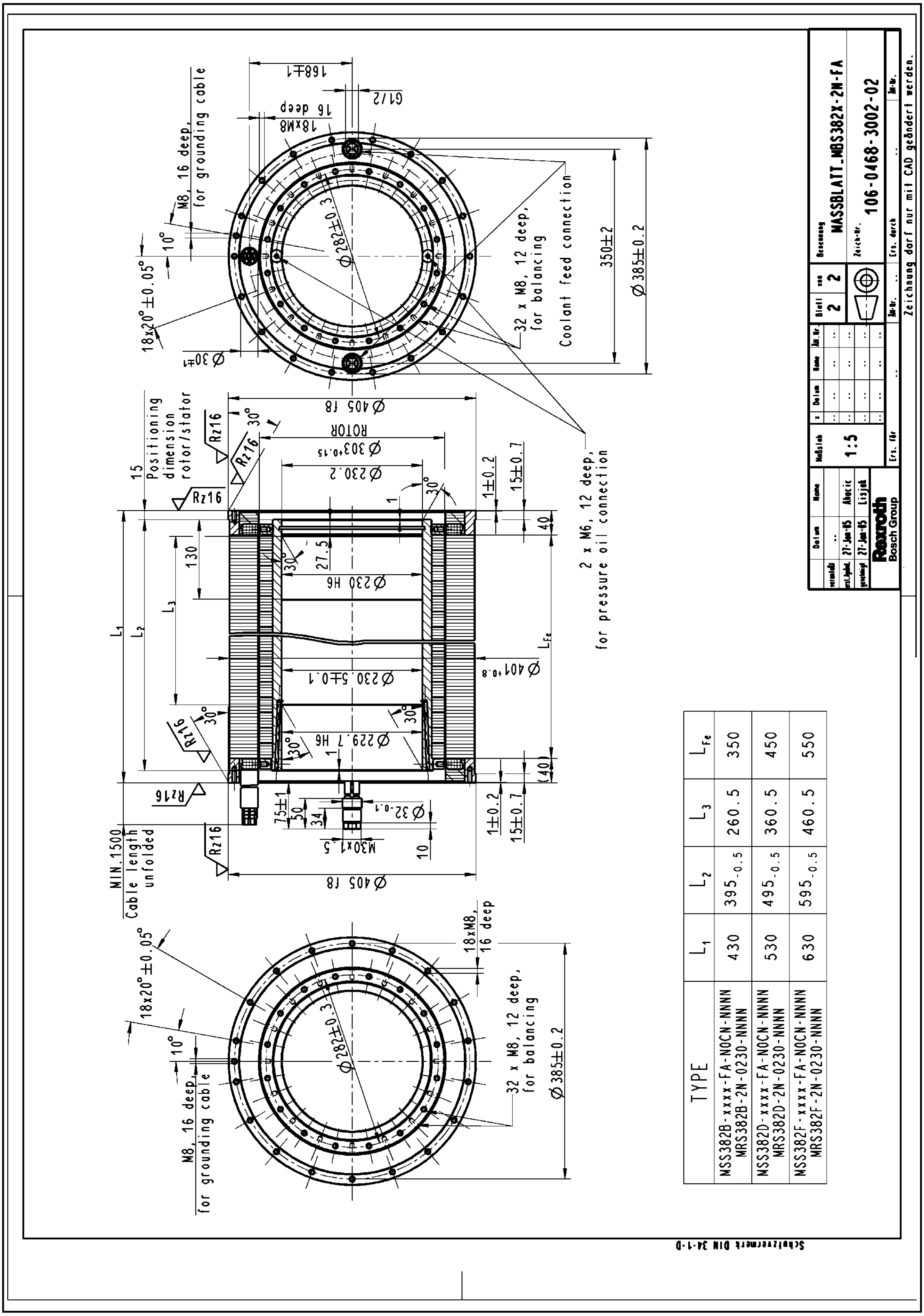
5.10.1 MBS382 with Axial Cooling Connection and Rotor Design "1N"



TYPE	L_1	L_2	L_3	L_4	L_{Fe}
NSS382B-xxxx-FA-N0CN-NNNN MRS382B-1N-0240-NNNN	430	$395_{-0.5}$	260	130	350
NSS382D-xxxx-FA-N0CN-NNNN MRS382D-1N-0240-NNNN	530	$495_{-0.5}$	330	160	450
NSS382F-xxxx-FA-N0CN-NNNN MRS382F-1N-0240-NNNN	630	$595_{-0.5}$	390	200	550

Dimensional Sheets IndraDyn H

5.10.2 MBS382 with Axial Cooling Connection and Rotor Design "2N"



TYPE	L_1	L_2	L_3	L_{Fe}
MSS382B-xxxx-FA-NOCN-NNNN MRS382B-2N-0230-NNNN	430	$395_{-0.5}$	260.5	350
MSS382D-xxxx-FA-NOCN-NNNN MRS382D-2N-0230-NNNN	530	$495_{-0.5}$	360.5	450
MSS382F-xxxx-FA-NOCN-NNNN MRS382F-2N-0230-NNNN	630	$595_{-0.5}$	460.5	550

Fig.5-49: MBS382 with axial cooling connection and rotor design "2N"

5.10.3 MSS382 with Axial Cooling Connection

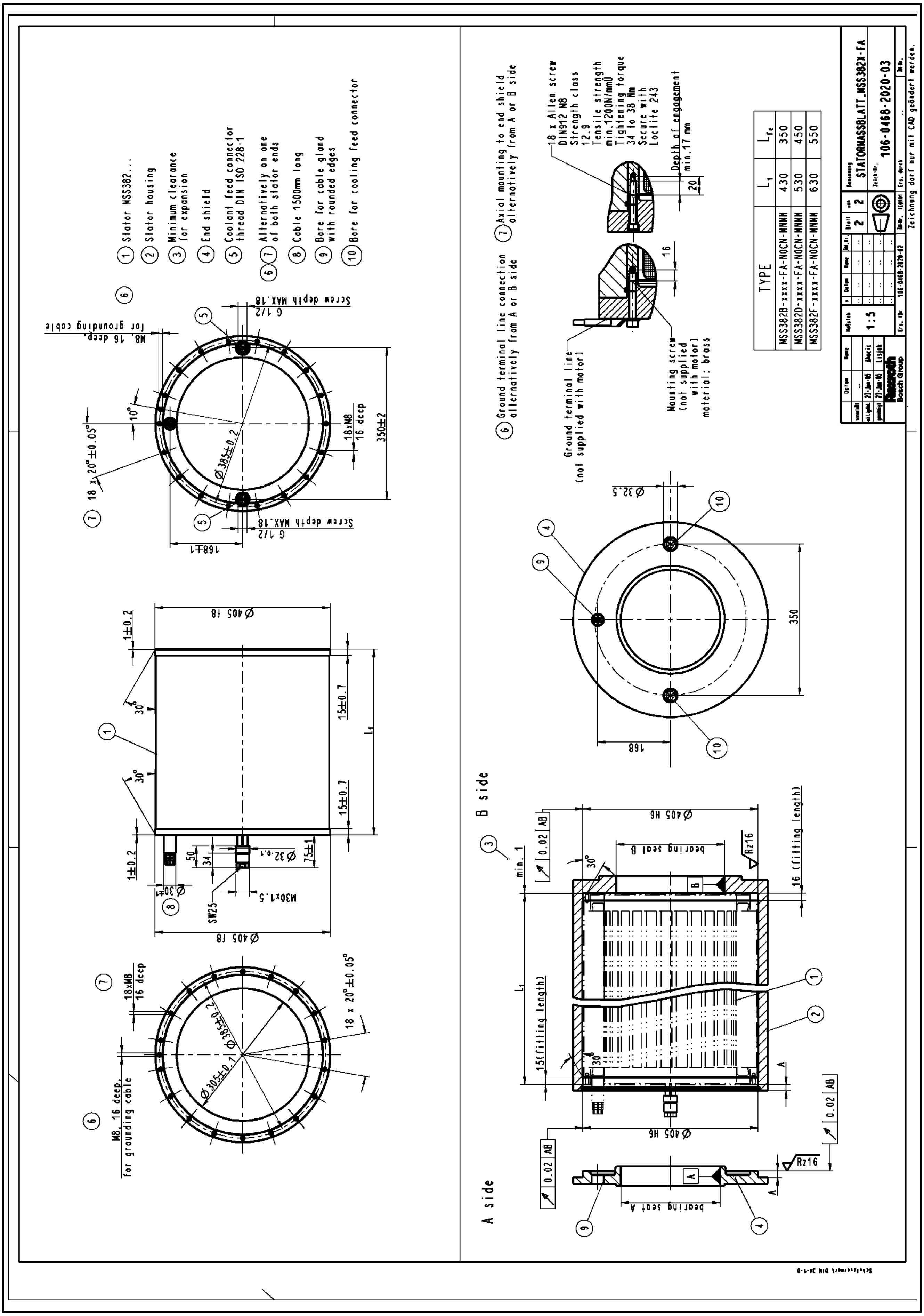


Fig.5-50: MSS382 with axial cooling connection

Dimensional Sheets IndraDyn H

5.10.4 MRS382 with "1N" Design

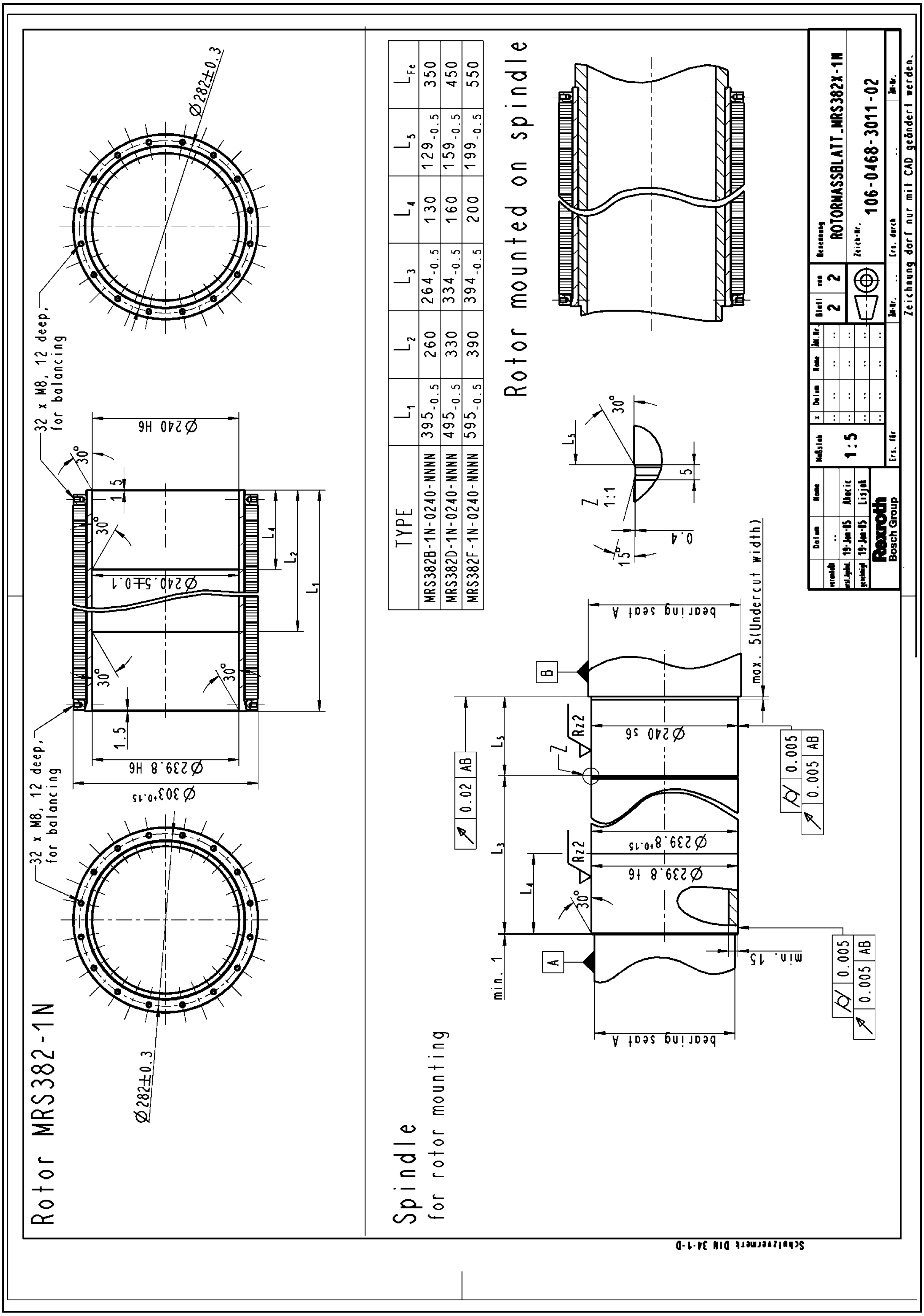


Fig.5-51: MRS382 with "1N" design

5.10.5 MRS382 with "2N" Design

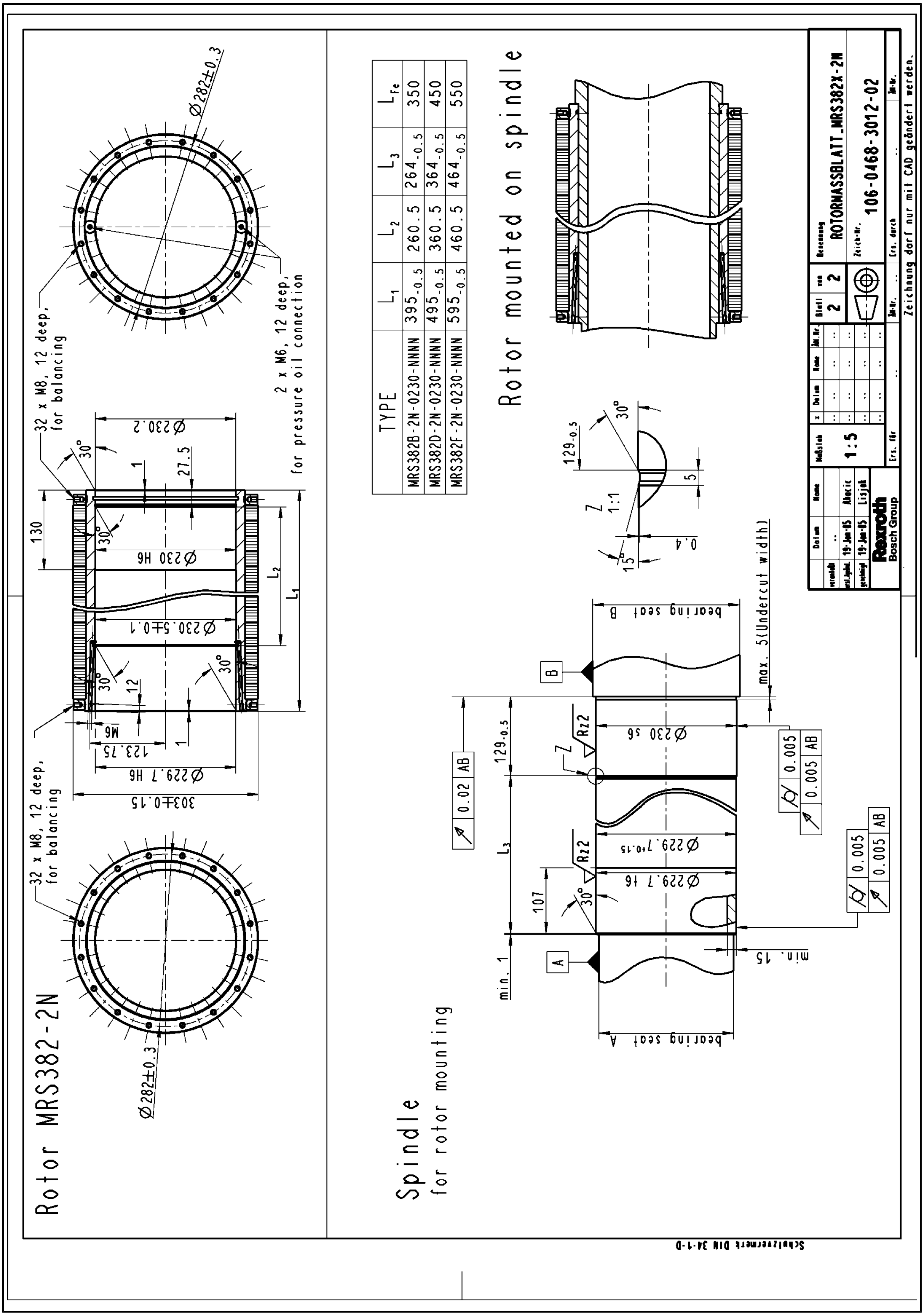


Fig.5-52: MRS382 with "2N" design

6 Type Codes IndraDyn H

6.1 Introduction

6.1.1 General

The type code describes the available motor variants; it is the basis for selecting and ordering products from BOSCH REXROTH. This applies to both new products as well as spare parts and repairs.

IndraDyn H Motors is the overall product designation for the new high-speed kit motor series of REXROTH and describes the technical developments made to the MBS motors.

IndraDyn H motors are kit motors. For this reason, both rotor and stator have an additional, unique and defined short description.

The designation of rotor (MRS) and stator (MSS) are the same as for MBS motors. The IndraDyn H motor generation contains a "2" in the 6th position of the type code (e.g. MSSxx2 / MRSxx2).

The following figures give an example of a motor type code for rotor and stator, by which an exact specification of the single parts (e.g. for orders) is possible.

The following description gives an overview over the separate columns of the type code (”abbrev. column”) and its meaning.

☞ When selecting a product, always consider the detailed specifications in the chapter 4 ”Technical Data” and chapter 9 ”Notes regarding Application”.

6.1.2 Type Code for Rotor MRS

1. Product Group

Abbrev. column 1 2 3

MRS is the rotor designation of a synchronous kit spindle motor of the IndraDyn H series.

2. Motor Frame Size

Abbrev. column 4 5 6

The motor frame size is derived from the mechanical stator dimensions and represents different power ranges.

3. Motor Frame Length

Short text column 7

Within a series, the graduation of increasing motor frame length is indicated by ID letters in alphabetic order.

Frame lengths are, for example, A, B, C, D and E.

4. Shape/Mechanical Construction

Abbrev. columns 9 10

Specifies the type of how the rotor is bored.

1N = smooth rotor drilling,

2N = step interference fit.

For more information regarding the design see chapter 9.6 ”Design and assembly principle of rotor/spindle shaft”.

5. Internal Rotor Diameter

Abbrev. column 12 13 14 15

Indicates the internal diameter of the rotor in millimeters (mm).

6. Other Designs

Abbrev. column 17 18 19 20

Reserved for optional types. You can find a short description in the appropriate type code; mechanical details are in the corresponding dimension sheet.

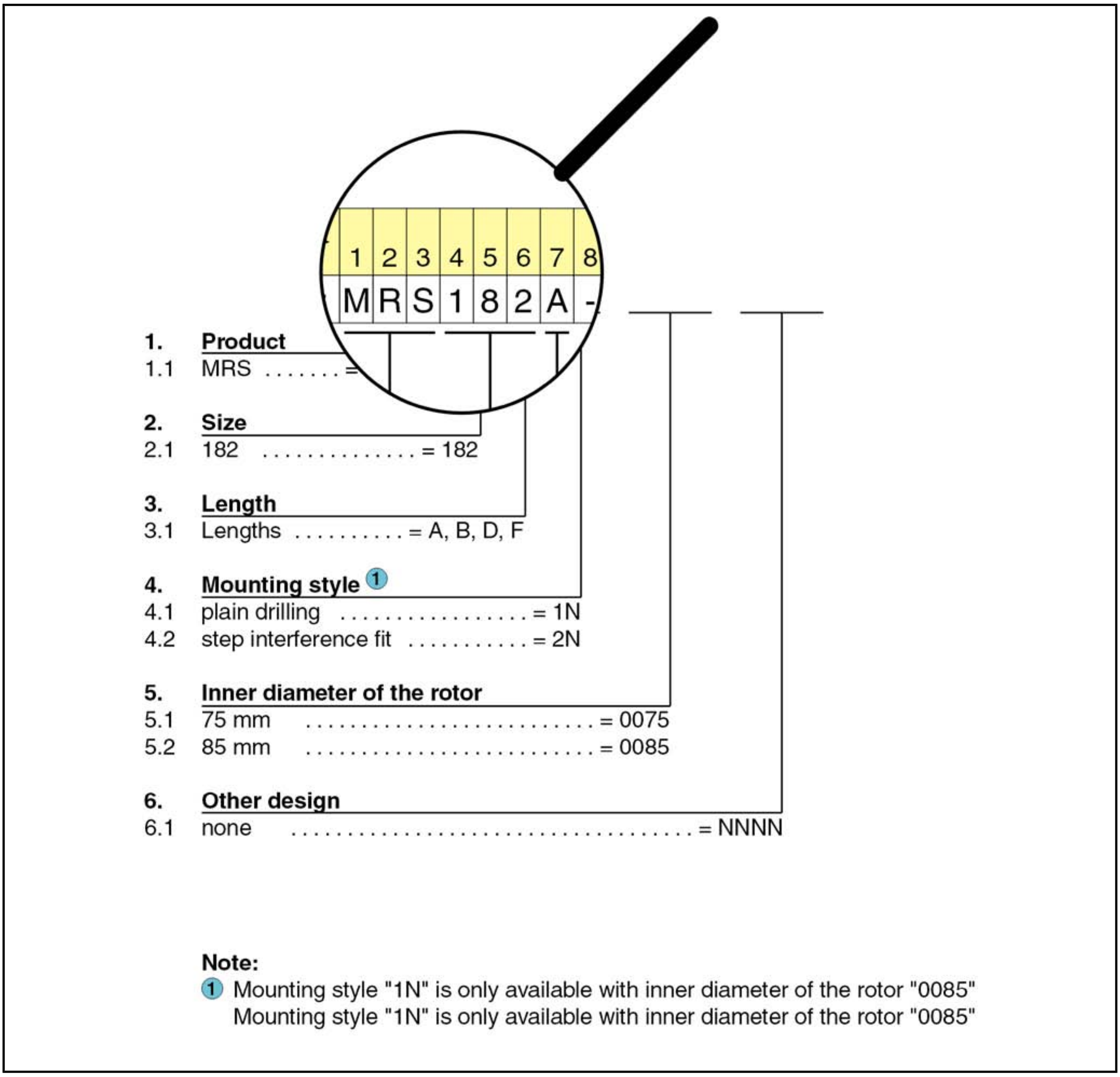


Fig.6-1: IndraDyn H type code example MRS

6.1.3 Type Code for Stator MSS

1. Product

Abbrev. column 1 2 3

MSS is the stator designation of a synchronous kit spindle motor of the IndraDyn H series.

2. Motor Frame Size

Abbrev. column 4 5 6

The motor frame size is derived from the mechanical stator dimensions and represents different power ranges.

3. Motor Frame Length

Short text column 7

Within a series, the graduation of increasing motor frame length is indicated by ID letters in alphabetic order. The longer the motor frame, the higher the torque.

Frame lengths are, for example, **A**, **B**, **C**, **D** and **E**.

4. Winding Code

Abbrev. column 9 10 11 12

Winding codes "**0120**", "**0170**", etc. are used to differentiate winding variants; they indicate the rated speed.

Example: Winding "0120" is the rated speed n_N = 1200 min^{-1}. An intermediate circuit voltage of 540 V_{DC} is used as a fixed reference value.

A drive combination is selected based on the corresponding selection data and operating characteristics.

5. Type of Cooling

Short text column 14

Generally, the motors of type IndraDyn H are fitted with a stator-cooling jacket for operating with **liquid cooling**.

6. Coolant Connection

Short text column 15

Specifies the position of the cooling connection on the stator.

7. Motor Encoder

Abbrev. columns 17 18

IndraDyn H motors are available without a motor encoder. For information to the motor encoder see chapter ”Application notes”.

8. Electrical Connection

Abbrev. columns 19 20

The electrical connection is made via an approx. 1.5 m long power cable consisting of flying leads.

For more information see chapter ”Connection system”.

9. Other Designs

Abbrev. column 22 23 24 25

Reserved for optional types. You can find a short description in the appropriate type code; mechanical details are in the corresponding dimension sheet.

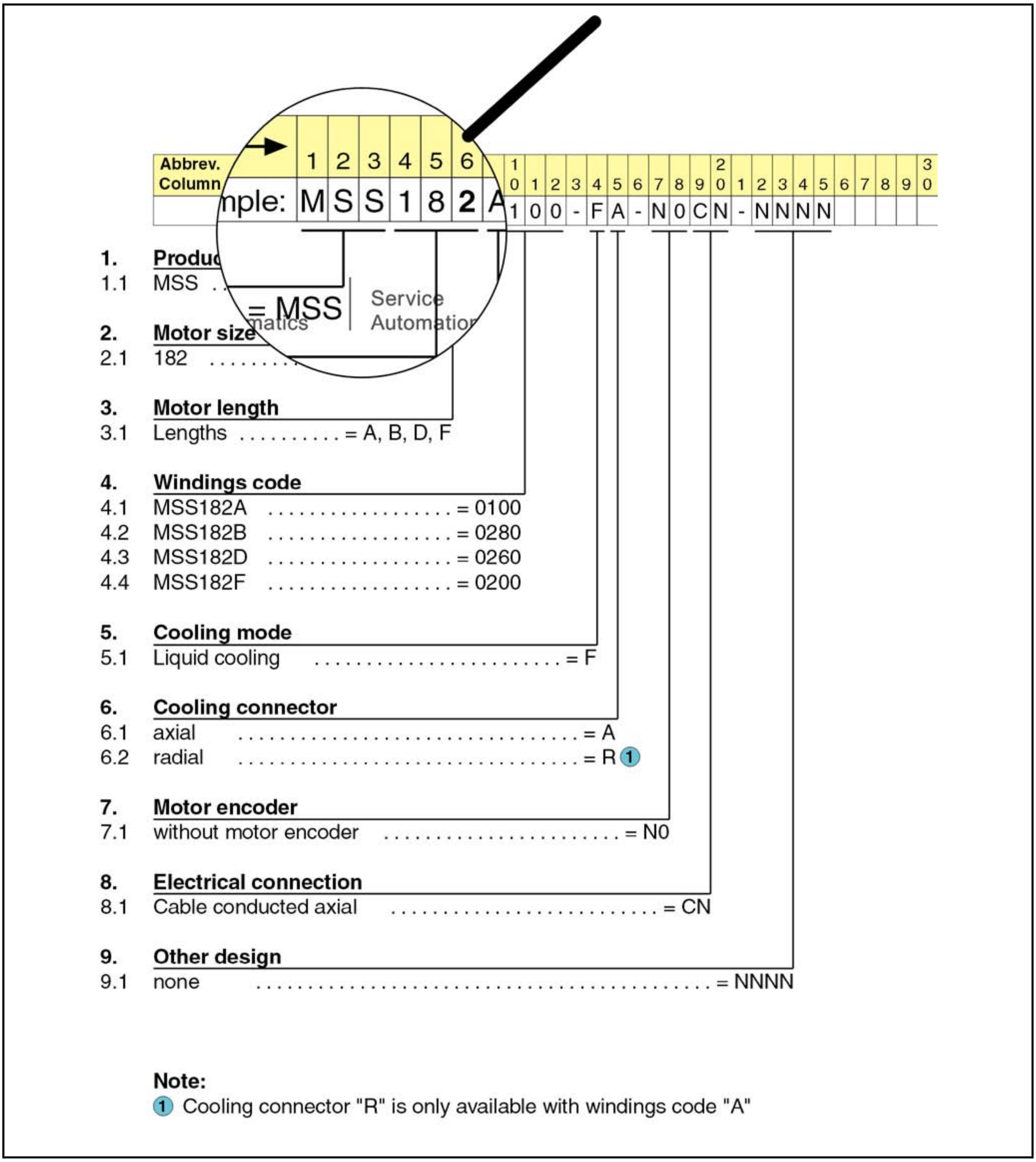


Fig.6-2: IndraDyn H type code example MSS

6.2 Type Code MRS102

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	R	S	1	0	2	B	-	1	N	-	0	0	4	6	-	N	N	N	N																				

1. Product
1.1 MRS .... = MRS

2. Size
2.1 102 .... = 102

3. Length
3.1 Lengths .... = B, D, F

4. Mounting style ①
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Inner diameter of the rotor
5.1 35 mm .... = 0035
5.2 46 mm .... = 0046

6. Other design
6.1 none .... = NNNN

Note:
① Mounting style "1N" is only available with inner diameter of the rotor "0046"
Mounting style "2N" is only available with inner diameter of the rotor "0035"

Fig.6-3: Type code MRS102

6.3 Type Code MSS102

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	1	0	2	B	-	0	8	0	0	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS . . . . = MSS

2. Size
2.1 102 . . . . = 102

3. Length
3.1 Lengths . . . . = B, D, F

4. Windings
4.1 MSS102B . . . . = 0800
4.2 MSS102D . . . . = 0800
4.3 MSS102F . . . . = 0300, 0800

5. Cooling mode
5.1 Liquid cooling . . . . = F

6. Cooling connector
6.1 axial . . . . = A

7. Encoder
7.1 without motor encoder . . . . = N0

8. Electrical connection
8.1 Cable conducted axial . . . . = CN

9. Other design
9.1 none . . . . = NNNN

Fig.6-4: Type code MSS102

6.4 Type Code MRS142

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	R	S	1	4	2	B	-	1	N	-	0	0	5	8	-	N	N	N	N																				

1. Product
1.1 MRS .... = MRS

2. Size
2.1 142 .... = 142

3. Length
3.1 Lengths .... = B, D, F

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Inner diameter of the rotor
5.1 50 mm .... = 0050
5.2 58 mm .... = 0058

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with inner diameter of the rotor "0058"
Mounting style "2N" is only available with inner diameter of the rotor "0050"

Fig.6-5: Type code MRS142

6.5 Type Code MSS142

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	1	4	2	B	-	0	7	0	0	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS . . . . = MSS

2. Size
2.1 142 . . . . = 142

3. Length
3.1 Lengths . . . . = B, D, F

4. Windings
4.1 MSS142B . . . . = 0700
4.2 MSS142D . . . . = 0700
4.3 MSS142F . . . . = 0700

5. Cooling mode
5.1 Liquid cooling . . . . = F

6. Cooling connector
6.1 axial . . . . = A

7. Encoder
7.1 without motor encoder . . . . = N0

8. Electrical connection
8.1 Cable conducted axial . . . . = CN

9. Other design
9.1 none . . . . = NNNN

Fig.6-6: Type code MSS142

6.6 Type Code MRS162

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Example:	M	R	S	1	6	2	B	-	1	N	-	0	0	6	8	-	N	N	N	N

1. Product
1.1 MRS .... = MRS

2. Motor size
2.1 162 .... = 162

3. Motor length
3.1 Lengths .... = B, D, F, J

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Inner diameter of the rotor
5.1 60 mm .... = 0060
5.2 68 mm .... = 0068

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with rotor inner diameter of the rotor "0068"
Mounting style "2N" is only available with rotor inner diameter of the rotor "0060"

Fig.6-7: Type code MRS162

6.7 Type Code MSS162

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	1	6	2	B	-	0	4	0	0	-	F	R	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS . . . . = MSS

2. Motor size
2.1 202 . . . . = 202

3. Motor length
3.1 Lengths . . . . = B, D, F, J

4. Windings code
4.1 MSS162B . . . . = 0400
4.2 MSS162D . . . . = 0400
4.3 MSS162F . . . . = 0310
4.4 MSS162J . . . . = 0200

5. Cooling mode
5.1 Liquid cooling . . . . = F

6. Cooling connector
6.1 axial . . . . = A

7. Motor encoder
7.1 without motor encoder . . . . = N0

8. Electrical connection
8.1 Cable conducted axial . . . . = CN

9. Other design
9.1 none . . . . = NNNN

Fig.6-8: Type code MSS162

6.8 Type Code MRS182

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	R	S	1	8	2	A	-	1	N	-	0	0	8	5	-	N	N	N	N																				

1. Product
1.1 MRS . . . . = MRS

2. Size
2.1 182 . . . . = 182

3. Length ①
3.1 Lengths . . . . = A, B, D, F

4. Mounting style ②
4.1 plain drilling . . . . = 1N
4.2 step interference fit . . . . = 2N

5. Internal diameter of the rotor
5.1 75 mm . . . . = 0075
5.2 85 mm . . . . = 0085

6. Other design
6.1 none . . . . = NNNN

Note:
① Length "A" is only available with Mounting style "1N"
② Mounting style "1N" is only available with internal diameter of the rotor "0085"
Mounting style "1N" is only available with internal diameter of the rotor "0085"

Fig.6-9: Type code MRS182

6.9 Type Code MSS182

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	1	8	2	A	-	0	1	0	0	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS .... = MSS

2. Motor size
2.1 182 .... = 182

3. Motor length
3.1 Lengths .... = A, B, D, F

4. Winding code
4.1 MSS182A .... = 0100, 0250
4.2 MSS182B .... = 0280
4.3 MSS182D .... = 0260
4.4 MSS182F .... = 0200

5. Cooling mode
5.1 Liquid cooling .... = F

6. Cooling connector
6.1 axial .... = A
6.2 radial .... = R (1)

7. Motor encoder
7.1 without motor encoder .... = N0

8. Electrical connection
8.1 Cable conducted axial .... = CN

9. Other design
9.1 none .... = NNNN

Note:
(1) Cooling connector "R" is only available with winding code "A"

Fig.6-10: Type code MSS182

6.10 Type Code MRS202

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	R	S	2	0	2	B	-	1	N	-	0	0	9	6	-	N	N	N	N																				

1. Product
1.1 MRS .... = MRS

2. Size
2.1 202 .... = 202

3. Length
3.1 Lengths .... = A, B, D, F

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Internal diameter of the rotor
5.1 66 mm .... = 0066
5.2 85 mm .... = 0085
5.3 96 mm .... = 0096

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with inner diameter of the rotor "0096"
Mounting style "2N" is only available with inner diameter of the rotor "0066" or "0085"

Fig.6-11: Type code MRS202

6.11 Type Code MSS202

Abbrev. Column → 1 … 40

Example: MSS202B-0150-FA-N0CN-NNNN

1. Product
1.1 MSS .... = MSS

2. Size
2.1 202 .... = 202

3. Length
3.1 Lengths .... = A, B, D, F

4. Winding code
4.1 MSS202A .... = 0200
4.2 MSS202B .... = 0150, 0210
4.3 MSS202D .... = 0170
4.4 MSS202F .... = 0120

5. Cooling mode
5.1 Liquid cooling .... = F

6. Cooling connector
6.1 axial .... = A

7. Motor encoder
7.1 without motor encoder .... = N0

8. Electrical connection
8.1 Cable conducted axial .... = CN

9. Other design
9.1 none .... = NNNN

Fig.6-12: Type code MSS202

Type Codes IndraDyn H

6.12 Type Code MRS242

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20
Example:	M	R	S	2	4	2	B	-	1	N	-	0	1	1	0	-	N	N	N	N

1. Product
1.1 MRS .... = MRS

2. Size
2.1 242 .... = 242

3. Length
3.1 Lengths .... = B, D, F

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Inner diameter of the rotor
5.1 100 mm .... = 0100
5.2 110 mm .... = 0110

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with inner diameter of the rotor "0110"
Mounting style "2N" is only available with inner diameter of the rotor "0100"

Fig.6-13: Type code MRS242

6.13 Type Code MSS242

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	2	4	2	B	-	0	1	0	0	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS .... = MSS

2. Size
2.1 242 .... = 242

3. Length
3.1 Lengths .... = B, D, F

4. Windings
4.1 MSS242B .... = 0100
4.2 MSS242D .... = 0070
4.3 MSS242F .... = 0060

5. Cooling mode
5.1 Liquid cooling .... = F

6. Cooling connector
6.1 axial .... = A

7. Encoder
7.1 without motor encoder .... = N0

8. Electrical connection
8.1 Cable conducted axial .... = CN

9. Other design
9.1 none .... = NNNN

Fig.6-14: Type code MSS242

Type Codes IndraDyn H

6.14 Type Code MRS272

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20
Example:	M	R	S	2	7	2	B	-	1	N	-	0	1	4	0	-	N	N	N	N

1. Product
1.1 MRS .... = MRS

2. Size
2.1 272 .... = 272

3. Length
3.1 Lengths .... = B, D, F

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Internal diameter of the rotor
5.1 94 mm .... = 0094
5.2 125 mm .... = 0125
5.3 135 mm .... = 0135

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with inner diameter of the rotor "0135"
Mounting style "2N" is only available with inner diameter of the rotor "0094" or "0125"

Fig.6-15: Type code MRS272

6.15 Type Code MSS272

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	2	7	2	B	-	0	0	6	5	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS . . . . = MSS

2. Size
2.1 272 . . . . = 272

3. Length
3.1 Lengths . . . . = B, D, F

4. Windings
4.1 MSS272B . . . . = 0065, 0080
4.2 MSS272D . . . . = 0050
4.3 MSS272F . . . . = 0040

5. Cooling mode
5.1 Liquid cooling . . . . = F

6. Cooling connector
6.1 axial . . . . = A

7. Encoder
7.1 without motor encoder . . . . = N0

8. Electrical connection
8.1 Cable conducted axial . . . . = CN

9. Other design
9.1 none . . . . = NNNN

Fig.6-16: Type code MSS272

6.16 Type Code MRS312

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	R	S	3	1	2	B	-	1	N	-	0	1	7	0	-	N	N	N	N																				

1. Product
   1.1 MRS .... = MRS

2. Size
   2.1 312 .... = 312

3. Length ①
   3.1 Lengths .... = B, D, F, H

4. Mounting style ②
   4.1 plain drilling .... = 1N
   4.2 step interference fit .... = 2N

5. Internal diameter of the rotor
   5.1 112 mm .... = 0112
   5.2 130 mm .... = 0130
   5.3 160 mm .... = 0160
   5.4 170 mm .... = 0170

6. Other design
   6.1 none .... = NNNN

Note:
① Length "H" ist only available with mountig style "2N"
② Mounting style "1N" is only available with internal diameter of the rotor "0170"
Mounting style "2N" is only available with internal diameter of the rotor "0112", "0130" or "0160"

Fig.6-17: Type code MRS312

6.17 Type Code MSS312

Abbrev. Column: 1–40

Example: MSS312B-0035-FA-N0CN-NNNN

1. Product
1.1 MSS .... = MSS

2. Size
2.1 312 .... = 312

3. Length
3.1 Lengths .... = B, D, F, H

4. Winding
4.1 MSS312B .... = 0035
4.2 MSS312D .... = 0028, 0060
4.3 MSS312F .... = 0028
4.4 MSS312H .... = 0025, 0085

5. Cooling mode
5.1 Liquid cooling .... = F

6. Cooling connection
6.1 axial .... = A
6.2 radial .... = R

7. Encoder
7.1 without motor encoder .... = N0

8. Electrical connection
8.1 cable conducted axial .... = CN

9. Other design
9.1 none .... = NNNN

Fig.6-18: Type code MSS312

6.18 Type Code MRS382

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Example:	M	R	S	3	8	2	F	-	1	N	-	0	2	4	0	-	N	N	N	N

1. Product
1.1 MRS .... = MRS

2. Motor size
2.1 382 .... = 382

3. Motor length
3.1 Length .... = B, D, F

4. Mounting style (1)
4.1 plain drilling .... = 1N
4.2 step interference fit .... = 2N

5. Internal diameter of rotor
5.1 230 mm .... = 0230
5.2 240 mm .... = 0240

6. Other design
6.1 none .... = NNNN

Note:
(1) Mounting style "1N" is only available with internal diameter of rotor "0240"
Mounting style "2N" is only available with internal diameter of rotor "0230"

Fig.6-19: Type code MRS382

6.19 Type Code MSS382

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	M	S	S	3	8	2	F	-	0	0	1	8	-	F	A	-	N	0	C	N	-	N	N	N	N															

1. Product
1.1 MSS . . . . = MSS

2. Motor size
2.1 382 . . . . = 382

3. Motor length
3.1 Length . . . . = B, D, F

4. Windings code
4.1 MSS382F . . . . = 0018
4.2 MSS382D . . . . = 0020
4.3 MSS382B . . . . = 0025

5. Cooling mode
5.1 Liquid cooling . . . . = F

6. Cooling connector
6.1 axial . . . . = A

7. Motor encoder
7.1 without motor encoder . . . . = N0

8. Electrical connection
8.1 Cable conducted axial . . . . = CN

9. Other design
9.1 none . . . . = NNNN

Fig.6-20: Type code MSS382

7 Accessories

7.1 O-Ring for the Rotor

If the O-ring for the step interference fit on the rotor was damaged during transport or assembly, it can be re-ordered through Bosch Rexroth according to the exact rotor type and the specified rotor material number, a.k.a. MNR:

Rotor MRS...	O-ring	MNR
102x-2N-0035-xxxx	35x4 75FKM	R911______*
142x-2N-0050-xxxx	50x4 75FKM	R911______*
162x-2N-0060-xxxx	60x4 75FKM	R911______*
182x-2N-0075-xxxx	75x4 75FKM	R911______*
202x-2N-0066-xxxx	66x4 75FKM	R911______*
202x-2N-0085-xxxx	85x4 75FKM	R911______*
242x-2N-0100-xxxx	100x4 75FKM	R911______*
272x-2N-0094-xxxx	94x4 75FKM	R911______*
272x-2N-0125-xxxx	125x4 75FKM	R911______*
312x-2N-0112-xxxx	112x4 75FKM	R911______*
312x-2N-0130-xxxx	130x4 75FKM	R911______*
312x-2N-0160-xxxx	160x4 75FKM	R911______*
382x-2N-0230-xxxx	230x4 75FKM	R911______*
*) In preparation		

Fig.7-1: O-Ring for rotor design ..-2N-..

8 Connection Technique

8.1 Notes

CAUTION

Destruction of the motors by direct connection to the 50/60Hz mains network (three-wire or single-phase mains)!

The motors described here may be operated only with suitable drive control devices, with variable output voltage and frequency (converter mode) as specified by Rexroth.

The user can either use ready-made Bosch Rexroth cables or assemble the required cables himself.

Bosch Rexroth offers a wide range of ready-made cables, which are optimally balanced for our products and different demands, for connecting IndraDyn H motors.

Decisive advantages of Rexroth ready-made cables are:

- Pre-wired without additional finishing
- Laid out for continuous alternate bending use
- Resistant against mineral oils, grease and biologic oils, silicon- and halogen-free, low adhesion
- Use of licensed cables acc. to UL and CSA
- Burning characteristics fulfill VDE0472-804 requirements
- Compliance of the EMV-guideline and protection class up to IP67

Note that self-assembled cables or cable systems of other manufacturers may not fulfill these criteria.

- **Rexroth shall not be held responsible for resulting malfunction states or damage.**
- The chosen connection must be suitable for the used intermediate circuit voltage.
- The design of the power cable also depends on the control device used. Please observe the documentation of the drive device.

You can find additional information ...

- on **selecting** power and encoder cables for IndraDyn H motors in the Documentation ”Rexroth Connection Cables”, MNR R911280894.
- for **assembling** cables and plugs, as well as technical data, in the documentation "Rexroth Connection Techniques, Assembling and Tools...", MNR R911280895.
- for **connecting and dimensioning** cooling systems in the documentation "Liquid Cooling of Rexroth Drive Components", MNR R911265836.
- for "**electromagnetic compatibility** (EMC) at drive and control systems” of the same denominator documentation, MNR R911259814.

8.2 Power Connection

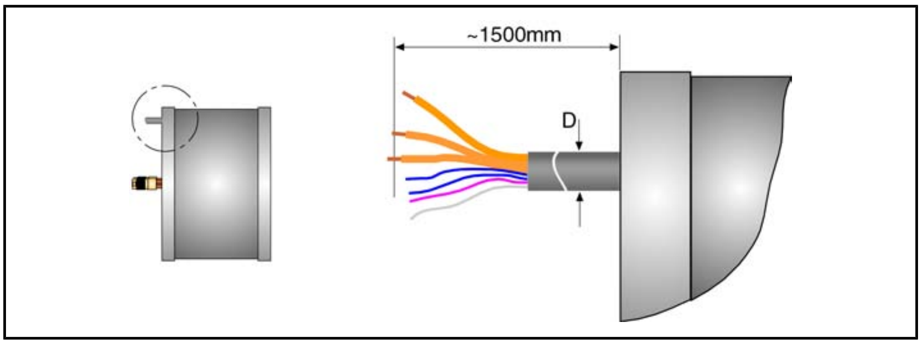
8.2.1 General

The power connection of the kit spindle motor can be made via

- **clamping connection** (terminal box) or with
- **connectors** (connector socket).

The power supply from this junction to the drive controller can be made via a power cable. The corresponding, ready-made power cables are available from Rexroth.

The stator is provided with an approx. 1.5 m long connection cable (flying leads in a protective conduit). The connection cable consists of three power leads and/or three pairs of power leads and two wire pairs for the thermistors within the end turns of winding.



D Diameter cable harness

Fig.8-1: IndraDyn H cable harness

Connection wires within the cable harness

The cross-sections of the power wires in the cable harness depend on the rated current of the motor. In the following table, you can find further details regarding the cross-section of the conductors.

The cross-section of the wire pairs for the motor thermistor connection is 0.25mm² (KTY84) or 0.5mm² (SNM.150).

Motor frame size	Cross-section of the power wires in the cable harness [mm²]	Cross-section of the control wires in the cable harness [mm²]	Diameter of the cable harness (D)+/- 1[mm]	Minimum bending radius static [mm]
MSS102B-0800	4	2 x 0,25 2 x 0,5	13	4 x D
MSS102D-0800	4			
MSS102F-0300	2,5			
MSS102F-0800	6			
MSS142B-0700	10		22	
MSS142D-0700	10			
MSS142F-0700	16			
MSS162B-0400	10		22	
MSS162D-0400	16			
MSS162F-0310	16			
MSS162J-0200	16			
MSS182A-0100	1,5		13	
MSS182A-0250	1,5		13	
MSS182B-0280	10		22	
MSS182D-0260	25		30	
MSS182F-0200	25		30	
MSS202A-0200	10		22	
MSS202B-0150	10		22	
MSS202B-0210	25		30	
MSS202D-0170	16		22	
MSS202F-0120	16		22	
MSS242B-0100	16		22	
MSS242D-0070				
MSS242F-0060				
MSS272B-0065	25		30	
MSS272B-0080				
MSS272D-0050				
MSS272F-0040				
MSS312B-0035	16		22	
MSS312D-0028	16		22	
MSS312D-0060	2 x 16		30	
MSS312F-0028	16		22	
MSS312H-0025	16		22	
MSS312H-0085	2 x 25		30	
MSS382B-0025	2 x 16		30	
MSS382D-0020				
MSS382F-0010				
MSS382F-0018				

Fig.8-2: Connection wire cross-sections

The connection cable is a motor-internal connection. The insulation of the connection cable is thus designed for higher temperatures than that of the power cable (connection between stator and controller). The details in chapter 4 "Technical Data" on page 17 regarding the minimum wire cross-section of the power wires may thus differ from the cross-sections of the power wires in the connection cable.

Route of the cable harness

The connection cable which is fixed on the stator is designed with flying leads and after the laying, must not be exposed to dynamic bending stresses.

When feeding the cable through the spindle housing, ensure that

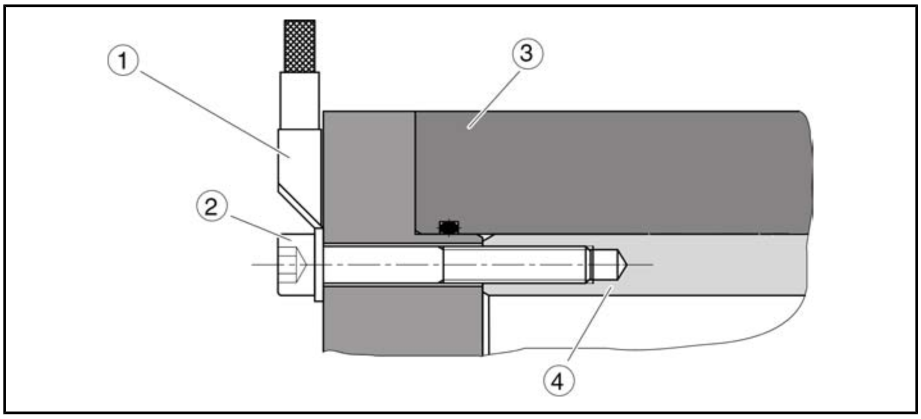
- the specified admissible bending radius of the cable is not undershot (see fig. 8-2 "Connection wire cross-sections" on page 121),
- the edges of the through-hole on the spindle housing are chamfered and/or protected with a plastic sleeve.

8.2.2 Ground Connection

There are threaded holes for the ground connection on both faces of the stator. Use a ring terminal to fasten the ground wire over one of these threaded holes.

You can find details on the exact position of the threaded holes and their connection threads in the dimension sheet of the respective motor. The minimum cross-section depends on the respective motor type. The corresponding data is given in fig. 8-2 "Connection wire cross-sections" on page 121.

> ☞ The indicated minimum cross-section for the power wires is also valid for the ground wire and must be observed.



①	Ground connection
②	Brass screw M6 or M8
③	Spindle housing
④	Stator

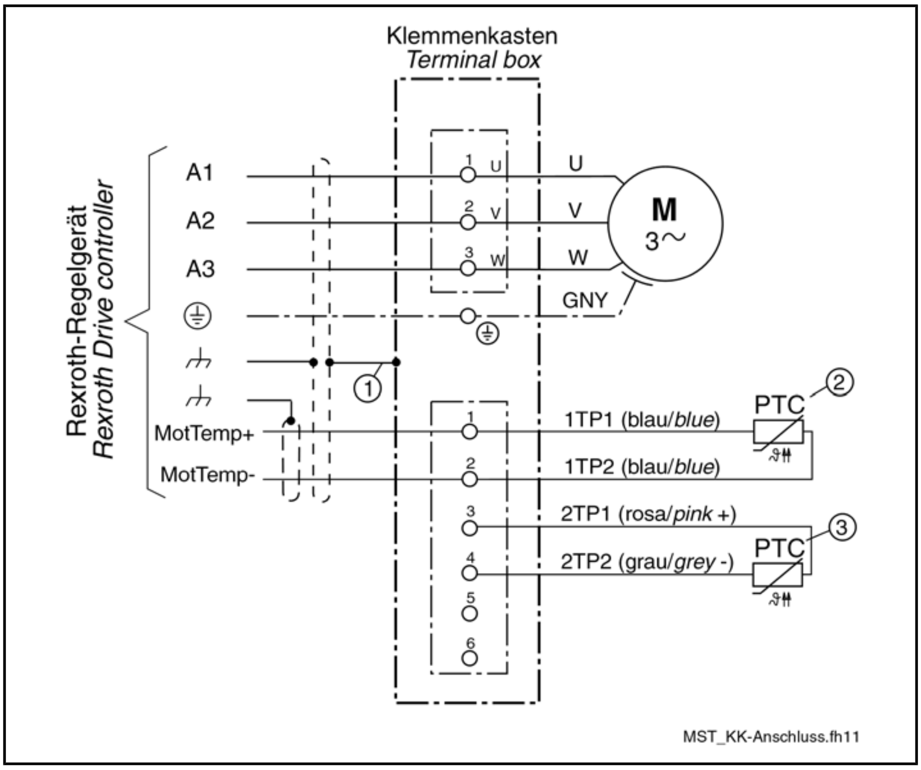
Fig.8-3: Example of an IndraDyn H ground connection

Proceed as follows:

1. Clean the contact surface for the bolt head. The surface has to be metallic bright so that both, the spindle housing and the stator are grounded.
2. Using a brass screw (M6 or M8, depending on the stator type), attach the ground wire with terminal to the end plate.
3. Grease the connection with Vaseline to protect it from corrosion.

8.2.3 Power Connection with Terminal Box

In the clamping connection, the connection cable of the stator is connected with the power cable in a terminal box. The terminal box is attached to the spindle housing. In it, a three- or six-pole terminal plate for the power connection and a terminal strip with at least four clamping points for the thermistor connection are to be provided.



①	Carry out the overall shield contact via the cable clamping of the strain relief in PG thread.
②	Connect temperature sensor SNM150 for protecting the motor to the controller.
③	Use temperature sensor KTY84 only for external temperature measurements.

Fig.8-4: Connection diagram for power connection using a terminal box

Note:

- The additional information regarding the wire identification of the temperature sensors in chapter 8.4.

For the appropriate realization of the clamp connection, the standards listed in the following table are to be complied with.

Description	Standard	Reference to the clamp connection
Terminal plate	DIN 46 294	Max. rated voltage AC 660 V
Terminal strip	DIN VDE 0110	Max. rated voltage AC 380 V
Terminal studs	DIN 46 200	Determination of the stud diameter; tightening torques
Crimping cable lugs	DIN 46 237	Power wires of the cable harness
Ferrules	DIN 46 228 part 3	Thermistor wires of the cable harness
Protection class	DIN VDE 0530 part 5	Minimum protection class IP54
Terminal marking	EN 60 445	

Fig.8-5: Standards for the clamp connection

The components for the connection with terminal box are not available from Rexroth. Possible suppliers include:

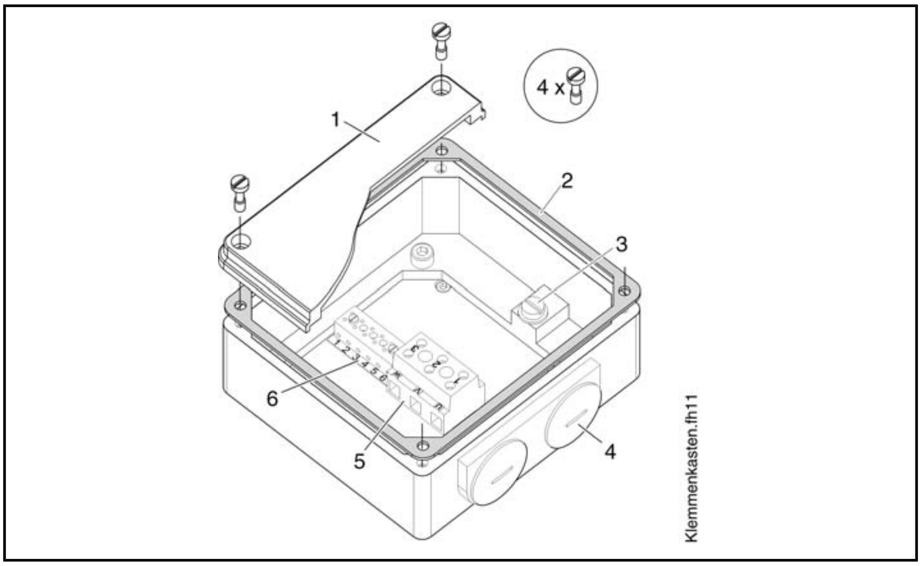
Component	Supplier
Terminal box	**KIENLE & SPIESS** Stanz- und Druckgießwerk GmbH Bahnhofstraße 23 74343 Sachsenheim, Germany Tel.: +49 (0) 71 47 29 - 0 Fax +49 (0) 71 47 29 - 1488 Internet: www.kienle-spiess.de
Terminal board	**MORGAN REKOFA** GmbH & Co. KG Walporzheimer Straße 100 53474 Bad Neuenahr-Ahrweiler, Germany Tel.: +49 (0) 26 41 / 387 - 0 Fax +49 (0) 26 41 / 387 - 33 95 Mail: info@morgan-rekofa.de
Terminal strip	**WIELAND ELECTRIC** GmbH Benzstraße 9 96052 Bamberg, Germany Internet: www.wieland-electric.com

Fig.8-6: Terminal box suppliers

Pay attention to the following when selecting the components:

- The components must be suited for the currents and voltages of the chosen drive system, especially for high intermediate circuit voltages up to 750 V_{DC}.
- Necessary cross-sections and connection threads of the thread.
- Impermeability of the housing. Minimum protection class IP65 recommended.

A complete terminal box consists, for example, of the following components:



①	Lid
②	Gasket
③	PE connection
④	Cable entry
⑤	U-V-W power connection
⑥	Terminal strip

Fig.8-7: Terminal box

Connection overview with double cabling

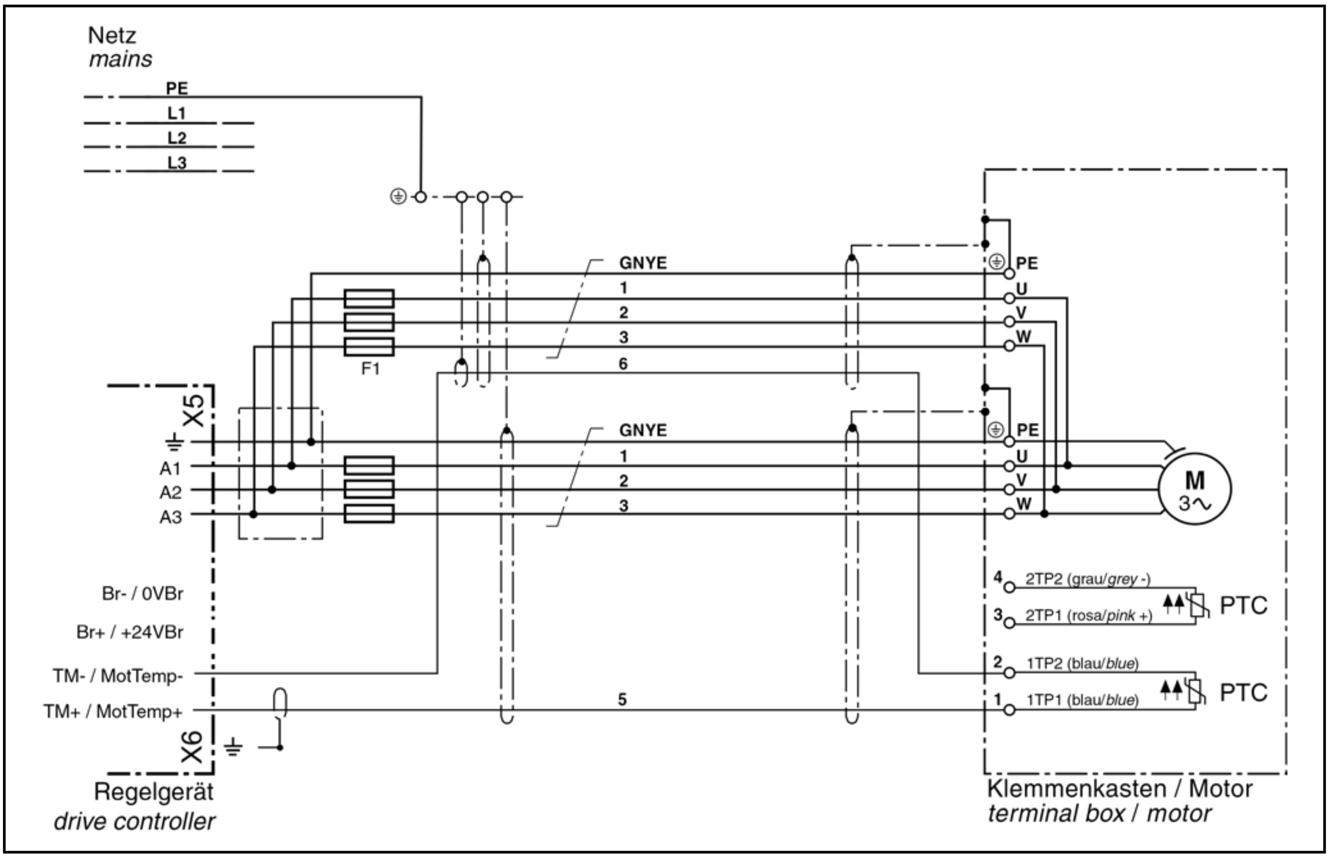


Fig.8-8: Connection diagram double cabling

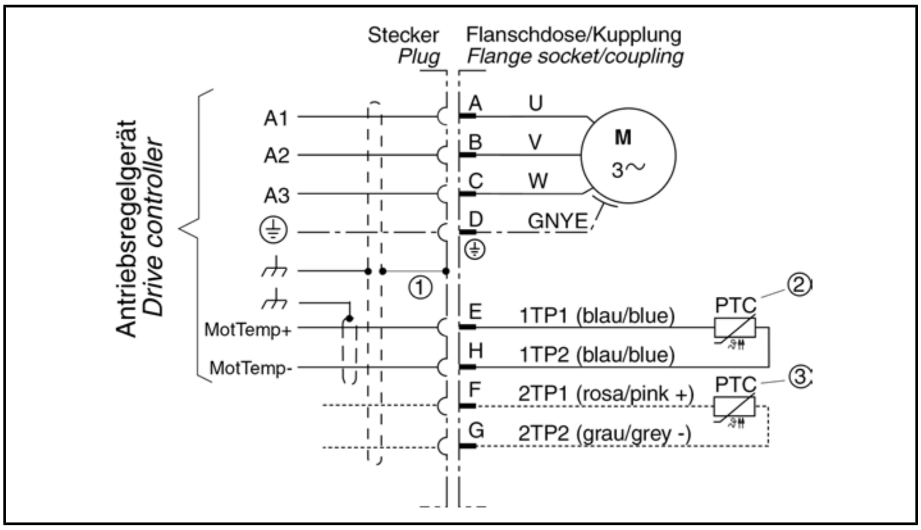
☞

- Double cabling may only be effected with the power connection by means of terminal box.
- For the thermal protection of the motor, the temperature sensor 1TPx (SNM.150.DK*) must be connected at the drive control device.

  The temperature sensor 2TPx (KTY84*) is only available for the external motor temperature monitoring.
- The fuses F1 (NH…) which protect the wires from overload in case of cable break are dimensioned in accordance with the current carrying capacity of the respective line cross-section.
- The fuses should be installed in the switch cabinet so that they are as close as possible to the power output of the drive device.
- The shields of the power cables should be connected to the switch cabinet with the largest possible surface area.
- Cable pairs must be properly connected to series terminal strips or to the terminal studs of the drive controllers; they must also fulfill safety requirements.

8.2.4 Power Connection with Connector Socket

General



① Carry out the overall shield contact via the cable clamping of the strain relief in PG thread.

② Connect temperature sensor SNM150 for protecting the motor to the controller.

③ Use temperature sensor KTY84 only for external temperature measurements.

Fig.8-9: Connection diagram for power connection using a connector socket

Choose a coupling with the corresponding connector and the necessary connecting diameter according to the motor data sheet.

Order designation: INS0382/**Lxx** or INS0482/**Lxx**

- ../**L** = Solder version (contact pin with solder contact)
- ../..**xx** = Connection cross-section (e.g. 6 mm² = **06**)

The coupling and connector to connect IndraDyn H motors have a bayonet socket and are not in the scope of delivery.

Note:

- If a power cable made available by Rexroth is used, the connection wires for the temperature measurement sensor (KTY84) must - on the side of the controller - not be connected. For the temperature measurement, they must be connected to an external device and analyzed.
- When assembling the connection with crimp contacts, special tools are necessary.
- INS0482 is suitable only for a connection diameter up to 10 mm².

Handling

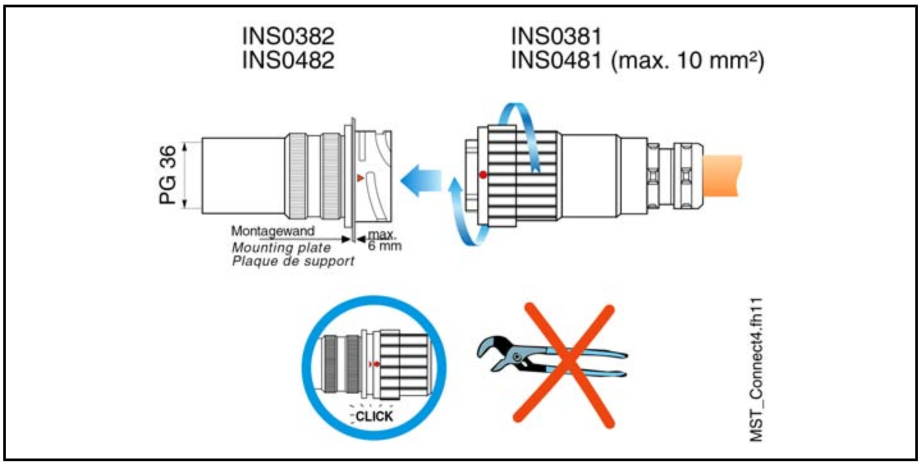


Fig.8-10: IndraDyn H power connector

1. Insert the plug into the coupling; pay attention to the coding.
2. Manually tighten the bayonet socket until it audibly locks in.

   The red marks on the flange socket and the plug are aligned when the bayonet connection is locked in.

8.3 Connection Designations at the Drive Control Device

The following overview shows the connection and clamp designations for the power connection and the motor temperature monitoring at the drive controller.

REXROTH drive controller	Power connection		Motor Temperature Overview	
	Terminal block	Clamp designation	Terminal block	Clamp designation
IndraDrive HMx.... IndraDrive HCS....	X5	A1, A2, A3, ⏚	X6	MotTemp+ MotTemp-

Fig.8-11: Clamp designations on drive control device

8.4 Temperature Sensors

In their standard configuration, IndraDyn H stators are equipped with the built-in motor protection temperature sensor SNM.150.DK.*. Furthermore all stators are fitted with an additional temperature sensor KTY84-130 for external temperature measurement.

☞

- In order to protect the motor from a thermal overload, the temperature sensor SNM.150.DK must be connected to the drive control device.
- When connecting the temperature sensor KTY84-130 for an external temperature measurement, pay attention to the polarity (see fig. 8-4 "Connection diagram for power connection using a terminal box" on page 123).

Also heed the notes regarding the motor temperature monitoring in chapter 9.7 "Motor Temperature Monitoring " on page 145.

8.5 Motor Cooling

8.5.1 General

The coolant connections on the stator can be designed for axial or radial connections.

You can find details about dimension, design and position of the cooling agent connections in the respective motor dimension sheet.

Axial cooling connection

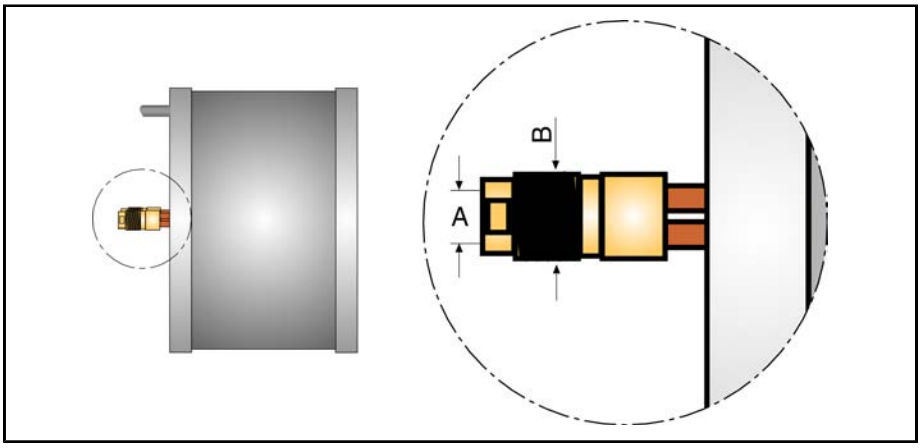


Fig.8-12: Axial cooling connection

Stator MSS....	Thread "A"	Thread "B"
102 / 142	G 1/8	M16x1
162 / 182	G 1/8	M16x1
202 / 242	G 1/4	M22x1.5
272 / 312 / 382	G 1/2	M30x1.5

Fig.8-13: Overview of axial cooling connection threads

Radial cooling connection

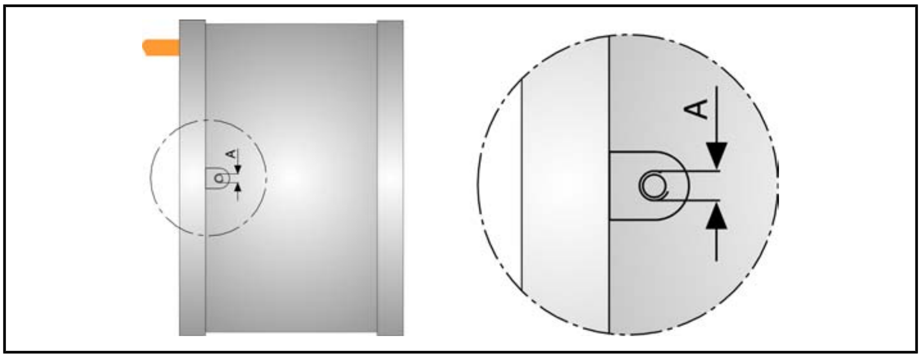


Fig.8-14: Radial cooling connection

Stator MSS....	Thread "A"
182A	G 1/8
312	G 1/4

Fig.8-15: Overview of radial cooling connection threads

You can find further information about motor cooling of IndraDyn H motors in chapter 9.7 "Motor Temperature Monitoring " on page 145.

- Note the motor data in this documentation as well as the general details for **dimensioning** of cooling systems in the documentation "Liquid cooling of Rexroth drive components...", MNR R911265836.
- Install systems in the cooling circuit for monitoring flow, pressure and temperature.
- Note that intake and outflow are possible only in the position shown in the dimension sheet.

The assignment of intake and outflow has no influence on the performance data of the motor. For standardization and easy handling, an arrangement that has been proven once should be maintained.

8.5.2 Operating Pressure

A maximum coolant supply pressure of **5 bar** applies to all IndraDyn H motors, regarding the pressure effectively existing directly at the coolant connection of the motor.

Please observe that additional threads or branch connections in the cooling circuit can reduce the flow and supply pressure of the coolant.

Select generously dimensioned connection threads and tube diameters.

8.6 Motor Encoder

An encoder and encoder connection components are not in the scope of delivery of the motor. Choose the components according to the requirements of the machine.

You can find information on encoder manufacturers in chapter 9.12 "Foreign Components" on page 151.

Note:

The connection cables for connecting motor encoders and the control device must have an encoder-compatible plug on the motor side. When using components of different manufacturers, always ensure that the connection system is compatible.

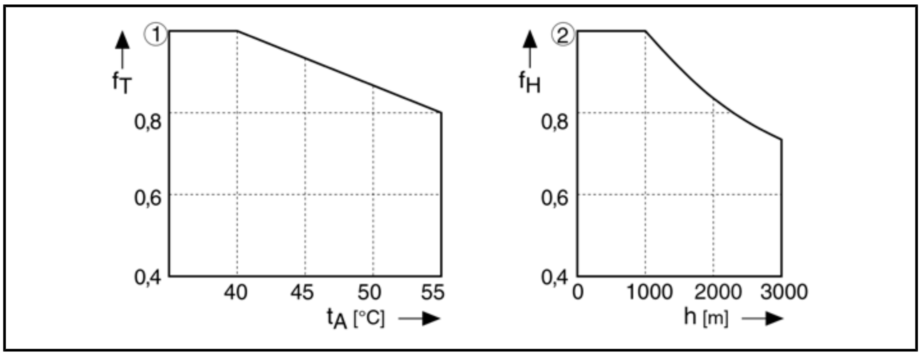
9 Application Notes

9.1 Setup Elevation and Ambient Temperature

The performance data specified for the motors apply in the following conditions:

- Ambient temperature of 0º to + 40º C
- Setup elevation of 0 m to 1,000 m above sea level.

If you want to use the motors in areas with values beyond these ranges, the performance data are reduced according to the following figure.



①	Utilization depending on the ambient temperature
②	Utilization depending on the setup elevation
f_T	Temperature utilization factor
t_A	Ambient temperature in degrees Celsius
f_H	Height utilization factor
h	Setup elevation in meters

Fig.9-1: Utilization factors

If **either** the ambient temperature **or** the setup height exceeds the nominal data:

1. Multiply the motor data provided in the selection data with the calculated utilization factor.
2. Ensure that the reduced motor data are not exceeded by your application.

If **both** the ambient temperature **and** the site altitude exceed the nominal data:

1. Multiply the determined utilization factors fT and fH by each other.
2. Multiply the value obtained by the motor data specified in the selection data.
3. Ensure that the reduced motor data are not exceeded by your application.

9.2 Humidity

Ambient climatic conditions are defined into different classes according to DIN EN 60721-3-3, Table 1. They are based on observations made over long periods of time throughout the world and take into account all influencing quantities that could have an effect, such as the air temperature and humidity.

Based on this table, Rexroth recommends class 3K4 for continuous use of the motors.

This class is excerpted in the following table.

Environmental factor	Unit	Class 3K4
Low air temperature	°C	+5 [1])
High air temperature	°C	+40

Environmental factor	Unit	Class 3K4
Low rel. air humidity	%	5
High rel. air humidity	%	95
Low absolute air humidity	g/m³	1
High absolute air humidity	g/m³	29
Speed of temperature change	°C/min	0,5
[1]) Rexroth permits 0°C as the lowest air temperature.		

Fig.9-2: Classification of climatic environmental conditions according to DIN EN 60721-3-3, Table 1

9.3 Vibration and Shock

9.3.1 Vibration

Sine-shaped vibrations occur in stationary use; depending on their intensity, they have different effects on the robustness of the motors.

The robustness of the overall system is determined by the weakest component.

Based on DIN EN 60721-3-3 and DIN EN 60068-2-6, the following values result for Rexroth motors:

Direction	Maximum permitted vibration load (10-2000 Hz)
axial	i.p.
radial	i.p.
i.p. = in preparation	

Fig.9-3: Maximum values for sine-shaped vibrations

9.3.2 Shock

The shock load of the motors is indicated by providing the maximum permitted acceleration in non-stationary use, such as during transport.

Damage to functions is prevented by maintaining the limit values specified.

Based on DIN EN 60721-3-3 and DIN EN 60068-2-6, the following values result for Rexroth motors:

Motor frame size	Maximum permitted shock load (6ms)	
	axial	radial
102	i.p.	i.p.
142		
162		
182		
202		
242		
272		
312		
382		
i.p. = in preparation		

Fig.9-4: Maximum values for shock load

☞ Ensure that the maximum values specified in fig. 9-3 "Maximum values for sine-shaped vibrations" on page 132 and fig. 9-4 "Maximum values for shock load" on page 132 for storage, transport, and operation of the motors are not exceeded.

☞ The construction and effectiveness of shock-absorbing or shock-decoupling attachments depends on the application and must be tested using measurements. This does not lie within the area of responsibility of the motor manufacturer. Modifications of the motor construction result in nullification of the warranty.

9.4 Protection Class

The degree of protection is defined by the abbreviation IP (International Protection) and two reference numbers specifying the degree of protection. The first reference number describes the degree of protection against contact and penetration of foreign bodies; the second reference number describes the degree of protection against water.

1st code number	Degree of protection
0	No protection
2nd code number	**Degree of protection**
0	No protection

Fig.9-5: IP protection class

Protection class **IP00** according to DIN EN 60529:2000-09 applies for the stator and rotor of the IndraDyn H series. The applicability of the IndraDyn H motor for certain conditions must thus be checked carefully.

☞ The machine manufacturer is responsible for the testing and execution of suitable protection measures.

Heed the following list (without any guarantee for completeness).

Difficulties

- Use of the motor in a damp environment or a high-humidity atmosphere.
- Use of cooling lubricants, aggressive materials or other liquids.
- Cleaning procedures with high pressures, steam or jets of water.

Possible influences

- Chemical or electro-chemical interaction with subsequent corrosion or decomposition of motor parts.
- Damage of the winding insulation and irreparable damage of the motor.

Possible countermeasures

- Plan suitable covers or seals to protect the motor.
- Use only cooling lubricants and other materials that have no aggressive or decomposing effect on the motor parts.
- Do not clean with high pressures, steam or jets of water.

9.5 Compatibility

All Rexroth controls and drives are developed and tested according to the state of the art.

However, since it is impossible to follow the continuing further development of every material with which our controls and drives could come into contact (e.g.

lubricants on tool machines), reactions with the materials that we use cannot be ruled out in every case.

For this reason, you will have to carry out a test for compatibility among new coolants or lubricants, detergents, etc. and our housing and/or our device materials.

9.6 Motor Cooling

9.6.1 General

Rexroth IndraDyn H kit motors have a novel cooling circuit that is already self-contained in the motor. The heat of the transformed motor power loss P_V is dissipated using this cooling circuit. Thus, IndraDyn H motors may only be operated if the supply of coolant is ensured.

The cooling system must be rated by the machine manufacturer in such a way that all requirements regarding flow, pressure, purity, temperature gradient etc. are maintained in every operating state.

CAUTION

Impairment or loss of motor, machine or cooling system!

- It is essential that you take into account the motor data in chapter 4 and the explanations and conceptions of the cooling systems in the documentation "Liquid Cooling, Dimensioning, Selection", MNR R911265836.
- Heed the manufacturer’s instructions when constructing and operating cooling systems.
- Do not use any lubricants or cutting materials from operating processes.
- Avoid pollution of the coolant as well as changes of the chemical consistency and of the pH value.

Used materials

When used with IndraDyn H motors, the coolant comes into contact with the following materials:

Motor frame size	Motor	Screwed connections
102.....382	CU	brass

Fig.9-6: Material contact Coolant

9.6.2 Coolants

General

All information and technical data are based on water as the coolant. If other coolants are used, these data no longer apply and must be recalculated.

Cooling with flowing tap water is not recommended. Calcareous tap water can cause deposits and damage the motor and the cooling system.

For corrosion protection and chemical stabilization, the cooling water must have an additional additive which is suitable for mixed installations with the materials copper (cooling lines) and brass (connectors).

IndraDyn H motors can be damaged irreparably by using aggressive coolants, additives and lubricants or by pollution of the coolant.

WARNING

Impairing the cooling effect of damaging the cooling system!

- Adjust coolant and flow to the required motor performance data
- Use systems with a closed circulation and a fine filter ≤ 100 µm
- Use a corrosion protection with water as a coolant and maintain the required ratio of mixture
- Use approved anticorrosion agents, only
- Do not use cooling lubricants from machining process
- Avoid pollution of the coolant as well as changes of the chemical consistency and of the pH value
- Do not use flowing water
- Use a closed cooling circuit
- Adhere to the specified inlet temperatures
- Do not exceed the maximum pressure
- Motor operation not without liquid cooling
- Heed the environmental protection and waste disposal instructions at the place of installation when selecting the coolant

☞ The performance test for the used coolants and the design of the liquid coolant system are generally the responsibility of the machine manufacturer.

Aqueous Solution

Aqueous solutions ensure reliable corrosion protection without significant changes of the physical property of the water. The recommended additives contain no materials harmful to water.

Emulsion with Corrosion Protection

Corrosion protection oils for coolant systems contain emulsifiers which ensure a fine distribution of the oil in the water. The oily components of the emulsion protect the metal surfaces of the coolant duct against corrosion and cavitation. An oil content of 0.5 - 2 volume percent has proven itself.

If the corrosion protection oil is responsible for not only corrosion protection but also for lubricating the coolant pump, an oil content of 5 volume percent is necessary.

☞ Heed the instructions of the pumping manufacturer!

Description	Manufacturer
1%...3%-Solutions	
Aquaplus 22	Petrofer, Hildesheim
Varidos 1+1	Schilling Chemie, Freiburg
33%-Solutions	
Glycoshell	Deutsche Shell Chemie GmbH, Eschborn
Tyfocor L	Tyforop Chemie GmbH, Hamburg
OZO antifreeze	Deutsche Total GmbH, Düsseldorf
Aral cooler antifreeze A	ARAL AG, Bochum

Description	Manufacturer
BP antifrost X 2270 A	Deutsche BP AG, Hamburg
mineral grease concentrate emulsive	
Shell Donax CC (WGK: 3)	Shell, Hamburg

Fig.9-7: Recommended coolant additives

9.6.3 Coolant Inlet Temperature

IndraDyn H motors are designed according to DIN EN 60034-1 for operating with +10...+40°C coolant inlet temperature. This temperature range must be strictly observed. At higher coolant temperatures, the reduction of the available torque is increased. Because of high coolant temperature gradients, lower temperatures can lead to destruction of the motor.

☞ Install systems in the cooling circuit for monitoring flow, pressure and temperature.

Setting of the inlet temperature

Observe the temperature range permitted and consider the existing ambient temperature when setting the coolant inlet temperature.

If necessary, the lower limit of the recommended coolant inlet temperature can be limited compared to the existing ambient temperature. To avoid condensation, a value of max. 5°C below the existing ambient temperature is permitted as the lowest temperature to be set.

Example 1:

Permitted coolant inlet temperature range +10... +10 ... +40°C

Ambient temperature: 20°C

Set coolant inlet temperature: +15 ... +40°C

Example 2:

Permitted coolant inlet temperature range +10... +10 ... +40°C

Ambient temperature: 30°C

Set coolant inlet temperature: +25 ... +40°C

9.6.4 Thermal Behavior

Power loss

The achievable rated torque of an IndraDyn H motor is mainly determined by the power loss P_V that is produced during the energy conversion process. The power loss fully dissipates in form of heat. Due to the limited permissible winding temperature it must not exceed a specific value.

☞ The maximum winding temperature of IndraDyn H kit motors is 155 °C. This corresponds to insulation class F.

The total losses of these kit motors are almost exclusively determined by the I2R losses of the stator:

$$P_V \approx P_{Vi} = \frac{3}{4} \cdot i^2 \cdot R_{12} \cdot f_T$$

P_V	Total loss in W
P_{Vi}	Direct load losses in W
i	Current in motor cable (peak value) in A
R_{12}	Electrical resistance of the motor at 20°C in Ohm (see Chapter 4 Technical Data)
f_T	Factor temperature-related resistance raise

Fig.9-8: Power loss of IndraDyn H kit motors

☞ When you determine the power loss, you must take the temperature-related rise of the electrical resistance into account. At a temperature rise of 115 K (from 20°C up to 135°C), for example, the electrical resistance goes up by the factor f_T = 1.45.

Thermal time constant

The temperature variation vs. the time is determined by the produced power loss and the heat-dissipation and –storage capability of the motor. The heat-dissipation and –storage capability of an electrical machine is (combined in one variable) specified as the thermal time constant.

☞ With liquid cooling systems, the thermal time constants of IndraDyn H kit motors are between 5...10 min (depending on size).

The following figure (fig. 9-9 "Heating up and cooling down of an electrical machine" on page 137) shows a typical heating and cooling process of an electrical machine. The thermal time constant is the period within which 63% of the final over temperature is reached. With liquid cooling, the cooling time constant corresponds to the heating time constant. Thus, the heating process and the cooling process can both be specified with the specified thermal time constant (heating time constant) of the motor.

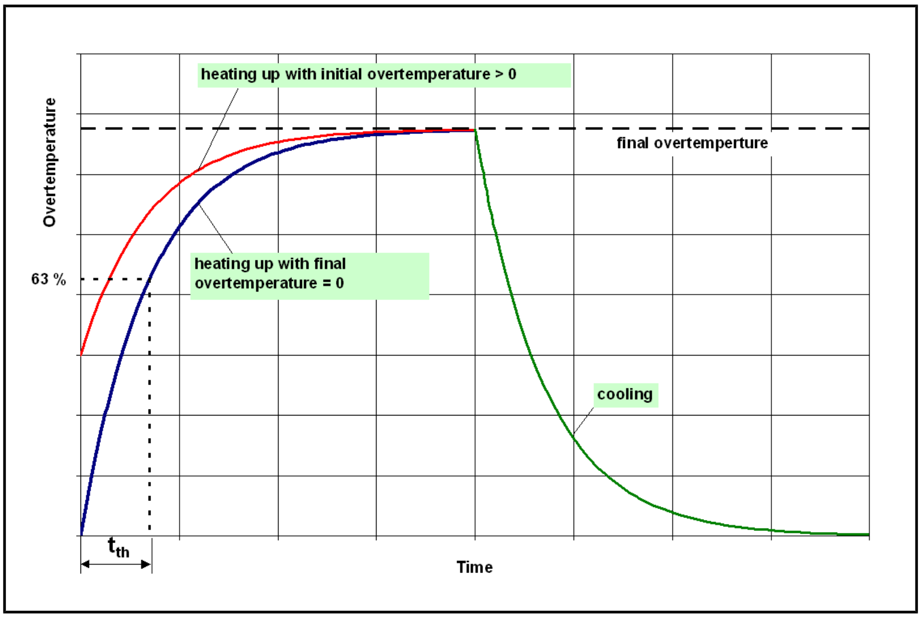
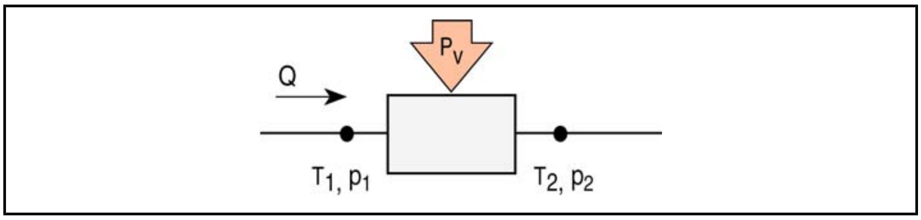


Fig.9-9: Heating up and cooling down of an electrical machine

Application Notes

9.6.5 Sizing the Cooling Circuit

General



Q	Flow quantity
T_1	Coolant inlet temperature
T_2	Coolant outlet temperature
p_1	Inlet pressure
p_2	Outlet pressure

Fig.9-10: Liquid-cooled component

Coolant temperature rise

$$\Delta T = T_2 - T_1$$

ΔT	Coolant temperature rise in K
T_2	Coolant outlet temperature in K
T_1	Coolant inlet temperature in K

Fig.9-11: Coolant temperature rise in K

Pressure Drop

$$\Delta p = p_1 - p_2$$

Δp	Pressure drop
p_1	Inlet pressure
p_2	Outlet pressure

Fig.9-12: Pressure drop across traversed component

Flow Rate

Coolant flow to maintain the rated motor torque

The coolant flow required to maintain the rated motor torque is defined in Chapter 4 Technical Data.

The specification of this value is based on a rise of the coolant temperature by 10 K.

fig. 9-13 "Coolant flow required for removing a given power loss." on page 138 and fig. 9-14 "Substance values of different coolants at 20°C" on page 139 are used to determine the necessary coolant flow at different temperature rises and / or other coolants than water:

$$Q = \frac{P_{co} \cdot 60000}{c \cdot \rho \cdot \Delta T}$$

Q	Rated coolant flow in l/min
P_{co}	Removed power loss in W
c	Specific heat capacity of the coolant in J / kg · K
ρ	Density of the coolant in kg/m³
ΔT	Coolant temperature rise in K

Fig.9-13: Coolant flow required for removing a given power loss.

Coolant	Specific heat capacity c in J / kg · K	Density ρ in kg/m³
Water	4183	998,3
Thermal oil (example)	1000	887
Air	1007	1,188

Fig.9-14: Substance values of different coolants at 20°C

Reduction of the motor torque with coolants other than water and identical flow

Assuming the **same** flow rate, you can estimate the reduction of the motor torque when using coolants other than water using the following formula:

$$k_{cred} = \sqrt{\frac{c_x \cdot \rho_x}{c_w \cdot \rho_w}} \cdot 100\%$$

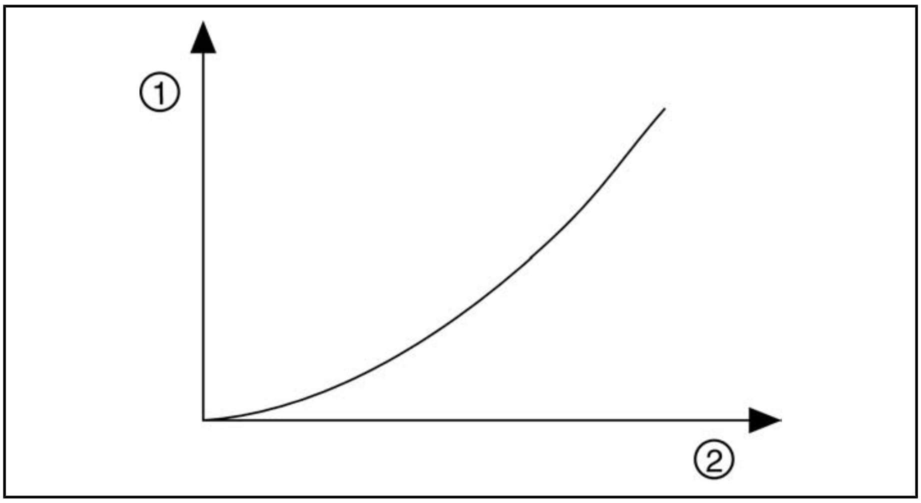
k_{cred}	Reduction factor of motor torque in percent relating to water
c_w	specific heat capacity of water in J / kg · K
ρ_w	Density of water in kg/m³
c_x	specific heat capacity of the coolant used in J / kg · K
ρ_x	Density of the coolant used in kg/m³

Fig.9-15: Reduced motor torque when using coolants other than water with identical flow

Pressure drop

The flow resistance at the pipe walls, curves, and changes of the cross-section produces a pressure drop along the traversed components (see fig. 9-12 "Pressure drop across traversed component" on page 138).

The pressure drop Δp rises as the flow quantity rises (see fig. 9-16 "Pressure drop vs. flow quantity; general representation" on page 139).



① Pressure drop Δp
② Flow quantity Q

Fig.9-16: Pressure drop vs. flow quantity; general representation

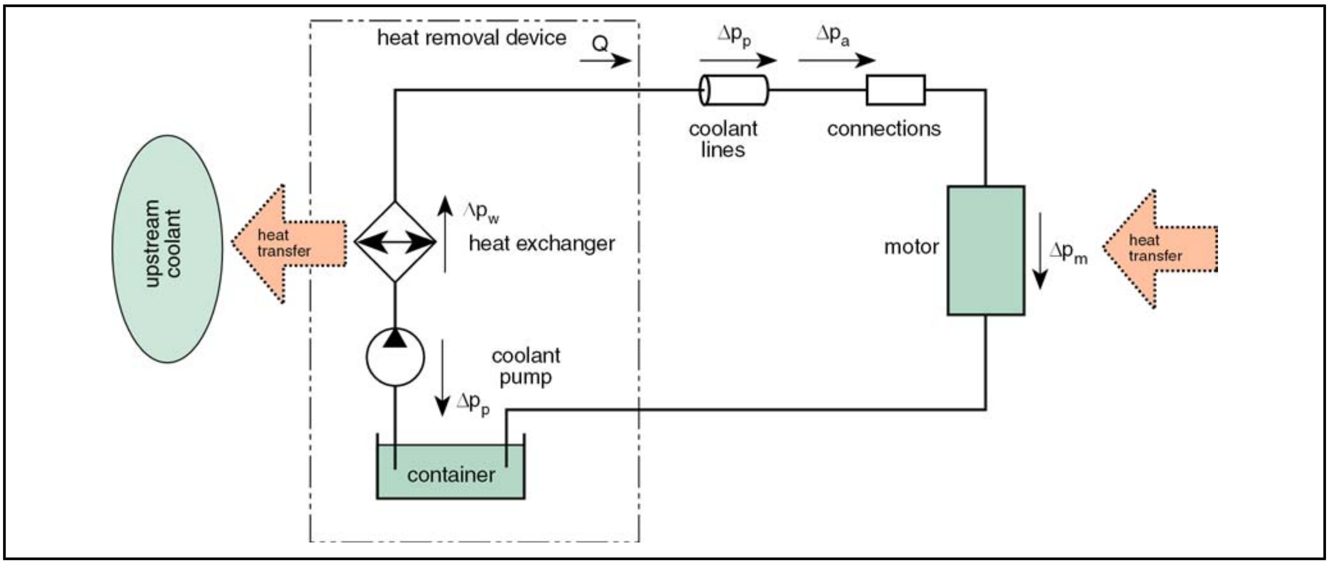


Fig.9-17: General arrangement of a liquid cooled motor with heat removal facility

☞ The overall pressure drop of the cooling system is determined by various partial pressure drops (motor, feeders, connectors, etc.). This must be taken into account when the cooling circuit is sized.

9.6.6 Liquid Cooling System

General

Machines and systems can require liquid cooling for one or more working components. If several liquid-cooled drive components exist, they are connected to the heat removal device via a distribution unit.

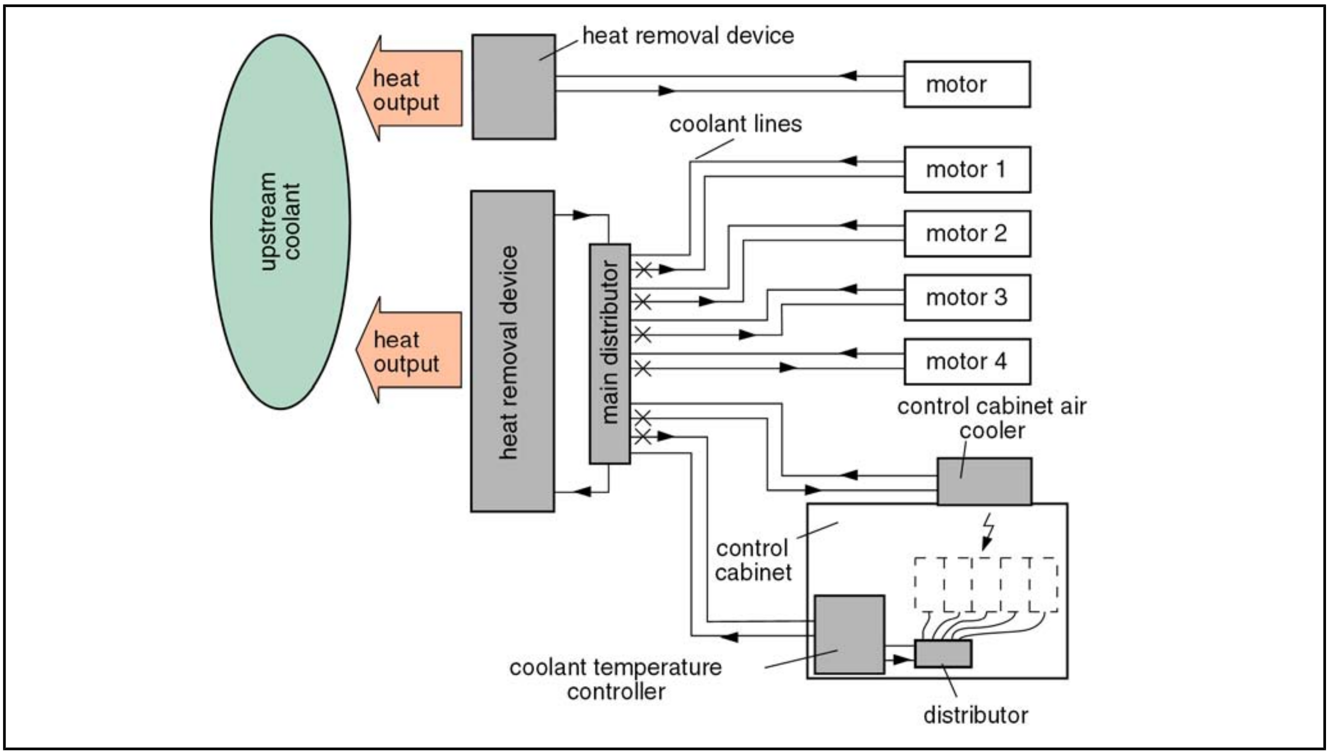


Fig.9-18: General arrangement of cooling systems with one and more drive components

Heat removal device

The heat removal device carries off the total heat that was fed into the liquid into a superordinated coolant. It provides a temperature-controlled coolant and thus maintains a required temperature level at the components that are to be cooled.

There are three different types of heat removal devices. They are identified by the type of the heat exchanger between the different media:

1. **Air-to liquid cooling unit**
2. **Liquid-to-liquid cooling unit**
3. **Cooling unit**

A heat removal device includes a heat exchanger, a coolant pump container and a coolant container (see fig. 9-18 "General arrangement of cooling systems with one and more drive components" on page 140).

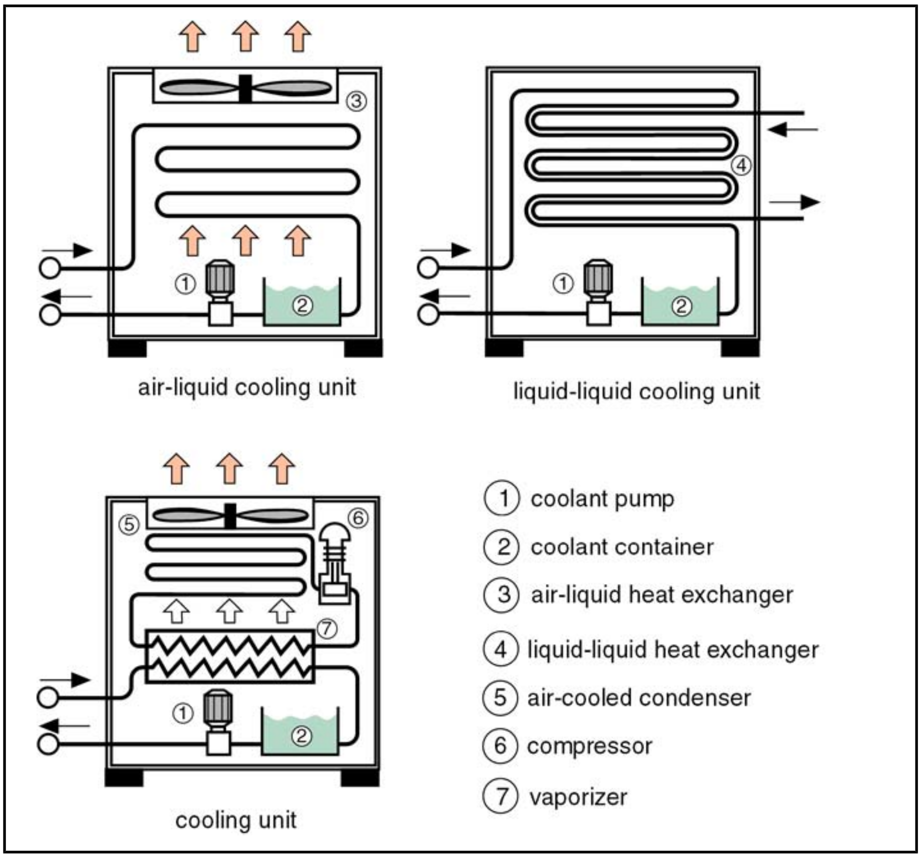


Fig.9-19: Heat removal devices

	Air-to liquid cooling unit	Liquid-to-liquid cooling unit	Cooling unit
Coolant temperature control accuracy	Low (±5 K)	Low (±5 K)	Good (±1 K)
Superordinated coolant circuit required	No	Yes	No
Heating of ambient air	Yes	No	Yes
Power loss recovery	No	Yes	No
Size of the cooling unit	Small	Small	Large
Dependent of ambient tem-perature	Yes	No	No

Application Notes

	Air-to liquid cooling unit	Liquid-to-liquid cooling unit	Cooling unit
Environment-damaging coolant	No	No	Yes
Notes on utilization criteria	Particularly suitable for standalone machines that do not have an superordinated coolant circuit available and do not have to fulfill high requirements on the stability of the coolant temperature.	This cooling type is particularly suitable for systems with existing central feedback cooler. Id does fulfill high requirements on the stability of the coolant temperature.	Particularly suitable for high requirements on the thermal stability (high-precision applications, for example).

Fig.9-20: Overview of the heat removal devices according to utilization criteria

Coolant Lines

The coolant lines are a major part of the cooling system. They have a great influence on the system´s operational safety and pressure drop. The lines can be made up as hoses or pipes.

The continuous bending strain of the coolant lines must always be taken into account when they are sized and selected.

Further Optional Components

- Distributions
- Coolant temperature controller
- Flow monitors

  A message is output when the flow drops below a selectable minimum flow quantity.
- Level monitors

  Chiefly minimum-maximum level monitors to check the coolant level in the coolant container
- Overflow valve
- Safety valve

  Opens a connection between the coolant inlet and the contained when a certain pressure is reached
- Coolant filter (100 µm)
- Coolant heaters

  To provide coolant of a correct temperature, in particular for coolant temperature control
- Restrictor and shut-off valves

Circuit Types

The two possible ways of connecting hydraulic components (series/parallel connection) show significant differences with respect to:

- Pressure drop of the entire cooling system
- Capacity of the coolant pump
- Temperature level and controllability of the individual components that are to be cooled

Parallel connection

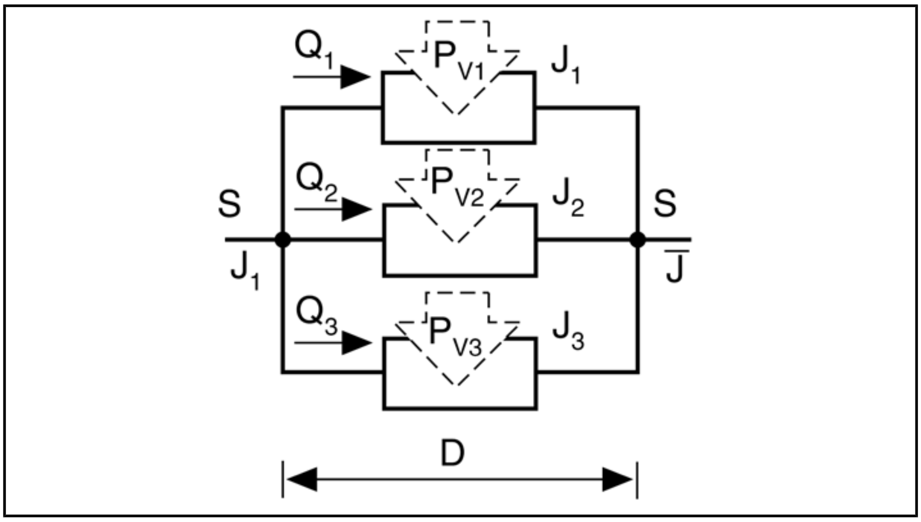


Fig.9-21: Parallel connection of liquid-cooled drive components

The parallel connection is characterized by nodes in the hydraulic system. The sum of the coolant streams flowing into a node is equal to the sum of the coolant streams flowing out of this node. Between two nodes, the pressure difference (pressure drop) is the same for all intermediate cooling system branches.

$$Q = Q_1 + Q_2 \; \ldots + Q_n$$

$$\Delta p = \Delta p_1 = \Delta p_2 = \Delta p_n$$

Δp Pressure drop
Q Flow quantity
Fig.9-22: Pressure drop and flow quantity in the parallel connection of hydraulic components

When several working components are cooled, a parallel connection is advantageous for the following reasons:

- The individual components that are to be cooled can be cooled at the individual required flow quantity. This means a high thermal operational reliability.
- Same temperature level at the coolant entry of all components (equal machine heating) (constant heat up of the machine)
- Same pressure difference between coolant entry and outlet of all components (no high overall pressure required)

Series connection

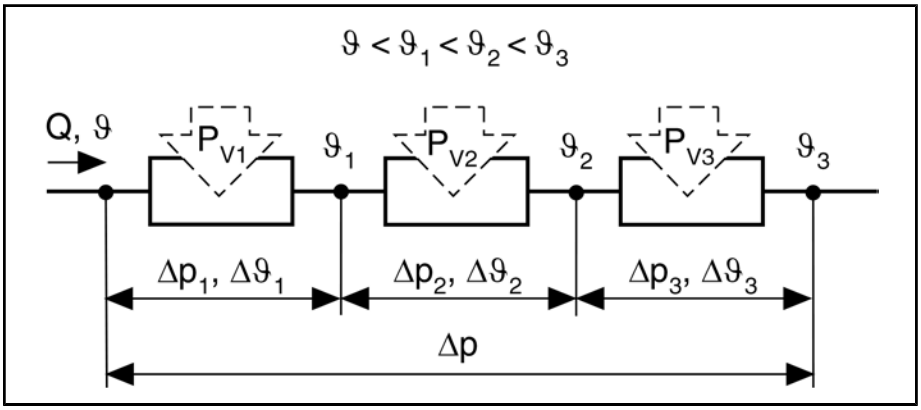


Fig.9-23: Series connection of liquid-cooled drive components

Application Notes

In series connection, the same coolant stream flows through all components that are to be cooled. Each component has a pressure drop between coolant inlet and coolant outlet. The individual pressure drops add up to the overall pressure drop of the drive components.

Series connection does not permit any individual selection of the flow quantity required for the individual components to be made. It is only expedient if the individual components that are to be cooled need approximately the same flow quantity and bring about only a small pressure drop or if they are installed very far away from the heat removal device.

$$Q = Q_1 = Q_2 = Q_n$$

$$\Delta p = \Delta p_1 + \Delta p_2 \; \dots \; + \Delta p_n$$

Δp	Pressure drop
Q	Flow quantity

Fig.9-24: Pressure drop and flow quantity in the series connection of hydraulic components

The following disadvantages of series connection must always be taken into account:

- The required system pressure corresponds to the sum of all pressure drops of the individual components. This means a reduced hydraulic operational safety due to a high system pressure.
- The temperature level of the coolant rises from one component to the next. Each power loss contribution to the coolant rises its temperature. (inhomogeneous machine heating)
- Some components may not be cooled as required since the flow quantity cannot be selected individually.

Combination of series and parallel connection

Combining series and parallel connections of the drive components that are to be cooled permits the benefits of both connection types to be used.

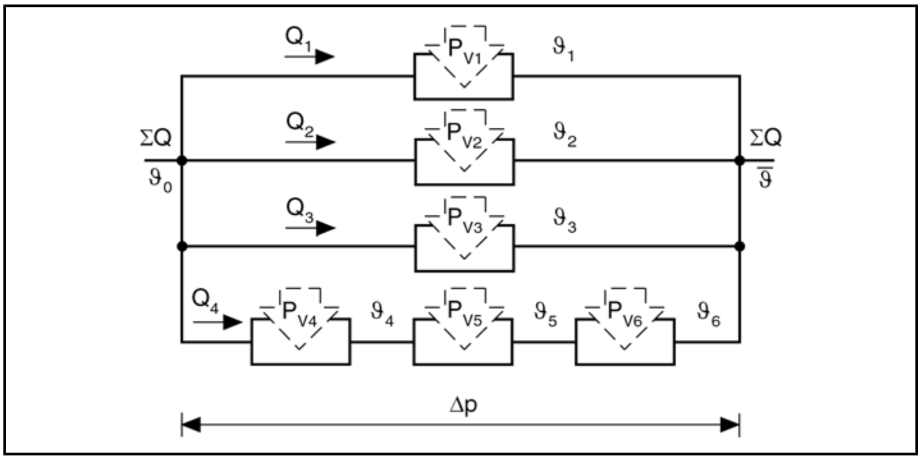


Fig.9-25: Combination of series and parallel connection

9.7 Motor Temperature Monitoring

CAUTION

Failure in the machine or damage by improper use of the sensors!

- The PTC sensors are not safety devices and are not suited for integration in safety systems to protect persons or machines.
- The PTC sensors are neither designed nor suitable for acquisition of the housing, rotor or bearing temperature. Additional requirements of the temperature monitor must be implemented by the machine manufacturer.
- The motor is only protected from a thermal overload if temperature sensor SNM.150.DK is connected to the drive control device.

In their standard configuration, stators of IndraDyn H motors are equipped with built-in motor protection temperature sensors. Every motor phase contains of one out of three switched in a row ceramic PTC´s, so that a sure thermal control of the motor in every operation phase is possible. This temperature sensor (in the following referred to as motor protection temperature sensor) has a switching character (see fig. 9-27 "Characteristic of motor protection sensors (PTC)" on page 145) and is evaluated on all Bosch Rexroth control devices.

Furthermore all stators are fitted with an additional temperature sensor for temperature measurements. This sensor (in the following referred to as temperature monitoring sensor) has a nearly linear characteristic curve (see fig. 9-28 "Characteristic of temperature measurement sensor KTY84-130 (PTC)" on page 146).

Temperature sensor motor protection

Type	PTC SNM.150.DK.***
Nominal activation temperature ϑ_{NAT}	302.00 °F
Resistor at 25°C	≈ 100...250 Ohm

Fig.9-26: Temperature sensor motor protection

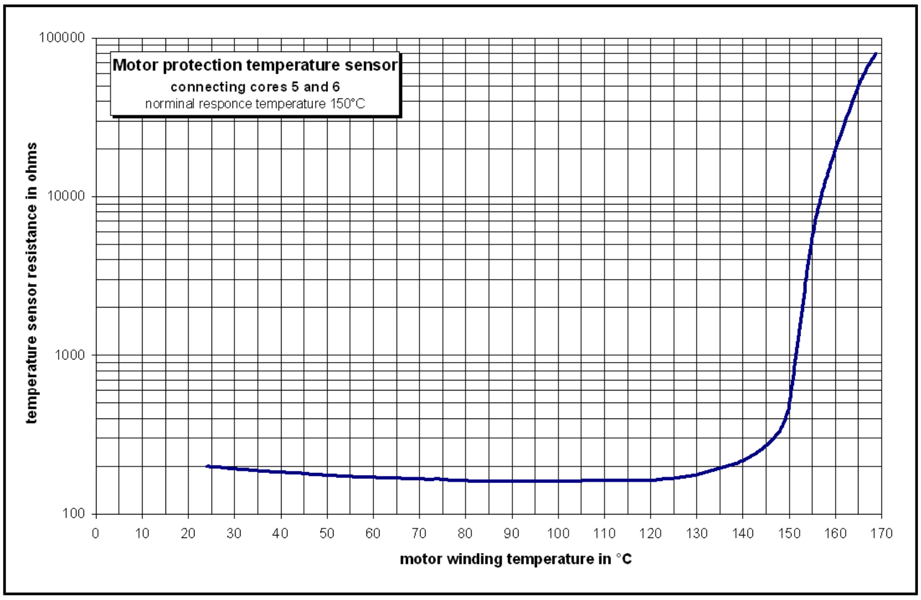


Fig.9-27: Characteristic of motor protection sensors (PTC)

Application Notes

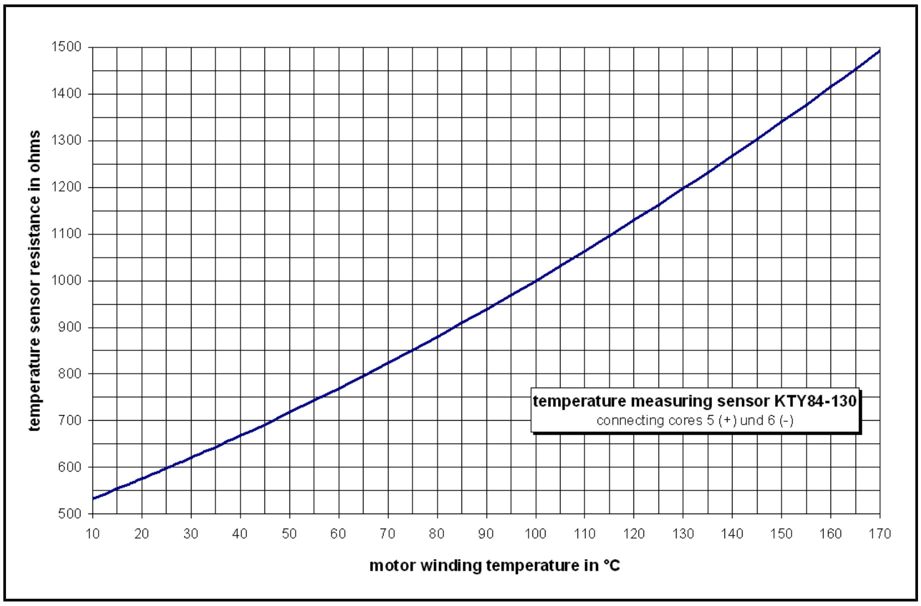


Fig.9-28: Characteristic of temperature measurement sensor KTY84-130 (PTC)

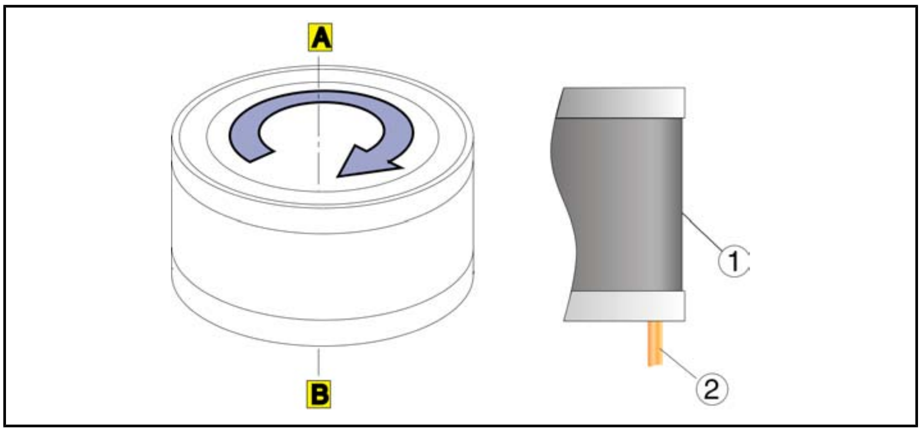
When connecting the temperature sensor KTY84-130 for a temperature measurement, pay attention to the polarity (see chapter 8 "Connection Technique").

You can find further details on connecting the temperature sensors in chapter 8, ”Connection Techniques”.

9.8 Motor Direction of Rotation

The rotation direction of the motor (rotor direction of rotation) of an IndraDyn H motor is described using the cable outlet side.

The following figure explains the assignment.



① Stator
② Power lead
Fig.9-29: Motor rotation direction

9.9 Design of Rotor and Assembly Principle of Rotor/Spindle Shaft

9.9.1 General

The rotor and the spindle shaft are connected to one another with a shrink fit (thermal joining). Due to the rotor design you must, however, in the assembly distinguish between

- **rotor with smooth bore** (type code designation **1N**)
- **rotor with step interference fit** (type code designation **2N**)

The following descriptions provide an appropriate overview of the required assembly steps for connecting the rotor to the spindle shaft. You can find detailed information regarding the assembly of IndraDyn H motors in chapter 11 "Assembly Instructions".

9.9.2 Rotor with Smooth Bore

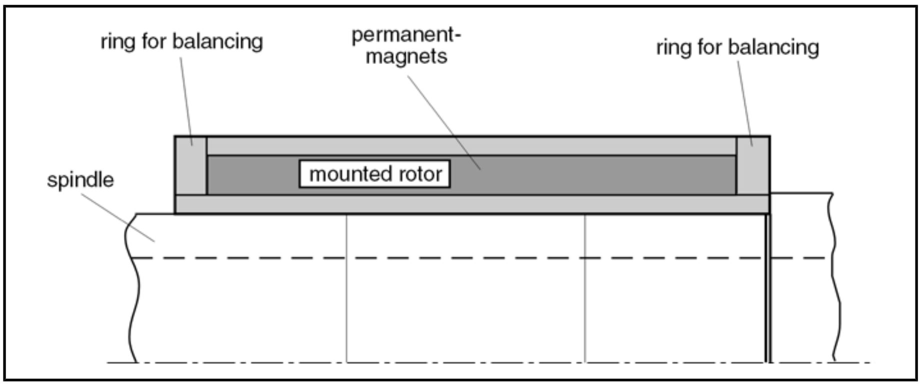


Fig.9-30: Rotor design 1N - smooth shaft

The rotor consists of a steel sleeve with permanent magnets on the inside. Depending on the rotor type, the spindle has several fitting surfaces arranged next to each other; these have slightly graduated diameter tolerances. The rotor and the spindle are frictionally engaged by the fitting surfaces, which align the assembled rotor to the spindle.

Due to the lack of pressurized oil connections, the advantages of this rotor design over the rotors with a step interference fit include:

- a more compact shape and
- an ability to convert a larger internal rotor diameter within the same amount of space.

The rotor is attached by shrink-fitting it onto the spindle.

The spindle construction in the area of the rotor bore must correspond to the information in the dimension sheets of the corresponding motor in chapter 5.

In this model, the rotor cannot be removed from the spindle without destroying it.

☞ When laying out the motor spindle remember that the rotor with the 1N design (smooth bore) cannot be removed from the spindle without destroying it after it has been shrink-fitted.

Assembly Due to the required interference fit, the rotor sleeve must be heated up to 135° C - max. 145°C before assembly.

Application Notes

CAUTION

Damage of the magnets within the rotor due to temperatures above 145° C!

Heating of the rotor sleeve must be monitored. Heating the rotor sleeve above 145°C is not permitted.

Due to the material expansion, the fittings of the rotor bore expand.

At the same time, the spindle must be cooled to –20°C.

The rotor and the spindle can then be joined in this state without force.

Dismantling

☞ Disassembly of the rotor with 1N design "smooth shaft" is not possible!

Balancing

After assembly, the rotor is balanced according to the necessary vibration severity grade (EN 60034-14:2004). To achieve equilibrium of the rotor, threaded pins are radially screwed into the circumference of the balancing ring and secured using glue.

9.9.3 Rotor with Step Interference Fit

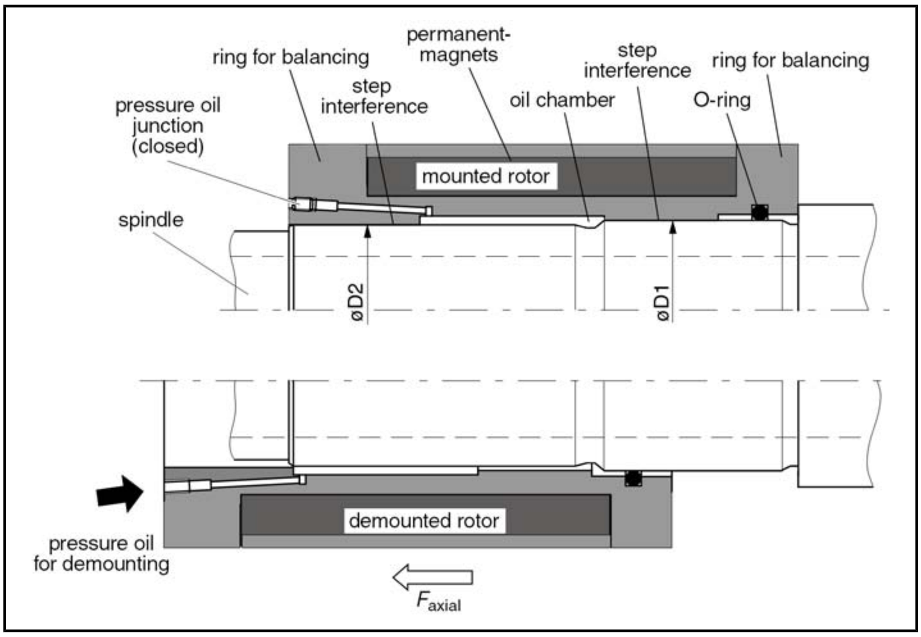


Fig.9-31: Rotor installation and functional principle of the step interference fit

The rotor consists of a steel sleeve with permanent magnets on the inside. The spindle has two fitting surfaces arranged next to each other; these have slightly graduated diameters (ØD1 > ØD2). The rotor and the spindle are frictionally engaged by the so-called step interference fit. The graduated fitting surfaces align the mounted rotor to the spindle; they are required so that the rotor can be removed without damage.

The spindle construction in the area of the step interference fit must correspond to the information in the dimension sheets of the corresponding motor in chapter 5.

The rotor is attached by shrink-fitting it onto the spindle; the oil-pressure procedure is used during removal.

Assembly

Due to the required interference fit, the rotor sleeve must be heated up to 135° C - max. 145°C before assembly. Due to the material expansion, the fittings expand to fit diameters D1 and D2.

CAUTION

Damage of the magnets within the rotor due to temperatures above 145° C!

Heating of the rotor sleeve must be monitored. Heating the rotor sleeve above 145°C is not permitted.

At the same time, the spindle must be cooled to –20°C.

The rotor and the spindle can then be joined in this state without force.

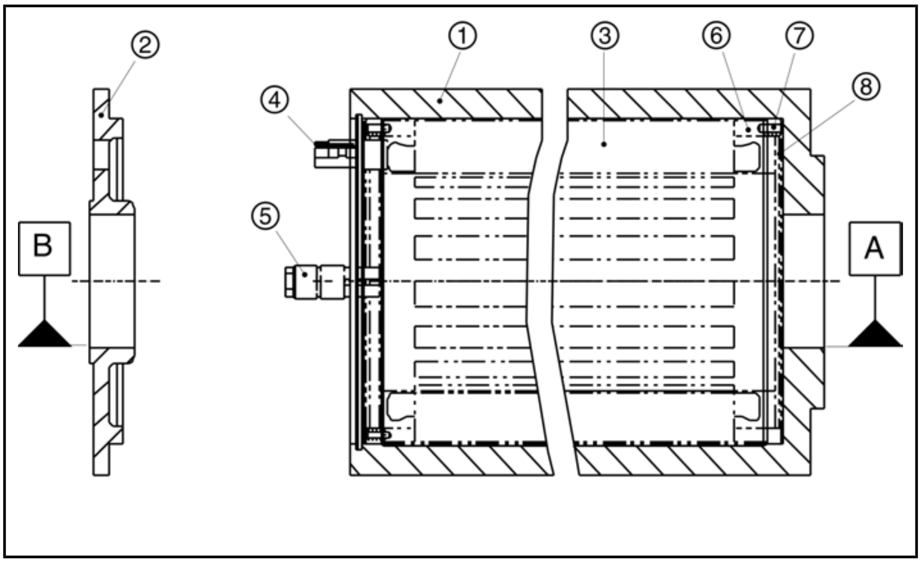
Dismantling

Oil under pressure is injected into the step interference fit during removal. This creates an axial force thanks to which the rotor can slide off the spindle as soon as there is a separating oil film between the fitting surfaces. The step interference fit loosens at diameter D1 first. The O ring keeps the oil from escaping at this side.

Balancing

After assembly, the rotor is balanced according to the necessary vibration severity grade (EN 60034-14:2004). To achieve equilibrium of the rotor, threaded pins are radially screwed into the circumference of the balancing ring and secured using glue.

9.10 Stator Installation Principle



① Spindle housing
② End plate
③ Stator iron core
④ Power lead
⑤ Coolant Connection
⑥ Stator flange
⑦ Stator fastening thread (Screw only one stator side!)
⑧ Gap for longitudinal expansion (take this into account on the opposite side of the stator fastening)

Fig.9-32: Stator installation principle

Stator

The stator is made up of an iron core with end windings located on the front, two stator flanges and an integrated cooling system.

Construct the mounting bore in the spindle housing according to the dimension sheets of the corresponding motor in chapter 5 "Dimension Sheets".

Attaching the stator

In the motor spindle, the stator is axially mounted on the corresponding side; it is then secured against movement. For this purpose, threads for axial attachment have been provided on both ends in the stator flange.

☞ It can be mounted to either the A or B side of the stator, but not on both!

There must be a clearance of at least 1 mm between the stator and the spindle housing on the end opposite of where the stator is attached so that the stator can expand in length. The longitudinal expansion is caused by the stator heating up while the motor spindle is operating.

The stator is light in weight and small in size. Therefore, it does not achieve its final flexural strength until it has been built into the spindle housing.

Cooling

The IndraDyn H motors have a stator-integrated cooling system. The cooling lines are connected to the A side of the stator using two connectors.

Further information for dimensioning and selecting a liquid cooling system is provided in the documentation "Liquid cooling of Indramat drive components", MNR R911265836.

Corrosion protection

The spindle housing must be protected against corrosion with a suitable corrosion-protection agent.

Electrical connection

The power connection is brought out through the A side of the stator. There are also two PTC thermistors in the end winding which monitor/measure the winding temperature through the control device.

Together, as cable, the power leads and the PTC thermistors are guided into a hose.

The grounding connection must be executed according to the information in chapter 8, ”Connection Technique”.

When feeding the cable through the spindle housing, ensure that

- the provided bending radius of the cable is not undershot (see chap. 8 "Connection Technique") and
- the edges of the through-hole on the spindle housing are chamfered.

9.11 Regenerative Power Uptake

If all motors of a drive package enter the braking mode simultaneously (e.g. when all the drives react to an error), it must be ensured that the total regenerative power (motor moment of inertia incl. the moment of inertia of the load) can be converted by the power supply into heat or returned to the power supply network.

CAUTION

Material damage due to overload of the braking resistor and due to extended braking times/paths!

Select the power supply device so that the sum of the peak regenerative power of all the drives does not exceed the peak braking resistor power of the power supply device.

In the case of power supply devices that are incapable of regeneration or ones that are capable of regeneration but whose control voltage could fail during an error, the active braking resistor must be capable of taking up the entire regenerated power of a fast braking action!

Calculation

Especially in the case of motors of the IndraDyn H series, the power that is regenerated during braking must be considered due to the high maximum speeds; this power must be compared to the regenerative power uptake of the power supply device/converter that is used!

☞ If necessary and if possible, an additional braking resistor should be used!

You can find notes regarding the calculation of the regenerative power as well as the relevant data of the power supply devices/ converters in the project planning manual

- Rexroth IndraDrive Drive System, DOK-INDRV*-SYSTEM*****-PRxx-EN-P,MNR R911309635

9.12 Foreign Components

9.12.1 Motor Encoder

General

A motor encoder is required for measuring the position and the velocity. The requirements for the motor encoder and its mechanical connection are particularly high.

☞ The motor encoder does not belong to the scope of delivery of IndraDyn H motors. The selection of suitable motor encoders is the machine manufacturer’s task and depends on the requirements of your application or machine.

For further questions about selection and technical clearance of the compatibility of the motor encoder to Rexroth drive-devices our sales and service facilities (see chapter 13) are available.

If due to the principle, it is necessary to receive the position of the rotor to the stator by return after start or after a malfunction (identification of pole position), we typically recommend absolute encoder systems.

Selection

The attainable precision of the IndraDyn H motors depends mainly on the

- mechanical rigidity of the system as a whole.

Taking into account the desired precision, pay attention to the following additional points when selecting the motor encoder:

- speed range of the motor
- speed range of the encoder
- encoder resolution / precision
- compatibility with the control device

Measuring Principles

Absolute encoder

The advantages of an absolute encoder system result from the fact that a high availability and operational reliability of the entire system is guaranteed. Further advantages are:

- Monitoring and diagnosis functions of the electronic drive system are possible without any additional wiring
- The maximum available motor force is available right after switch-on.
- No referencing required
- Simple start-up
- Commutation adjustment is only required for initial commissioning

☞ Using an absolute encoder system makes it possible that the commutation of the motor must only be performed once for initial commissioning.

Incremental encoder

Using an incremental encoder, the pole position must be detected at every time the drive device is turned on. This is done, using a drive-internal procedure that must be executed whenever the motor is switched on. After this, a force processing of the motor is possible.

☞ With incremental encoder systems, the drive-internal procedure for commutation must be executed upon each switch-on.

You can find further details regarding the particular encoder types in the appropriate publications of the encoder manufacturer.

Suppliers of encoder systems are, for example:

Component	Supplier
ER.... angle measuring instruments	**DR. JOHANNES HEIDENHAIN GmbH** Dr.-Johannes-Heidenhain-Str. 5 83301 Traunreut, Germany Tel.: +49 (0) 86 69 31 – 0 Fax +49 (0) 86 69 50 61 Internet: www.heidenhain.de
RESR angle measuring systems	**RENISHAW GmbH** Karl-Benz-Straße 12 72124 Pliezhausen, Germany Tel.: +49 (0) 71 27 / 98 10 Fax +49 (0) 71 27 / 88 23 7 Internet: www.renishaw.com
GEL... gear encoder	**Lenord, Bauer &Co.GmbH** Dohlenstraße 32 46145 Oberhausen, Germany Tel.: +49 (0) 208 / 9963 – 0 Fax +49 (0) 208 / 6762 – 92 Internet: www.lenord.de

Fig.9-33: Motor encoder suppliers

9.12.2 Bearings

☞ Bearings do not belong to the scope of delivery of IndraDyn H motors. The selection of the required bearings depends on the demands of the application or machine.

Selection

Taking into account their lifetime, pay attention to the following when selecting bearings:

- the speed range of the motor and
- the radial and axial loads on the bearing during operation.

You can find detailed notes on selecting bearings in the corresponding publications of the bearing manufacturer.

Suppliers of bearings include:

Component	Supplier
YRT... bearing	**INA-SCHAEFFLER KG** Industriestraße 1-3 91074 Herzogenaurach, Germany Tel.: +49 (0) 91 32 / 82 - 0 Fax +49 (0) 91 32 / 82 - 49 50 Internet: www.ina.de
Bearing	**SKF GmbH** Gunnar-Wester-Straße 12 97421 Schweinfurt, Germany Tel:+49 (0)-9721-56-0 Fax +49 (0)-9721-56-6000 Internet: www.skf.com
Bearing	**NSK Deutschland GmbH** Hauptverwaltung Harkortstraße 15 40880 Ratingen, Germany Tel:+49 (0)-21-02-4810 Fax +49 (0)-21-02-4812290 Internet: www.nsk.com
Bearing	**NTN Wälzlager GmbH** Max-Planck-Straße 23 40699 Erkrath, Germany Tel:+49 (0)-211-2508-0 Fax +49 (0)-211-2508-400 Internet: www.ntn-europe.com

Fig.9-34: Motor bearing suppliers

10 Handling, Transport and Storage

10.1 General

When selecting the transport and lift equipment, heed the different weights and sizes of the separate motor designs. Weight specifications regarding the rotor and the stator can be found in the data sheet of the particular motor in chapter 4 "Technical Data".

Even the manually-transported models must be handled with the greatest care and the appropriate transport and storage instructions have to be heeded.

10.2 Delivery Status

10.2.1 General

Depending on their size, IndraDyn H motors are packed in cardboard boxes with polystyrene peanuts or in wooden crates.

The goods are delivered on a pallet or in a box. Packing units on pallets are secured by retaining straps.

Rotor and stator are separately packed so that they are protected against damage during transport.

Are several kit-spindle motors or components ordered, they are packed together into one package, if possible.

On the wooden crates or on the cardboard boxes, an envelope with the delivery note is fixed.

Additionally, the following labels are fixed on the package:

- one label with notes regarding safe handling
- one label with instructions for safe transport and delivery
- barcode label (quantity depends on the content) with details about:
  - Customer
  - the delivery note
  - Consignment
  - Forwarding agent ordered

Further accompanying documents are not existent, if not requested.

WARNING

Injuries due to uncontrolled movement of the retaining straps when cutting!

1. Observe sufficient distance
2. Remove the bandages carefully

CAUTION

Risk of injury and/or damage when handling rotors of IndraDyn H motors!

- Strictly observe and adhere to the warnings and safety instructions!
- Sign the working space as containing dangerous magnetic fields.
- Due to their strong magnetic field, do only unpack the rotors immediately before the assembly.

10.2.2 Factory Test

All IndraDyn H motors undergo the following inspections, among others, at the factory:

- High-voltage test according to EN 60034-1 (= VDE 0530-1).
- Insulation resistance according to EN 60204-1/1.92, Section 20.3.
- Geometric measurement of all mounting sizes.

10.2.3 Test on the Customer Side

Since all IndraDyn H motors undergo a standardized inspection procedure, high-voltage tests on the customer side are not required. Motors and components could be damaged if they undergo several high-voltage tests. If nevertheless, additional tests are to be carried out, please contact Rexroth in any case.

CAUTION

Destruction of motor components by improperly executed high-voltage test! Invalidation of warranty!

- Avoid repeated inspections.
- Observe the regulations of EN 60034-1 (= VDE 0530-1)

10.2.4 Scope of Delivery

The total scope of delivery can be seen in the delivery note or the waybill. The content, however, can consist of several packages. Each individual package can be identified using the shipment label attached to the outside.

An individual type label with the device designation and technical details as well as a supply note with information for handling is provided in the packaging for both stator and rotor.

- After receiving the goods, compare the ordered and the supplied type. Submit claims concerning deviations immediately.

10.3 Identification

Barcode label

For every rotor and stator, a barcode label is affixed to the package. The barcode label serves the identification of the content of the packages and is necessary for the order processing.

Name plate

Both, stator (MSS) and rotor (MRS) components are delivered with one type plate each.

Attach the name plates to an easily visible portion of the machine. In this way, you can read the motor data at any time without having to work in areas that are difficult to access.

☞ Before sending questions to Bosch Rexroth, always specify the full type identification data and serial number of the products involved.

Stator

The stator is labelled on the front with the electrical connections. The details of this labelling are identical with the details of the related stator name plate and consist of

- Type designation
- Serial no.
- Year and month of production

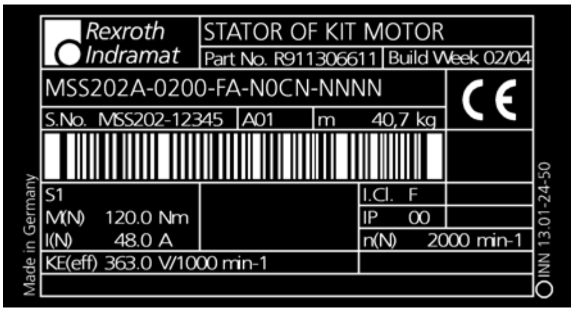
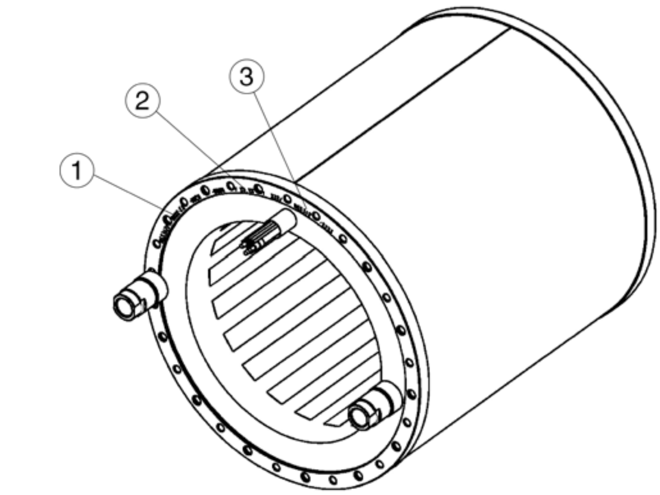


Fig. 10-1: Stator name plate (example)



① Type designation
② Serial number
③ Year and month of production

Fig. 10-2: Stator identification

Rotor

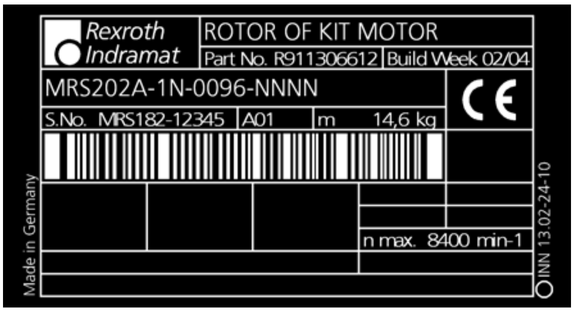


Fig. 10-3: Rotor name plate (example)

As with the stator, the rotor is also labelled on one of the two fronts. In this connection, the details correspond to the related rotor name plate. The following details are applied:

- Type designation
- Serial no.
- Year and month of production

10.4 Transport and Storage

10.4.1 General

Also observe the notes regarding storage and transport on the packages. Clearly mark your work space and the place of storage with warnings corresponding to the following information.

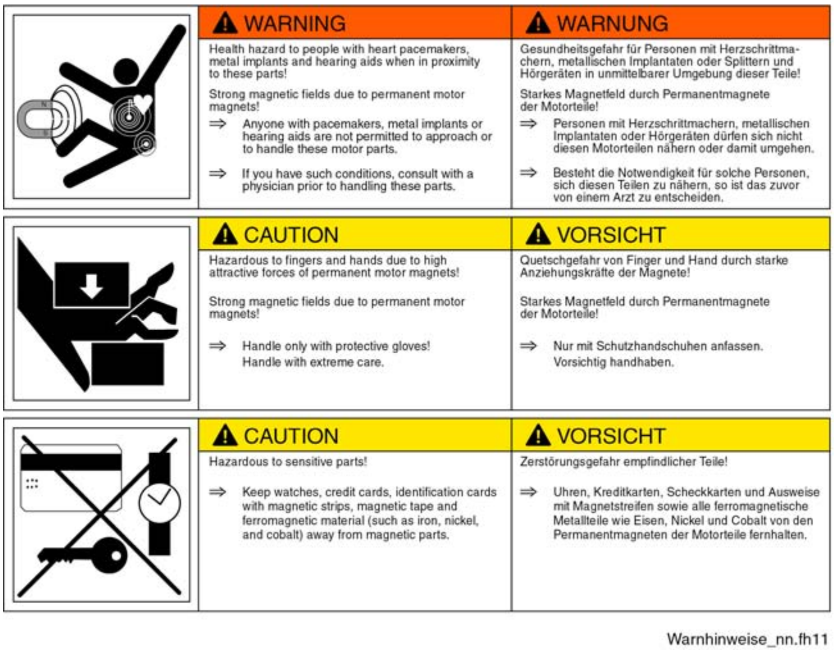


Fig. 10-4: Warning label

☞ The self-sticking warning label (sizes approx. 110mm x 150mm) can be ordered from Rexroth for any further use using the material number R911278745.

CAUTION

Damages or injuries and invalidation of the warranty due to improper handling!

⇒ Strict compliance of all safety notes and warnings

⇒ Protect the products from dampness and corrosion .

⇒ Avoid mechanical stressing, jolts, throwing, tipping or dropping of the products.

⇒ Use only suitable lifting equipment.

⇒ Do never pick up a motor on the connectors, cables or connection thread.

⇒ Use suitable protective equipment and wear protective clothing during transport.

⇒ Sign your working space according to the warnings in fig. 10-4 "Warning label" on page 158.

⇒ Store rotor and stator in the original packaging under dry, shock-free, dust-free and corrosion-protected conditions. Permitted temperature range –20 °C to +80 °C.

10.4.2 Transport

CAUTION

Damages or injuries and invalidation of the warranty due to improper handling!

⇒Strict compliance of all safety notes and warnings

⇒ Protect the products from dampness and corrosion .

⇒ Avoid mechanical stressing, jolts, throwing, tipping or dropping of the products.

⇒ Use only suitable lifting equipment.

⇒ Do never pick up a motor on the connectors, cables or connection thread.

⇒ Use suitable protective equipment and wear protective clothing during transport.

⇒ Sign your working space according to the warnings in fig. 10-4 "Warning label" on page 158.

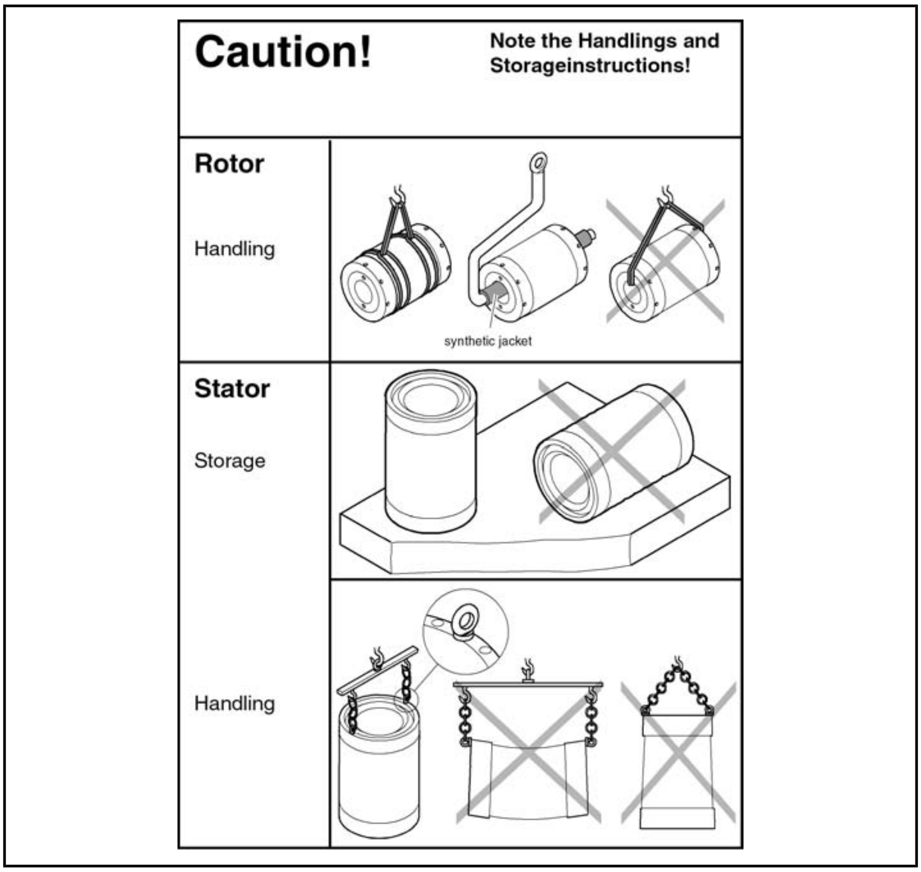


Fig. 10-5: Transport IndraDyn H

Note:

- Use ring screws for transport only in opposite holes. Use only suitable lifting equipment.
- Only set the rotor and the stator down if the base is clean and straight. Preferably, both assemblies are to be stored in a standing position and secured against toppling. If contrary to this statement, it is recommended to store certain rotor or stator assemblies in a lying position, the parts have to be secured against rolling. In the rotor, you must additionally ensure that the base is not magnetic.

- Avoid damage to the fitting at the stator flanges in order not to complicate the installation.

10.4.3 Storage

Rexroth recommends storing the rotor and stator motor assemblies in their original packaging in order to protect them from contamination and damage.

☞ Before you store or ship the parts, remove the remaining coolant and other pollution.

CAUTION

Damages or injuries and invalidation of the warranty due to improper handling!

⇒ Avoid mechanical stressing, jolts, throwing, tipping or dropping of the products.

⇒ Sign your storage space extensively according to fig. 10-4 "Warning label" on page 158.

⇒ Store rotor and stator in the original packaging under dry, shock-free, dust-free and corrosion-protected conditions.

⇒ Permitted temperature range –20 °C to +80 °C.

11 Assembly Instructions

11.1 General

In addition to providing technical characteristics, this chapter describes how

- the rotor is mounted to the spindle,
- the rotor is removed from the spindle,
- the stator is installed in the spindle housing,
- the stator is removed from the spindle housing,
- the rotor package is installed in the stator package.

Careful execution of the steps described here will ensure:

- proper and safe assembly and disassembly of the constructional parts,
- proper functioning of the kit spindle motor.

Notes regarding safety

The "Notes Regarding Safety" listed in chapter 3 and in this chapter must absolutely be heeded. They help to prevent accidents and damage to materials resulting from improper handling.

Additionally, special notes regarding safety are listed in the assembly guidelines. These can be found where there is increased danger or where it could possibly occur.

Legal validity

The general procedure for mounting and removing the components is always the same. It may, however, vary from the procedure described here, depending on the construction of the spindle and its housing. These assembly instructions are therefore simply general in nature and must be adapted to suit the given demands. The assembly instructions of the manufacturer of the spindle and of the spindle housing are binding and have priority over the procedure described here.

Assembly steps

The procedures depicted below offer an overview of the individual assembly steps.

Assembly Instructions

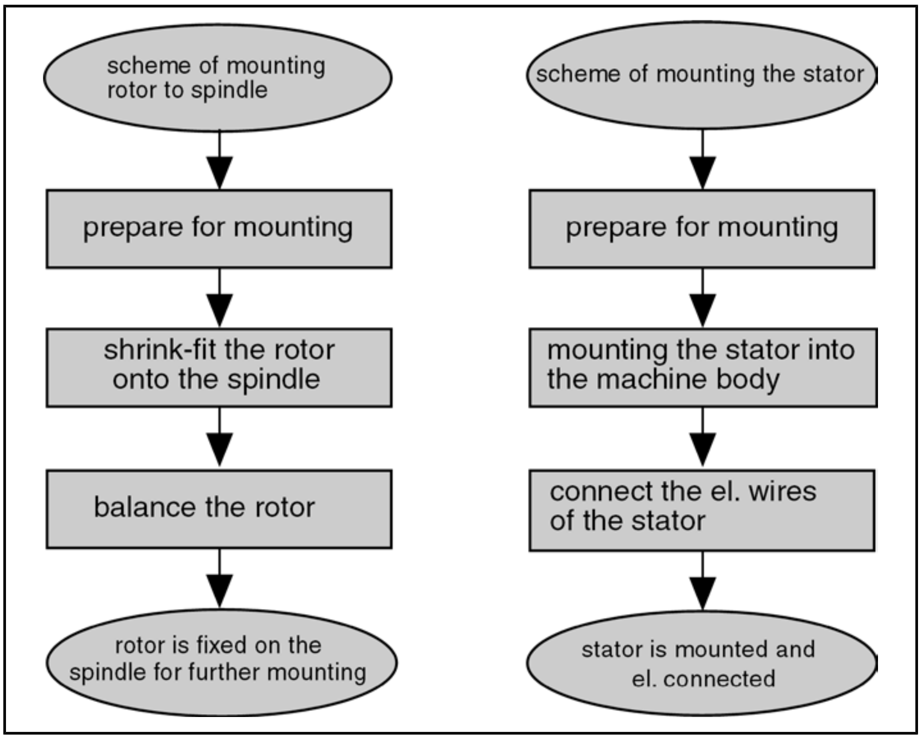


Fig.11-1: Procedure for assembling the rotor and the stator

11.2 General Notes Regarding Safety

General notes regarding safety in addition to those in chapter 3 "Notes Regarding Safety" are listed in this chapter.

General

- Pay attention to the strong magnetic field surrounding the rotor. Only remove the rotor from the original packaging just before the assembly.
- Keep the rotor away from ferromagnetic bodies (e.g. tools, metal workbenches, etc.)

Work clothes

During assembly, wear appropriate industrial safety materials such as

- protective goggles
- protective gloves and
- work clothes for the protection from high and low surface temperatures and leaking oil.

Work area, handling and transport

Extensively mark your work area with information according to fig. 10-4 "Warning label" on page 158 and heed the handling and transport regulations in chapter 10 "Handling, Transport and Storage".

Accident prevention

Heed the accident prevention guidelines "Electrical Installations and Resources" (VBG 4):

Prior to working on live parts in electrical systems and on electrical equipment, disconnect the power and make sure it cannot be reconnected while work is being carried out. Prior to the initial start-up, the electrical systems and electrical equipment must be checked by a qualified electrician for their proper functioning.

The user is responsible for the proper grounding of the entire system. To prevent accidents due to contact with live parts, protective measures must be taken against direct and indirect contact. See the notes in DIN VDE 0100, part 410.

Emergency tools

Ensure that emergency tools such as wedges (10°-15° wedge angle) and a hammer made of non-magnetic material is on hand to separate tightened equipment.

Oil pump

When dismantling a rotor with the "step interference fit" design from the spindle, only **manually operated** oil pumps may be used. Manually operated oil pumps guarantee that the oil pressure will immediately drop to 0 bar in the event of leaks in the step interference fit, the connection thread or the pump piping system. For safety reasons, the oil pump must be additionally equipped with a pressure relief valve which prevents the oil pressure from rising above 1500 bar.

Securing the threaded pins

The threaded pins in the rotor must be secured to keep them from loosening during operation and thereby endangering both machinery and personnel. For this purpose, glue the threaded pins with LOCTITE. See the gluing guidelines in chapter 11.4 "Securing Screws with LOCTITE " on page 165.

11.3 Aids for Assembly and Disassembly

Tools and equipment	Mount rotor to spindle	Dismount rotor from spindle	Mount stator	Elec. test of motor spindle	Remove stator
Crane (size sufficient for weight of part)	x	x	x		x
Lifting device (sufficient size for weight of part)	x	x	x		x
Work fixture for attaching rotor 1)	x				
Warming cupboard (+150°C minimum)	x				
Refrigerator (-20°C)	x				
Balancing equipment	x				
Test assembly to check concentricity	x				
Clamping device for fixing spindle-rotor 1)	(x)				
Compressed air deviced	(x)				
Oil pump (max. 1500bar) with accessories 1)	(x)	x			
Arresting device 1)		x			
Drilling device			x		
Water pump to check tightness (up to 6 bar)			x		
Ohmmeter				x	
High-voltage testing equipment				x	
Inductance measuring equipment				x	
Torque wrench up to 35Nm			x		
Conventional tools and cleaning equipment	x	x	x		x
Aids					
LOCTITE 243			x		
LOCTITE 620	x				
LOCTITE quick clean 7061	x		x		
LOCTITE activator 7649	x		x		
Mineral oil: viscosity 300 mm²/s at 20°C	(x)				
Mineral oil: viscosity 900 mm²/s at 20°C		x			
Oil, conventional type, for lubrication	x				
Grease, conventional type	x		x		
Vaseline			x		
Coolant			x		

1) See explanations on next page.
(x) Only applies to mounting errors

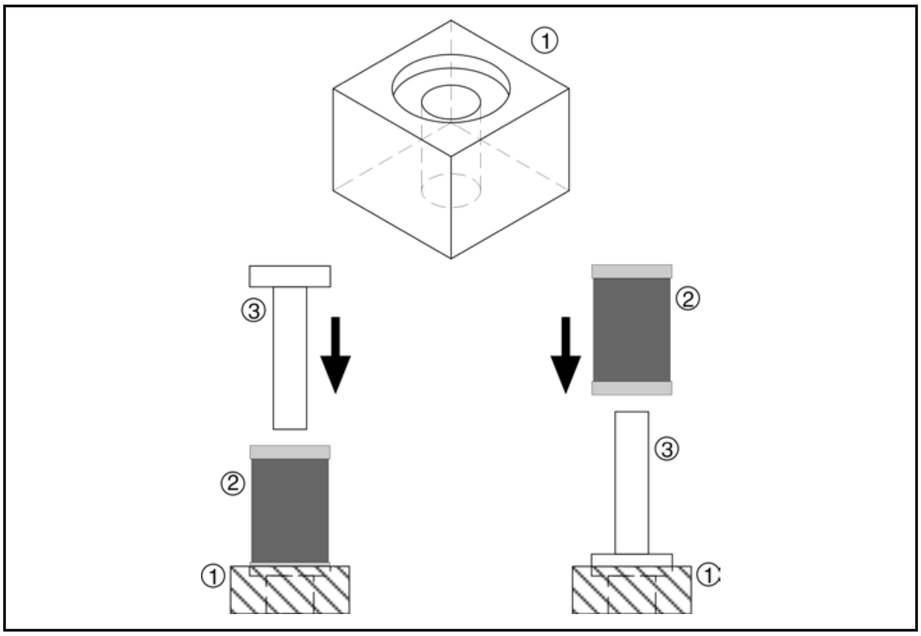
Fig.11-2: Aids for assembly / disassembly

☞ Use only suitable tools and equipment!

Explanations

Fixture for mounting the rotor:

The fixture must be heat-resistant up to at least +150°C; it must also be able to support the weight of both, the rotor and the spindle. In addition, it must be made of non-ferromagnetic material and the rotor or spindle must create a level and horizontal surface. An example of a possible design is shown below.



① Mounting device
② Rotor
③ Spindle

Fig. 11-3: Mounting device principle

Manually operated oil pump and accessories:

Oil pressure: 1500 bar with pressure relief valve; connection winding of the high-pressure hose: M4x0.5 or M6 (depending on the rotor type)

Oil pumps and accessories can usually be obtained from the manufacturers of roller bearings.

Clamping device for spindle-rotor attachment:

If the spindle is deformed once the rotor with the step interference fit has been fitted by shrinking, then a clamping device, among other things, is needed to correct this deformation. This device must firmly hold the rotor in place on the spindle and prevent any axial movement of the rotor. fig. 11-12 ""Floating" of the rotor" on page 174 shows a corresponding example.

Arresting device:

When removing the rotor with the step interference fit from the spindle, it can suddenly slide off the spindle. The spindle must therefore be equipped with an arresting device. fig. 11-16 "Example of an end stop in the disassembly" on page 177 shows a corresponding example. In doing so, the mounting dimension A must be complied with.

11.4 Securing Screws with LOCTITE

General

LOCTITE is a plastic adhesive, which is applied to the installation parts in liquid form. The adhesive remains liquid as long as it is in contact with oxygen. Only after the parts have been mounted, it converts from its liquid state into hard plastic. This chemical conversion takes place under exclusion of air and the produced metallic contact. The result is a form-locking connection that is impact- and vibration-resistant. It is shock-proof and resistant to vibrations.

The hardening accelerator Activator 7649 reduces the hardening time of the adhesive.

LOCTITE 620 is heat-resistant up to +200°C, LOCTITE 243 up to +150°C.

Gluing

Procedure [1]:

1. Clean metal chips and coarse dirt from threaded hole and screw or grub screw.
2. Use LOCTITE rapid cleanser 7061 to clean oil, grease and dirt particles from threaded hole and screw/grub screw. The threads have to be absolutely restless.
3. Spray LOCTITE activator into the threaded hole and let it dry.
4. Use LOCTITE adhesive to moisten the same threaded hole in its entire thread length thinly and evenly.
5. Screw in the matching screw/grub screw.
6. Allow join to harden. Heed the following setting times!

Securing screwed connections using LOCTITE in tapped blind holes:

The adhesive must always be dosed into the tapped hole, never on the screw. This prevents that the compressed air extrudes the adhesive when the screw or grub screw is screwed in.

	Hardened	Hard to the touch without activator	Hard to the touch with activator 7649
LOCTITE 243	~ 12h	15-30 min	10-20 min
LOCTITE 620	~ 24h	1-2h	15-30 min

Fig.11-4: Setting times for LOCTITE glues

Detach the connection

To detach the connection, use a wrench for unscrewing the screw or grub screw in the traditional way.

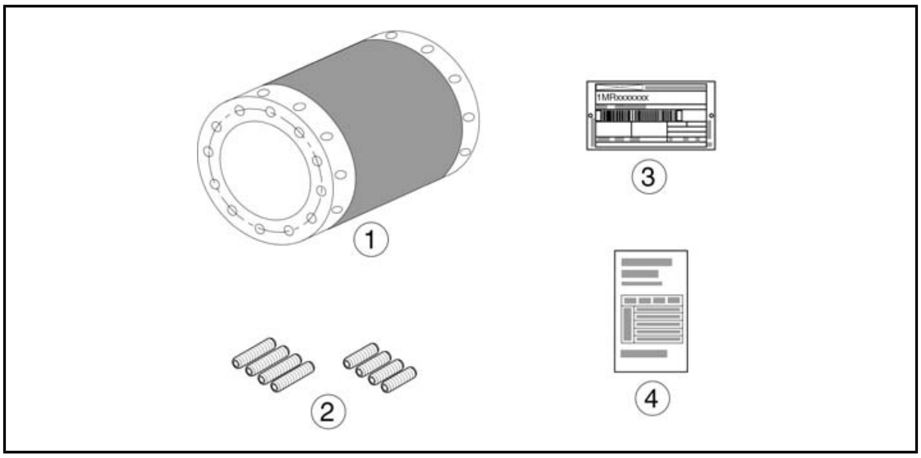
The breakaway torque of LOCTITE 620 is 20-45 Nm, the one of LOCTITE 243 is 14-34 Nm (acc. to DIN 54 454). Blowing hot air on the screw connection reduces the breakaway torque.

Is the screw/grub screw removed, the residuals of the adhesive must be removed from the threaded hole (e.g. re-cutting the thread).

[1] The German version of the chapter was checked by LOCTITE Germany for correctness and was approved for publication.

11.5 Assembling a Rotor with a Smooth Bore on the Spindle

11.5.1 Parts/Scope of Delivery of the Rotor with Smooth Bore



①	Rotor MRSxx2 / 1N
②	Threaded pins for balancing the rotor (different number and versions depending on the rotor type)
③	Name Plate
④	Waybill

Fig. 11-5: Scope of delivery of the rotor with design 1N

11.5.2 Before Assembly

Assembly should be carried out in a dry, dust-free environment. For this purpose, the following preparatory measures should be taken:

- Check to see whether all parts of the delivery are available.
- Visually check the rotor for any damage.
- Mount the type plate in a conspicuous position on the spindle housing.
- The internal diameter of the rotor and the press fits on the spindle must be thoroughly cleaned of dirt, dust and metal shavings, etc.
- Oil the press fits on the spindle.

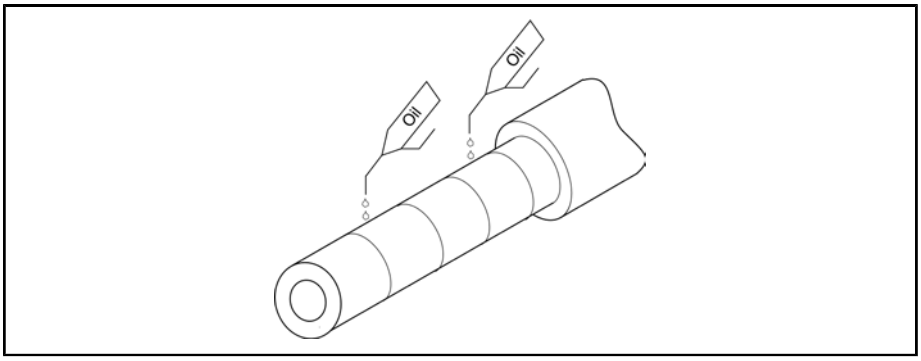


Fig. 11-6: Preparing the spindle for assembly

- Prepare the work fixture for the rotor so that the rotor is supported vertically and can take up the spindle.

11.5.3 Shrink-fitting the Rotor onto the Spindle

Proceed as follows:

1. Carefully heat the rotor in the heating cabinet to at least +135°C, but no more than 145°C.

☞
- If the rotor is not heated to at least +135°C, it is possible for the spindle to get stuck in the rotor during the shrink-fitting process before reaching its final position.
- If the rotor is heated above +145°C, the magnets are damaged and the rotor thus becomes useless.

CAUTION

Burns due to hot components with temperatures above 50°C!

- The rotor is hot! Contact leads to serious burn injuries!
- Wear heat-resistant work clothes and heat-resistant gloves!

2. Cool the spindle to -20°C.

☞ If the spindle is not cooled to at least -20°C, it is possible for the spindle to get stuck in the rotor during the shrink-fitting process before reaching its final position.

CAUTION

Injuries due to supercooled components with temperatures down to -20°C!

- The spindle is cold!
- Wear suitable protection clothes and safety gloves!

3. Place the rotor into the prepared work fixture.
4. Pick up the spindle and quickly slide it into the rotor.

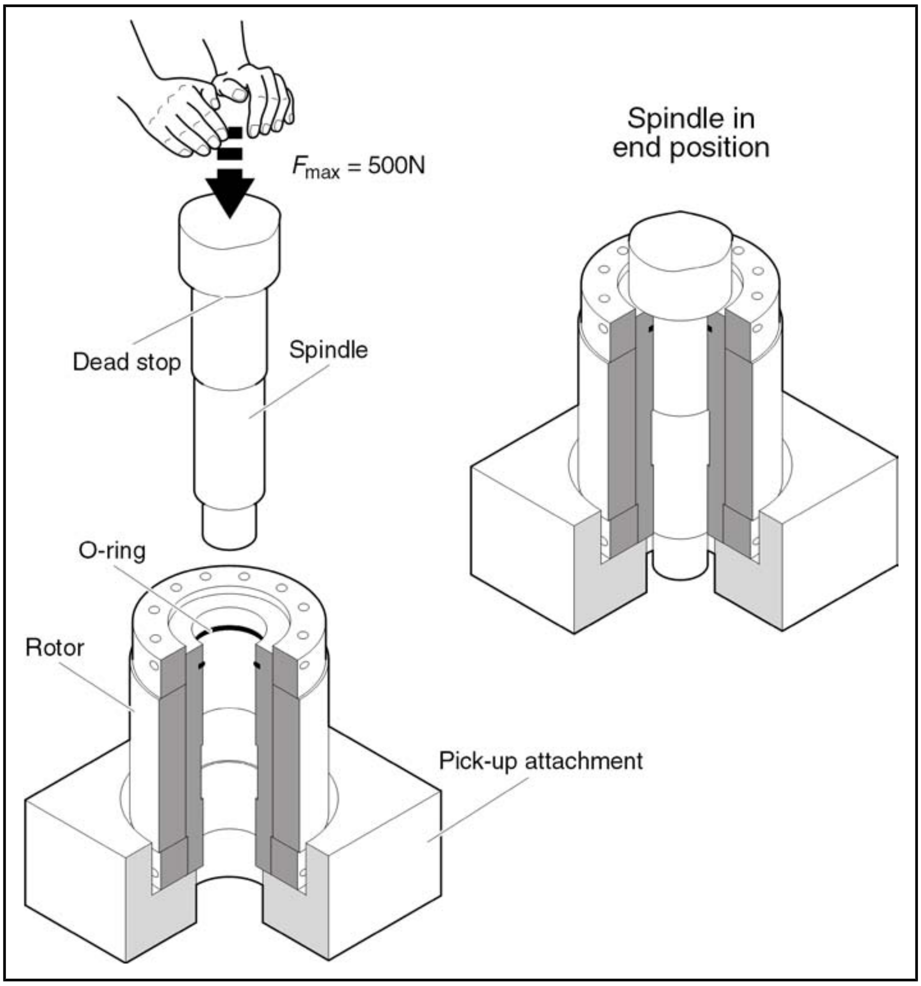


Fig.11-7: Assembling rotor and spindle

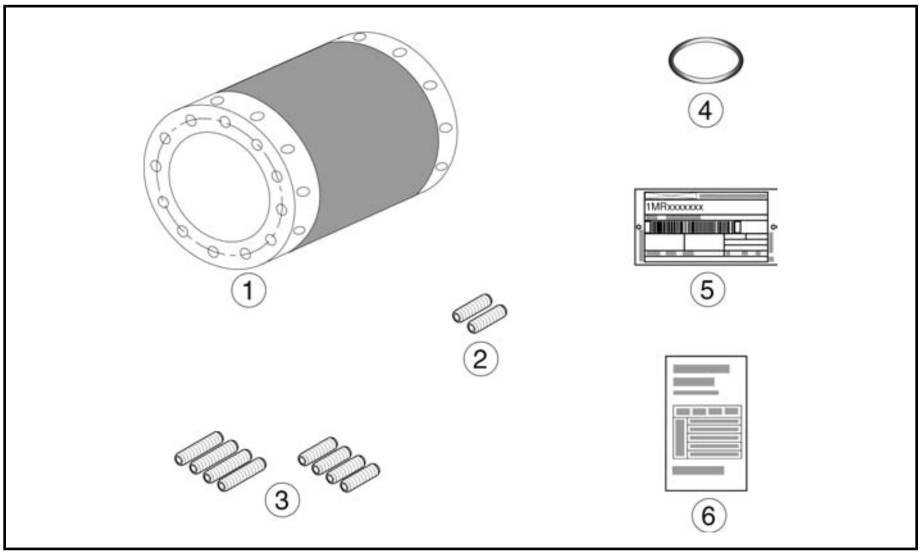
The spindle usually slides into its end position (final stop on spindle) without requiring additional force. If it does not slide into its end stop by virtue of its own weight, the spindle can be forced into place in the rotor with no more than 500 N (the force equal to the body weight of the mechanic).

5. Let the rotor and the spindle cool to room temperature.
6. Check whether the rotor has properly shrunk onto the spindle:
   - Visually check whether the spindle is in its final position in the rotor
   - Check the concentricity of the spindle:

     Check whether the concentricity of the spindle is still as high as it was prior to shrink-fitting. If the concentricity has deteriorated, the spindle is slightly deformed. This deformation is caused by stress which can occur in the parts during cooling.

11.6 Assembling a Rotor with a Step Interference Fit on the Spindle

11.6.1 Parts/Scope of Delivery of the Rotor with a Step Interference Fit



①	Rotor MRSxx2 / 2N
②	2 threaded pins for sealing the pressure oil connections
③	Threaded pins for balancing the rotor (different number and versions depending on the rotor type)
④	O-ring (material: Viton)
⑤	Name Plate
⑥	Waybill

Fig. 11-8: *Scope of delivery of the rotor with design 2N*

11.6.2 Before Assembly

Assembly should be carried out in a dry, dust-free environment. For this purpose, the following preparatory measures should be taken:

1. Check to see whether all parts of the delivery are available.
2. Visually check the rotor for any damage.
3. Mount the type plate in a conspicuous position on the spindle housing.
4. Make sure that the bevels and edges of the spindle press fits are free of burrs. Remove burrs if necessary.
5. The internal diameter of the rotor, the oil connection drill holes and the press fits on the spindle must be thoroughly cleaned of dirt, dust and metal shavings, etc.
6. Lubricate the O-ring and insert it into the groove in the rotor. Do not twist the O-ring. Make sure everything is clean.
7. Oil the press fits on the spindle.

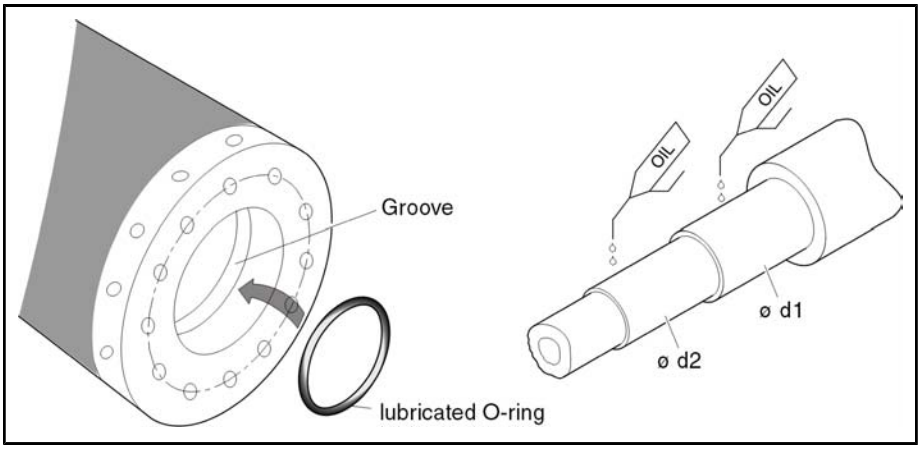


Fig.11-9: Preparing the rotor and the spindle for assembly

8. Prepare the work fixture for the rotor so that the rotor is supported vertically and can take up the spindle.

11.6.3 Shrink-fitting the Rotor onto the Spindle

Proceed as follows:

1. Heat the rotor in the heating cabinet to at least +135°C, but no more than 145°C.

☞
- If the rotor is not heated to at least +135°C, it is possible for the spindle to get stuck in the rotor during the shrink-fitting process before reaching its final position.
- If the rotor is heated above +145°C, the magnets are damaged and the rotor thus becomes useless.

CAUTION

Burns due to hot components with temperatures above 50°C!

- The rotor is hot! Contact leads to serious burn injuries!
- Wear heat-resistant work clothes and heat-resistant gloves!

2. Cool the spindle to -20°C.

☞ If the spindle is not cooled to at least -20°C, it is possible for the spindle to get stuck in the rotor during the shrink-fitting process before reaching its final position.

CAUTION

Injuries due to supercooled components with temperatures down to -20°C!

- The spindle is cold!
- Wear suitable protection clothes and safety gloves!

3. Place the rotor into the prepared work fixture. The O-ring must be at the top.
4. Pick up the spindle and quickly slide it into the rotor.

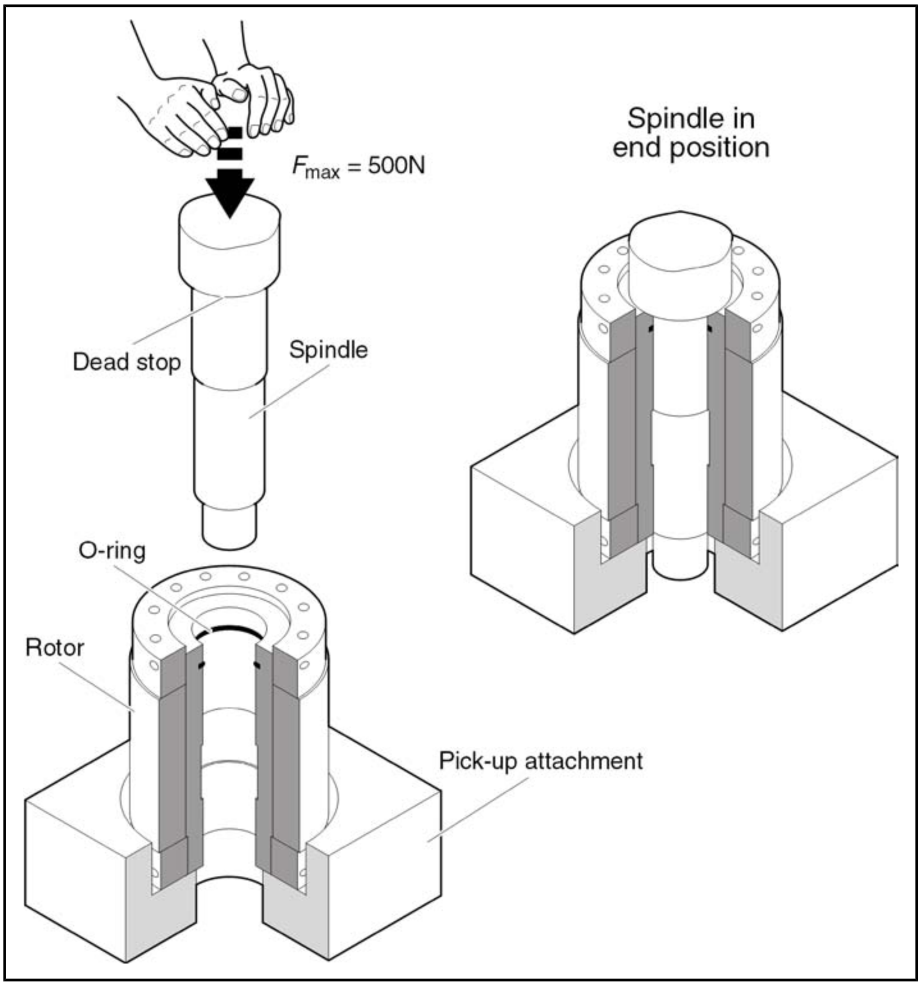


Fig.11-10: Assembling rotor and spindle

The spindle usually slides into its end position (final stop on spindle) without requiring additional force. If it does not slide into its end stop by virtue of its own weight, the spindle can be forced into place in the rotor with no more than 500 N (the force equal to the body weight of the mechanic).

5. Let the rotor and the spindle cool to room temperature.
6. Check whether the rotor has properly shrunk onto the spindle:
   - Visually check whether the spindle is in its final position in the rotor
   - Check the concentricity of the spindle:

     Check whether the concentricity of the spindle is still as high as it was prior to shrink-fitting. If the concentricity has deteriorated, the spindle is slightly deformed. This deformation is caused by stress which can occur in the step interference fit during cooling.

☞ If the spindle is not in its final position and the necessary concentricity cannot be achieved, the measures described in the "Measures to be Taken in the Case of Faulty Assembly" section (below) must be taken.

---

7. Use the supplied threaded pins to close the pressure oil connections in the rotor. To do this, screw the threaded pins in completely and secure them with LOCTITE 620; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165. The threaded pins must be glued

into place in such a way that they completely seal the connections against oil pressure.

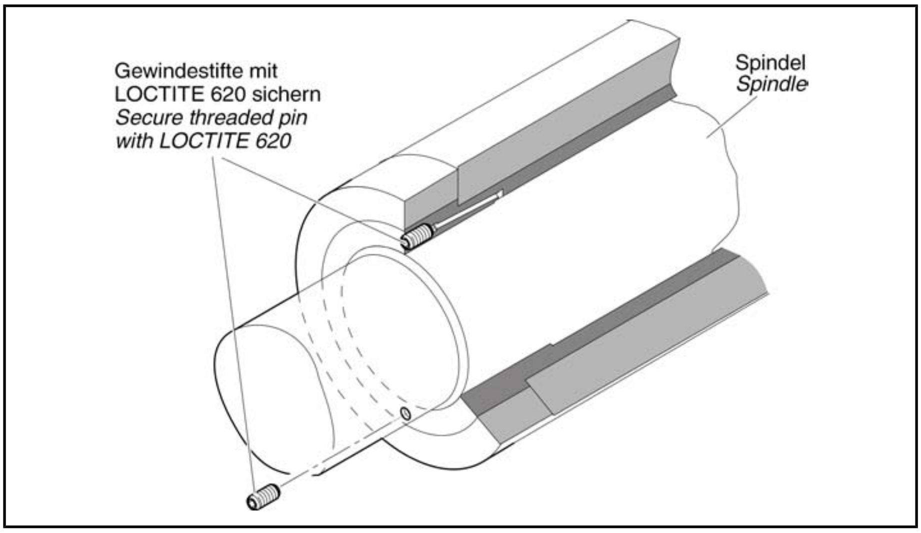


Fig.11-11: Sealing the pressure oil connections

11.7 Measures to be Taken in the Case of Faulty Assembly

☞ The following measures only apply to a rotor with a step interference fit. Assembly mistakes in rotors with a smooth shaft cannot be corrected!

Error:

Spindle gets stuck in the rotor during the shrink-fitting process before reaching its final position.

Proceed as follows:

1. Let the rotor and the spindle cool.
2. Seal one of the two pressure oil connections on the rotor with a threaded pin. To do this, screw the threaded pin in completely and secure it against turning with LOCTITE 620; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165. The threaded pin must be glued into place in such a way that it completely seals the connection against oil pressure.
3. With the help of the pressure oil, force the rotor off the spindle (proceed as described below under "Removing the rotor from the spindle").
4. Check the tolerances of the press fits.
5. If necessary, remove burrs from the internal diameter of the rotor and at press fits Ød1 and Ød2 of the spindle.

   ☞ Both, the spindle and the rotor must be absolutely free of burrs!

6. Shrink-fit the rotor onto the spindle again.

Error:

The spindle is warped after the rotor has been shrink-fitted.

Tensions in the step interference fit can occur during shrink-fitting. These can cause spindle deformations in the micrometer size range. By forcing pressure oil into the step interference fit, these tensions are partially released and the spindle deformations are partially undone.

Proceed as follows:

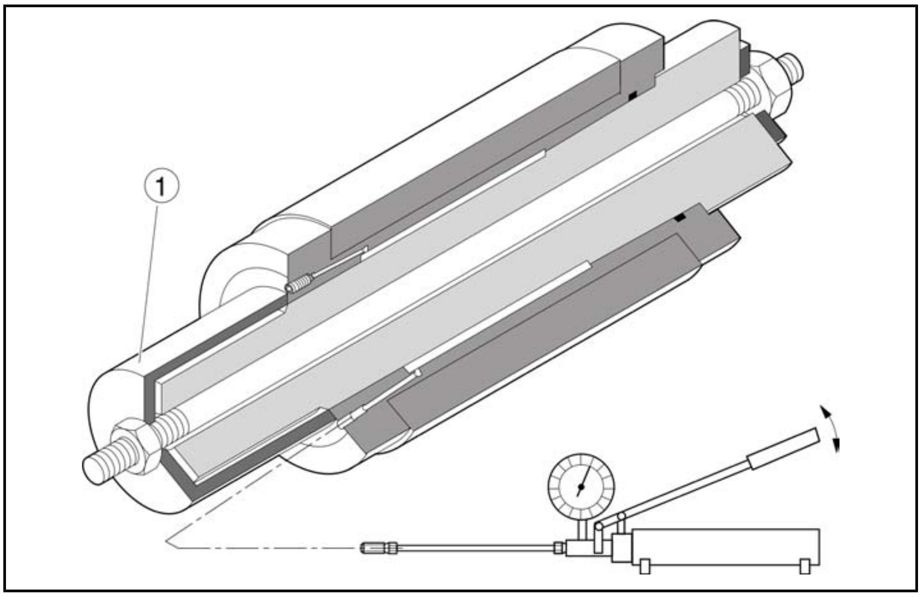
1. Let the rotor and the spindle cool.
2. Seal one of the two pressure oil connections on the rotor with a threaded pin. To do this, screw the threaded pin in completely and secure it against turning with LOCTITE 620; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165. The threaded pin must be glued into place in such a way that it completely seals the connection against oil pressure.
3. Using appropriate assembly tools, clamp the rotor and the spindle to each other in such a way that the rotor is firmly held in position on the spindle.

☞ The rotor must not be permitted to shift axially on the spindle while the pressure oil is being injected.

---

4. Connect the oil pump.

   Use oil with a viscosity of 300 mm^2/s at +20°C! This ensures that the oil will quickly and completely flow out after "floating".



① Assembly tools

Fig.11-12: "Floating" of the rotor

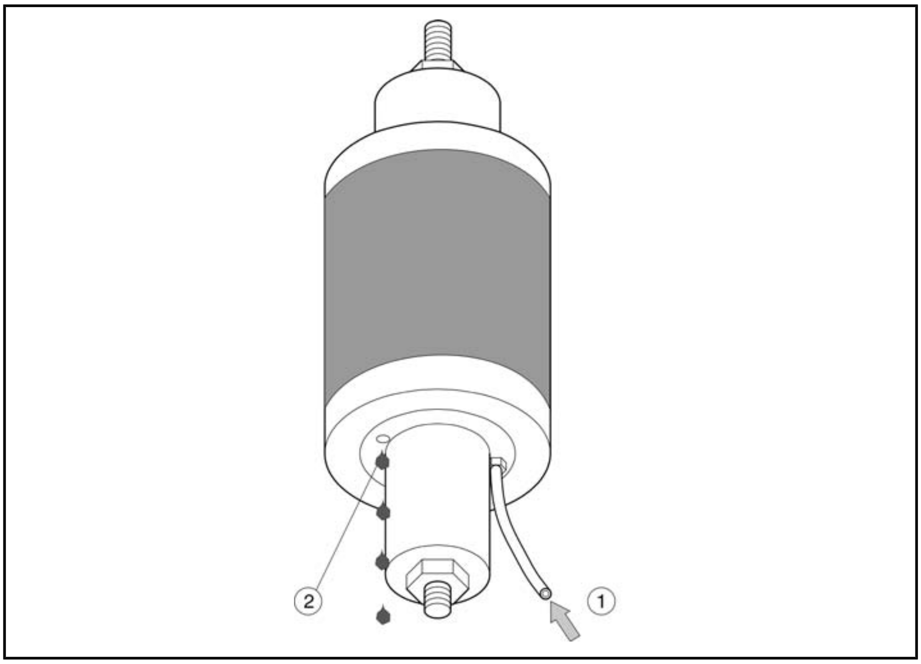
5. Pump oil into the step interference fit.

☞ Oil leaks!

Have a collecting pan ready.

- Slowly increase the oil pressure until oil begins to leak out of the coil end of the interference interface.
- A separating oil film forms between the rotor and the spindle. Due to this "floating" of the rotor on the spindle, the tension that resulted from shrink-fitting is released.

6. Eliminate all pressure from the oil pump, the supply lines and the press group.
7. Open both pressure oil connections.
8. By means of the clamping device, bring the spindle into a vertical position and using compressed air, force the oil out of the step interference fit.



① Compressed air
② Oil drain

Fig. 11-13: Using compressed air, force the oil out

9. Let the oil completely run out of the step interference fit.

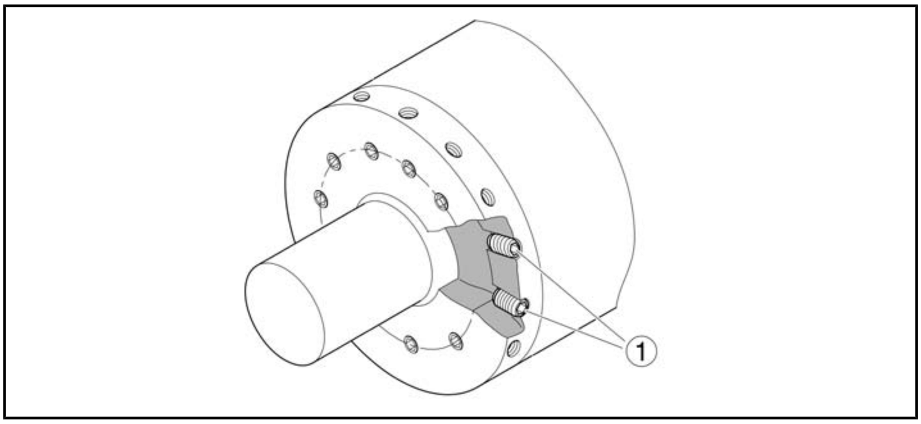
> ☞ The step interference fit can only be placed under full load after 24 hours!

10. Seal both pressure oil connections with the threaded pins supplied and secure them with LOCTITE 620.

11.8 Balancing the Rotor

The rotor must be balanced with the spindle to achieve the desired vibration severity grade of the spindle. There are balancing rings with tapped holes on the front of the rotor. Threaded pins should be screwed in as needed for balancing. fig. 11-15 "Summary of the threaded pins supplied" on page 176 lists the threaded pins that are supplied.

The vibration severity grade needed depends on the finishing accuracy of the motor spindle; this accuracy is determined by the builder of the motor spindle.



① Securing screws using Loctite 620

Fig. 11-14: Balancing by inserting threaded pins

- No material may be removed from the balancing rings when balancing the spindle!
- Depending on the mass equilibrium required, the threaded pins can be inserted to a greater or lesser degree. They must, however, not protrude out of the balancing rings! It is not necessary to insert them completely!
- Make sure that the threaded pins cannot become loose on their own. To do this, glue them with LOCTITE 620; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165.

Threaded pins DIN 913	Number / MRS xx2									Mass g/ unit
	102	142	162	182	202	242	272	312	382	
M5x6	8									0,53
M5x8	8									0,71
M6x6		8	8	8	8					0,76
M6x8		8	8	8	8					1,11
M8x8						8	8	8	10	1,89
M8x10						8	8	8	10	2,52
*) In preparation										

Fig.11-15: Summary of the threaded pins supplied

11.9 Removing the Rotor with a Step Interference Fit from the Spindle

In the following cases, it may be necessary to remove the rotor from the spindle again:

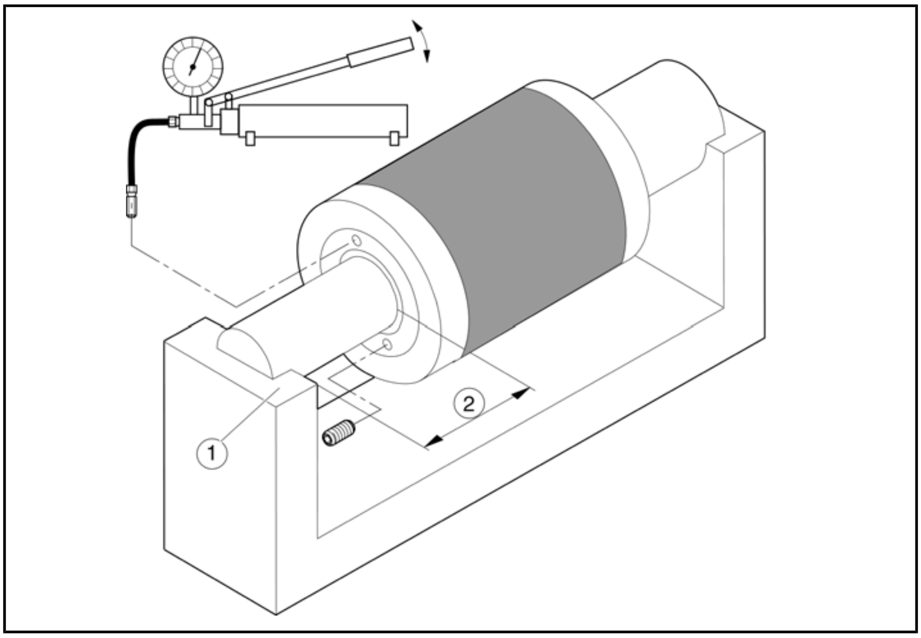
- damage to the bearings on the spindle
- rotor damage
- an assembly failure

Before the disassembly, the angular position of the rotor must be marked on the spindle!

Proceed as follows:

1. Open a pressure oil connection.

   The second connection must remain closed. If necessary, secure it with one of the supplied threaded pins. To do this, screw the threaded pin in completely and secure it against turning with LOCTITE 620; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165. The threaded pin must be glued into place in such a way that it completely seals the connection against oil pressure.
2. Mount the end stop. Note the mounting dimension A for the stop.



① End stop
② Mounting dimension A

Fig.11-16: Example of an end stop in the disassembly

Rotor	Dimension A (mm)
MRS 102	i.p.
MRS 142	i.p.
MRS 162	min. 80
MRS 182	min. 90
MRS 202	min. 90
MRS 242	min. 100
MRS 272	min. 110
MRS 312	min. 130
MRS 382	min. 140

Fig.11-17: Mounting dimension A for various rotor types

3. Connect the manually-operated oil pump.
4. Use oil with a viscosity of 35.43 in^2/s at +20°C!

WARNING

Injuries due to sudden rotor movements!

⇒ The rotor can suddenly side off the spindle when oil is pumped into the stop interference fit.

⇒ The spindle must be equipped with an arresting device when pumping oil in.

5. Pump oil into the step interference fit.

Oil leaks!
Have a collecting pan ready.

6. Slowly increase the oil pressure until the axial force affecting the step interference fit permits the rotor to slide off the spindle.
7. If oil is already leaking on the coil end of the step interference fit and the rotor still cannot be dislodged from the spindle, gently tap the rotor in the direction of the end stop with a plastic hammer.

11.10 Installing the Stator in the Spindle Housing

11.10.1 Parts/Scope of Delivery of the Stator

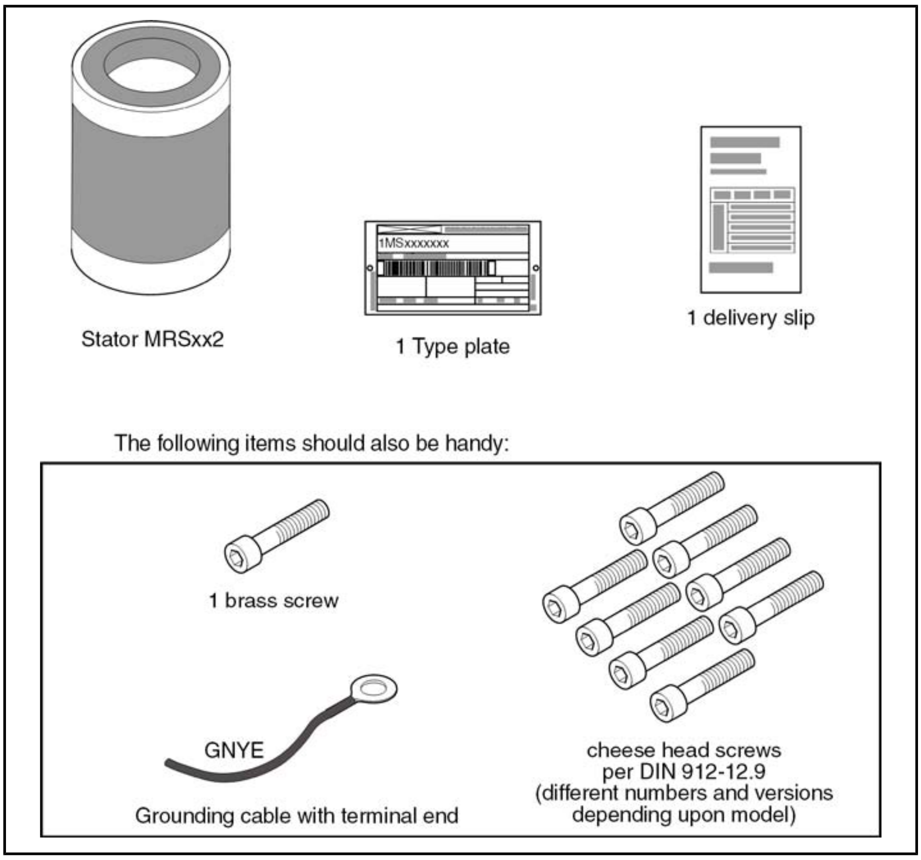


Fig. 11-18: Scope of delivery of the stator and additional materials

11.10.2 Before Assembly

Installation should be carried out in a dry, dust-free environment. For this purpose, the following preparatory measures should be taken:

- Check to see whether all parts of the delivery are available.
- Have additional materials ready. The exaction dimensions of these materials are noted in the construction drawings.
- Visually check the stator for any damage.
- Mount the type plate in a conspicuous position on the spindle housing.
- Check to make sure that the drill holes for the connections on the spindle housing are free of burrs; remove the latter if present.

☞ The inside edges of the drill holes must be absolutely free of all burrs so as not to damage the stator during installation.

11.10.3 Installation Procedure

There are tapped holes on both ends of the stator for attaching the stator in the spindle housing.

☞ Attachment occurs either on the A or the B side of the stator, but absolutely not on both sides, since a gap between the stator and the housing is provided for the longitudinal expansion of the stator during operation.

Note: The general procedure for attaching the stator in the housing is always the same. It may, however, slightly vary from the procedure described here, depending on the construction of the spindle housing. The following describes how the stator is mounted at the housing.

Proceed as follows:

1. Let the stator glide into the spindle housing so that it is centered. Use parallel chains or ropes to lift the stator.

   ☞
   - In the assembly, do not use the cable loom as a mounting aid and do not pull or push the cable loom in any way!
   - The transport and handling regulations must be absolutely observed!

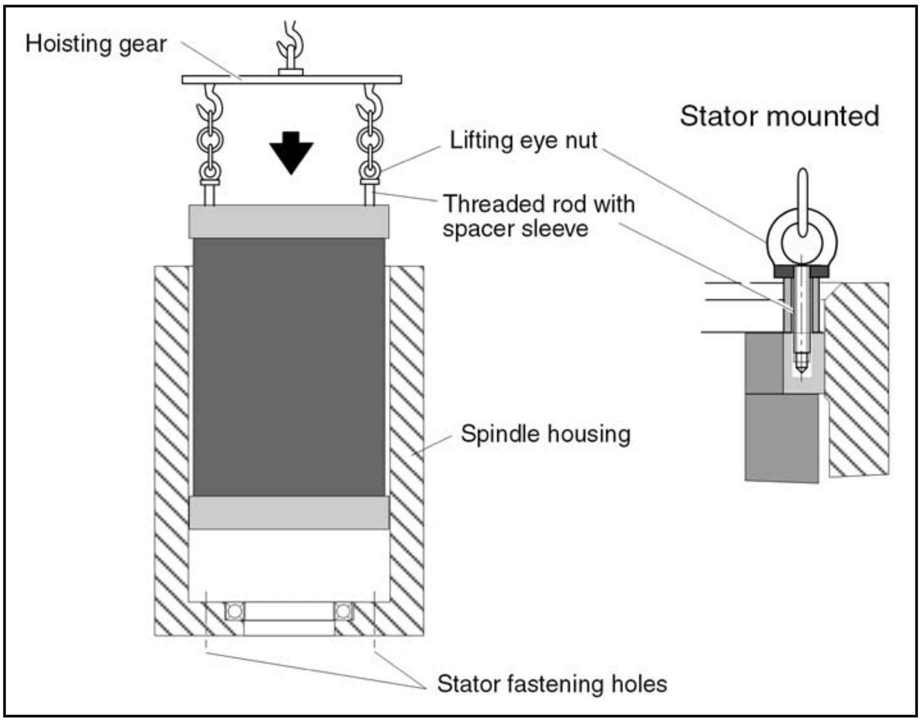


Fig.11-19: Installing the stator into the spindle housing

2. Push the stator into its final position. Use suitable tools if assembly is difficult.
3. Screw the stator onto the end of the housing.
   - Secure the screws with LOCTITE 243; gluing guidelines see chapter 11.4 "Securing Screws with LOCTITE " on page 165.
   - Using a torque wrench, uniformly tighten the screws.

Assembly Instructions

Stator	Fastening thread	Quantity	Tensile strength	Tightening torque (for friction coefficient μ=0.1)
MSS102	i.p.	i.p.		i.p.
MSS142	i.p.	i.p.		i.p.
MSS162	M6 x 12	6		12 – 14 Nm
MSS182	M6 x 12	6		12 – 14 Nm
MSS202	M6 x 12	10	12.9	12 – 14 Nm
MSS242	M8 x 15	12		32 – 35 Nm
MSS272	M8 x 16	14		32 – 35 Nm
MSS312	M8 x 20	14		32 – 35 Nm
MSS382	M8 x 20	18		32 – 35 Nm

Fig.11-20: Fastening screws for stator

11.10.4 Connecting the Stator

You can find notes regarding the electrical and cooling connections of the stator in chapter 8 "Connection Techniques" of this documentation.

11.11 Removing the Stator from the Spindle Housing

The stator may have to be removed if, for example:

- a winding has burned out
- or the PTC resistors are defective.

DANGER

Electrocution due to live parts!

⇒ Before removing the stator, it is absolutely necessary that you switch off the power for the electrical system and ensure that it cannot be switched on again accidentally!

Proceed as follows:

1. Detach the electrical connections:
   - Power connection
   - PTC resistor connection
   - Grounding cable
2. Loosen the cooling connections.
3. Loosen and remove the stator fastening screws.
4. Using appropriate tools, slowly pull out the end plate.
5. Screw transportation rings into the appropriate holes.

   ☞
   - Avoid pulling or pushing the cable loom during removal to avoid damaging the stator!
   - The transport and handling regulations must be absolutely observed.

6. Using appropriate lifting equipment, slowly pull out the stator (caution: the stator is heavy!).

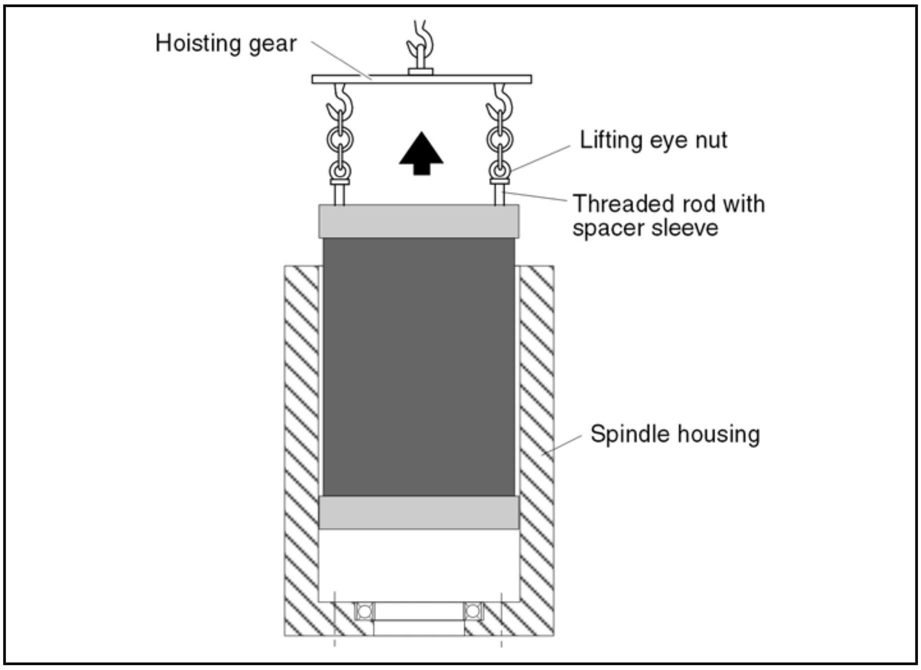


Fig.11-21: Removing the stator from the spindle housing

11.12 Mounting the Motor Spindle

After the rotor has been mounted on the spindle and the stator has been installed in the spindle housing, the parts can be assembled into a complete motor spindle.

☞ The pre-assembled rotor package must be inserted centrally into the prepared stator package.

Ensure that assembly equipment is on hand (example see fig. 11-22 "Motor spindle assembly" on page 182) so that the rotor can be inserted centrally into the stator.

⚠ CAUTION

Material damage and/or injuries due to transport procedures! Danger of bruising!

⇒ Heed all required notes regarding safety when working with transport and load handling equipment.

⇒ Carefully move the spindle with the rotor towards the stator.

Proceed as follows:

1. Ensure that both components are free of dirt.
2. Using suitable lifting equipment, move the rotor package over the center of the stator package.
3. Slowly lower the rotor package over the stator package and let it move into the center of the stator package.

   ☞ Avoid contact with or damage to the surfaces of the interiors of the rotor and stator during insertion.

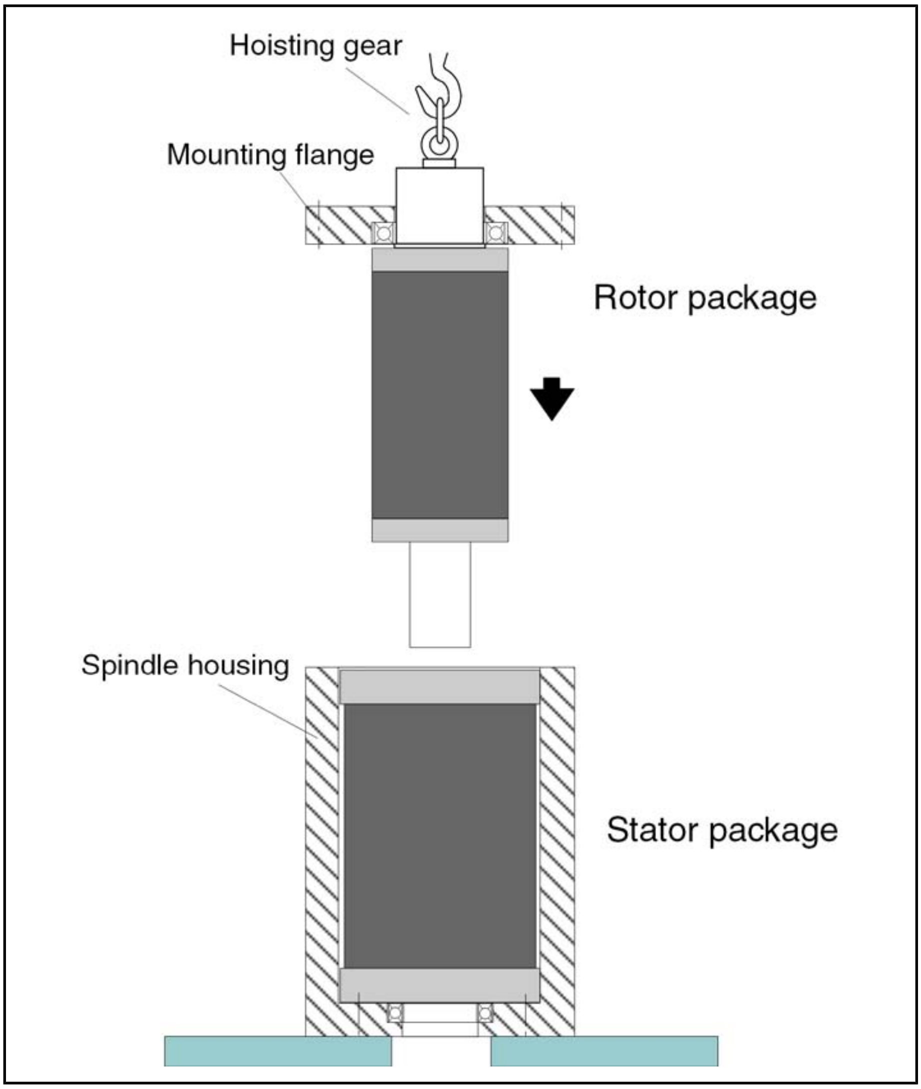


Fig.11-22: Motor spindle assembly

Pay attention to the resulting radial and axial forces when inserting the rotor.

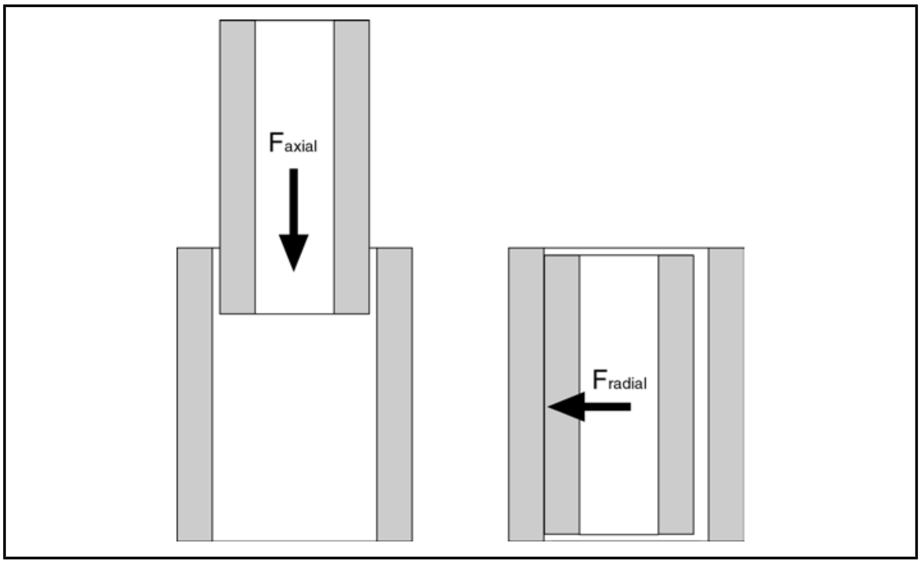


Fig.11-23: Attractive forces during assembly

Motor frame size		F_{axial} [N]	F_{radial} [N]
102	B	186	295
	D		444
	F		740
142	B	265	635
	D		890
	F		1140
162	B	310	960
	D		1214
	F		1518
	J		1973
182	A	360	214
	B		1498
	D		1890
	J		2730
202	A	420	1658
	B		2206
	D		2758
	F		3860
242	B	480	3050
	D		4576
	F		5490

Motor frame size		F_{axial} [N]	F_{radial} [N]
272	B	570	5290
	D		6880
	F		8470
312	B	690	9180
	D		11480
	F		13780
382	F	870	27280

Fig. 11-24: Magnetic forces of attraction

4. Attach the end plate at the spindle housing.

WARNING

Injuries / damage via a strong magnetic field! Danger of bruising!

⇒ Carefully move the rotor package towards the stator.

⇒ Due to permanent magnets on the rotor and the therewith existing magnetic forces, the rotor will be removed from the stator.

11.13 Dismantling the Motor Spindle

Dismantling of the motor spindle occurs in reverse order of assembly. Therefore, you should, also for the disassembly and/or the removal of the rotor from the stator, use equipment pulling or pushing the rotor out of the stator without contacting the stator (example see fig. 11-25 "Dismantling the motor spindle" on page 185).

Proceed as follows:

1. Loosen and remove the fastening screw between the end plate and the spindle housing.
2. Using suitable lifting equipment, pull the rotor package out of the center of the stator package.

☞ Avoid contact with or damage to the surfaces of the interiors of the rotor and stator during removal.

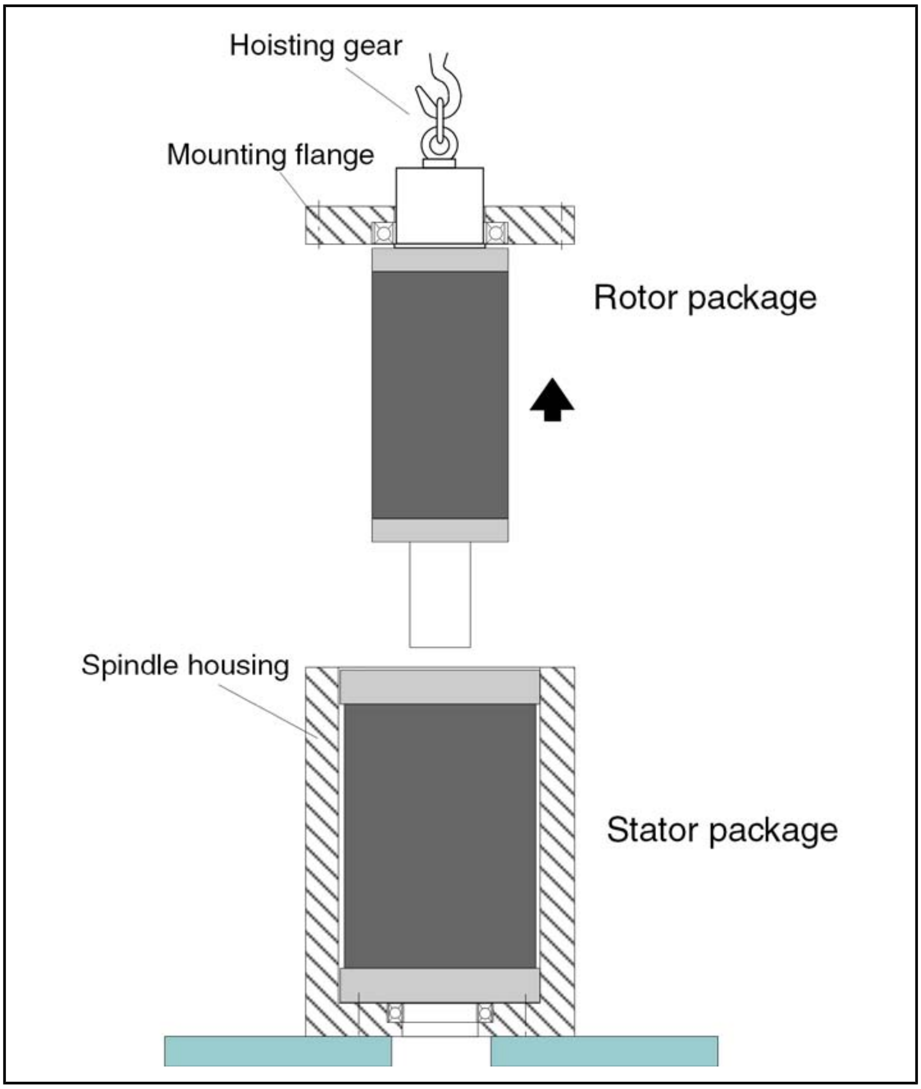


Fig.11-25: Dismantling the motor spindle

12 Startup, Operation and Maintenance

12.1 General Information on the Startup of the IndraDyn H Motors

The following points must be heeded especially during the commissioning of IndraDyn H synchronous kit motors:

Parameters

IndraDyn H motors are kit motors whose single components are – completed by an encoder system – directly installed into the machine by the manufacturer. As a result of this, kit motors have no data memory to supply motor parameters or standard controller adjustment. At startup, all parameters must be manually entered or loaded into the drive. The startup program IndraDrive makes all motor parameters of Bosch Rexroth available.

Encoder polarity

When looking onto the A-side (the opposite side of the cable output) the encoder must show a positive nominal value at clockwise rotation of the rotor. This connection has to be established before commutation adjustment.

Commutation adjustment

It is necessary at IndraDyn H motors to receive the position of the rotor to the stator by return after start or after a malfunction. This is called identification of pole position or commutation adjustment. The commutation adjustment-process is the establishment of a position reference to the electrical or magnetic model of the motor. The commutation adjustment method depends on the encoder used.

Further applicable documents

Beside this documentation, you need for a startup of IndraDyn H motors the following additional documents:

- Rexroth IndraDrive Firmware for Drive Control Devices - Functional Description, MNR R911299224
- Rexroth IndraDrive Drive Control Devices - Parameter Description, MNR R911297316
- Rexroth IndraDrive Notes Regarding Error Elimination, MNR R911297318

12.2 Basic Requirements

12.2.1 General

The following preconditions have to be provided for a successful startup.

- Adherence of the safety instructions and notes.
- Check of electrical and mechanical components for a safe function.
- Availability and supply of required implements.
- Adherence of the following described start-up.

12.2.2 Check of All Electrical and Mechanical Components

Do a check of all electrically and mechanically components before start-up. Heed the following points in particular:

- Safety warranty of personnel and machine
- Proper installation of the motor
- Correct power connection of the motor
- Correct connection of the encoder system
- Functioning of available limit switch, door switch, ...
- Proper functioning of the emergency stop circuit and emergency stop.
- Machine construction (mechanical installation) in proper and complete condition.

- Correct connection and function of the motor cooling system.
- Proper connection and functioning of the drive control unit.

12.2.3 Materials

IndraDrive start-up software The start-up can be made directly using a NC terminal or using special start-up software. The IndraDrive start-up software makes a menu-driven, custom-designed and motor-specific parameterizing and optimization possible.

PC In the start-up using IndraDrive, a usual Windows PC is needed.

Start-up via NC For a start-up using NC control, access to all drive parameters and functions must be guaranteed.

Oscilloscope An oscilloscope is needed for drive optimization. It serves to display the signals, which can be shown via the adjustable analog output of the drive controller. Viewable signals are, e.g. nominal and actual values for the speed, position or voltage, position lag, intermediate circuit, etc.

Multimeter During troubleshooting and check of the components, a multimeter which can measure voltages, currents and resistance can be helpful.

12.3 General Start-up Procedure

In the following flow-chart, the general start-up procedure at synchronous-kit motors of the IndraDyn H series is shown. In the following chapters are these points explained in detail.

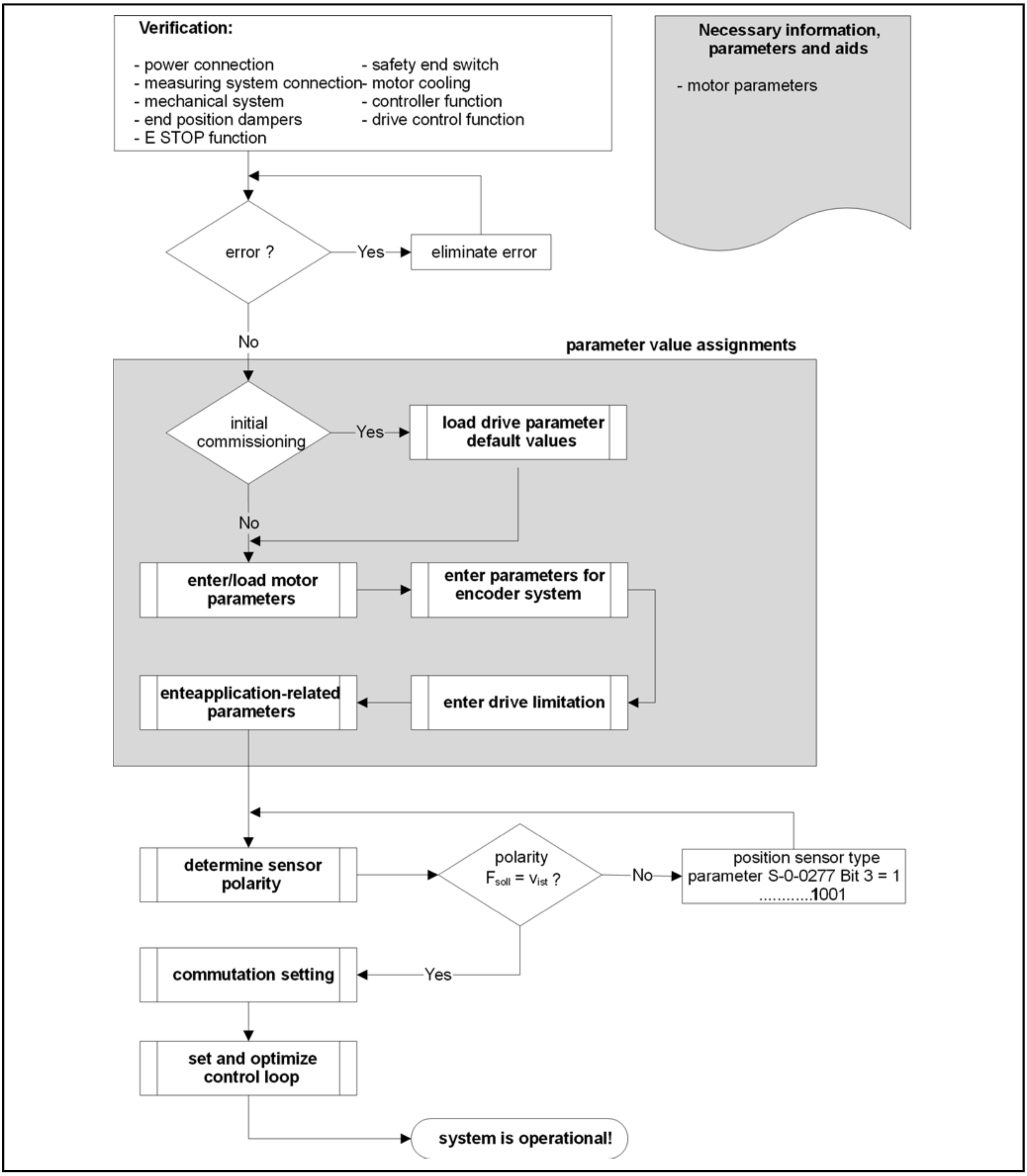


Fig.12-1: General start-up procedure at synchronous-kit motors

12.4 Parameterization

12.4.1 General

With IndraDrive, entering or editing certain parameters and executing commands during the commissioning process is done inside menu-driven dialog boxes or in list representations. Optionally, this can also be performed via the control terminal.

12.4.2 Entering Motor Parameters

☞ The motor parameters are specified by Rexroth and must not be changed by the user. Commissioning is not possible if these parameters are not available. In this case, please get in contact with your Rexroth Sales and Service Facility.

⚠ WARNING

Injuries and mechanical damage if the motor is switched on immediately after the motor parameters have been entered! Entering the motor parameters does not make the motor operational!

⇒ Do not switch on the motor immediately after the motor parameters have been entered.

⇒ Enter the parameters for the encoder system.

⇒ Check and adjust the encoder polarity.

⇒ Perform the commutation adjustment

The motor parameters should be entered in the following way:

- Loading all motor parameters using IndraDrive.

If the IndraDrive commissioning software is not available,

- enter the individual parameters manually via the controller. You will receive a list with the required motor parameters from your responsible sales office.

Motor parameters

SercosID	Motor parameters
P-0-0004	Velocity loop smoothing time constant
P-0-0018	Number of pole pairs/pole pair distance
P-0-0045	Control word of current controller
P-0-0051	Torque/force constant
P-0-0512	Temperature sensor
P-0-0533	Voltage loop proportional gain
P-0-0534	Voltage loop integral action time
P-0-0535	Motor idling voltage
P-0-0536	Maximum motor voltage
P-0-4002	Characteristic of quadrature-axis induct. of motor, inductance
P-0-4003	Characteristic of quadrature-axis induct. of motor, currents
P-0-4005	Flux-generating current, limit value
P-0-4014	Motor type
P-0-4016	Motor series inductance
P-0-4017	Motor shunt inductance
P-0-4034	Thermal time constant of winding
P-0-4035	Thermal time constant of motor

SercosID	Motor parameters
P-0-4036	Rated motor speed
P-0-4037	Thermal short-time overload of winding
P-0-4048	Motor winding resistance
S-0-0100	Velocity loop proportional gain
S-0-0101	Velocity loop integral action time
S-0-0106	Current loop proportional gain 1
S-0-0107	Current loop integral action time 1
S-0-0109	Motor peak current
S-0-0111	Motor current at standstill
S-0-0113	Maximum motor speed
S-0-0201	Motor warning temperature
S-0-0204	Motor shutdown temperature

Fig. 12-2: IndraDyn H motor parameters

12.4.3 Entering Encoder System Parameters

Encoder type

The encoder type must be defined. Parameter P-0-0074 is used to do this (encoder type see fig. 12-3 "Encoder type definition" on page 191).

Encoder type	P-0-0074
Incremental encoder, e.g. Lenord&Bauer gear-wheel encoder	2
Absolute encoder, e.g. Rexroth DSF or Rexroth HSF Encoder	1

Fig. 12-3: Encoder type definition

Signal period

Encoder systems for IndraDyn H motors generate and interpret **sinusoid signals**. The sine signal period must be entered in parameter S-0-0116, sensor 1 resolution.

The required data are made available by the encoder manufacturer.

12.4.4 Input of Drive Limitations and Application-Related Parameters

Drive limitations

The possible selectable drive limitations include:

- Current limitation
- Torque limitation
- Speed limitation
- Travel range limits

Application-related parameters

The application-related drive parameters include, for example, the parameters of the drive fault reaction.

☞ For detailed descriptions, refer to the documentation: “IndraDrive Description of Functions”, MNR R911299224

12.5 Determining the Polarity of the Encoder System

In order to avoid direct feedback in the velocity control loop, the effective direction of the motor force and the count direction of the encoder system must be the same.

WARNING

Different effective directions of motor torque and count direction of the encoder system cause uncontrolled movements of the motor upon power-up!

⇒ Ensure that uncontrolled movements do not occur.

⇒ Effective direction of motor torque = count direction of encoder system.

Make sure that the following parameters according to fig. 12-4 "Table of polarity parameters" on page 192 are adjusted before the encoder polarity test.

ID number	Description	Value
S-0-0085	Torque/force polarity parameter	0000000000000000
S-0-0043	Velocity polarity parameter	0000000000000000
S-0-0055	Position polarities	0000000000000000

Fig. 12-4: Table of polarity parameters

The encoder polarity is selected via parameter

S-0-0277, position feedback type 1 (bit 3)

Position, velocity and force data must not be inverted when the encoder system count direction is set:

S-0-0085, Force polarity parameter 0000000000000000

S-0-0043, Velocity polarity parameter 0000000000000000

S-0-0055, Position polarities 0000000000000000

☞ After adjusting the polarity of the encoder, it must be ensured that the encoder supplies positive signals for clockwise motor rotation and negative signals for counterclockwise motor rotation.

12.6 Commutation adjustment

DANGER

Malfunction due to errors in activating motors and moving elements! Commutation adjustment must always be performed in the following cases:

⇒ Initial commissioning

⇒ Modification of the mechanical attachment of the encoder system

⇒ Exchange of the encoder system

⇒ Modification of the mechanical attachment of the stator and/or rotor

WARNING

Malfunction and/or uncontrolled motor movement due to error in commutation adjustment!

⇒ Effective direction of motor torque = count direction of encoder system

⇒ Adhering to the described setting procedures

⇒ Correct motor and encoder parameterization

⇒ Expedient parameter values must be assigned for current and velocity control loop

⇒ Correct connection of motor power cable

⇒ Protection against uncontrolled movements

Setting the correct commutation angle is a prerequisite for maximum and constant torque development of the synchronous kit motor.

This procedure ensures that the angle between the current vector of the stator and the flux vector of the rotor is always 90°. The motor supplies the maximum torque in this state.

Motor connection

The individual phases of the motor power connection must be assigned correctly. See also Chapter 8 ”Electrical Connection”.

Adjustment procedure

Different commutation adjustment procedures have been implemented in the firmware. The selection must be done via parameter P-0-0522. The following figure gives an overview of the relationship between the encoder system used and the procedure to be used.

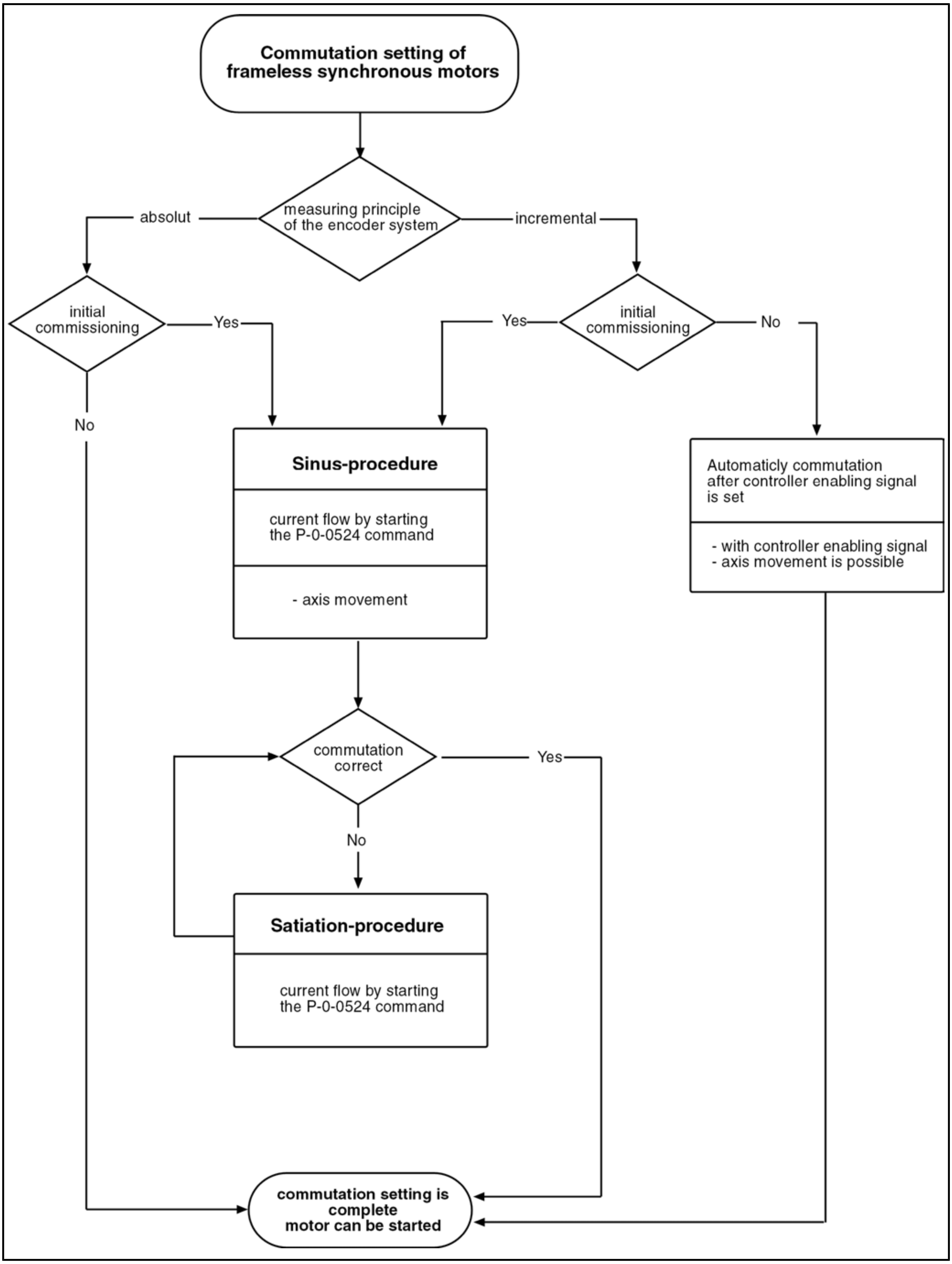


Fig.12-5: Commutation adjustment method for synchronous kit motors

☞ A detailed description of the particular procedures is given in the firmware description for Rexroth IndraDrive drive devices, MNR R911299224.

12.7 Setting and Optimizing the Control Circuit

12.7.1 General Sequence

The control loop settings in a digital drive controller are significant to the characteristics of the servo axis. The control loop structure consists of a cascaded position, velocity and current controller. The corresponding mode defines the active controllers.

☞ Defining the control loop settings requires the corresponding expertise.

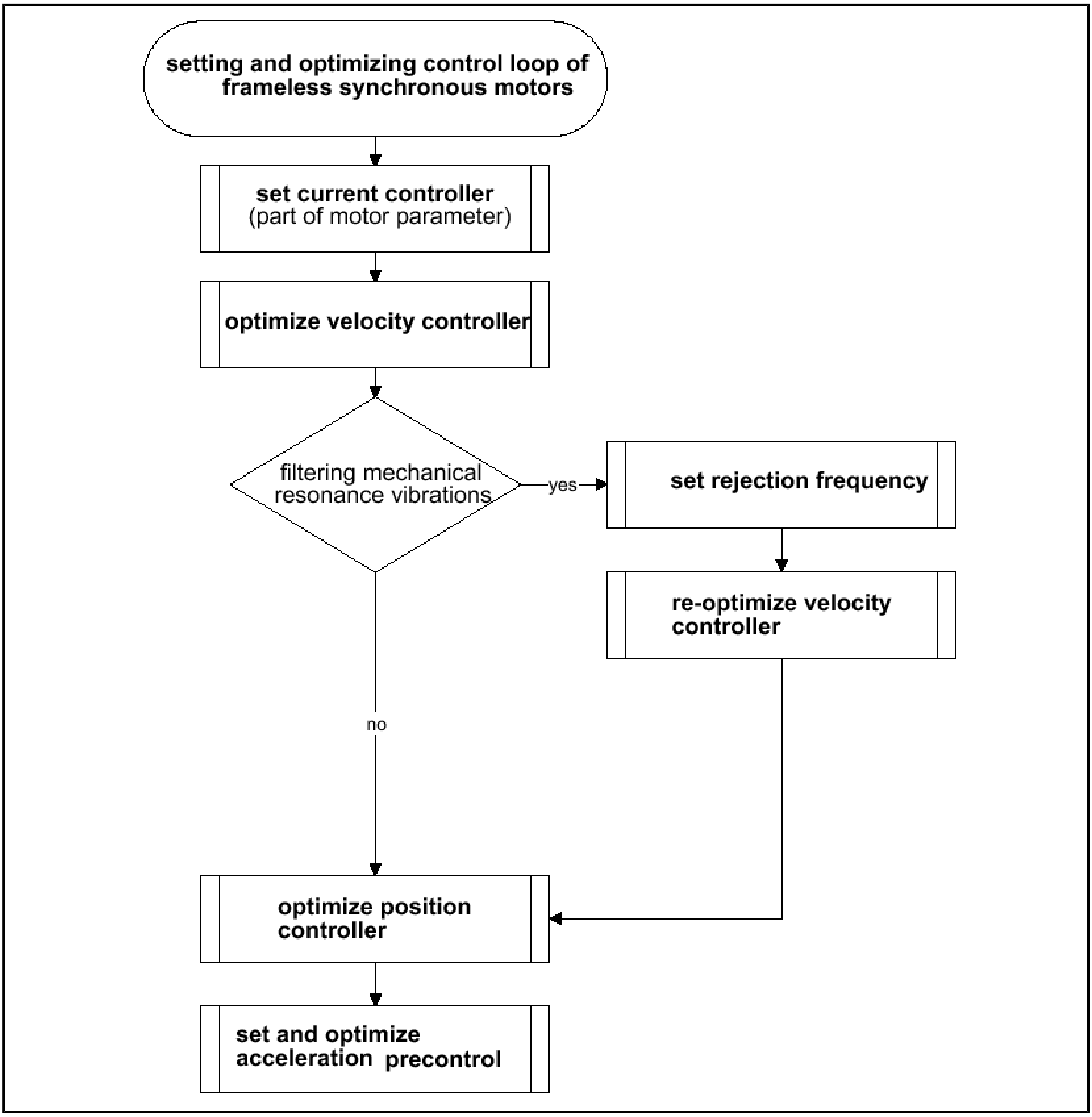


Fig.12-6: Setting and optimizing the control loop of synchronous-kit motors.

☞ Use the functional description of the drive controller for more detailed information

Filtering mechanical resonance vibrations

Digital drives from Rexroth are able to provide narrow-band suppression of vibrations that are produced due to the power train between the motor and the mechanical axis system. This results in increased drive dynamics with good stability.

The position or velocity feedback in the closed control circuit excites the mechanical system of the machine that is moved by the motor to perform mechanical vibrations. This behavior, known as "two-mass vibration", is mainly in the frequency range between 400 and 800 Hz. It depends on the rigidity of the mechanical system and the spatial expansion of the system.

In most cases, this ”two-mass vibration” has a clear resonance frequency that can selectively be suppressed by a cutoff filter in the drive.

Suppressing the mechanical resonance frequency may improve the dynamic properties of the velocity control circuit and of the position control circuit compared with closed-loop operation without the cutoff filter.

This leads to an increased profile accuracy and to smaller cycle times for positioning processes at a sufficient distance from the stability limit.

The cutoff frequency and bandwidth of the filter can be selected. The highest attenuation takes effect on the cutoff frequency. The bandwidth defines the frequency range at which the attenuation is less than -3dB. A higher bandwidth leads to less attenuation of the cutoff frequency!

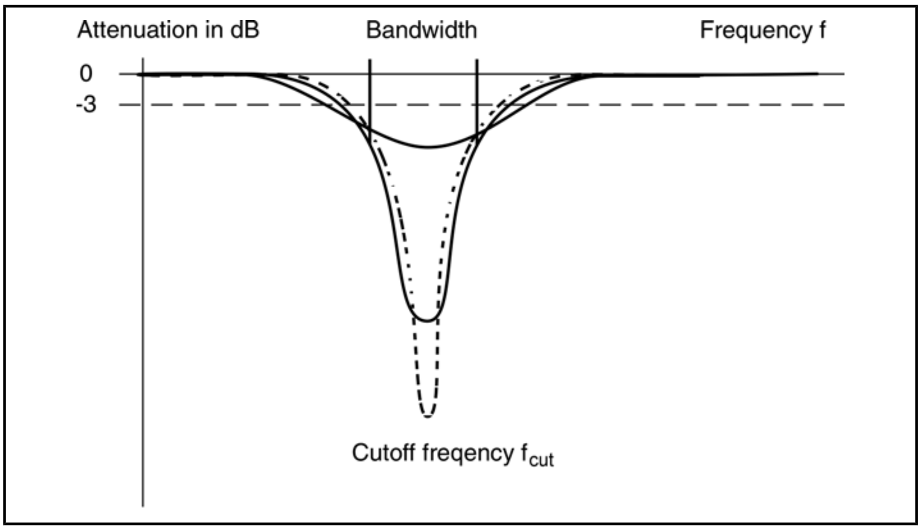


Fig.12-7: Amplitude response of cutoff filter depending on bandwidth, qualitative

12.8 Maintenance and check of Motor components

12.8.1 General

The motor components of IndraDyn H motors do not need any maintenance. Due to external influence, the motor components can be damaged during operation. There should be a preventive maintenance within the service intervals of the machine or system.

12.8.2 Check of Motor and Auxiliary Components

The following points should among other things be observed during the preventive check of motor and auxiliary components:

- Tightness of liquid cooling, hoses and connections
- Condition of power and encoder cables

12.8.3 Electrical Check of Motor Components

The electrical defect of a stator can be checked by measuring electrical characteristics. The following variables are relevant:

- Resistance between motor connecting wires 1-2, 2-3 and 1-3
- Inductance between motor connecting wires 1-2, 2-3 and 1-3
- Insulation resistance between motor connecting wired and guides

Resistance and inductance

The measured values of resistance and inductance can be compared with the values specified in Chapter 4 ”Technical Data”. Within a certain tolerance, the individual values of resistance and inductance measured between the connections 1-2, 2-3 and 1-3 should be identical. There can be a phase short circuit, a fault between windings, or a short circuit to ground if one or more values differ significantly.

☞ If the measured values differ to a great degree, consult the Bosch Rexroth customer service department.

Insulation resistance

The insulation resistance – measured between the motor connecting leads and ground – should be at least 1 MΩ (MegaOhm).

☞ If the resistance is too low, consult the Bosch Rexroth customer service department.

12.9 Start-up

12.9.1 General

⚠ CAUTION

Material damage due to errors in the controls of motors and moving elements! Unclear operating states and product data!

⇒ Do not carry out commissioning if connections, operating states or product data are unclear or faulty!

⇒ Do not carry out commissioning if the safety and monitoring equipment of the system is damaged or not in operation.

⇒ Damaged products may not be operated!

⇒ Contact Rexroth for missing information or support during commissioning!

☞ Commutate IndraDyn H motors according to chapter 12.6 "Commutation Adjustment" and the function description of the firmware used in the drive controller.

The following commissioning notes refer to the motors as part of a drive system with a drive and control unit.

12.9.2 Preparation

1. Keep the documentation of all applied products ready.
2. Log all measures taken in the commissioning log.
3. Check the products for damage.
4. Check all mechanical and electrical connections.
5. When installing and programming the machine, heed the allocation of the rotational directions of the motor and encoder.
6. Activate the safety and monitoring equipment of the system.

12.9.3 Execution

When all prerequisites have been fulfilled, proceed as follows:

1. Activate the cooling system to supply the motor and check for proper operation. Heed the notes of the manufacturer.
2. Carry out the commissioning of the drive system according to the instructions of the corresponding product documentation. You can find the respective information in the functional description of the drive-devices.

3. Log all measures taken in the commissioning report.

Commissioning of drive controllers and the control unit may require additional steps. The inspection of the functioning and performance of the systems is not part of the commissioning of the motor; instead, it is carried out within the framework of the commissioning of the entire machine. Observe the information and regulations of the machine manufacturer.

12.10 Deactivation

In the case of malfunctions or maintenance, or to deactivate the motors, proceed as follows:

1. Observe the instructions of the machine documentation.
2. Use the machine-side control commands to bring the drive to a controlled standstill.
3. Switch off the power and control voltage of the drive device.
4. Switch off the master switch of the machine and deactivate external systems according to the instructions of the manufacturer.
5. Secure the machine against accidental movements and against unauthorized operation.
6. Wait for the discharge time of the electrical systems to elapse; then disconnect all electrical connections, if necessary. Protect all electrical cables and contacts against contact with other electrically conducting parts.
7. Document all executed measures in the commissioning report and the machine maintenance plan.

12.11 Dismantling

DANGER

Fatal injury due to errors in activating motors and working on moving elements!

⇒ Do not work on unsecured and operating machines.

⇒ Secure the machine against accidental movements and against unauthorized operation.

⇒ Before dismantling, secure the motor and power supply against falling or movement before disconnecting the mechanical connections.

⇒ Pay attention to the strong magnetic field surrounding the rotor

1. Observe the instructions of the machine documentation and the dismantling instructions.
2. Please heed the safety notes and carry out all steps as described in the above instructions in the "Deactivation" section.
3. Before dismantling, secure the motor and power supply against falling or movement before disconnecting the mechanical connections.
4. Empty the coolant duct of the motor and dismantle the motor from the machine. Store the motor properly!
5. Document all executed measures in the commissioning report and the machine maintenance plan.

12.12 Maintenance

12.12.1 General

Synchronous motors of the IndraDyn H series operate maintenance-free within the given operating conditions. However, operation under unfavorable conditions can lead to limitations in availability.

- Increase availability with regular preventive maintenance measures. Heed the information in the maintenance schedule of the machine manufacturer and the service measures described below.
- Log all maintenance measures in the machine maintenance plan.

12.12.2 Measures

DANGER

Danger of injury due to moving elements! Danger of injury due to hot surfaces!

⇒ Do not carry out any maintenance measures when the machine is running.

⇒ During maintenance work, secure the system against restarting and unauthorized use.

⇒ Do not work on hot surfaces.

Bosch Rexroth recommends the following maintenance measures, based on the maintenance plan of the machine manufacturer:

Measure	Interval
Check the functioning of the coolant system	According to the guidelines in the machine maintenance plan, but at least every 1,000 operating hours.
Check the mechanical and electrical connections.	According to the guidelines in the machine maintenance plan, but at least every 1,000 operating hours.
Check the machine for smooth running, vibrations and bearing noises.	According to the guidelines in the machine maintenance plan, but at least every 1,000 operating hours.
Remove dust, chips and other dirt from the motor housing, cooling fins and the connections.	Depending on the degree of soiling, but after one operating year at the latest.

Fig. 12-8: IndraDyn H maintenance measures

12.12.3 Coolant Supply

It may become necessary to dismantle the coolant supply for maintenance measure or troubleshooting.

- This work must be carried out only by skilled personnel.
- Do not carry out any maintenance measures if the machine is running or if the coolant lines are under pressure. Please observe the safety notes.
- Protect open supply cables and connections against penetration of pollution.

12.12.4 Connection Cable

Check connection cables and power track chains (drag chains) that might be available for damage at regular intervals and replace them, if necessary.

Check the protective conductor connection for proper state and tight seat at regular intervals and replace it, if necessary.

WARNING

Death by electrocution possible due to live parts with more than 50V!

⇒ Do not repair any connection lines provisionally. Even if the cable sheath (insulation) is only slightly damaged, the system must be immediately decommissioned!

12.13 Troubleshooting

12.13.1 General

DANGER

Danger of injury due to moving elements! Danger of injury due to hot surfaces!

⇒ Do not carry out any maintenance measures when the machine is running.

⇒ Switch off the control device and the machine and wait for the discharging time of the electric systems to elapse.

⇒ During maintenance work, secure the system against restarting and unauthorized use.

⇒ Do not work on hot surfaces.

Possible causes for the malfunctioning of IndraDyn H motors can be limited to the following areas:

- Motor cooling circuit and temperature variation
- internal temperature sensor
- mechanical damage of the motor
- mechanical connection to machine

The encoder and the temperature sensor are controlled by the drive-controller or control unit and are displayed according to the diagnosis. Observe the notes in the corresponding documentation.

Some sample faults are shown below, along with potential causes. This list does not lay claim to completeness.

12.13.2 Excess Temperature of Motor Housing

Status The housing temperature of the motor climbs to unusually high values.

CAUTION

Damage of motor or machine by restarting after increased motor temperature!

⇒ Liquid-cooled motors should not be restarted or supplied with cold coolant immediately after failure of the coolant system and an increased motor temperature. Danger of damage!

⇒ Wait until the motor temperature has dropped to approx. 40° C before restarting.

Possible causes

1. Malfunction in the coolant system.
2. Original operating cycle has been changed.
3. Original motor parameters have been changed.
4. Motor bearings worn or defective.

Measures

1. Check the coolant system. Clean or rinse the cooling circuit if required. Contact the machine manufacturer if the coolant system malfunctions.

2. Check the layout of the drive for changed requirements. If overloading occurs, stop operation. Danger of damage!
3. Reset to the original parameters. Check the layout of the drive in the case of changed requirements.
4. Contact the machine manufacturer.

12.13.3 High Motor Temperature Values, but Housing Temperature is Normal

Status

The diagnostics system of the drive controller shows unusually high values for the winding temperature via the display or control software. However, the motor housing has a normal temperature.

Possible causes

1. Wiring error or cable break in sensor cable.
2. Diagnostics system defective.
3. Winding temperature sensor malfunction (PTC).

Measures

1. Check the wiring and connection of the temperature sensor according to the terminal diagram.
2. Check the diagnostics system on the drive device or the control unit.
3. Check the resistance value of the temperature sensor using a multimeter.
   - Shut down the system and wait for the discharging time to elapse.
   - Disconnect the temperature sensor from the control device. Set the measuring instrument to resistance measurement and connect the wire pair with the measuring instrument (as a result, the sensor cable is also checked). Check the values according to the characteristic curve in chapter 9 “Application Notes”.

12.13.4 Motor or Machine Generates Vibrations

Status

Audible or tactile vibrations occur on the motor or on the machine.

Possible causes

1. Driven machine elements are insufficiently coupled or damaged.
2. Motor bearings worn or defective. Available bearing lifetime or grease lifetime elapsed.
3. Motor mount loose.
4. Drive system is instable from a control point of view.

Countermeasures

1. Contact the machine manufacturer.
2. Contact the machine manufacturer.
3. Check the mechanical connection. Do not continue to use damaged parts. Contact the machine manufacturer.
4. Check parameters of the drive system (motor and encoder data). Observe the notes in the documentation for the drive controller.

12.13.5 Specified Position is not Attained

Status

The positioning command of the control unit is not precisely executed, or not at all. No malfunction display on the device controller or the control.

Possible causes

1. Wiring of encoder cable is incorrect or defective. Pin assignment (encoder signals) in cable or plug may be switched.
2. Insufficient shielding of encoder cable against interference.
3. Incorrect encoder parameters set in drive controller.
4. Motor-machine connection loose.
5. Encoder defective.

Countermeasures

1. Check wiring according to terminal diagram and check state of cables for damage.

2. Check shielding; if necessary, increase effective contact surfaces of shielding.
3. Correct the parameters. Observe the commissioning log.
4. Check the mechanical connection. Do not continue to use damaged parts. Contact the machine manufacturer.
5. The encoder must be replaced. Contact the machine manufacturer.

12.14 Waste Disposal

Manufacturing process

The products are manufactured such that the associated manufacturing process saves energy and raw material to an optimum extent while simultaneously permitting recycling and utilization of incidental waste.

Bosch Rexroth regularly tries to replace polluted raw materials and supplies by environmentally friendly alternatives.

Application

Bosch Rexroth products do not contain any kind of dangerous substances which could be released with proper use. Normally, negative effects on the environment must not be expected.

Forbidden substances

We guarantee that our products include no substances according to chemical ban regulations. Furthermore, our products are free of mercury, asbestos, PCBs and chlorinated hydrocarbons.

Material composition

Basically our motors contain

- steel
- aluminum
- copper
- brass
- magnetic materials
- Electronic components and assemblies
- Insulation material

Recycling

Most of the products can be recycled due to the high metal proportion. To reach optimum metal recovery, disassembly into individual components is necessary.

The metals also contain electrical and electronical components that can be recycled using special separation processes. The hereby arising plastics could be thermally recycled.

Returns

The products manufactured by us can be returned to our premises for waste disposal at no charge. This is possible only if the product does not contain any disturbing adhesions such as oil, grease or other contamination.

Furthermore, it is not permitted that the product contains inappropriate foreign materials when it is returned.

The products must be delivered free domicile to the following address:

Bosch Rexroth AG

Electric Drives and Controls

Buergermeister-Dr.-Nebel-Straße 2

97816 Lohr am Main, Germany

Packaging

High-quality products need optimal packaging. The packaging material consists of paper, wood and polystyrene. They can be recycled everywhere.

For ecological reasons, a return transport of the packaging should not take place.

13 Service and Support

13.1 Helpdesk

Our service helpdesk at our headquarters in Lohr, Germany, will assist you with all kinds of inquiries.

Contact us:

- By phone through the Service Call Entry Center,
  Monday to Friday 7:00 am - 6:00 pm CET
  +49 (0) 9352 40 50 60
- By fax
  +49 (0) 9352 40 49 41
- By e-mail: service.svc@boschrexroth.de

13.2 Service Hotline

Out of helpdesk hours please contact our German service department directly:

+49 (0) 171 333 88 26

or

+49 (0) 172 660 04 06

Hotline numbers for other countries can be found in the addresses of each region (see below).

13.3 Internet

Additional notes regarding service, maintenance and training, as well as the current addresses of our sales and service offices can be found on

http://www.boschrexroth.com

Outwith Germany please contact our sales/service office in your area first.

13.4 Helpful Information

For quick and efficient help please have the following information ready:

- Detailed description of the fault and the circumstances
- Information on the type plate of the affected products, especially type codes and serial numbers
- Your phone and fax numbers as well as your e-mail address so we can contact you in case of questions

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