The Drive & Control Company

Rexroth
Bosch Group

Rexroth IndraDyn A

Asynchronous Motors MAD / MAF

Project planning manual
R911295781

Edition 10

Title
Rexroth IndraDyn A
Asynchronous Motors MAD / MAF

Type of Documentation
Project planning manual

Document Typecode
DOK-MOTOR*-MAD/MAF****-PR10-EN-P

Internal File Reference
RS-217b481c84cf5c230a6846a001447b0d-8-en-US-3

Purpose of Documentation
This documentation ...

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

Record of Revision

Edition	Release Date	Notes
DOK-MOTOR*-MAD/MAF***-PR06-EN-P	08/2008	6th edition
DOK-MOTOR*-MAD/MAF***-PR07-EN-P	03/2011	7th edition
DOK-MOTOR*-MAD/MAF***-PR08-EN-P	10/2015	8th edition
DOK-MOTOR*-MAD/MAF***-PR09-EN-P	11/2015	9th edition
DOK-MOTOR*-MAD/MAF***-PR10-EN-P	01/2018	10. edition; update of technical data and motor characteristic curves

Liability
The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

Published by
Bosch Rexroth AG
Electric Drives and Controls
Dept. DC-AE/EPI5 (fs)
Buergermeister-Dr.-Nebel-Strasse 2
97816 Lohr, Germany
Tel. +49 93 52 18 0 / Fax +49 93 52 18 8400
http://www.boschrexroth.com/electrics

Note
This document has been printed on chlorine-free bleached paper.

Table of Contents

Table of Contents

Table of Contents

Page

Table of Contents

Page

Table of Contents

Page

Table of Contents

Page

Table of Contents

Page

Table of Contents

1 Introduction to the product

1.1 General information

The Rexroth **IndraDyn A** motor generation consists of asynchronous box motors with squirrel-cage rotor and it is available as

- **MAD series** with surface cooling by permanently connected fan units.

Fig. 1-1: Example MAD130

- **MAF series** with liquid cooling

Fig. 1-2: Example MAF100

With their high continuous ratings and compact dimensions, IndraDyn A motors can be used as main and servo drives for all rotary driving tasks.

The optimized design with safety class IP65 for motor and fan allows for operation under adverse conditions. Due to their easy-to-service structure, the motors require less maintenance and allow maintenance work to be carried out during ongoing operation.

What is more, **EX-type** IndraDyn A motors can be used in potentially explosive atmospheres under certain conditions. To achieve this, however, the special notes on these motors in chapter 13 "Motors for potentially explosive atmospheres" on page 287 must be observed.

When combined with the controllers from the Rexroth IndraDrive product line, these motors offer intelligent drive solutions with high power density and open functionality.

1.2 About this documentation

1.2.1 Document structure

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

<table>
<tr><th>Ch.</th><th>Title</th><th colspan="2">Content</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-related guidelines</td></tr>
<tr><td>3</td><td>Safety</td></tr>
<tr><td>4</td><td>Technical Data</td><td rowspan="4">Product description</td><td rowspan="6">for project planners and developers</td></tr>
<tr><td>5</td><td>Dimension Drawings</td></tr>
<tr><td>6</td><td>Type Codes</td></tr>
<tr><td>7</td><td>Accessories</td></tr>
<tr><td>8</td><td>Connection Method</td><td rowspan="5">Practice</td></tr>
<tr><td>9</td><td>Application Guidelines</td></tr>
<tr><td>10</td><td>Handling and Transport</td><td rowspan="3">for operating and maintenance staff</td></tr>
<tr><td>11</td><td>Installation</td></tr>
<tr><td>12</td><td>Operation</td></tr>
<tr><td>13</td><td>Notes on Motors with Protection Class Ex-px d</td><td>Product description</td><td>for project planners and developers</td></tr>
<tr><td>14</td><td>Service and Support</td><td colspan="2" rowspan="2">Additional information</td></tr>
<tr><td>15</td><td>Index</td></tr>
</table>

Tab. 1-1: Chapter structure

1.2.2 Related documentation

Depending on the devices used, related documentation may be required for configuring drive systems with IndraDyn A motors. Rexroth provides the complete product documentation in PDF format in the following Bosch Rexroth media directory:

http://www.boschrexroth.com/various/utilities/mediadirectory/index.jsp?language=en-GB&publication=NET

1.2.3 Additional components

Documentations for external components associated with Bosch Rexroth systems are not included in the scope of delivery and must be ordered directly from the respective manufacturers.

For information on manufacturers, please refer to the appropriate chapters in this documentation.

1.2.4 Your 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.

Please send your feedback to:

Bosch Rexroth Electric Drives and Controls GmbH

Dept. DC-IA/EDM3 (fs)

Buergermeister-Dr.-Nebel-Strasse 2

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 copyright protection and may not be passed on to third parties by Rexroth. Documents and sheets on standards are subject to copyright protection and may not be passed on to third parties by Rexroth. If need be, please contact the authorized sales outlets or, in Germany, directly:

BEUTH Verlag GmbH

Burggrafenstrasse 6

10787 Berlin, Germany

Phone +49 (0) 30-26 01-22 60

Fax +49 (0) 30-26 01-12 60

Internet: http://www.din.de/beuth

E-mail: postmaster@beuth.de

2 Important Instructions on Use

2.1 Intended Use

2.1.1 Introduction

Rexroth products are developed and manufactured in accordance with the corresponding state of the art. 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 inappropriately used, situations may arise that result in damage to material and personnel.

☞ Regarding damages caused by inappropriate use of the product, Bosch Rexroth, as the manufacturer, does not provide any warranty, assume any liability or pay any damages. Any risks resulting from the products not being used as intended are the sole responsibility of the user.

Before using Bosch Rexroth products, the following prerequisites have to be fulfilled 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 the intended use.
- If the products are hardware, they must be kept in their original state, i.e. no constructional modifications must be made. Software products must not be decompiled; their source codes must 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 specified in the documentation.

2.1.2 Areas of Use and Application

Rexroth IndraDyn A series asynchronous motors are designed to be used as rotary main and servo drive motors. The following are typical fields of application:

- Machine tools
- Printing and paper-processing machines
- Packaging and food-processing machines
- Metal-forming machines.

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 must neither be attached nor connected. The same holds 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 functional description.

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

The motors may only be operated under the assembly, mounting and installation conditions, in the normal position, and under the environmental conditions (temperature, protection class, 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”.

IndraDyn A motors may not be used if:

- They are subject 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 extreme maximum temperatures.
- The intended fields of application have not been expressly released for the motors by Rexroth. For this, it is important to observe the statements in the general safety instructions as well as the details in chapters 13 and 14 for explosion protection of the motors.

3 Safety Notes for Electric Drives and Controls

3.1 Term Definition

System An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Electrical drive system An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

User A user is a person installing, commissioning or using a product which has been placed on the market.

Application documentation Application documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Description, etc.

Electrical apparatus Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Device A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Manufacturer The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Component A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Machine A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Product Examples of a product: Device, component, part, system, software, firmware, among other things.

Project planning manual A Project Planning Manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified personell In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them

2) to be trained or instructed to maintain and use adequate safety equipment

3) to attend a course of instruction in first aid

Control system A control system comprises several interconnected control components placed on the market as a single functional unit.

3.2 General information

3.2.1 Using the Safety instructions and passing them on to others

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

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

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

3.2.2 Requirements for safe use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Bosch Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technolo-

gy". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that their individual 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 allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed 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 application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.

- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

- European countries: In accordance with 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)

3.2.3 Hazards by improper use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!

- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

3.3 Danger-Related Notes

3.3.1 Protection against Touch of Electric Parts and Housings

☞ This section concerns components of electric drive and control systems with a voltage **over 50 volt.**

In the case of touching parts with a voltage higher than 50 volt, this can be dangerous for personnell and can lead to electric shock. During operation of components of electric drive and control systems, certain parts of these components are inevitably under dangerous voltage.

High electrical voltage! Danger of life, risk of injury due to electric shock or heavy bodily harm.

- Operation, maintenance and/or repair of components of electric drive and control systems may only be done by qualified personnel.
- Observe the general construction and safety instructions about work on high voltage systems.
- Before switching on, establish the fixed connection of the protective conductor to all electric components according to the interconnection diagram.
- Operation, even for short-term measuring and testing purposes, is only permitted with the protective conductor securely connected to the component points provided.
- Disconnect electric components from the mains or from the power supply, before you have contact with electric parts with a voltage higher than 50 V. Secure the electric components against restarting.
- Observe for electrical components:

  Please, always wait **30 minutes**, after switch-off, so live capacitors discharge before they have access to electric components. To exclude any danger due to any contact, measure electric voltage of live parts before working.
- Before switch-on install the provided covers and protective devices for the touch guard.
- Do not touch any electric junctions of live components.
- Do not disconnect or connect connectors under voltage.

High housing voltage and high discharge current! Danger! Risk of injury due to electric shock!

- Before switch-on and start-up, ground or connect the components of the drive and control system with the protective conductors on the grounding points.

- Connect the protective conductors of the electric drive and control systems always fix and continuously with the external supply network.
- Do a protective conductor connection with a minimum cross section according to the following table.

Cross-sectional area A of the live wires	Minimum cross-sectional area A_{PE} of the protective conductor
A ≤ 16 mm²	A
25 mm² < A ≤ 50 mm²	25 mm²
50 mm² < A	A / 2

Tab. 3-1: Minimum cross-section of protective conductor connection for motors

3.3.2 Protective extra-low voltage as protection against electric shock

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

On components of an electric drive and control system provided by Bosch Rexroth, all connections and terminals with voltages up to 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Bosch Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

3.3.3 Protection against dangerous movements

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

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

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

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property 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.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to 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 counterbalancing of the vertical axes.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") 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 components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

3.3.4 Protection against electromagnetic and magnetic fields during operation and mounting

Electromagnetic and magnetic fields!

Hazards for persons with active medical implants or passive metallic implants, as well as for pregnant women.

- Persons with active medical implants (e.g. heart pacemakers), passive metallic implants (e.g. hip implants) and pregnant women might possibly risk hazards by electromagnetic or magnetic fields in the immediate vicinity of components of the electric drive and control system and the associated current-carrying conductors.

  Entering the following areas can cause danger to these persons:

  – Areas in which components of the electric drive and control system and the associated current-carrying conductors are mounted, commissioned and operated.

  – Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- Before entering these areas, the above-mentioned persons should seek advice from their physician.
- Observe the occupational safety and health regulations applicable at the site of operation, for installations equipped with components of the electric drive and control system and the associated current-carrying conductors.

3.3.5 Protection against contact with hot parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers 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, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

3.3.6 Protection during handling and mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

3.3.7 Battery safety

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

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 attempt to 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 the electrical parts installed in the devices.
- Only use the battery types specified for the product.

☞ 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 separately from other waste. Observe the national regulations of your country.

3.3.8 Protection Against Pressurized Systems

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

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 (safety goggles, safety shoes, safety gloves, for example).
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

☞ Environmental protection and disposal! The agents (e.g., fluids) used to operate the product might not be environmentally friendly. Dispose of agents harmful to the environment separately from other waste. Observe the national regulations of your country.

3.4 Explanation of signal words and the Safety alert symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

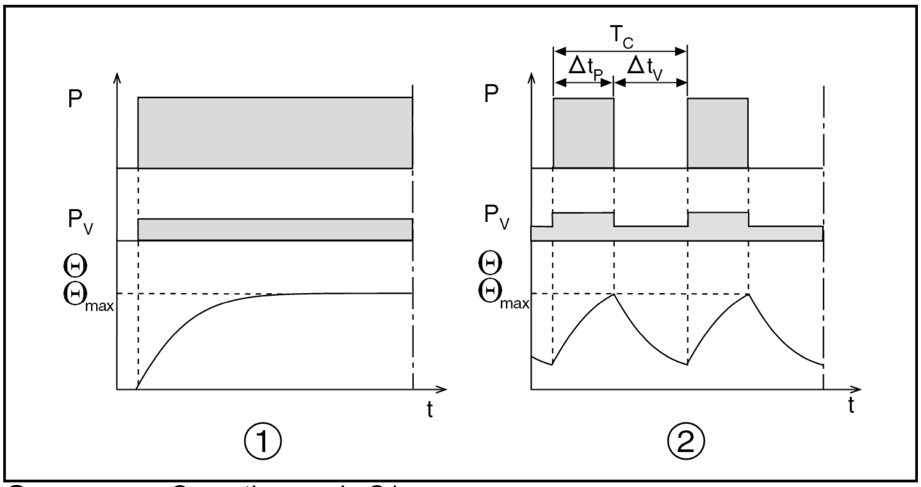
In case of non-compliance with this safety instruction, property damage could occur.

4 Technical data

4.1 Operation modes

4.1.1 General

Bosch Rexroth motors are documented according to the test criteria and measuring methods of EN 60034-1. The technical data specified below refers to operation modes S1 (continuous operation) and S6 (periodic operation), each with surface cooling through direct-connected fan units or liquid cooling.



①	Operation mode S1
②	Operation mode S6
P	Load
P_V	Electric losses
Θ	Temperature
$Θ_{max}$	Highest temperature (stator)
t	Time
T_C	Cycle duration
$Δt_P$	Operating time with constant load
$Δt_V$	Idle time

Fig. 4-1: Operation modes according to EN 60034-1

4.1.2 Duty cycle

Operation mode S6 is specified along with the duty cycle (DC) in %. The duty cycle is calculated as follows:

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

ED	Relative duty cycle in %
$Δt_P$	Operating time with constant load
T_C	Cycle duration

Fig. 4-2: Relative duty cycle

4.2 Operating behavior

4.2.1 Description of the parameters specified

Rated torque

M_N = available torque at rated speed in operation mode S1 (continuous mode). Unit: newton meter [Nm].

Rated power

P_N = output power of the motor at rated speed and load with rated torque, specified in kilowatt [kW].

Rated current

I_N = phase current of the motor at rated speed and load with rated torque, specified as r.m.s. value in ampere [A].

Rated speed

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

Maximum torque

M_{max} = maximum torque that can be supplied at maximum current I_{max}, specified in newton meter [Nm].

- The reachable maximum torque depends on the drive controller used. The only binding maximum torque M_{max} is that specified in the selection lists.

Maximum power

P_{max} = maximum output power of the motor at 540 V_{DC}, specified in kilowatt [kW].

- The reachable maximum power depends on the drive controller used and on the supply voltage.

  To allow uniform presentation of motor characteristic curves, P_{max} is specified at the same speed at which M_{max} can also be output. However, the actually reachable P_{max} value may be different and is specified in the data sheet of the motor.
- Therefore, the only binding maximum power is that specified in the technical data (data sheet).

Maximum current

I_{max} = maximum briefly allowed phase current of the motor, that has no damaging effect on the winding, specified as r.m.s. value in ampere [A].

- To avoid thermal overload during operation of the motor with external controllers, note that the current is to be reduced to 2.2 times the rated current after 400 ms and that I_{max} may be reapplied only if the winding temperature is in the allowed range and the degree of relief of the motor permits this.

Maximum speed

n_{max} = maximum allowed speed of the motor in (min^{-1}), depending on the selected bearing type. The maximum speed can be limited by mechanical factors, such as centrifugal forces, bearing wear and use of a holding brake.

☞ Please observe the maximum speed of the holding brake (optional).

Torque constant at the nominal working point and at 20 °C

K_{M_N} = ratio of torque increase to motor torque-forming current. Applicable up to the rated current I_N and up to the rated speed n_N. Manufacturing tolerance ±5 %. Unit: [Nm/A].

Discharge capacity

C_{ab} = capacity of short-circuited power connections U, V, W against the motor housing. Unit: [nF].

Power wire cross-section A

Unit: [mm²]. Rated for cables by current carrying capacity according to VDE 0298-4 and laying type B2 according to EN 60204-1 at a surrounding air temperature of 40 °C. The power wire cross-section specified in the data sheet may be different, depending on the selected connection type (connector socket or terminal box). When selecting the appropriate power cable, therefore please observe the information given in chapter 8 "Connection technique" on page 199.

Moment of inertia of the rotor

J_{rot} = moment of inertia of the rotor without bearing, brake and motor encoder. Unit: [kgm²].

Motor mass

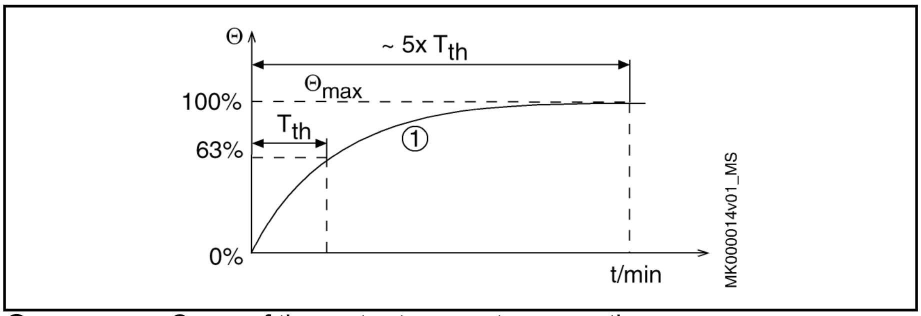
m = motor mass in standard design, without holding brake, specified in kilogram [kg].

Sound pressure level

L_P = at a distance of 1 m, with PWM = 4 kHz. Unit: [dB(A)].

Thermal time constant

T_{th} = duration of the temperature rise to 63% of the final temperature of the KTY in the coil end under load at rated torque in S1 mode and surface ventilation by direct-connected fan units.



① Curve of the motor temperature over time
T_{th} Thermal time constant

Fig. 4-3: Thermal time constant

Cycle duration

T_C = duration of the cycle in S6 mode, required to reach the thermal steady-state condition where the maximum temperature value corresponds to the final temperature in S1 mode (see fig. 4-1 "Operation modes according to EN 60034-1" on page 25).

Number of pole pairs

p = number of pole pairs of the motor.

Allowed coolant supply temperature

See information in chapter 9.8.6 "Coolant inlet temperature " on page 229.

Constant for determining the pressure drop with water as cooling medium

Δp_{diff} = pressure drop in bar without quick coupling at Q_{min}.

If the coolant port is provided with a quick coupling (optional), the following constant of the quick coupling must be taken into account in addition to the pressure drop constant specified in the data sheet:

$$\text{MAF100...130:} \quad k_{dp2} = 0{,}032 \text{ bar} / (\text{l}/\text{min})^{1{,}75}$$

$$\text{MAF160...225:} \quad k_{dp2} = 0{,}036 \text{ bar} / (\text{l}/\text{min})^{1{,}75}$$

k_{dp2} Pressure drop constant of the quick coupling
l/min Coolant flow rate

Fig. 4-4: Constant for determining the pressure drop with quick coupling

When the quick coupling (optional) is used, this results in the following pressure drop across the complete motor:

Technical data

$$\Delta p_{diff2} = (k_{dp} + k_{dp2}) \cdot Q_{min}^{1,75}$$

Δp_{diff2}	Pressure drop with quick coupling
k_{dp}	Constant without quick coupling (see motor data sheet)
k_{dp2}	Constant with quick coupling
Q_{min}	See motor data sheet

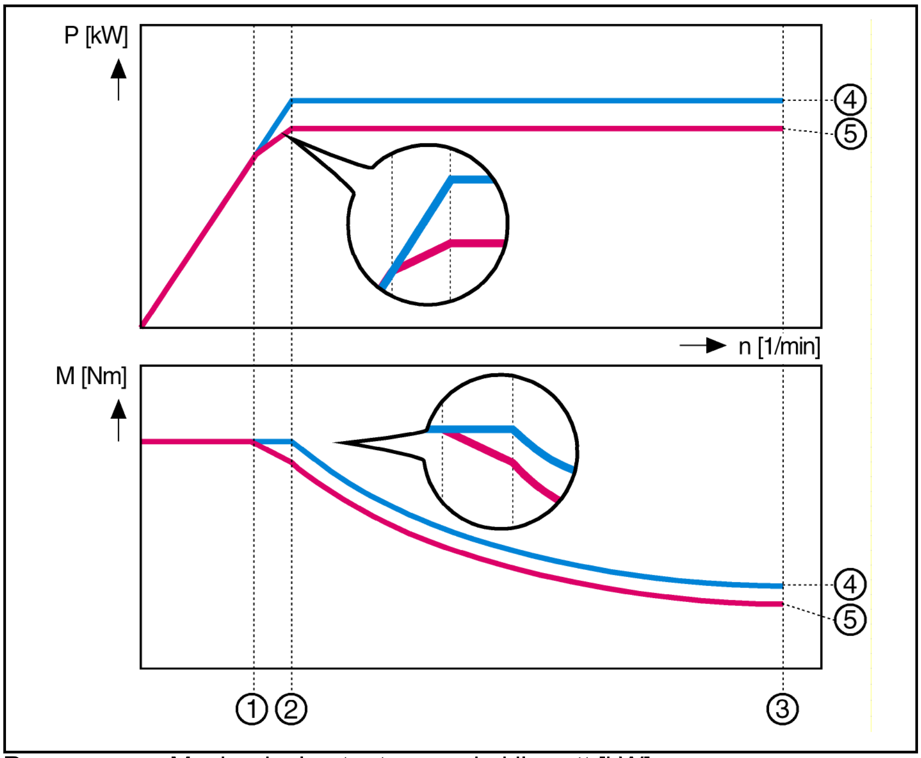
Fig. 4-5: Pressure drop with quick coupling

When other couplings or coolant ports are used, the customer must take the corresponding pressure drop value into account while designing the coolant system.

Maximum allowed coolant input pressure

See chapter 8.9.3 "Coolant input pressure " on page 214.

4.2.2 Example characteristic curves



P	Mechanical output power in kilowatt [kW]
M	Torque available at the output shaft in newton meter [Nm]
n	Motor speed in revolutions per minute [min^{-1}]
①	Key speed (n_1 in data sheet)
②	Rated speed (n_N)
③	Maximum speed (n_{max})
④	Characteristic curve without derating
⑤	Characteristic curve with derating

Fig. 4-6: Example IndraDyn A characteristic curves

The achievable torque depends on the drive controller used. The reference value for the motor characteristic curves is an unregulated DC bus voltage of 540 V_{DC}.

Explanation:

(1) Key speed

Start of a drop in torque and power before the rated speed n_N is reached. This behavior is called **De-rating** and occurs only with some versions of motor windings. **If there is no derating behavior, the key speed is equal to the rated speed.**

Until the key speed is reached, continuous current at standstill I_1 applies (effective value). **If there is no derating behavior, the continuous current at standstill is equal to the rated current I_N.**

Before the key speed is reached, the continuous torque at standstill M_1 is available for S1 mode. **If there is no derating behavior, the continuous torque at standstill is equal to the rated torque M_N.**

If derating is in effect, the torque is reduced once the key speed is reached. fig. 4-6 " Example IndraDyn A characteristic curves" on page 28 shows two characteristic curves each starting at key speed.

(2) Rated speed

If derating is not in effect, asynchronous motors provide a constant torque (rated torque) until the rated speed is reached; thereafter, the constant **rated power P_N** is available.

(3) Maximum speed

Speed limit up to which a motor can be safely operated. Usually limited by the mechanical construction (bearing) or by the use of a holding brake.

4.3 Technical data of MAD100

4.3.1 Data sheet of MAD100B

Parameter[1)]	Symbol	Unit	MAD100B				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	34.0	31.0	30.0	28.0	25.0
Rated power	P_N	kW	1.80	3.20	4.71	5.90	6.50
Rated current	I_N	A	5.3	8.9	12.9	14.6	16.2
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Maximum torque	M_{max}	Nm	75.1	74.7	68.0	66.2	61.5
Maximum power	P_{S6max}	kW	3.69	6.56	9.66	12.10	13.33
Maximum current	$I_{max(eff)}$	A	10.3	18.0	23.5	28.9	28.3
Continuous torque at standstill	M_{n1}	Nm	34.0		31.0	30.0	28.0
Continuous current at standstill	I_{n1}	A	5.3	9.4	13.0	+15.3	16.2
Torque constant at 20 °C	K_{M_N}	Nm/A	7.66	4.31	2.83	2.41	2.11
Thermal time constant	T_{th_nom}	min	20.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	6.0	5.7		6.0	
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	1.5				2.5
Mass	m_{mot}	kg	43.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0190000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-1: MAD100B - Technical data

4.3.2 Motor characteristic curves MAD100B

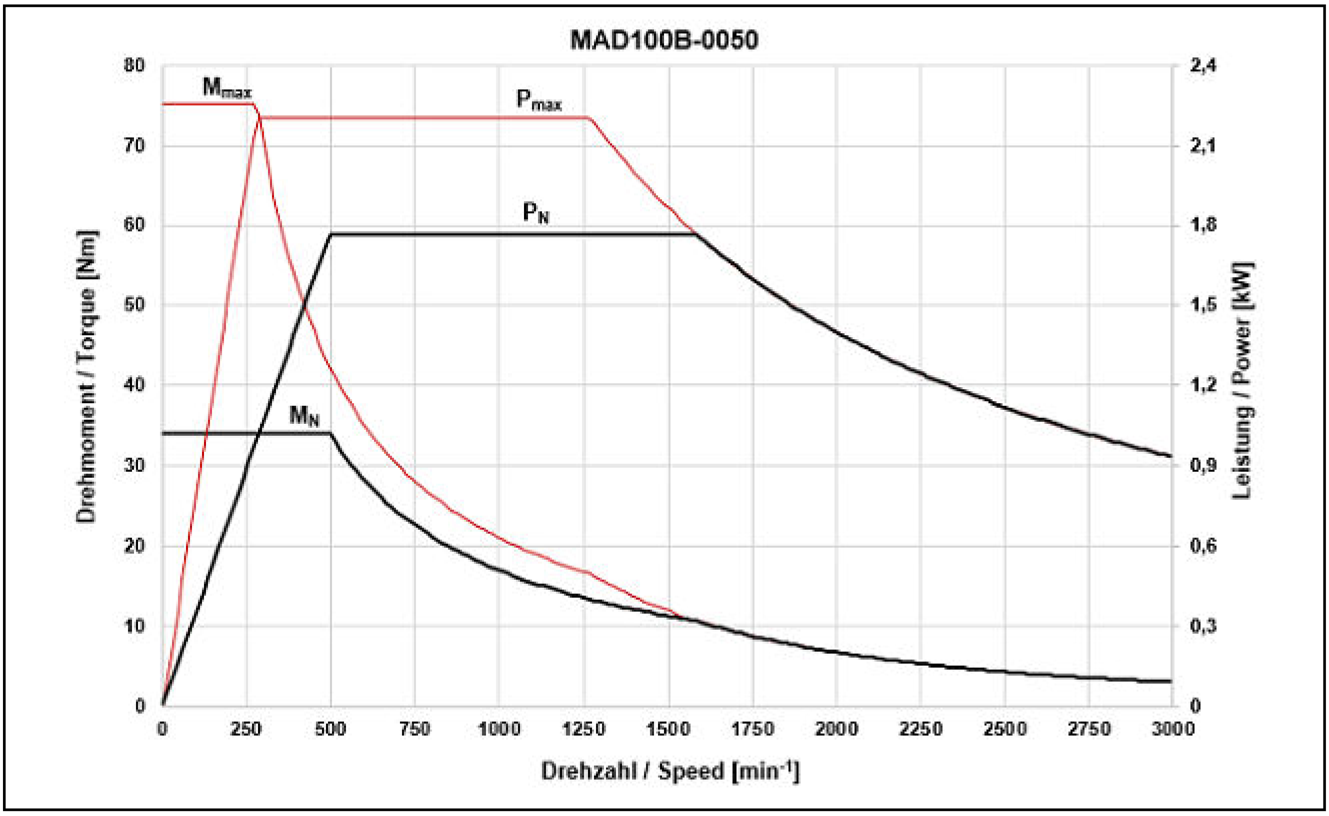


Fig. 4-7: Motor characteristic curve MAD100B-0050

Technical data

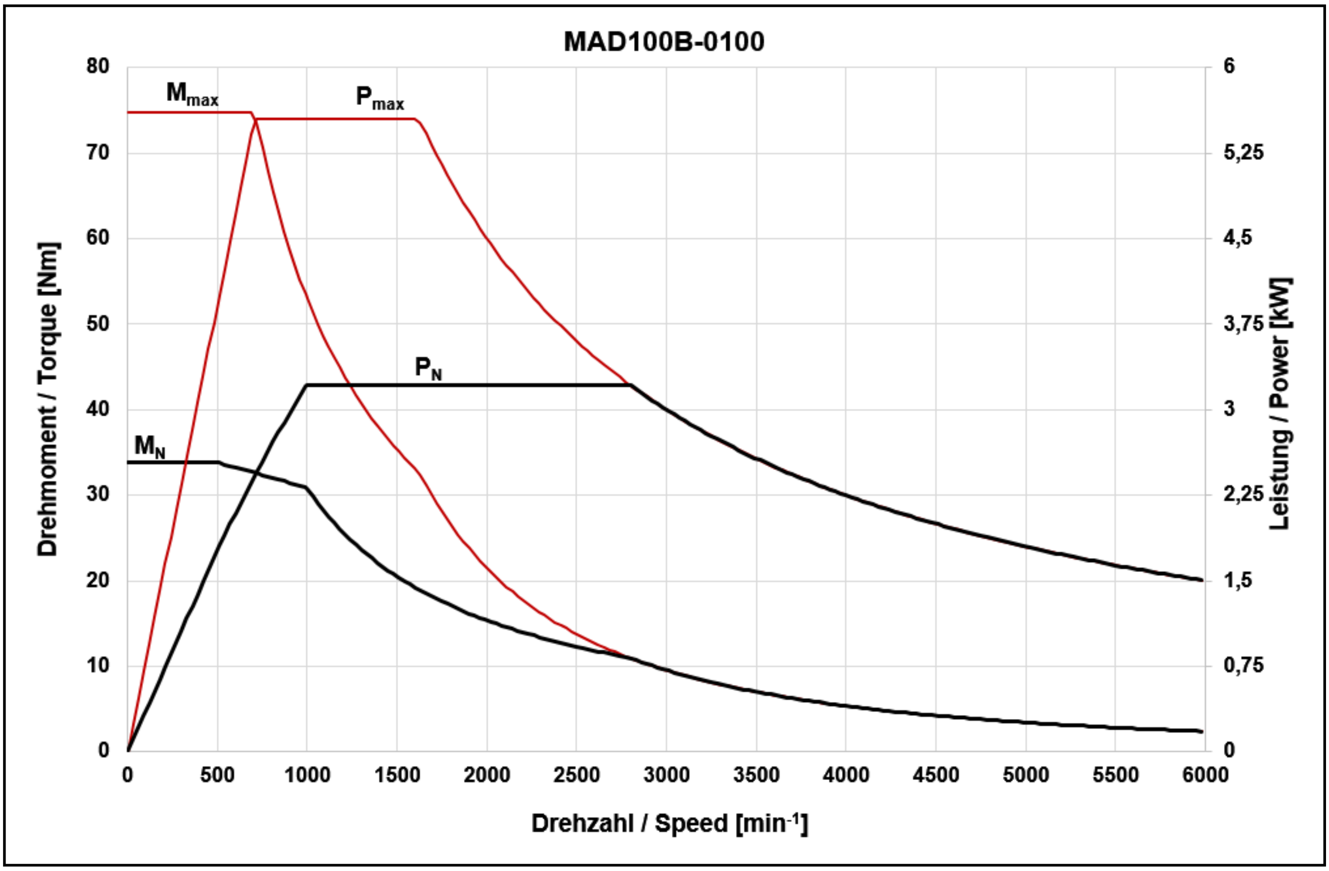


Fig. 4-8: Motor characteristic curve MAD100B-0100

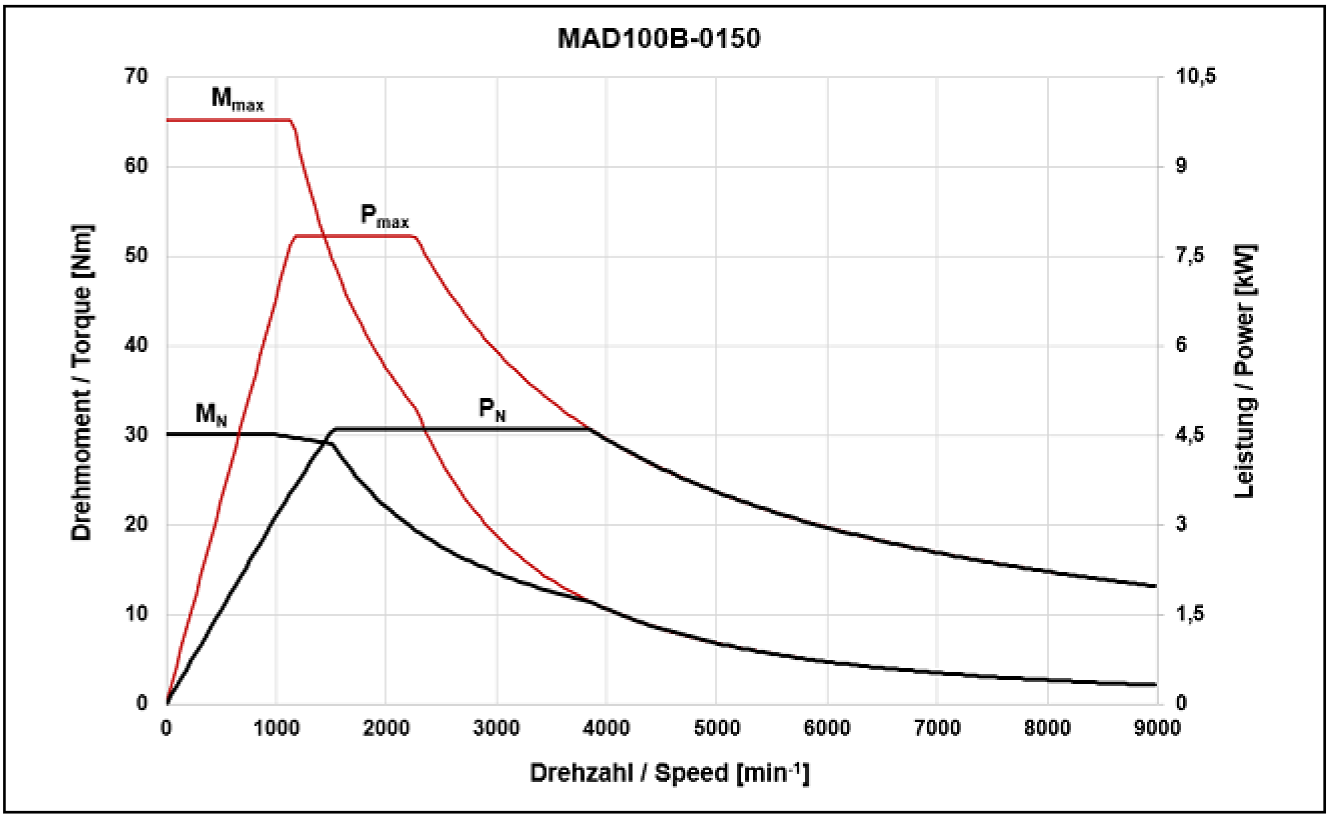


Fig. 4-9: Motor characteristic curve MAD100B-0150

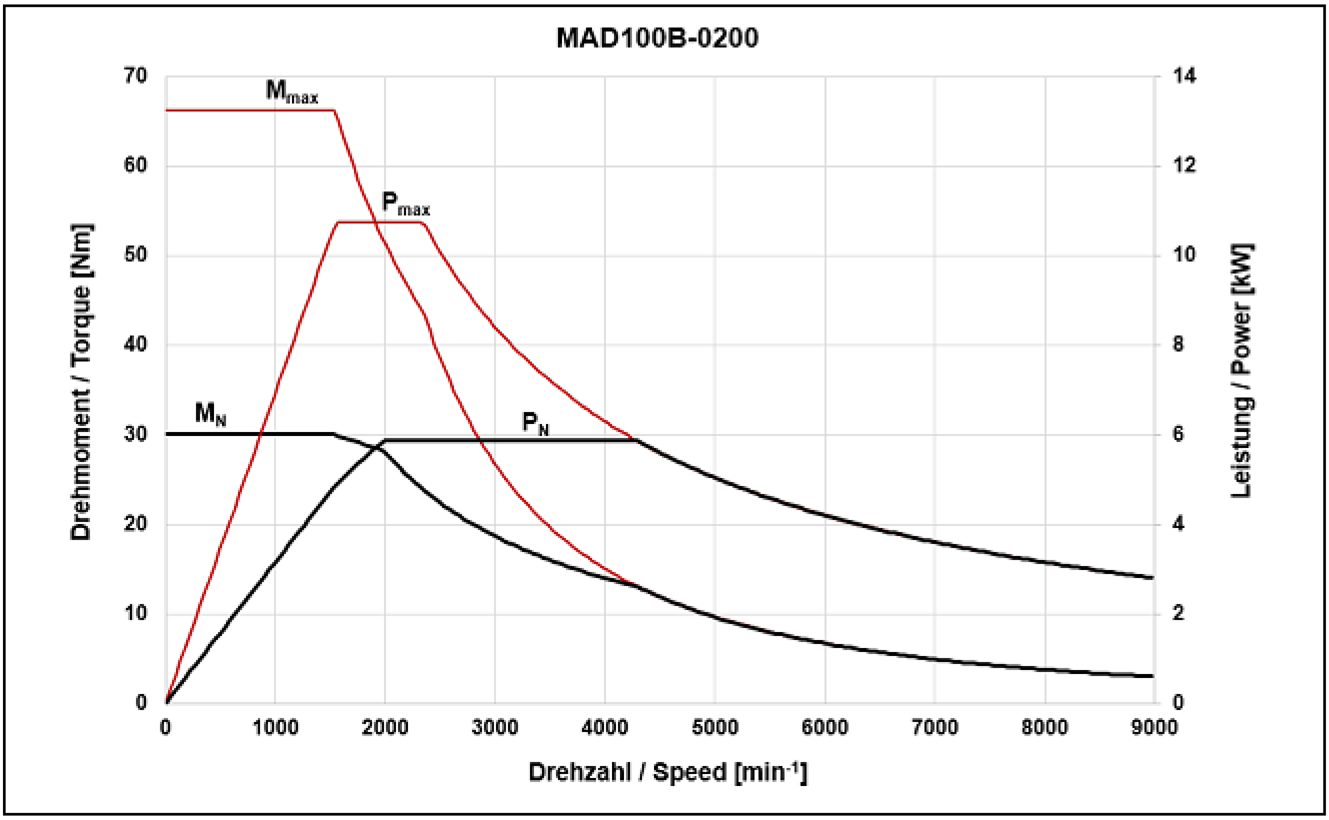


Fig. 4-10: Motor characteristic curve MAD100B-0200

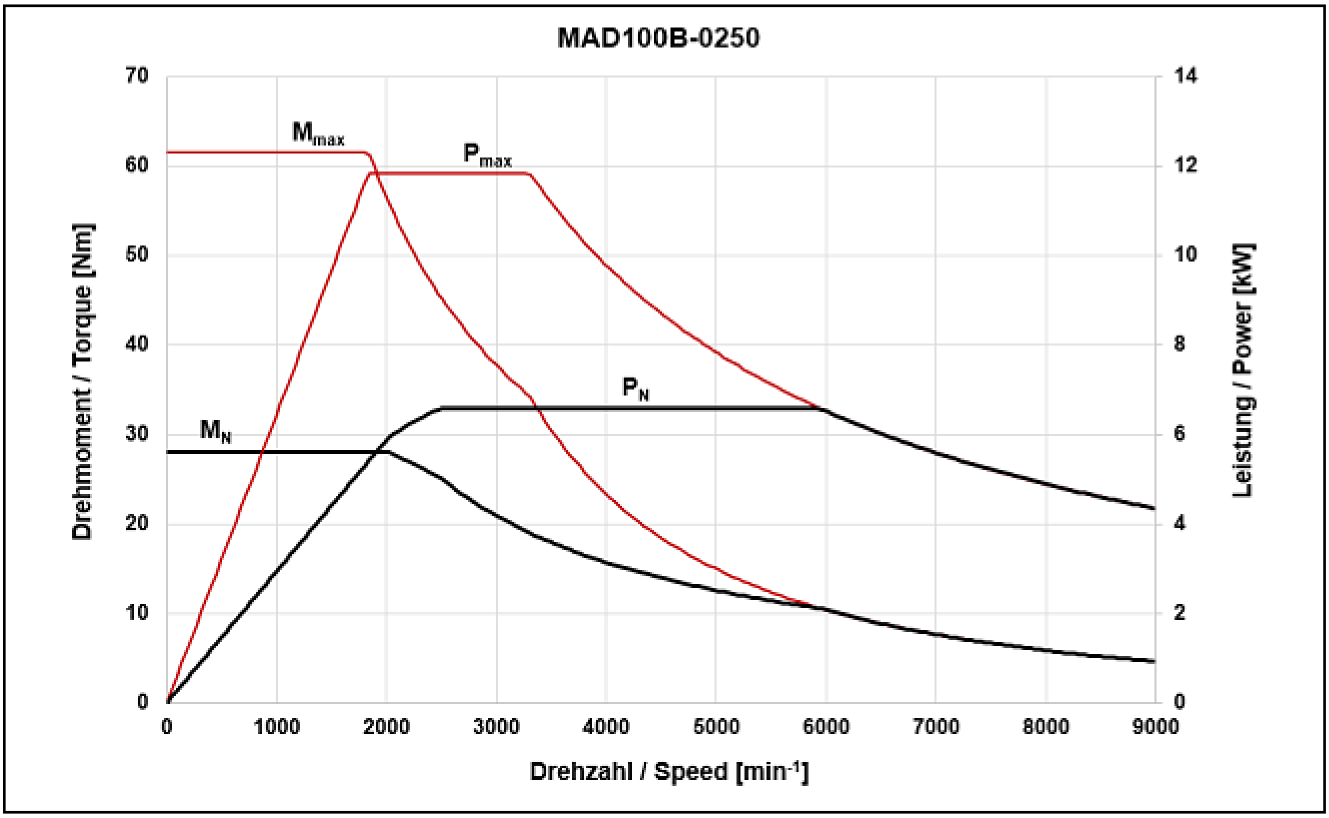


Fig. 4-11: Motor characteristic curve MAD100B-0250

Technical data

4.3.3 Data sheet MAD100C

Parameter[1)]	Symbol	Unit	MAD100C				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	51.0	50.0	48.0	45.0	40.0
Rated power	P_N	kW	2.70	5.20	7.50	9.40	10.47
Rated current	I_N	A	8.2	13.2	19.7	25.7	27.8
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Maximum torque	M_{max}	Nm	112.3	118.8	110.4	105.5	91.0
Maximum power	P_{S6max}	kW	5.54	10.66	15.38	19.27	22.50
Maximum current	$I_{max(eff)}$	A	15.9	25.4	39.0	47.3	64.3
Continuous torque at standstill	M_{n1}	Nm	51.0	54.0	50.0	48.0	42.0
Continuous current at standstill	I_{n1}	A	8.2	13.8	20.2	26.6	28.8
Torque constant at 20 °C	K_{M_N}	Nm/A	7.40	4.94	2.94	2.41	1.67
Thermal time constant	T_{th_nom}	min	20.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	9.0	8.5	8.1	8.5	9.2
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	1.5		2.5	4.0	
Mass	m_{mot}	kg	59.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0284000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-2: MAD100C - Technical data

4.3.4 Motor characteristic curves MAD100C

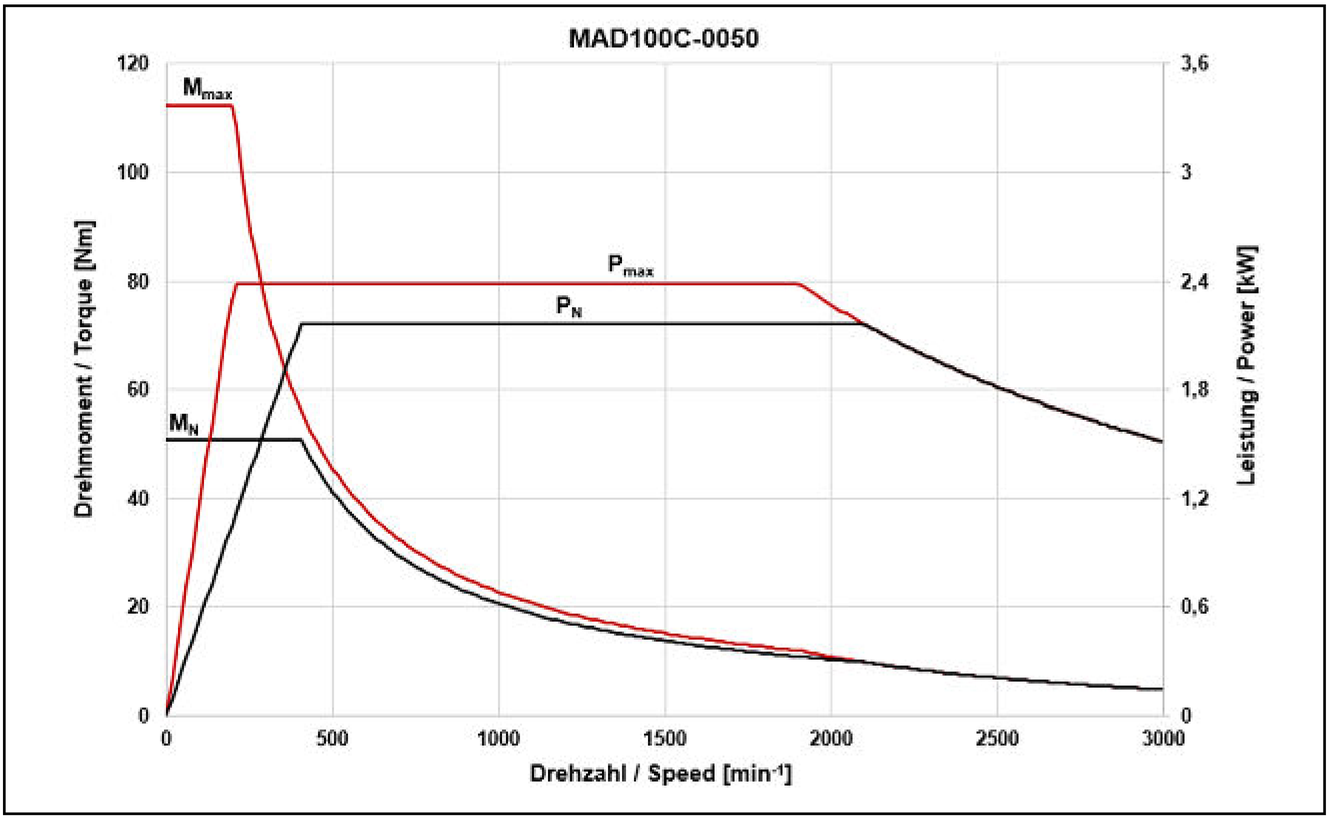


Fig. 4-12: Motor characteristic curve MAD100C-0050

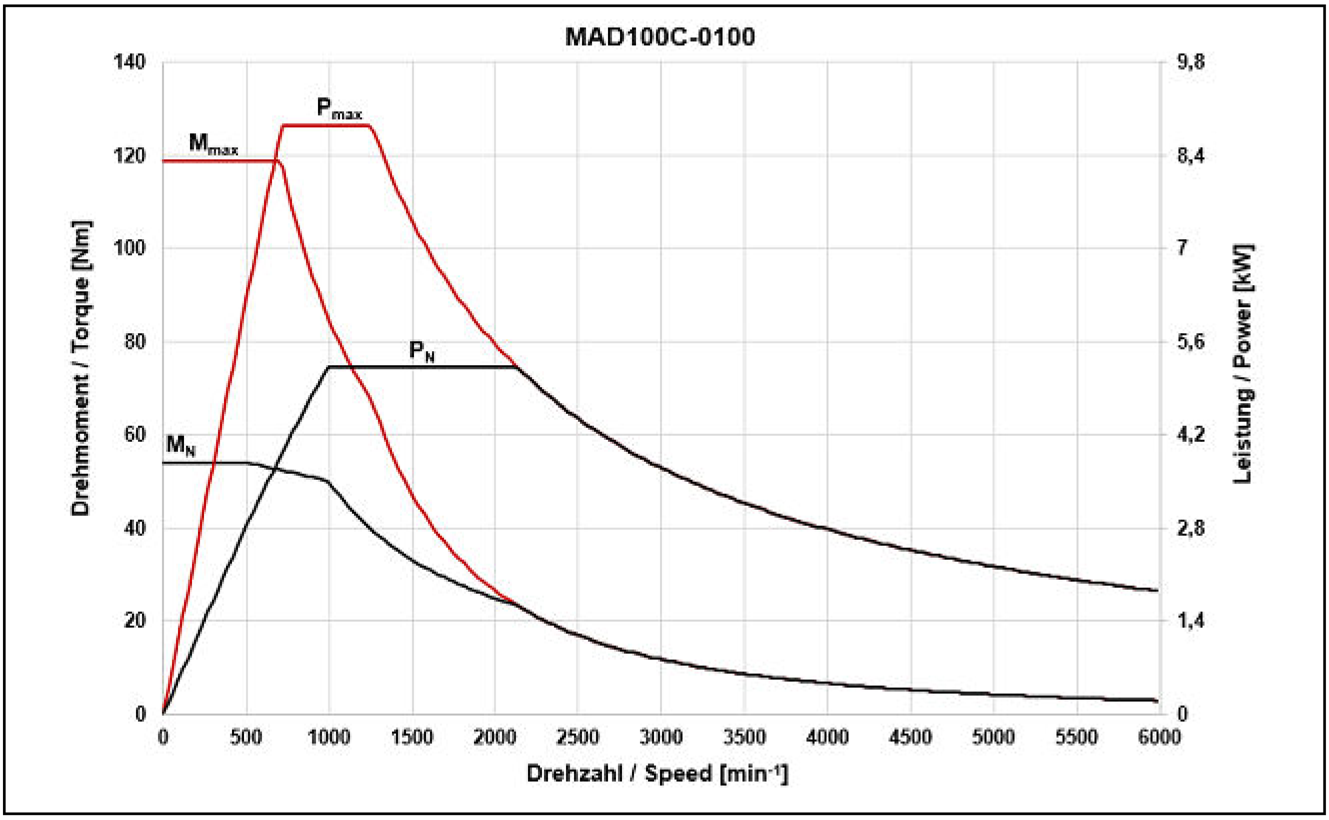


Fig. 4-13: Motor characteristic curve MAD100C-0100

Technical data

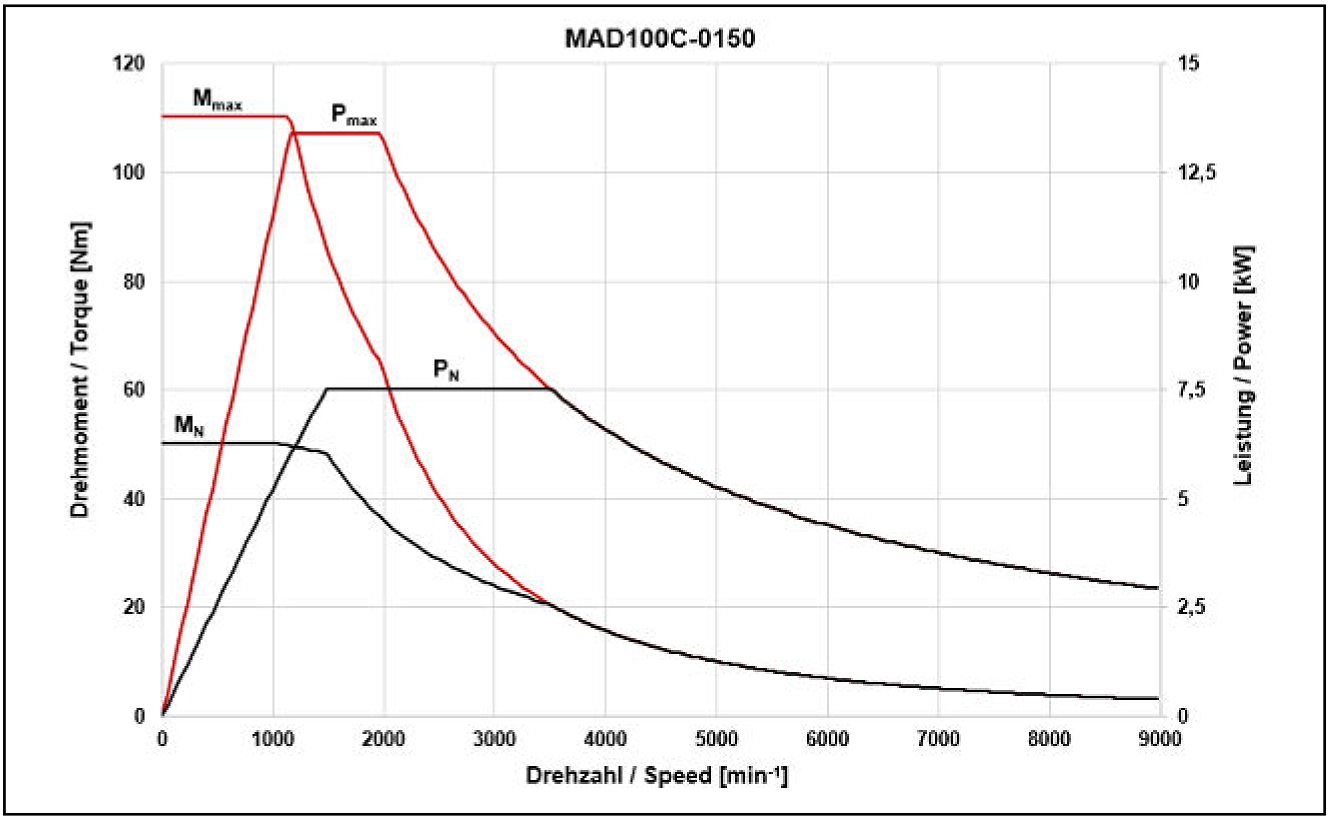


Fig. 4-14: Motor characteristic curve MAD100C-0150

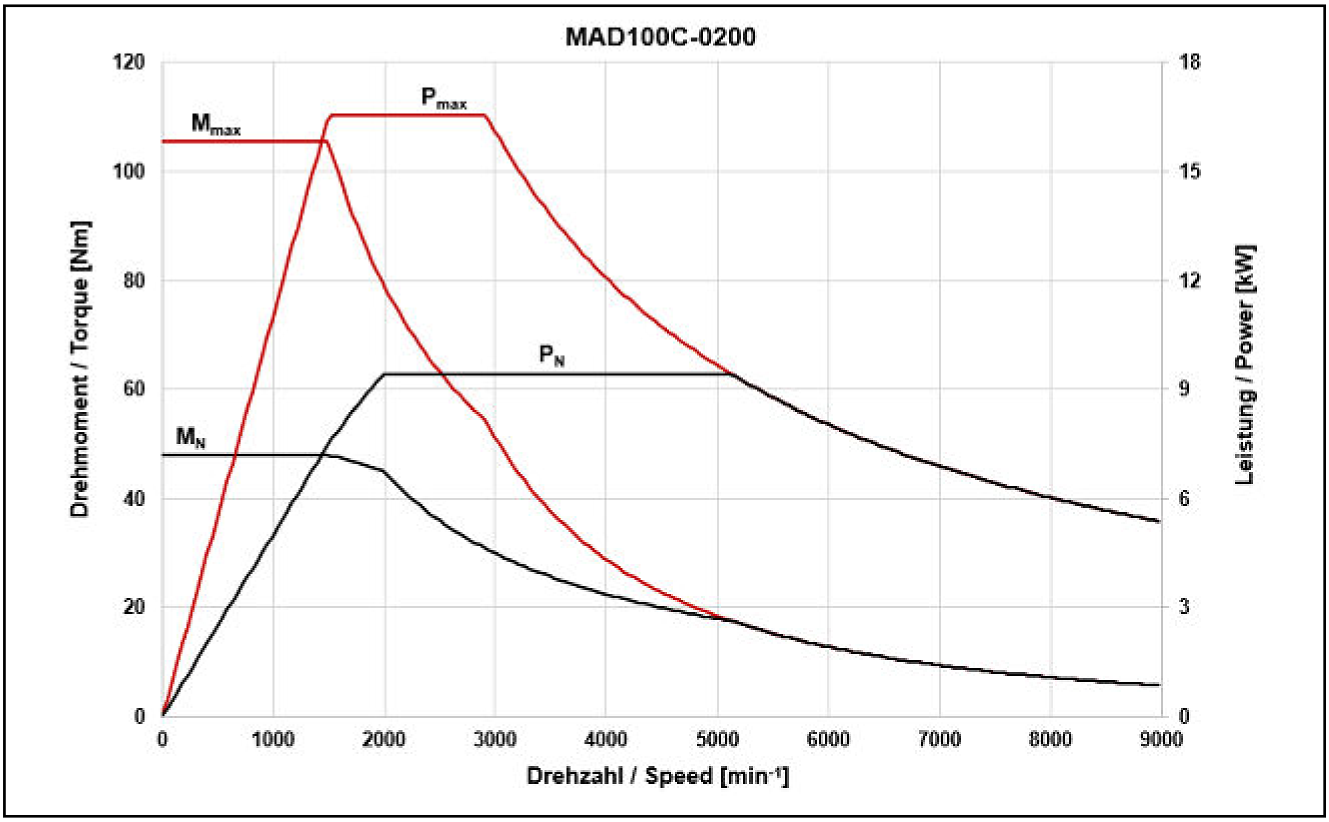


Fig. 4-15: Motor characteristic curve MAD100C-0200

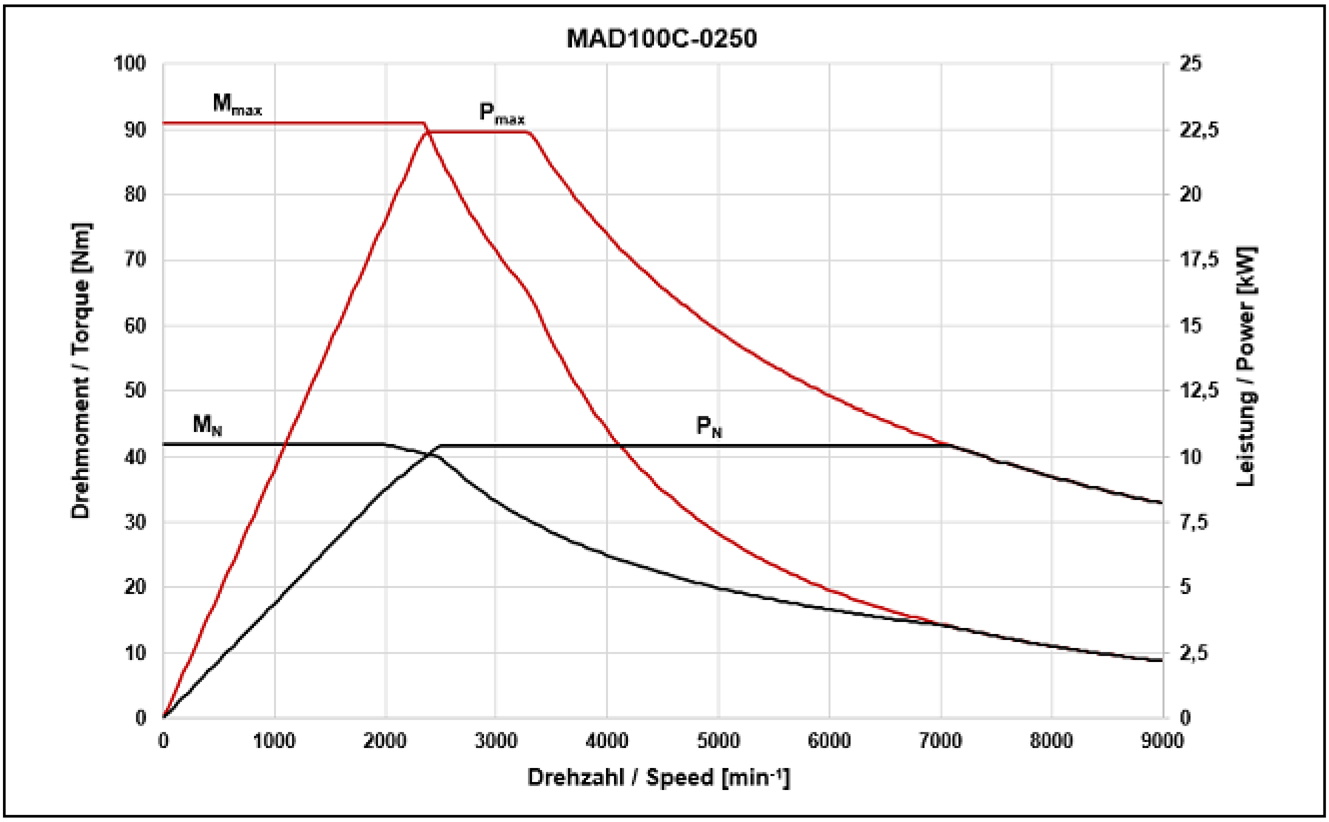


Fig. 4-16: Motor characteristic curve MAD100C-0250

4.3.5 Data sheet MAD100D

Parameter[1)]	Symbol	Unit	MAD100D				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	70.0	64.0	59.0	54.0	50.0
Rated power	P_N	kW	3.70	6.70	9.27	11.30	13.10
Rated current	I_N	A	10.1	19.3	24.7	27.2	32.4
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Maximum torque	M_{max}	Nm	153.6	146.5	140.6	129.8	118.7
Maximum power	P_{S6max}	kW	7.59	13.74	19.07	23.17	26.86
Maximum current	$I_{max(eff)}$	A	19.1	34.3	44.3	52.7	64.0
Continuous torque at standstill	M_{n1}	Nm	70.0		64.0	59.0	54.0
Continuous current at standstill	I_{n1}	A	10.1	20.4	25.6	28.6	34.7
Torque constant at 20 °C	K_{M_N}	Nm/A	8.52	4.11	3.19	2.62	2.04
Thermal time constant	T_{th_nom}	min	20.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	11.0		10.2	11.5	11.9
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	1.5	2.5	4.0		6.0
Mass	m_{mot}	kg	72.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0392000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-3: MAD100D - Technical data

4.3.6 Motor characteristic curves MAD100D

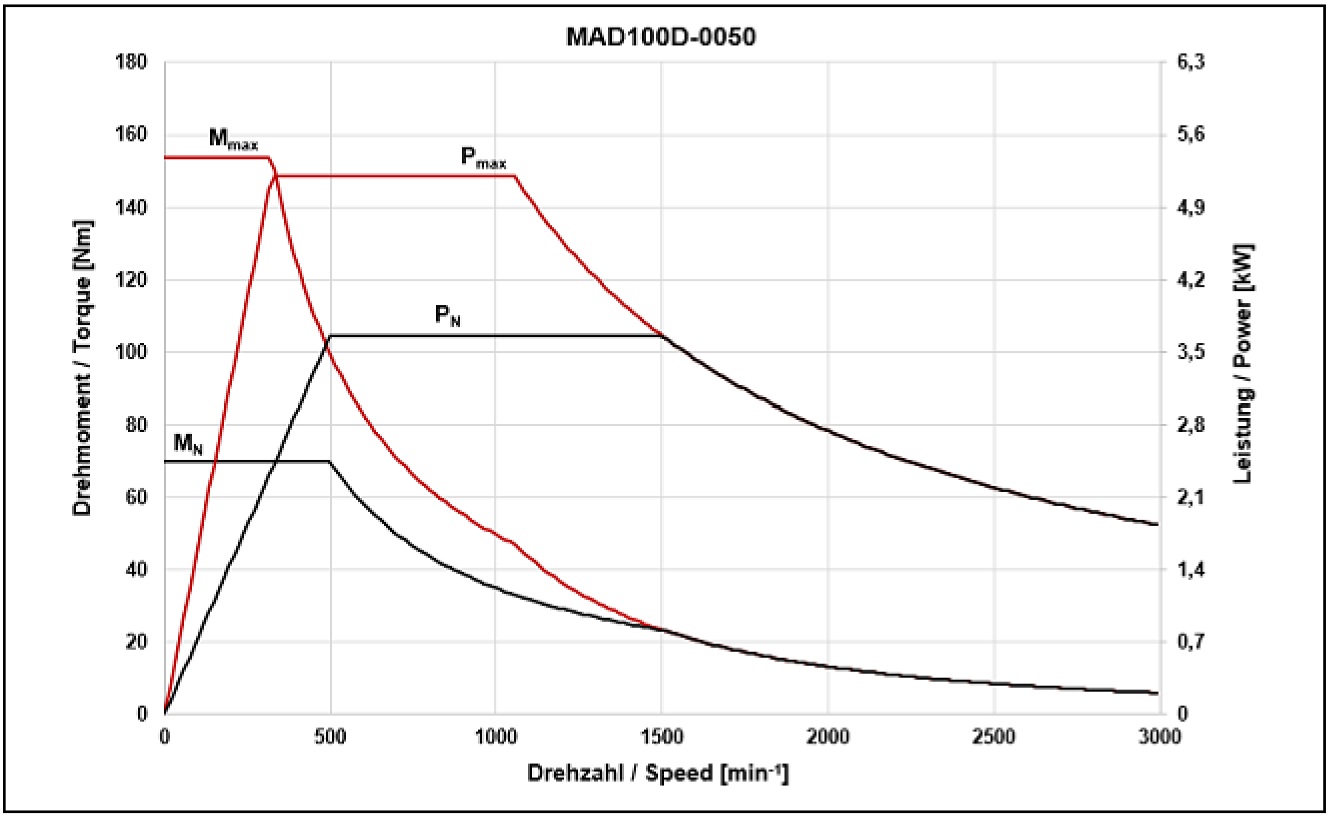


Fig. 4-17: Motor characteristic curve MAD100D-0050

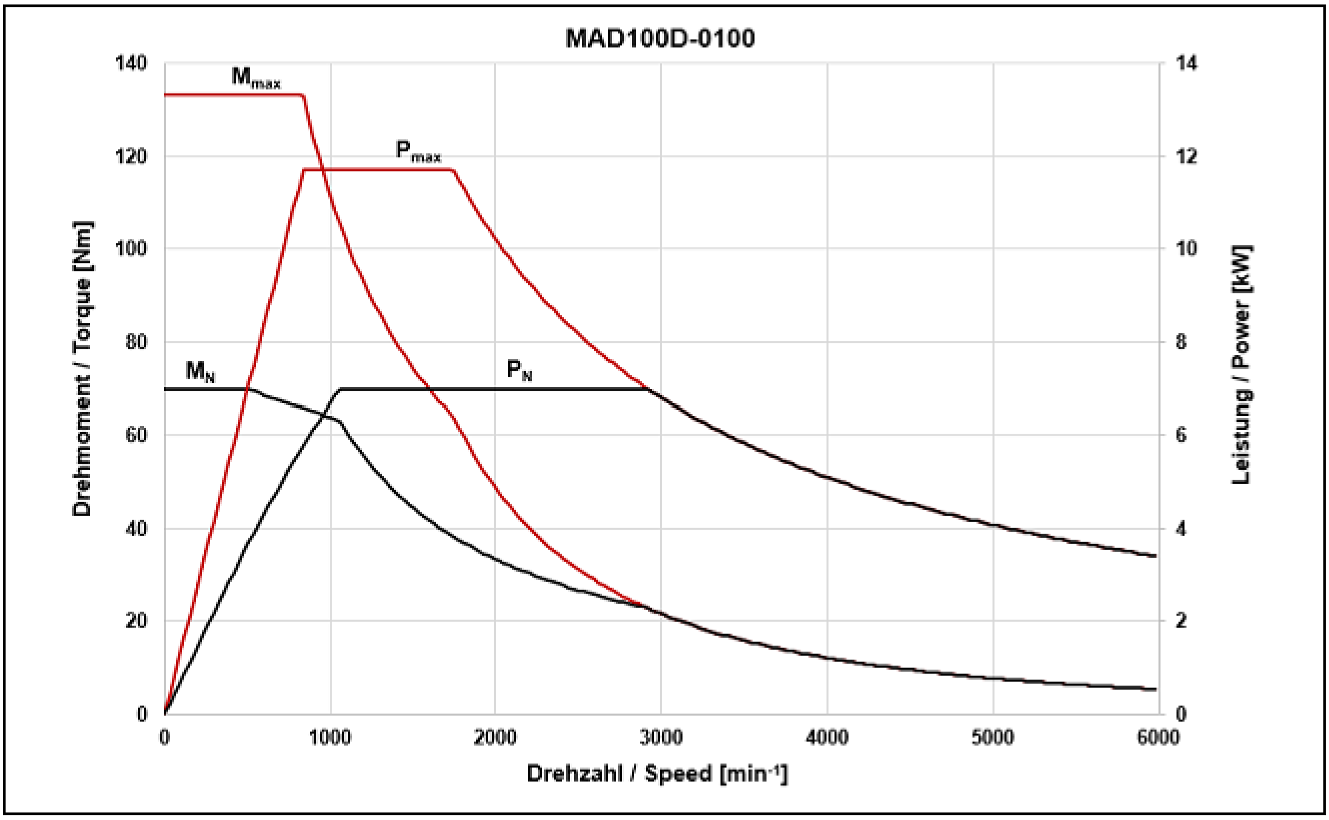


Fig. 4-18: Motor characteristic curve MAD100D-0100

Technical data

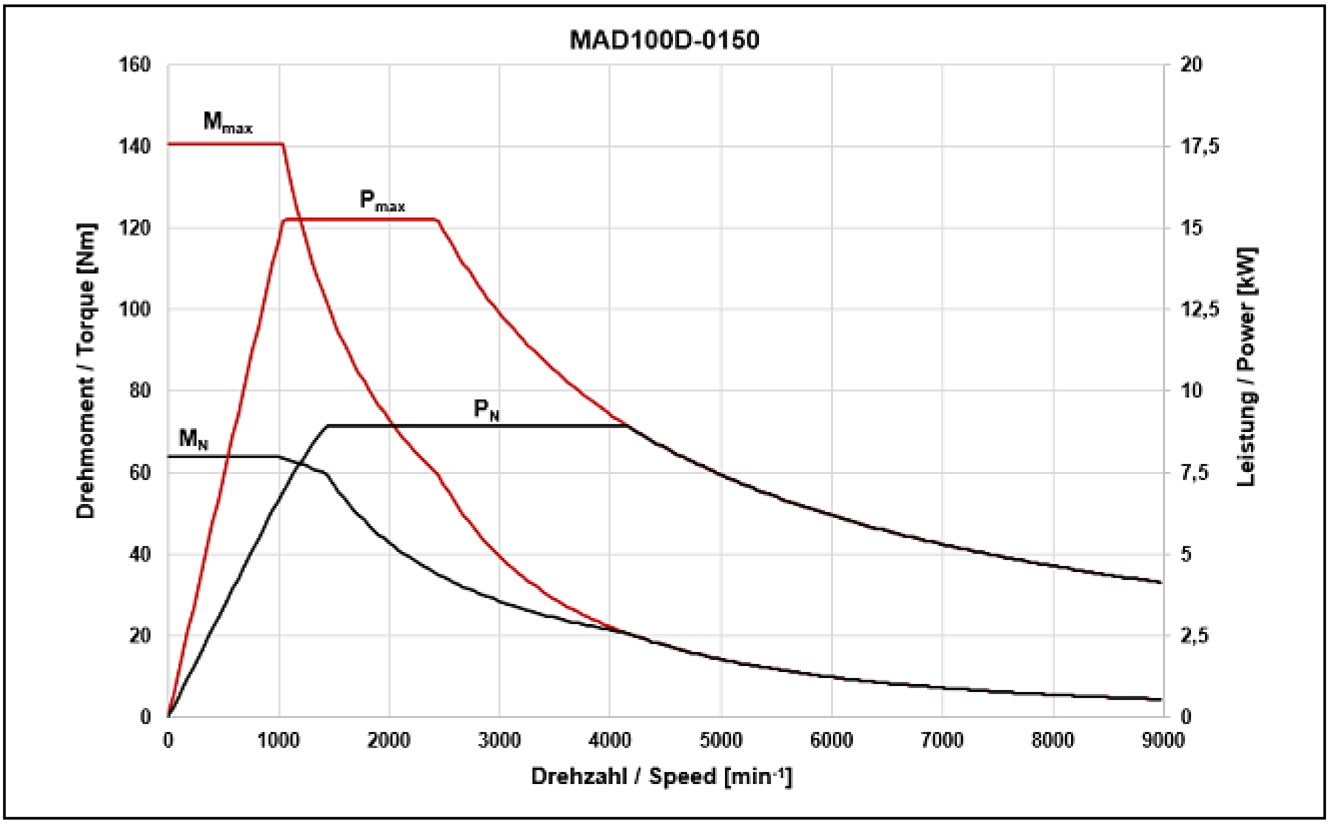


Fig. 4-19: Motor characteristic curve MAD100D-0150

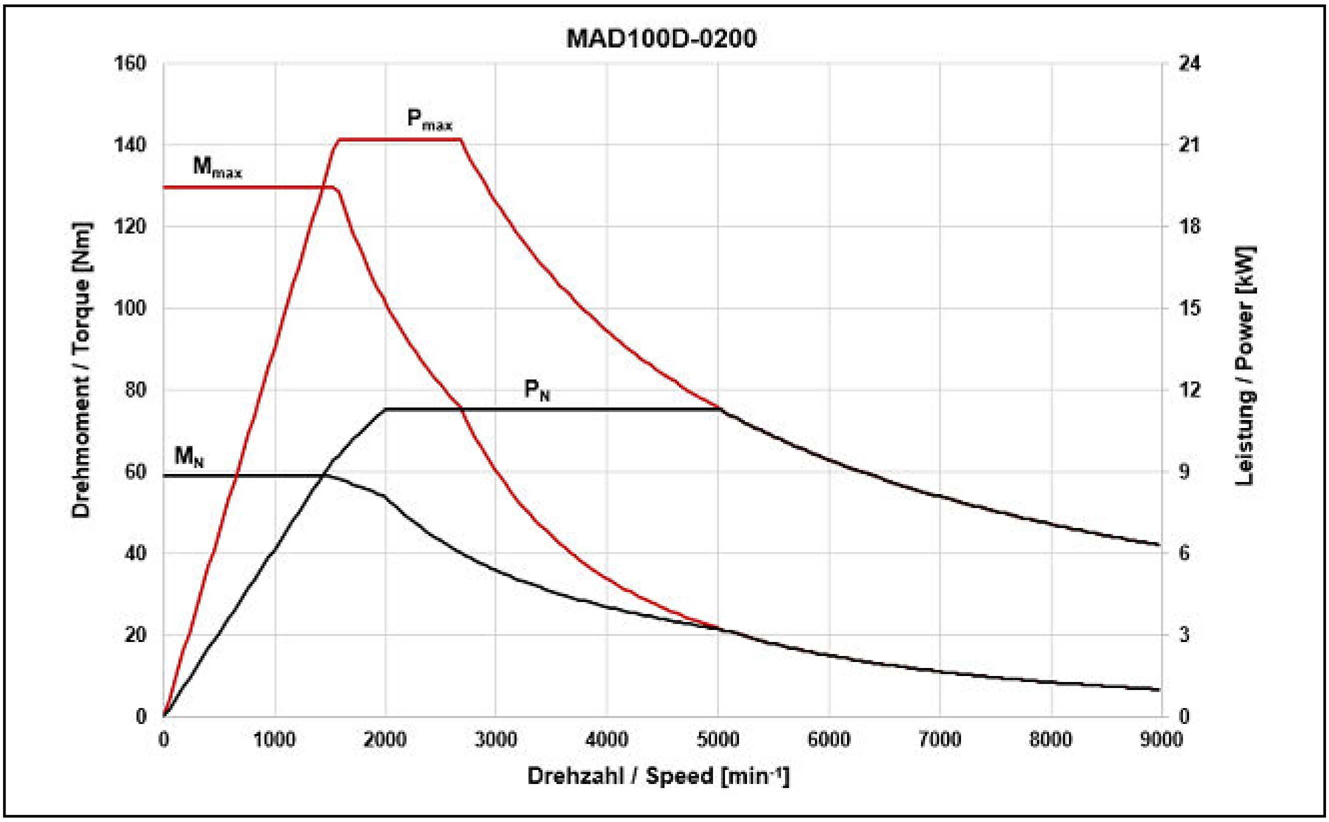


Fig. 4-20: Motor characteristic curve MAD100D-0200

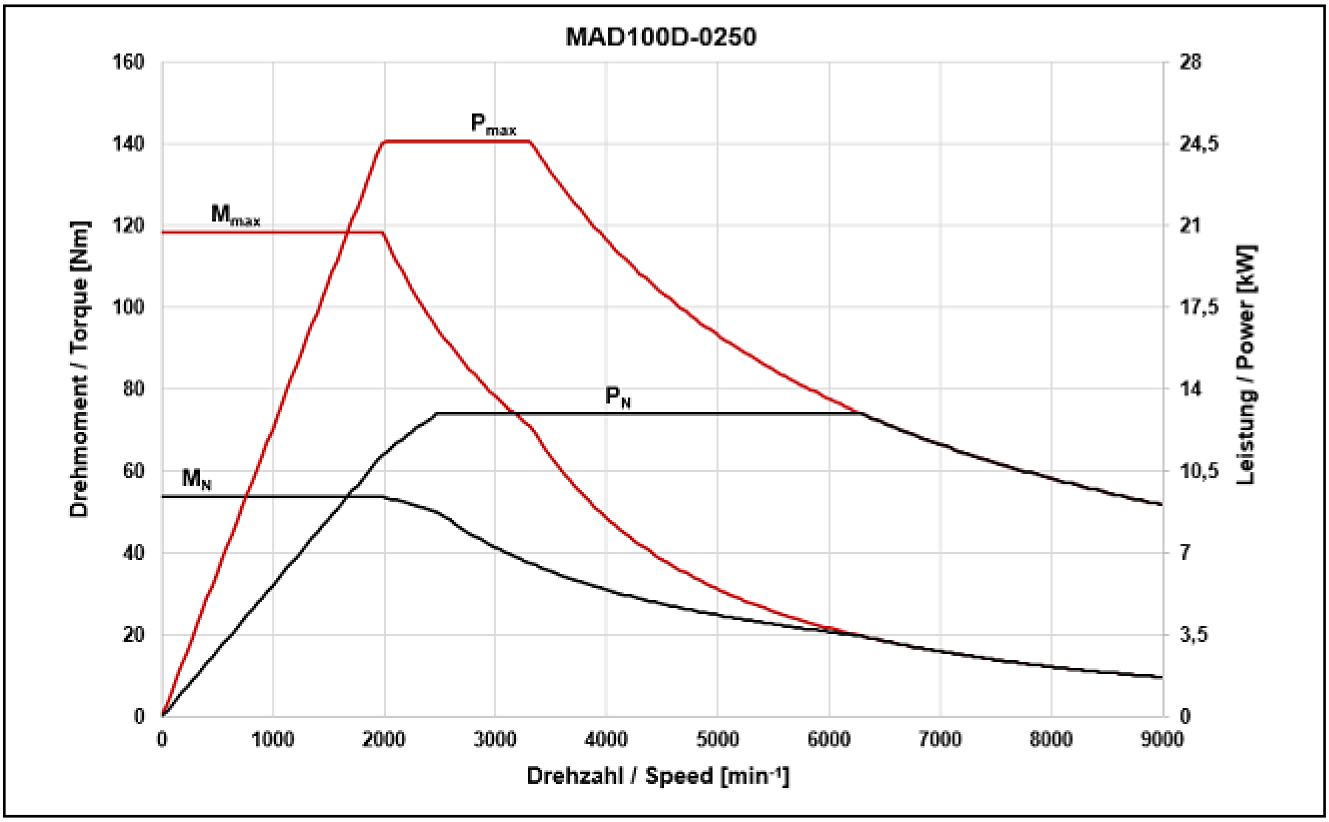


Fig. 4-21: Motor characteristic curve MAD100D-0250

4.3.7 Motor fan MAD100

Motor fan MAD100 - electrical data

Designation	Symbol	Unit	Value	
Voltage type		-	3~ AC	
Air flow direction		-	blowing	
Mean volume flow		m^3/h	360.0	
Nominal voltage	U_N	V	**400**	**480**
Nominal frequency	f	Hz	50 / 60	50 / 60
Fan current [1)]	I_N	A	0.12 / 0.10	0.17 / 0.12
Blocking current	I_{block}	A	0.34 / 0.33	0.41 / 0.39
Power consumption	S_N	VA	83 / 69	141 / 100
				Latest amendment: 2018-01-15

1) Fan current monitoring should start at I_N + 20%.

Tab. 4-4: Data sheet of motor fan MAD100

4.3.8 Holding Brake MAD/MAF100 (Optional)

Data sheet - holding brake MAD/MAF100

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	30.0	24.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	0.90	1.10
Holding brake moment of inertia	J_{br}	$kg*m^2$	0.000529	0.000556
Connection time	t_1	ms	42	30
Disconnection time	t_2	ms	50	90
Maximum holding brake speed	n_{Br_max}	min^{-1}	10000	
Last revision: 2006-10-23				

Tab. 4-5: Technical data of holding brake MAD/MAF100 (optional)

4.4 Technical data MAD130

4.4.1 Data sheet MAD130B

Parameter[1)]	Symbol	Unit	MAD130B				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	95.0	100.0	85.0	80.0	75.0
Rated power	P_N	kW	5.00	10.50	13.35	16.80	19.60
Rated current	I_N	A	12.8	26.9	34.9	43.0	47.2
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000	7500		
Maximum torque	M_{max}	Nm	208.8	230.0	200.0	187.2	176.5
Maximum power	P_{S6max}	kW	10.25	21.53	27.37	34.44	40.18
Maximum current	$I_{max(eff)}$	A	25.4	51.3	68.3	80.8	83.3
Continuous torque at standstill	M_{n1}	Nm	94.8	110.0	95.0	85.0	80.0
Continuous current at standstill	I_{n1}	A	12.8	28.7	37.4	44.5	47.2
Torque constant at 20 °C	K_{M_N}	Nm/A	8.49	4.79	3.07	2.47	2.15
Thermal time constant	T_{th_nom}	min	20.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	16.0	15.8		16.1	17.4
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	1.5	4.0	6.0	10.0	
Mass	m_{mot}	kg	105.2				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0840000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-6: MAD130B - Technical data

4.4.2 Motor characteristic curves MAD130B

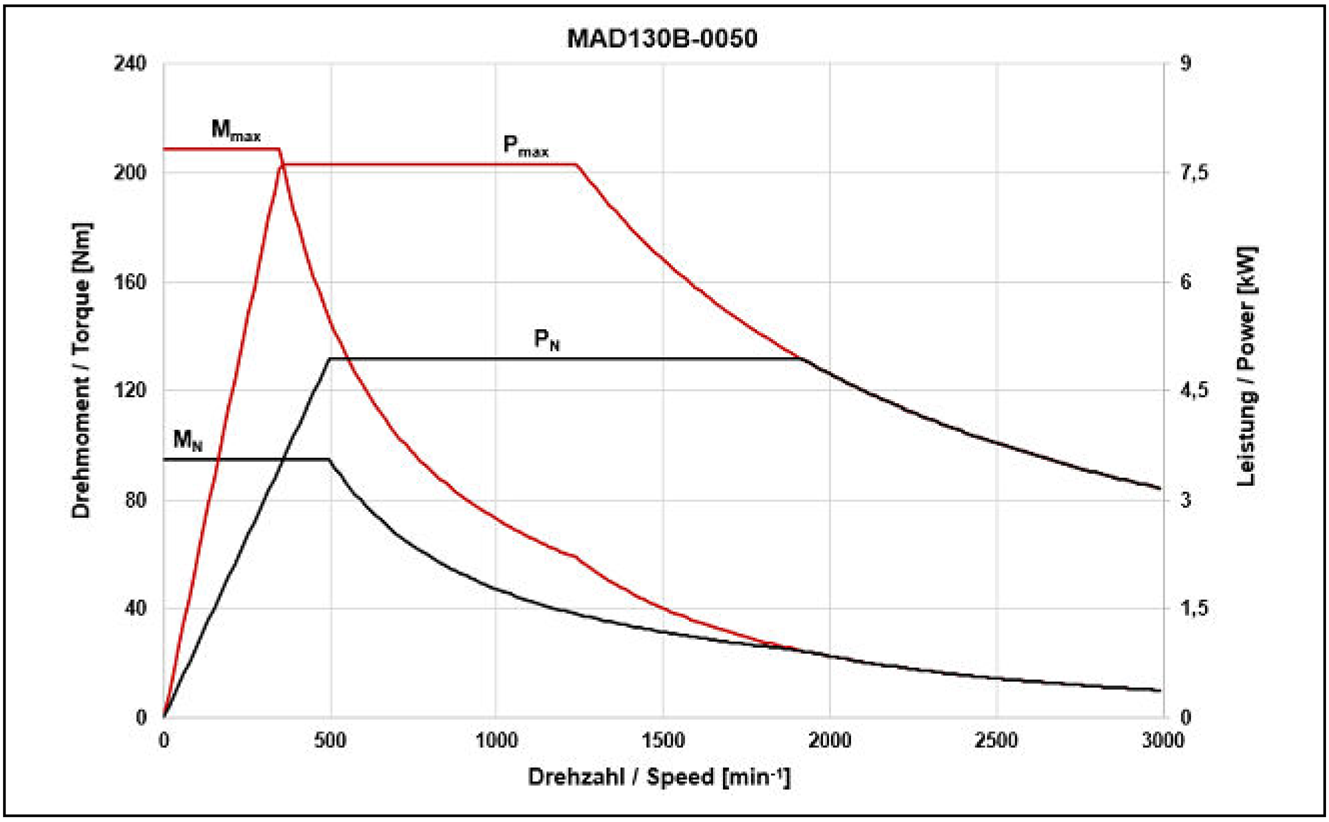


Fig. 4-22: Motor characteristic curve MAD130B-0050

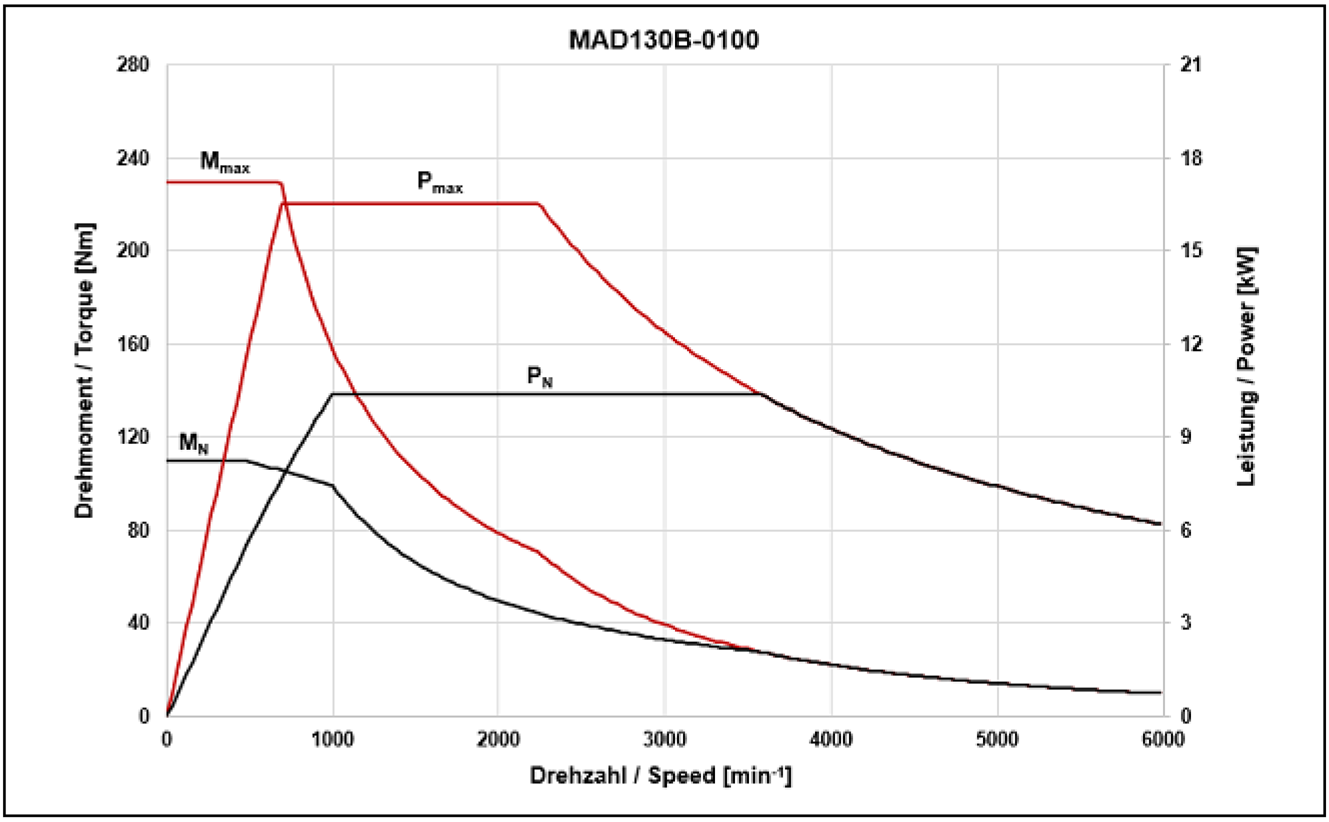


Fig. 4-23: Motor characteristic curve MAD130B-0100

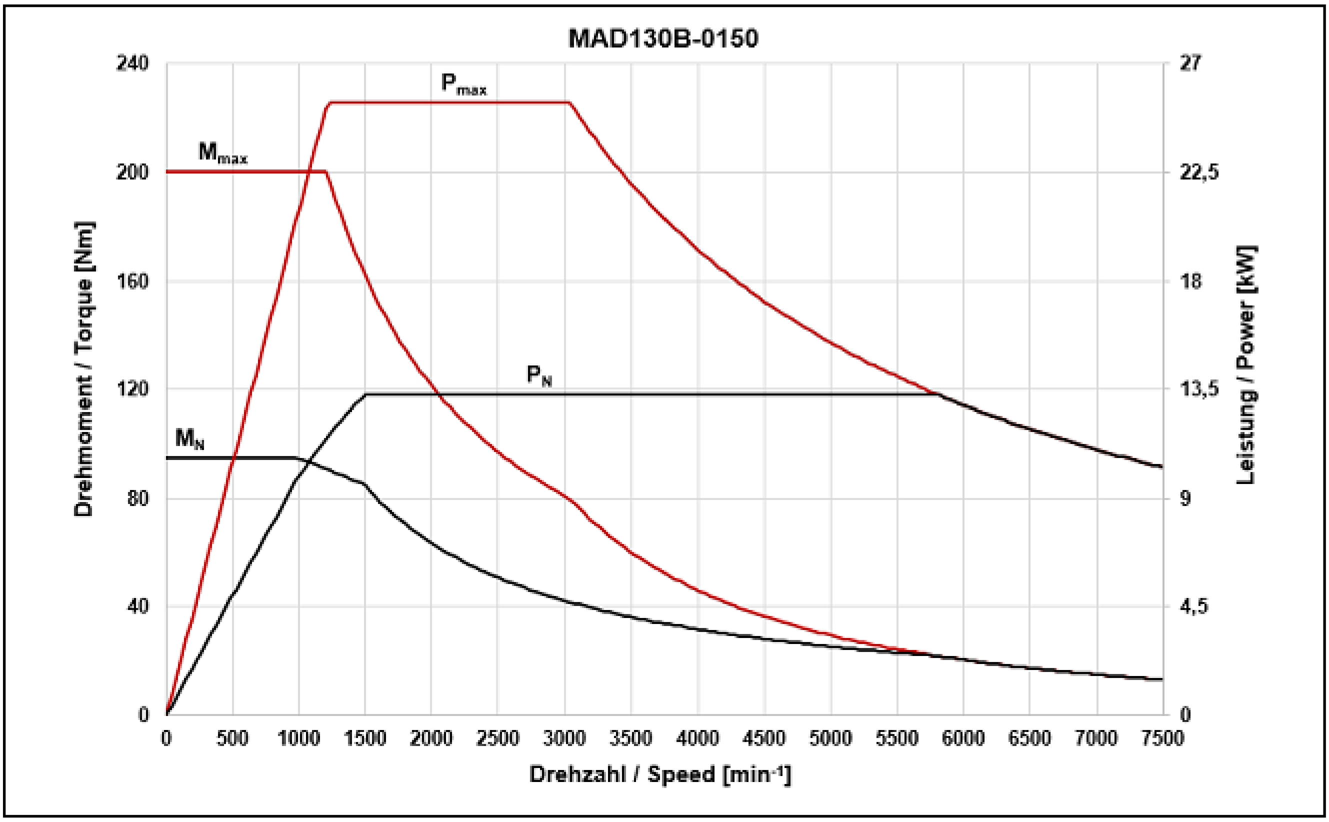


Fig. 4-24: Motor characteristic curve MAD130B-0150

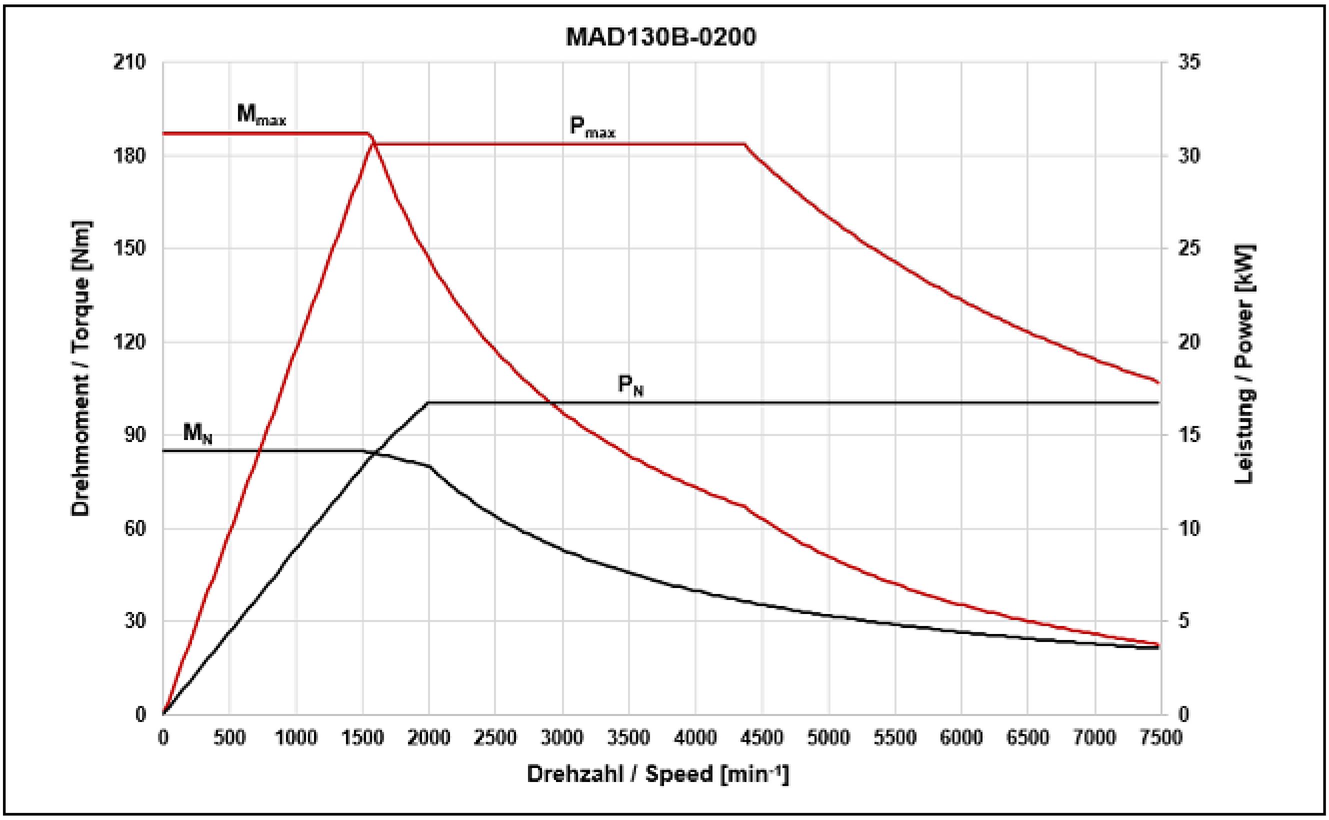


Fig. 4-25: Motor characteristic curve MAD130B-0200

Technical data

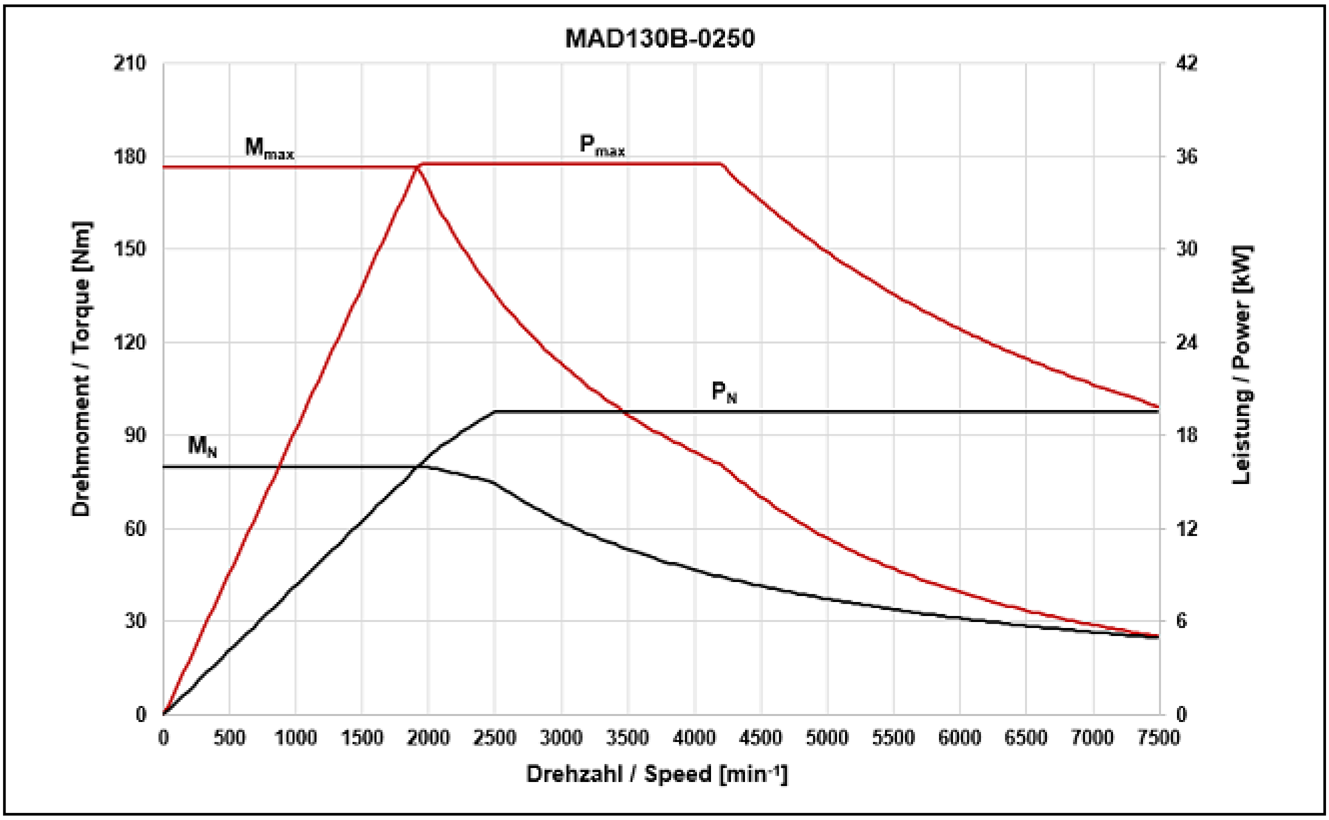


Fig. 4-26: Motor characteristic curve MAD130B-0250

4.4.3 Data sheet MAD130C

Parameter[1)]	Symbol	Unit	MAD130C				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	140.0	125.0	117.0	110.0	100.0
Rated power	P_N	kW	7.30	13.09	18.40	23.00	26.20
Rated current	I_N	A	19.7	36.2	48.9	57.0	62.0
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	600	7500		
Maximum torque	M_{max}	Nm	307.9	305.0	275.2	252.9	250.0
Maximum power	P_{S6max}	kW	14.97	26.83	37.72	47.15	53.70
Maximum current	$I_{max(eff)}$	A	35.4	73.8	93.3	106.7	130.3
Continuous torque at standstill	M_{n1}	Nm	139.9	140.0	125.0	115.0	110.0
Continuous current at standstill	I_{n1}	A	19.7	38.5	51.0	59.6	65.6

Parameter[1)]	Symbol	Unit	MAD130C				
			0050	0100	0150	0200	0250
Torque constant at 20 °C	K_{M_N}	Nm/A	9.31	4.26	3.10	2.64	1.96
Thermal time constant	T_{th_nom}	min	30.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	20.0	20.9	20.5	19.3	20.1
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	2.5	6.0	10.0	16.0	
Mass	m_{mot}	kg	124.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.1080000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-7: MAD130C - Technical data

4.4.4 Motor characteristic curves MAD130C

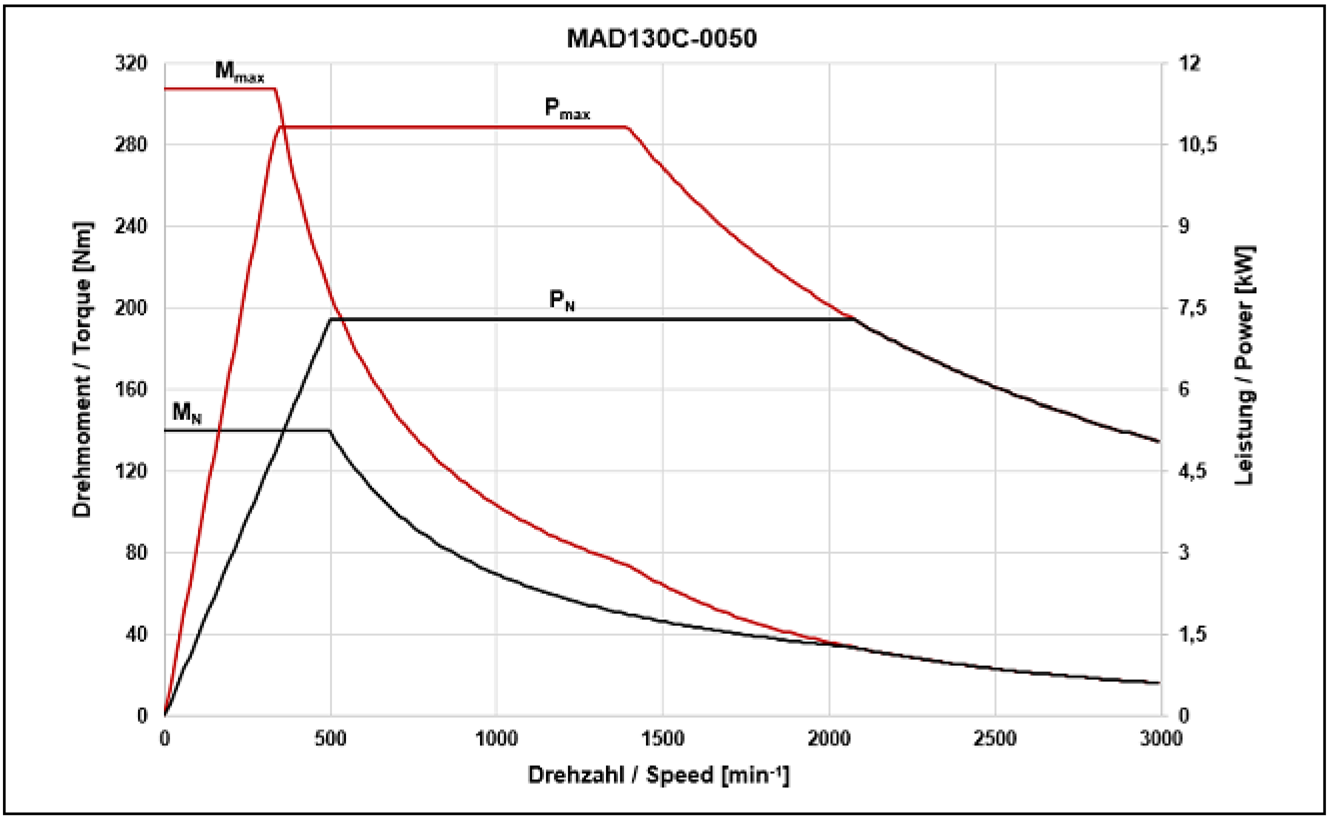


Fig. 4-27: Motor characteristic curve MAD130C-0050

Technical data

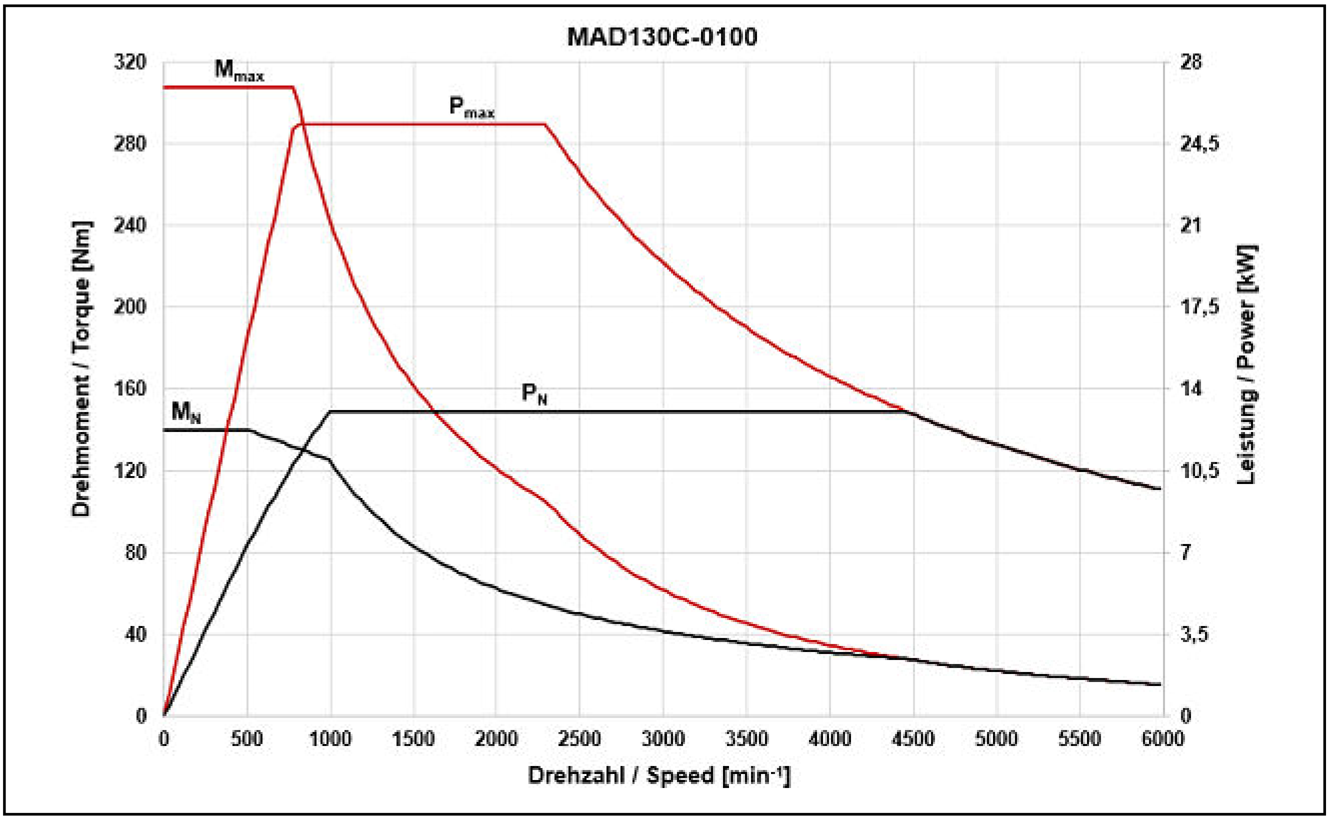


Fig. 4-28: Motor characteristic curve MAD130C-0100

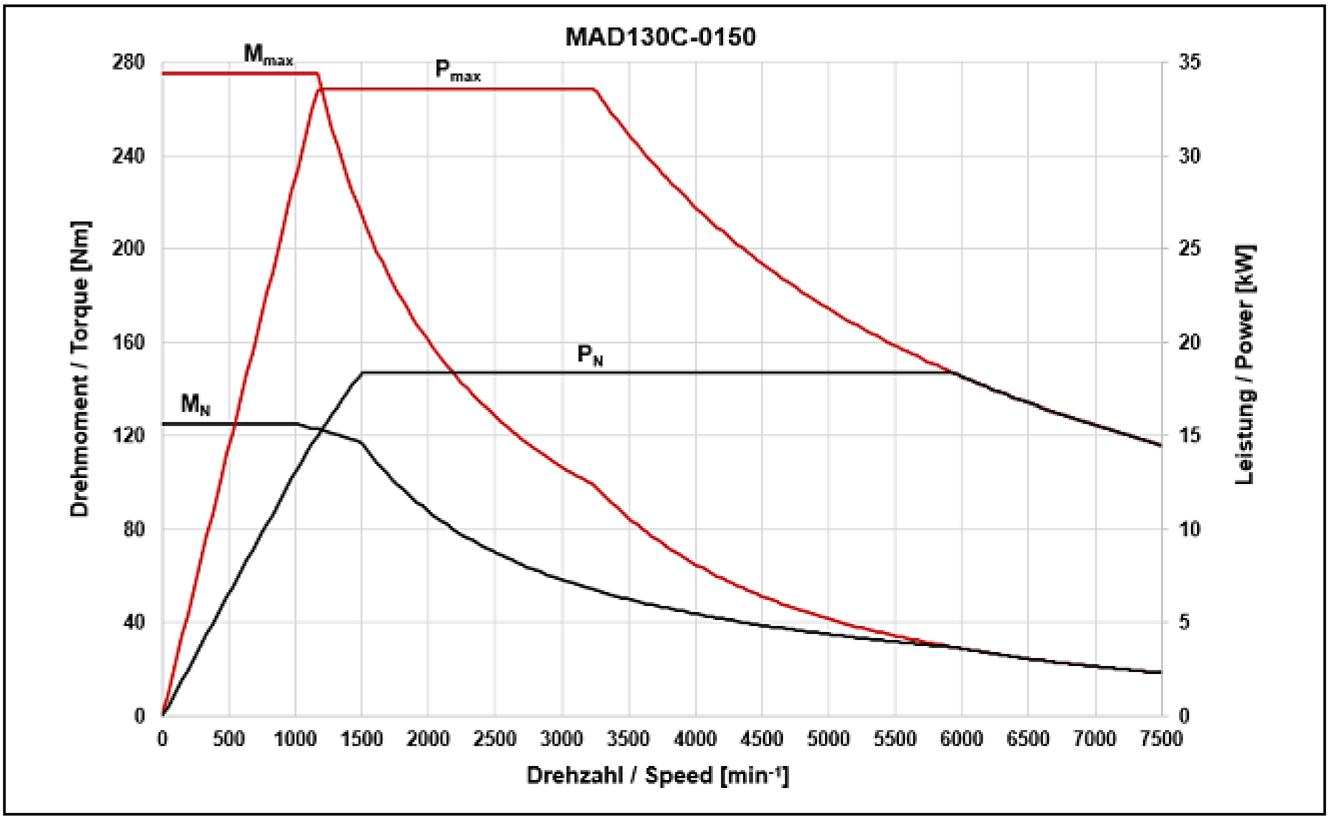


Fig. 4-29: Motor characteristic curve MAD130C-0150

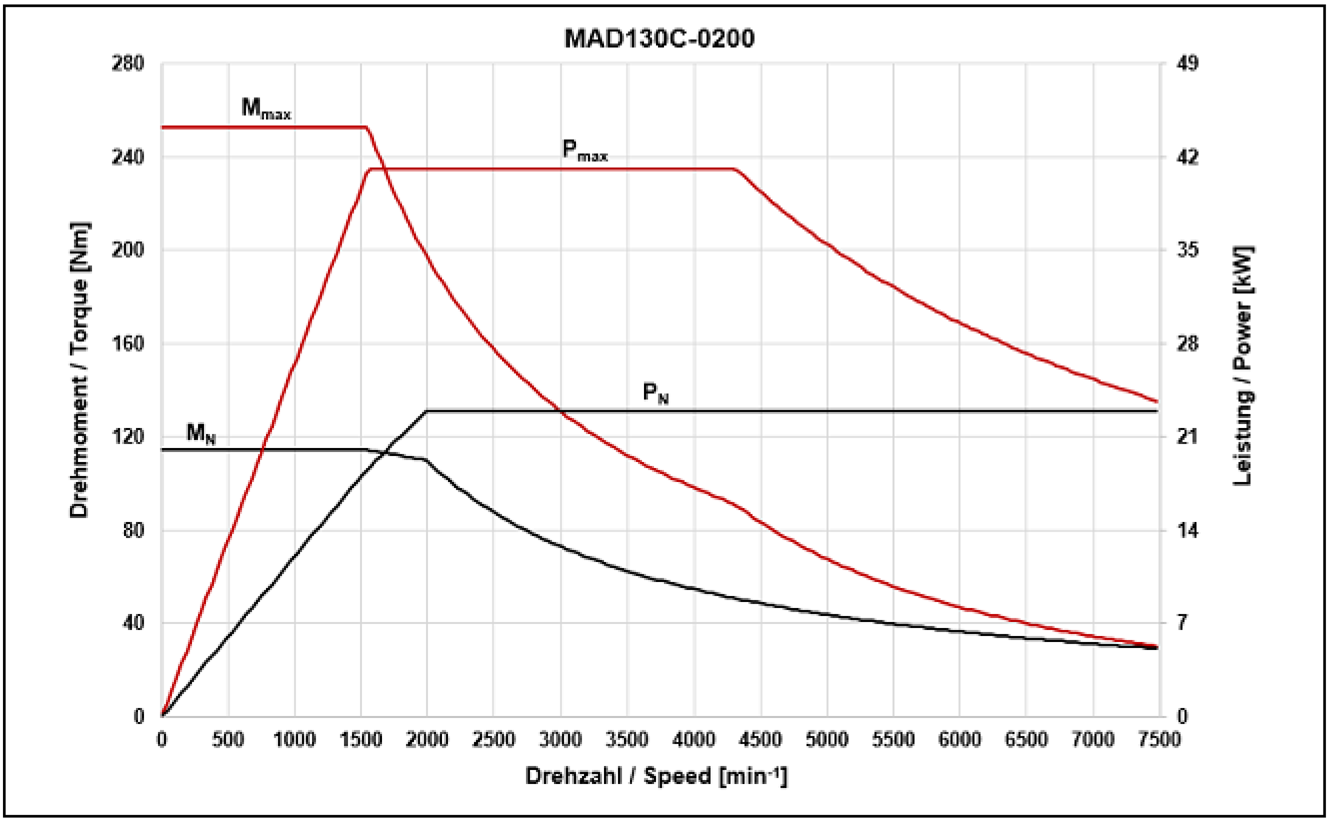


Fig. 4-30: Motor characteristic curve MAD130C-0200

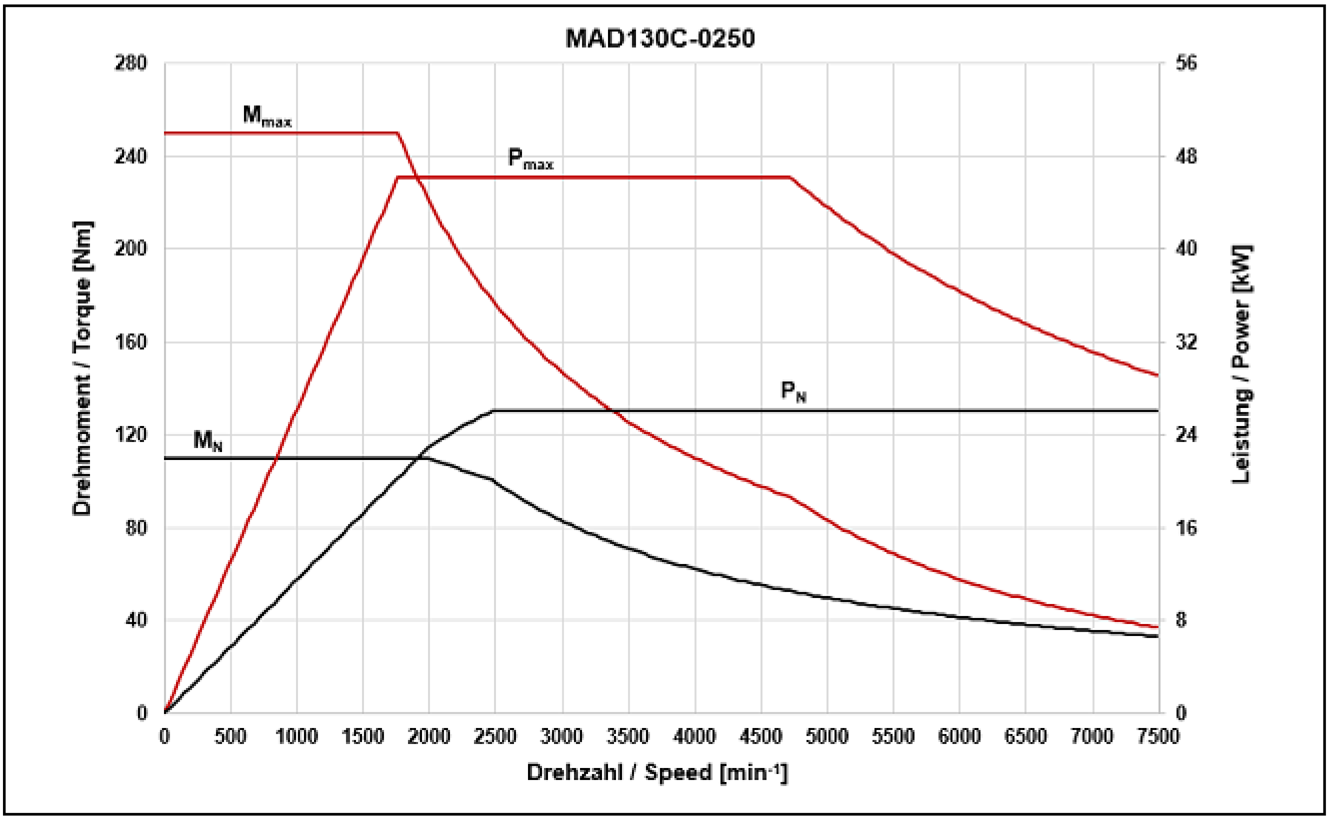


Fig. 4-31: Motor characteristic curve MAD130C-0250

Technical data

4.4.5 Data sheet MAD130D

Parameter[1)]	Symbol	Unit	MAD130D				
			0050	0100	0150	0200	0250
Rated torque	M_N	Nm	180.0	170.0	155.0	150.0	120.0
Rated power	P_N	kW	9.40	17.80	24.30	31.40	
Rated current	I_N	A	24.2	43.7	61.5	71.3	72.4
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000	7500		
Maximum torque	M_{max}	Nm	395.6	417.8	374.6	340.7	310.0
Maximum power	P_{S6max}	kW	19.27	36.49	49.82	64.37	
Maximum current	$I_{max(eff)}$	A	47.0	93.4	123.0	137.0	131.3
Continuous torque at standstill	M_{n1}	Nm	179.8	190.0	170.0	155.0	130.0
Continuous current at standstill	I_{n1}	A	24.2	47.8	64.1	72.8	75.4
Torque constant at 20 °C	K_{M_N}	Nm/A	8.75	4.72	3.09	2.62	2.69
Thermal time constant	T_{th_nom}	min	30.0				
Cycle duration (S6 - 44%)	T_C	min	10				
Discharge capacity of the component	C_{dis}	nF	27.5	27.3	30.5	27.5	26.4
Number of pole pairs	p	-	3				
Power wire cross-section	A	mm^2	4.0	10.0	16.0		25.0
Mass	m_{mot}	kg	165.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.1640000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class (EN 60034-1)	T.CL.	-	155				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-8: MAD130D - Technical data

4.4.6 Motor characteristic curves MAD130D

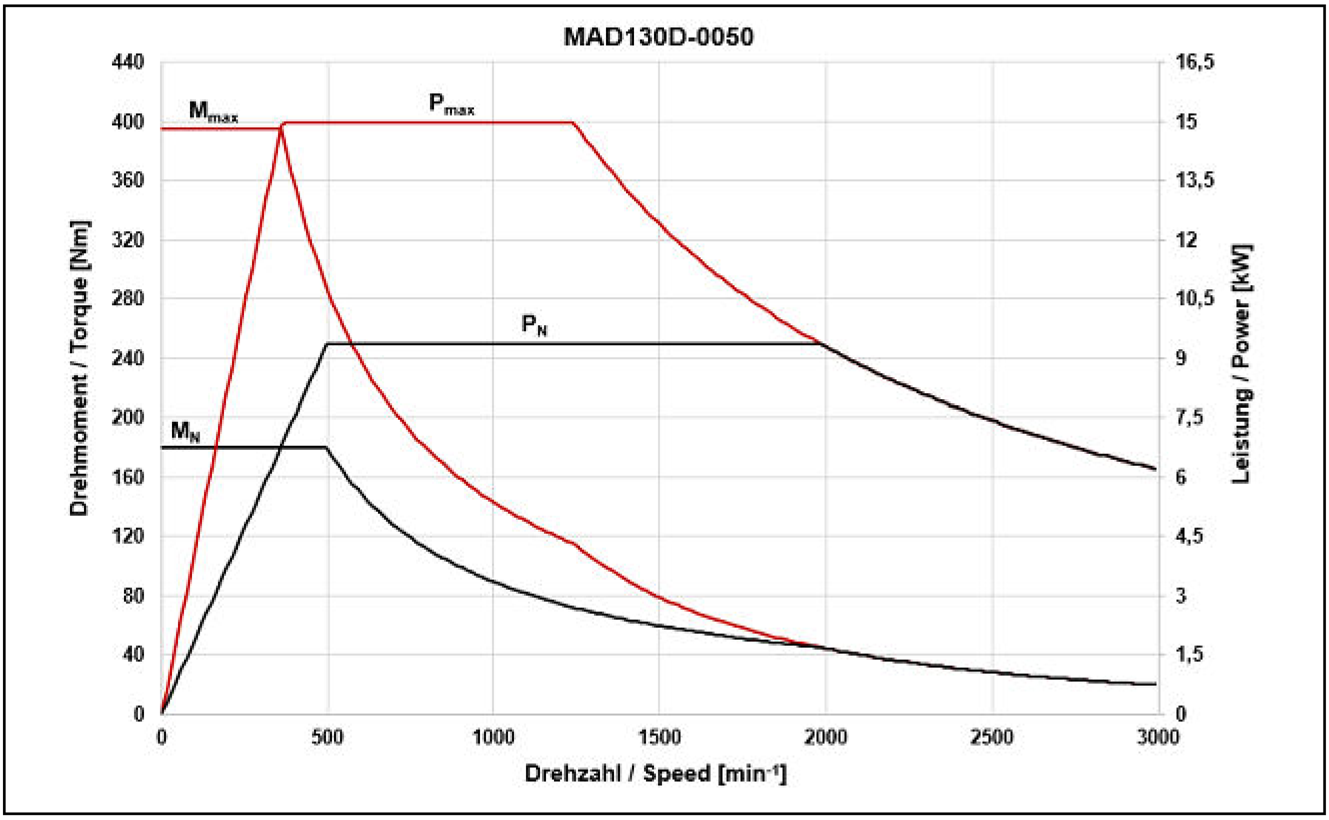


Fig. 4-32: Motor characteristic curve MAD130D-0050

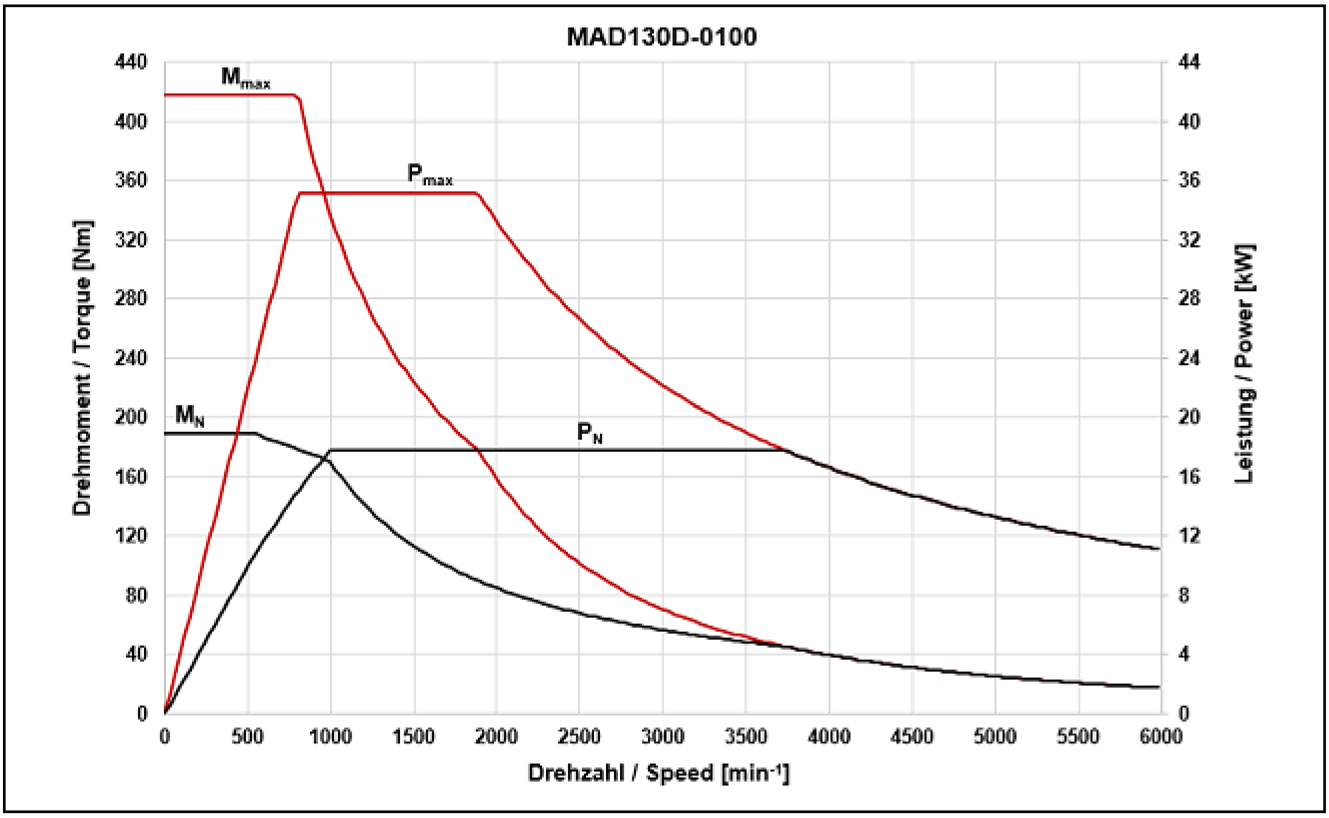


Fig. 4-33: Motor characteristic curve MAD130D-0100

Technical data

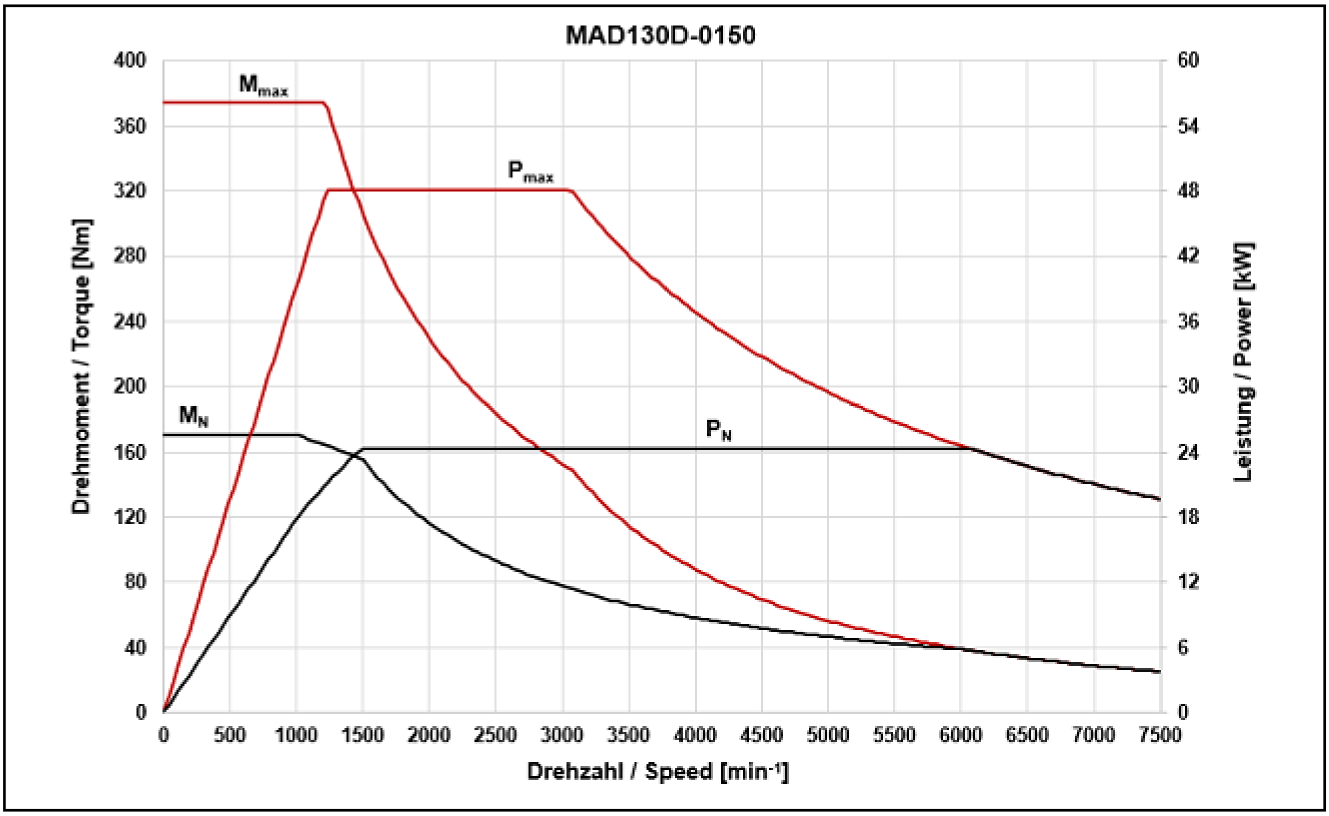


Fig. 4-34: Motor characteristic curve MAD130D-0150

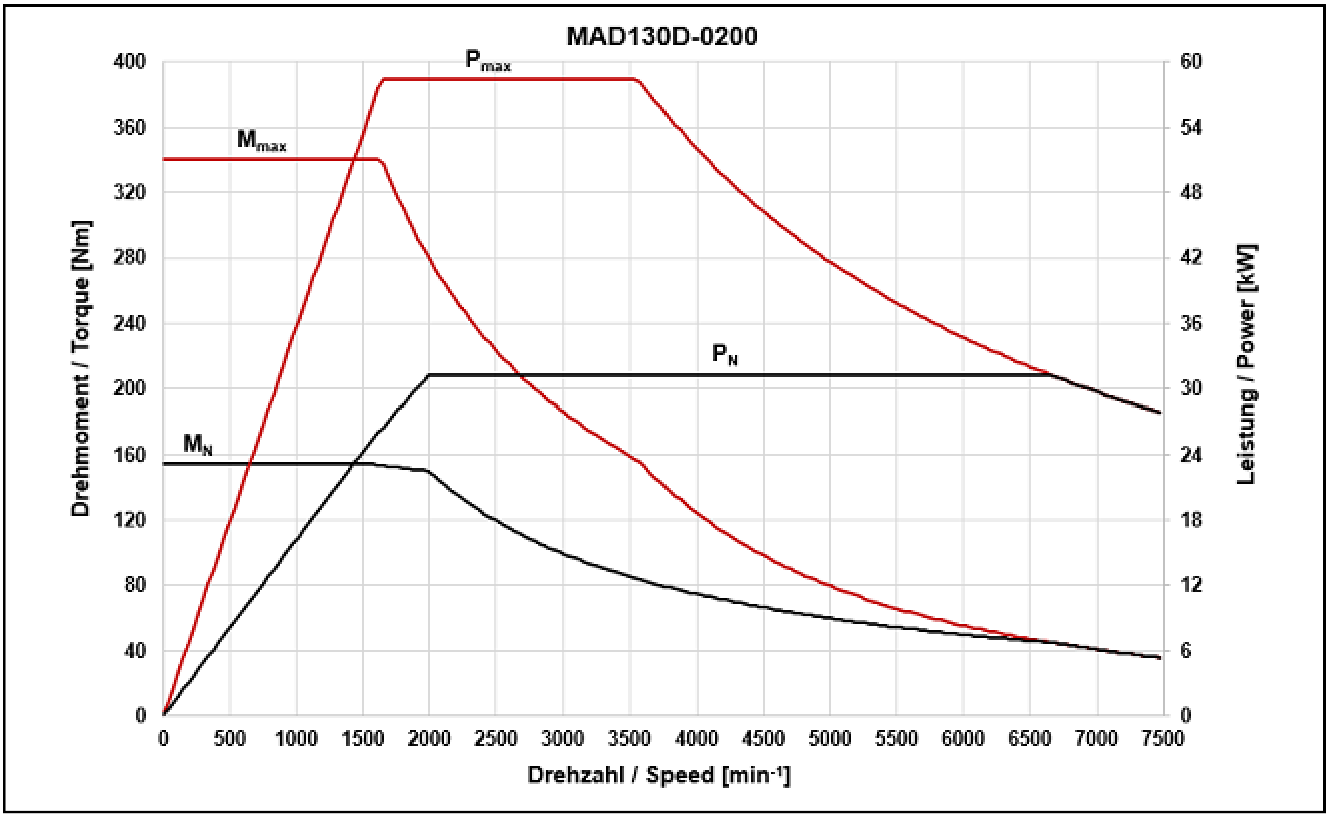


Fig. 4-35: Motor characteristic curve MAD130D-0200

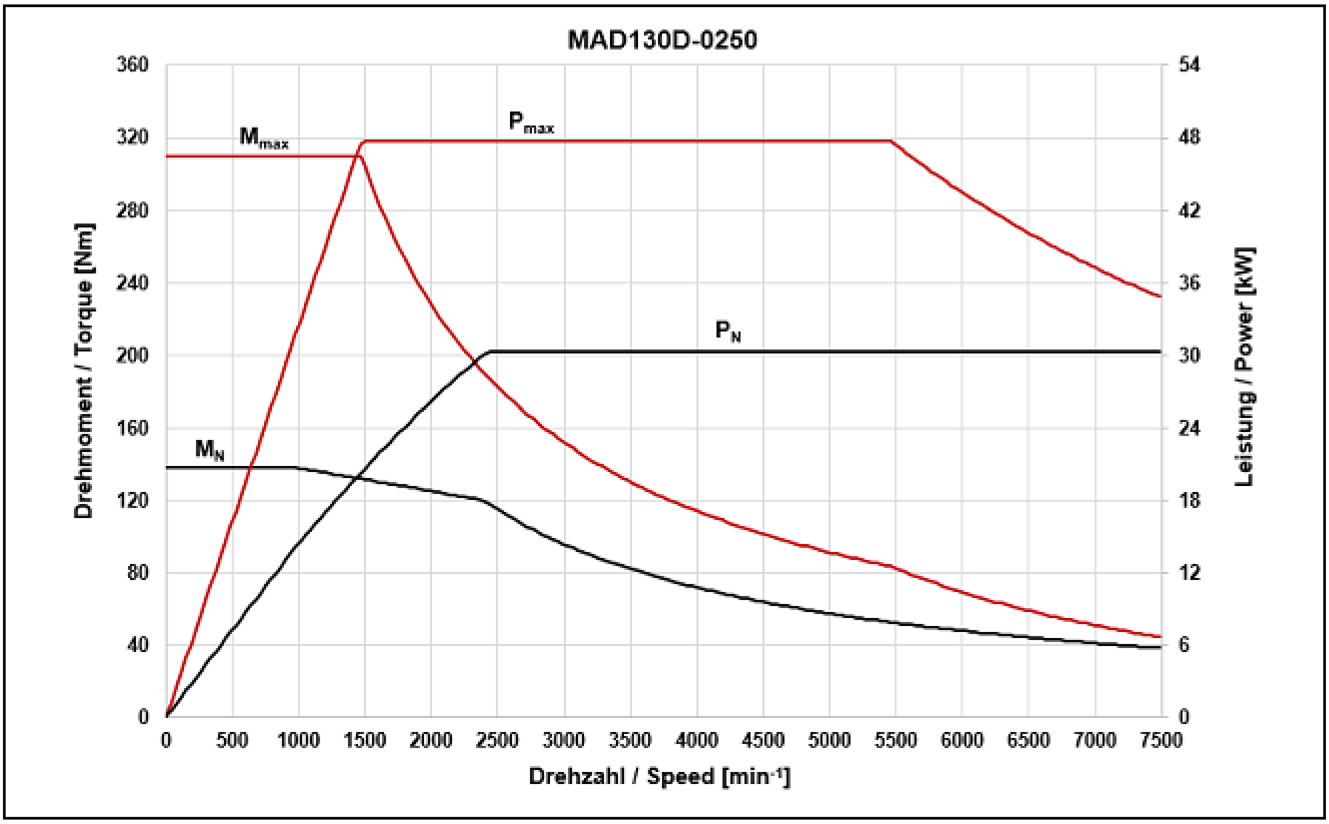


Fig. 4-36: Motor characteristic curve MAD130D-0250

4.4.7 Motor fan MAD130

Motor fan MAD130 - electrical data

Designation	Symbol	Unit	Value	
Voltage type		-	3~ AC	
Air flow direction		-	blowing	
Mean volume flow		m^3/h	350.0	
Nominal voltage	U_N	V	**400**	**480**
Nominal frequency	f	Hz	50 / 60	50 / 60
Fan current [1)]	I_N	A	0.21 / 0.26	0.28 / 0.25
Blocking current	I_{block}	A	0.64 / 0.6	0.76 / 0.73
Power consumption	S_N	VA	145 / 180	233 / 208
Latest amendment: 2017-12-07				

1) Fan current monitoring should start at I_N + 20%.

Tab. 4-9: Data sheet of motor fan MAD130

4.4.8 Holding Brake MAD/MAF130 (Optional)

Data sheet - holding brake MAD/MAF130

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	100.0	80.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	1.50	1.60
Holding brake moment of inertia	J_{br}	$kg*m^2$	0.003180	0.001710
Connection time	t_1	ms	110	50
Disconnection time	t_2	ms	65	140
Maximum holding brake speed	n_{Br_max}	min^{-1}	8,000	
Last revision: 2006-10-23				

Tab. 4-10: Technical data of holding brake MAD/MAF130 (optional)

4.5 Technical data MAD160

4.5.1 Data sheet MAD160B

Parameter[1)]	Symbol	Unit	MAD160B			
			0050	0100	0150	0200
Rated torque	M_N	Nm	220.0	200.0	190.0	160.0
Rated power	P_N	kW	11.50	20.94	29.80	33.50
Rated current	I_N	A	26.1	50.8	61.6	75.8
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	8000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000		
Maximum torque	M_{max}	Nm	483.9	490.0	440.1	375.3
Maximum power	P_{S6max}	kW	23.58	58.00	61.20	68.68
Maximum current	$I_{max(eff)}$	A	51.7	110.0	132.2	157.4
Continuous torque at standstill	M_{n1}	Nm	220.0		200.0	170.0
Continuous current at standstill	I_{n1}	A	26.1	53.7	64.0	80.9
Torque constant at 20 °C	K_{M_N}	Nm/A	9.66	4.44	3.37	2.54
Thermal time constant	T_{th_nom}	min	35.0			
Cycle duration (S6 - 44%)	T_C	min	10			
Discharge capacity of the component	C_{dis}	nF	25.5	35.0		34.4
Number of pole pairs	p	-	2			
Power wire cross-section	A	mm^2	4.0	10.0	16.0	25.0
Mass	m_{mot}	kg	201.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.2500000			
Sound pressure level	L_P	dB[A]	75 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class (EN 60034-1)	T.CL.	-	155			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-11: MAD160B - Technical data

Technical data

4.5.2 Motor characteristic curves MAD160B

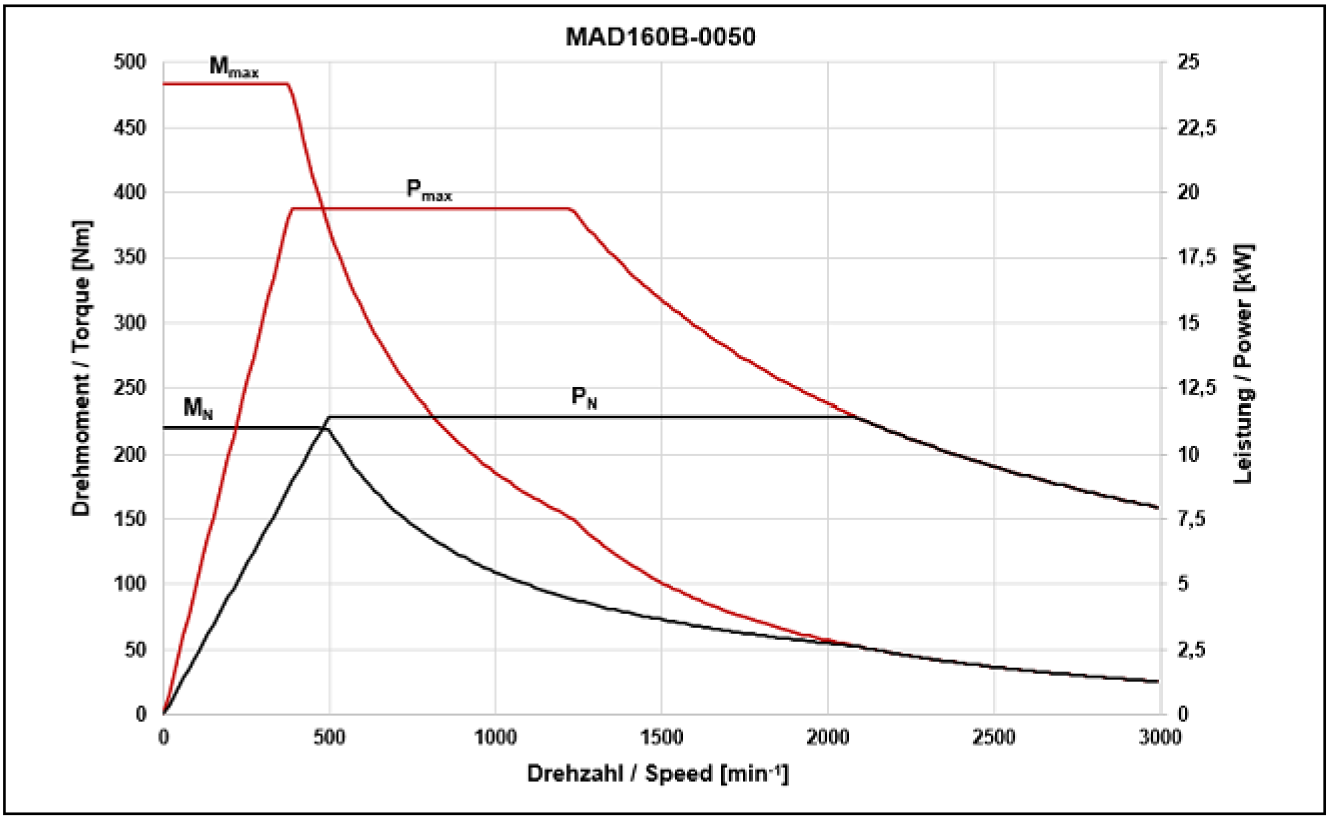


Fig. 4-37: Motor characteristic curve MAD160B-0050

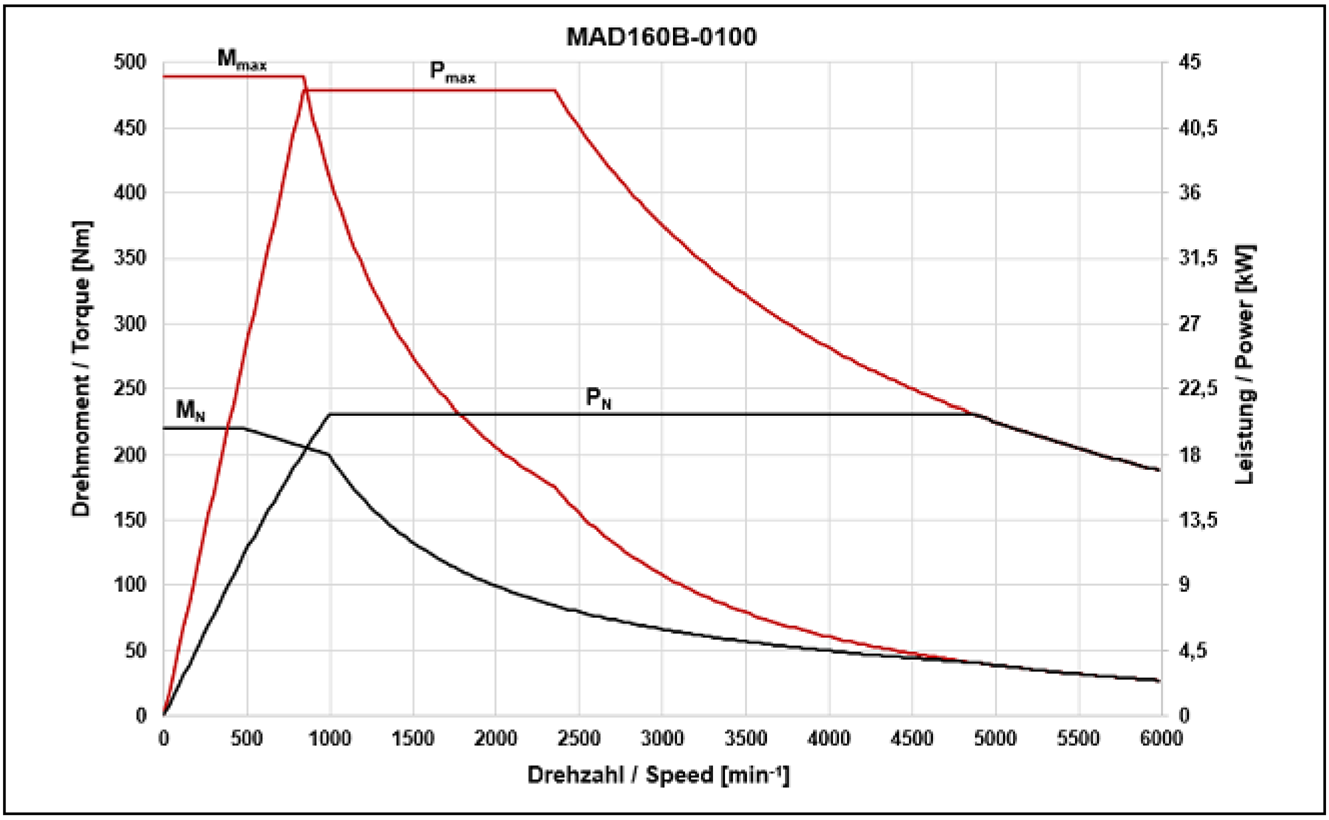


Fig. 4-38: Motor characteristic curve MAD160B-0100

Technical data

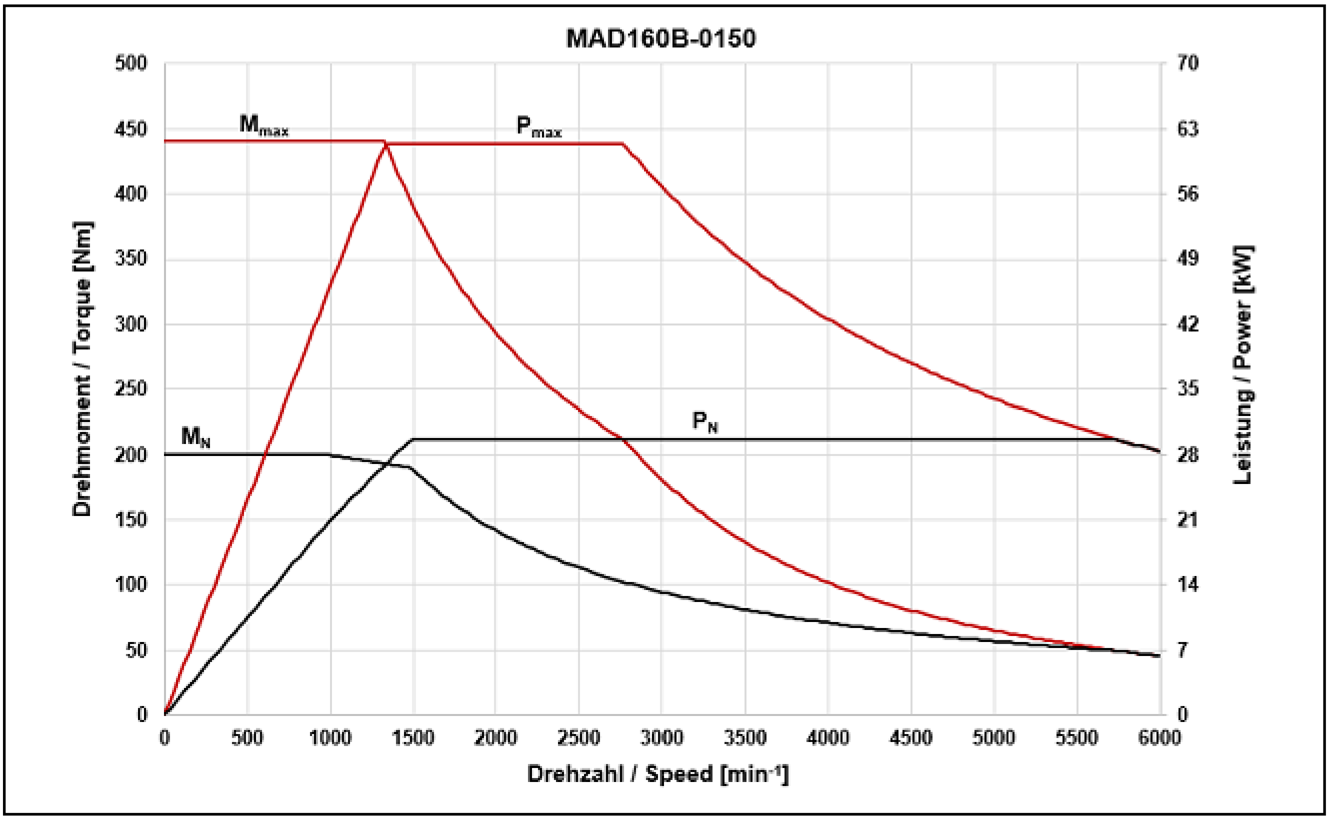


Fig. 4-39: Motor characteristic curve MAD160B-0150

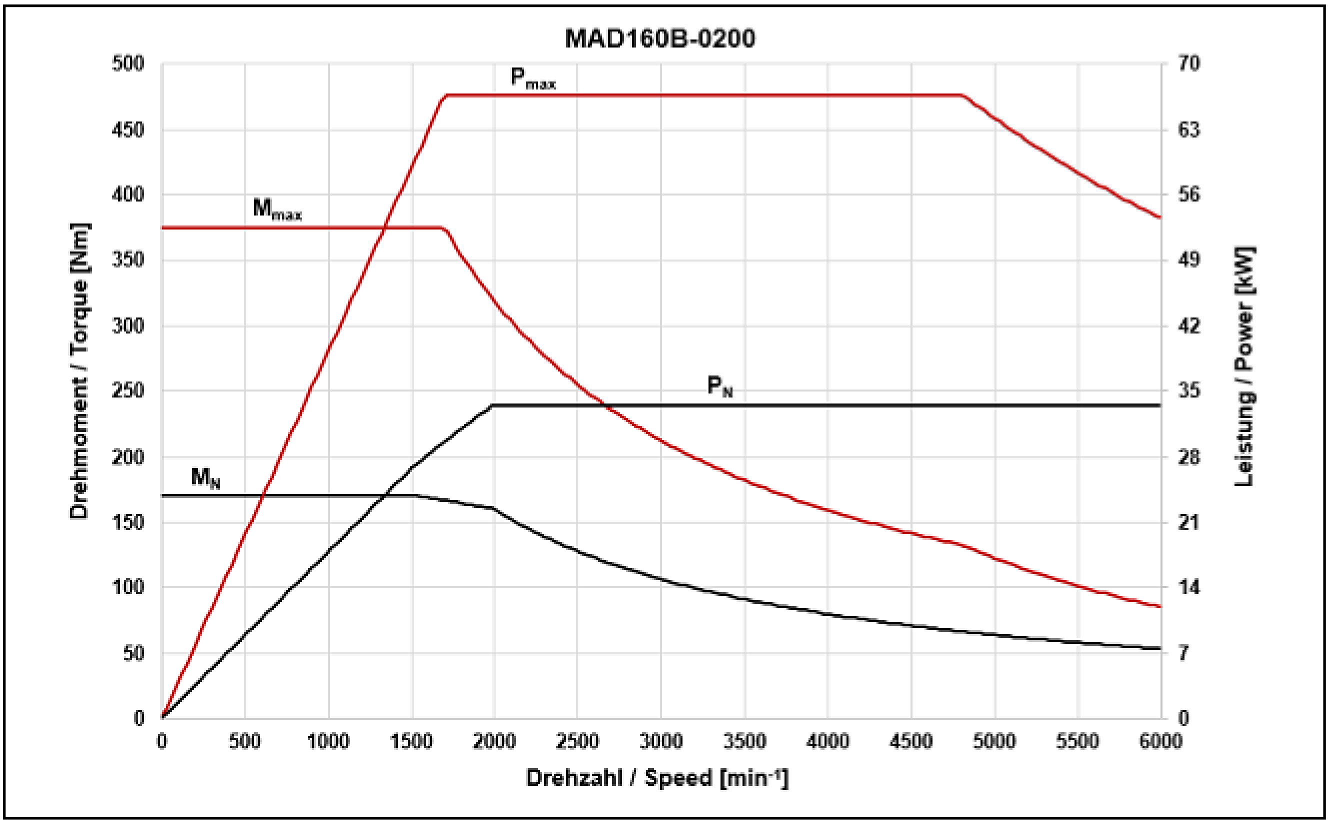


Fig. 4-40: Motor characteristic curve MAD160B-0200

Technical data

4.5.3 Data sheet MAD160C

Parameter[1)]	Symbol	Unit	MAD160C			
			0050	0100	0150	0200
Rated torque	M_N	Nm	240.0	225.0	215.0	210.0
Rated power	P_N	kW	12.60	23.56	33.80	44.00
Rated current	I_N	A	27.6	52.9	75.3	93.9
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	8000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000		
Maximum torque	M_{max}	Nm	528.2	530.0	496.0	494.2
Maximum power	P_{S6max}	kW	25.83	51.52	69.29	90.20
Maximum current	$I_{max(eff)}$	A	54.8	112.3	152.6	182.4
Continuous torque at standstill	M_{n1}	Nm	240.0		225.0	
Continuous current at standstill	I_{n1}	A	27.6	55.7	77.8	93.9
Torque constant at 20 °C	K_{M_N}	Nm/A	9.95	4.95	3.36	2.63
Thermal time constant	T_{th_nom}	min	15.0			
Cycle duration (S6 - 44%)	T_C	min	10	1	10	
Discharge capacity of the component	C_{dis}	nF	28.0	25.7	27.2	32.3
Number of pole pairs	p	-	2			
Power wire cross-section	A	mm^2	4.0	10.0	25.0	
Mass	m_{mot}	kg	238.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.3110000			
Sound pressure level	L_P	dB[A]	75 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class (EN 60034-1)	T.CL.	-	155			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-12: MAD160C - Technical data

4.5.4 Motor characteristic curves MAD160C

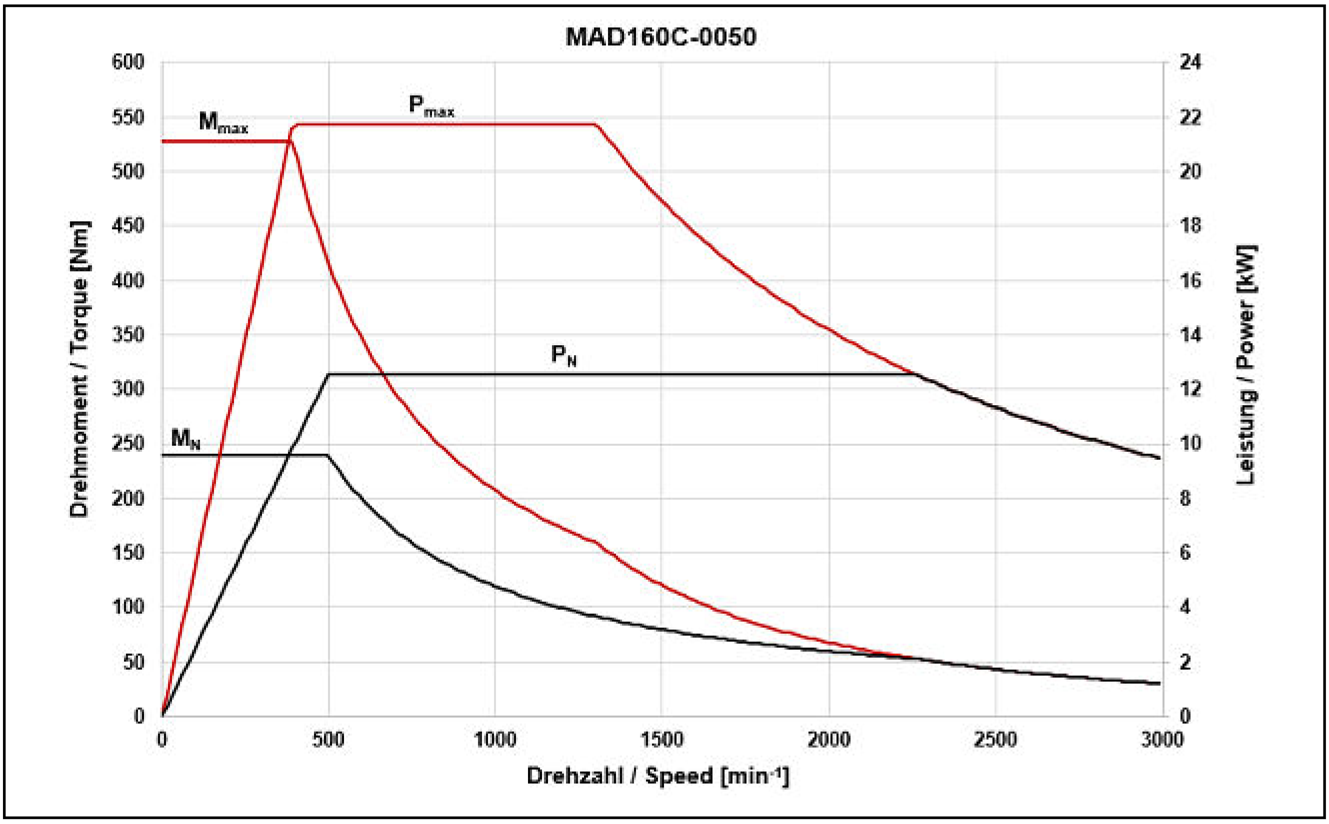


Fig. 4-41: Motor characteristic curve MAD160C-0050

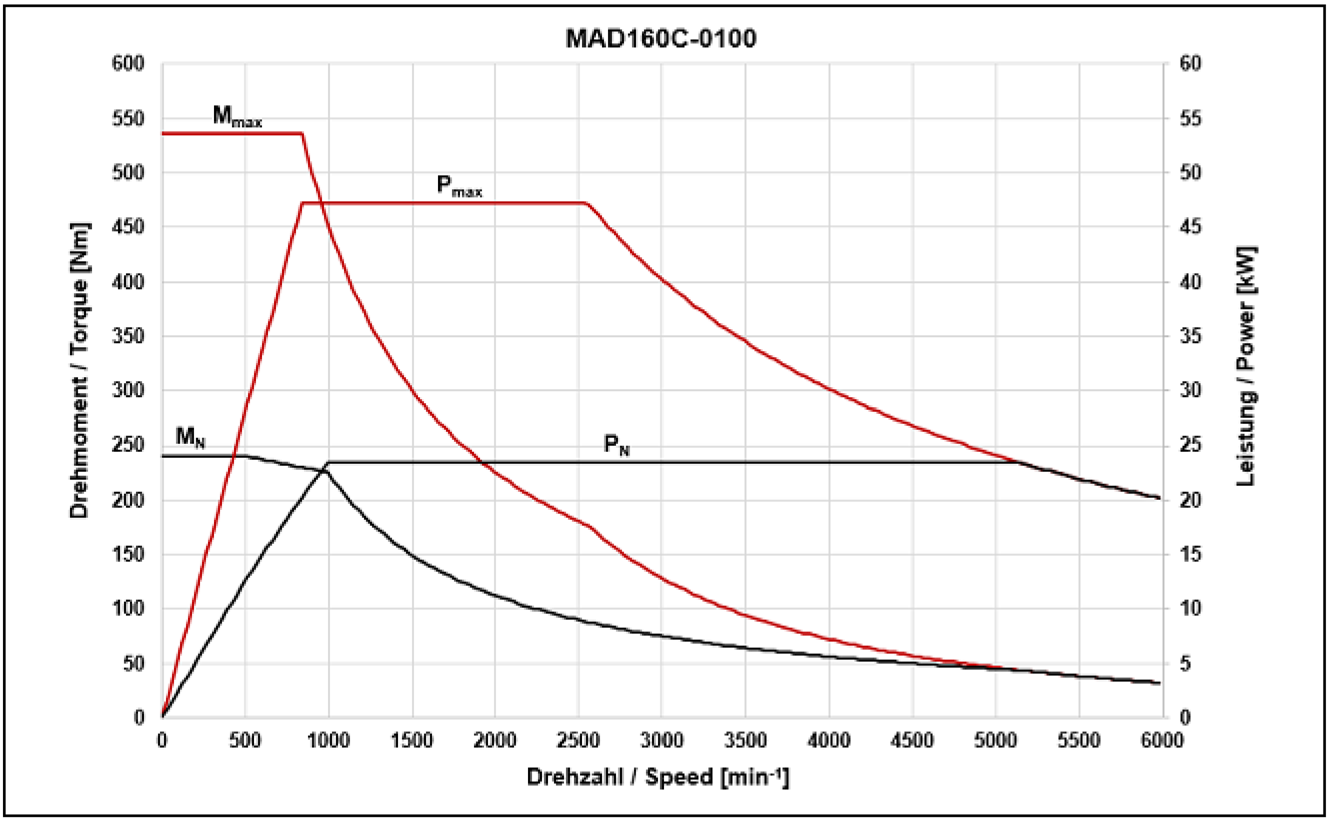


Fig. 4-42: Motor characteristic curve MAD160C-0100

Technical data

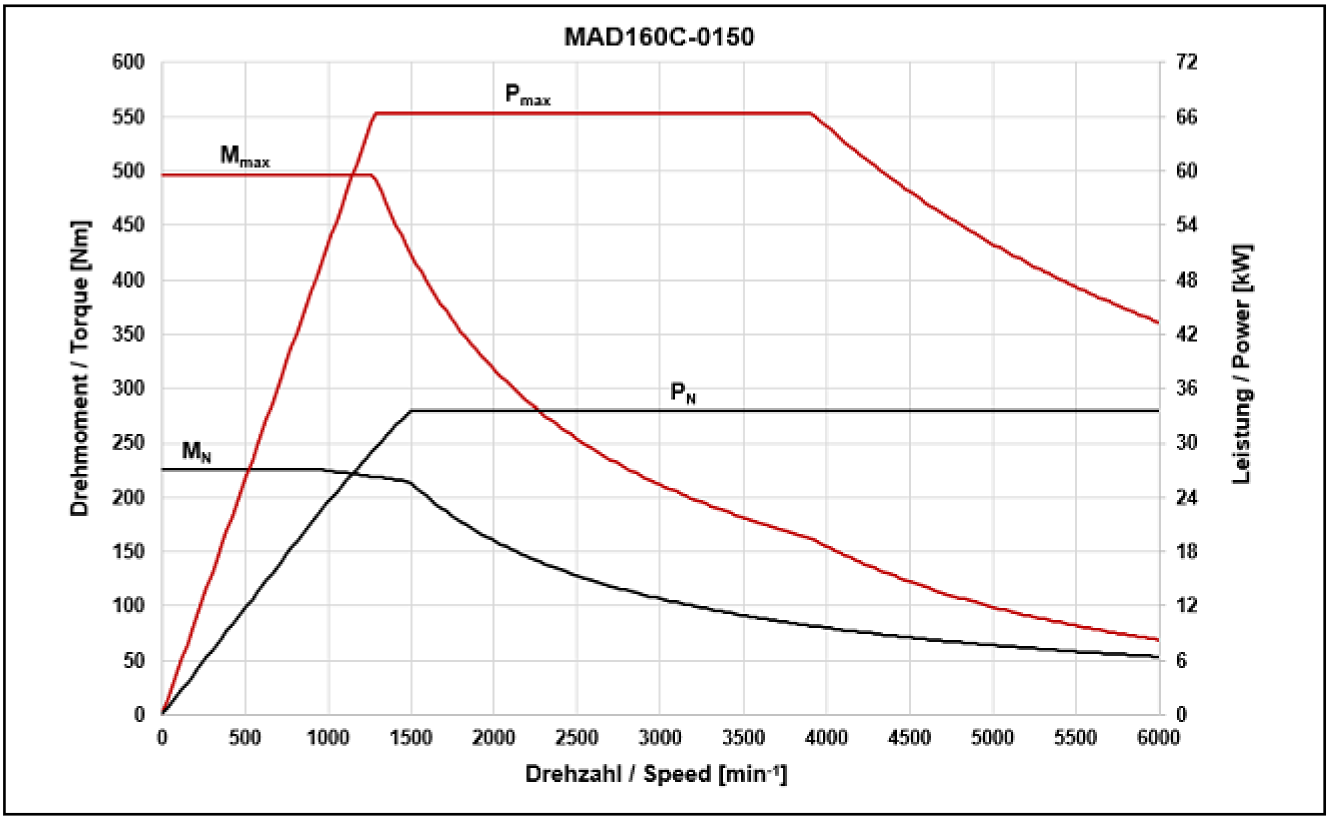


Fig. 4-43: Motor characteristic curve MAD160C-0150

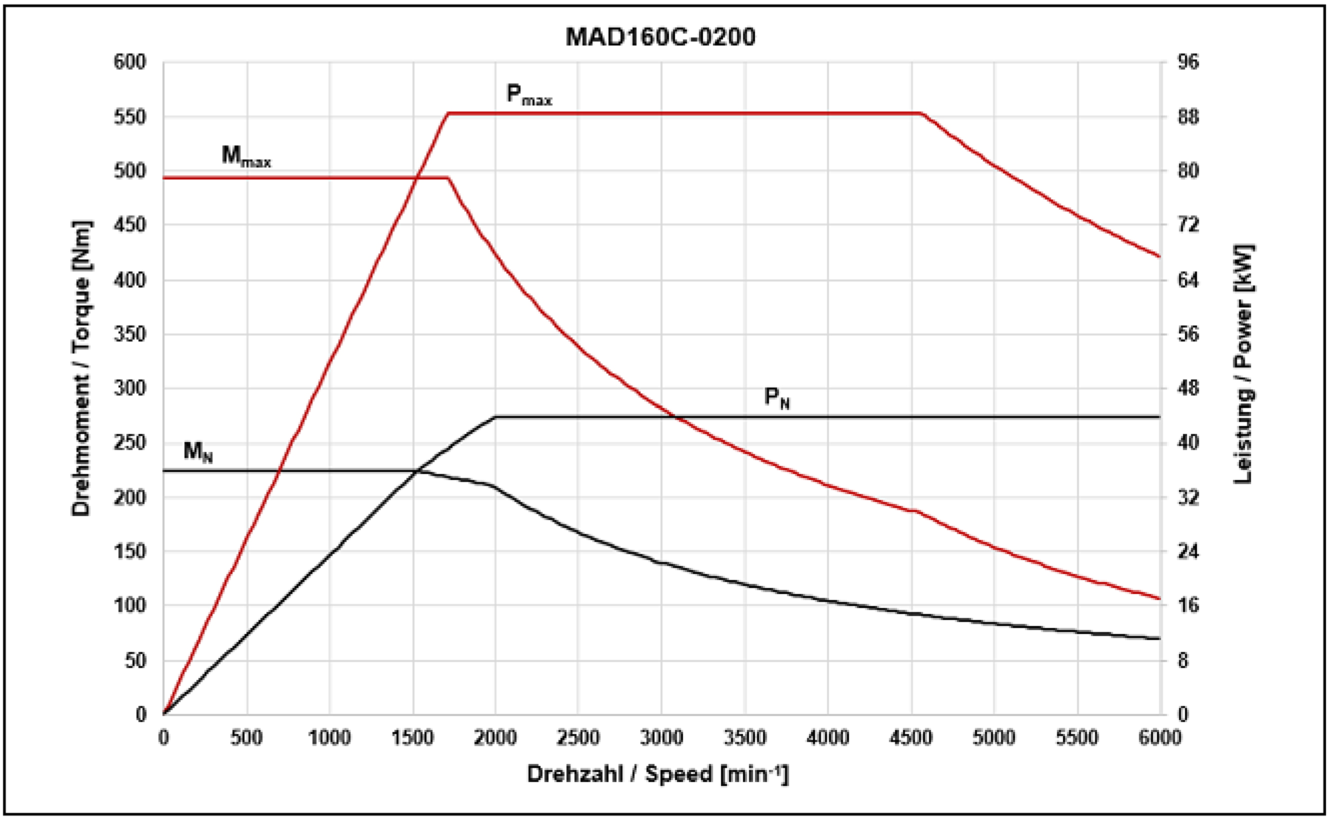


Fig. 4-44: Motor characteristic curve MAD160C-0200

4.5.5 Motor fan MAD160

Motor fan MAD160 - electrical data

Designation	Symbol	Unit	Value	
Voltage type		-	3~ AC	
Air flow direction		-	blowing	
Mean volume flow		m^3/h	520.0	
Nominal voltage	U_N	V	**400**	**480**
Nominal frequency	f	Hz	50 / 60	50 / 60
Fan current [1)]	I_N	A	0.21 / 0.26	0.28 / 0.25
Blocking current	I_{block}	A	0.64 / 0.6	0.76 / 0.73
Power consumption	S_N	VA	145 / 180	233 / 208
Latest amendment: 2017-12-07				

1) Fan current monitoring should start at I_N + 20%.

Tab. 4-13: Data sheet of motor fan MAD160

4.5.6 Holding Brake MAD/MAF160 (Optional)

Data sheet - holding brake MAD/MAF160

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 3 (MAD only) Electrically releasing, reinforced design	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	100.0	240.0	100.0
Rated voltage	U_N	V	24		
Rated current	I_N	A	1.80	1.87	2.00
Holding brake moment of inertia	J_{br}	$kg*m^2$	0.005010	0.018800	0.005300
Connection time	t_1	ms	85	130	70
Disconnection time	t_2	ms	100	300	190
Maximum holding brake speed	n_{Br_max}	min^{-1}	8,000	6,000	8,000
Last revision: 2006-10-23					

Tab. 4-14: Technical data of holding brake MAD/MAF160 (optional)

4.6 Technical data MAD180

4.6.1 Data sheet MAD180C

Parameter[1]	Symbol	Unit	MAD180C			
			0050	0100	0150	0200
Rated torque	M_N	Nm	325.0	300.0	270.0	250.0
Rated power	P_N	kW	17.00	31.40	42.40	52.40
Rated current	I_N	A	38.2	69.0	88.6	104.6
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	5000		
Maximum torque	M_{max}	Nm	715.5	726.4	681.0	594.4
Maximum power	P_{S6max}	kW	34.85	64.37	86.92	107.42
Maximum current	$I_{max(eff)}$	A	76.6	147.6	182.1	221.7
Continuous torque at standstill	M_{n1}	Nm	325.0	330.0	300.0	270.0
Continuous current at standstill	I_{n1}	A	38.2	75.0	91.0	110.0
Torque constant at 20 °C	K_{M_N}	Nm/A	10.00	5.19	3.47	2.71
Thermal time constant	T_{th_nom}	min	45.0			
Cycle duration (S6 - 44%)	T_C	min	10			
Discharge capacity of the component	C_{dis}	nF	29.2	25.2	28.3	31.6
Number of pole pairs	p	-	2			
Power wire cross-section	A	mm^2	6.0	16.0	25.0	35.0
Mass	m_{mot}	kg	334.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.4580000			
Sound pressure level	L_P	dB[A]	78 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class (EN 60034-1)	T.CL.	-	155			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-15: MAD180C - Technical data

4.6.2 Motor characteristic curves MAD180C

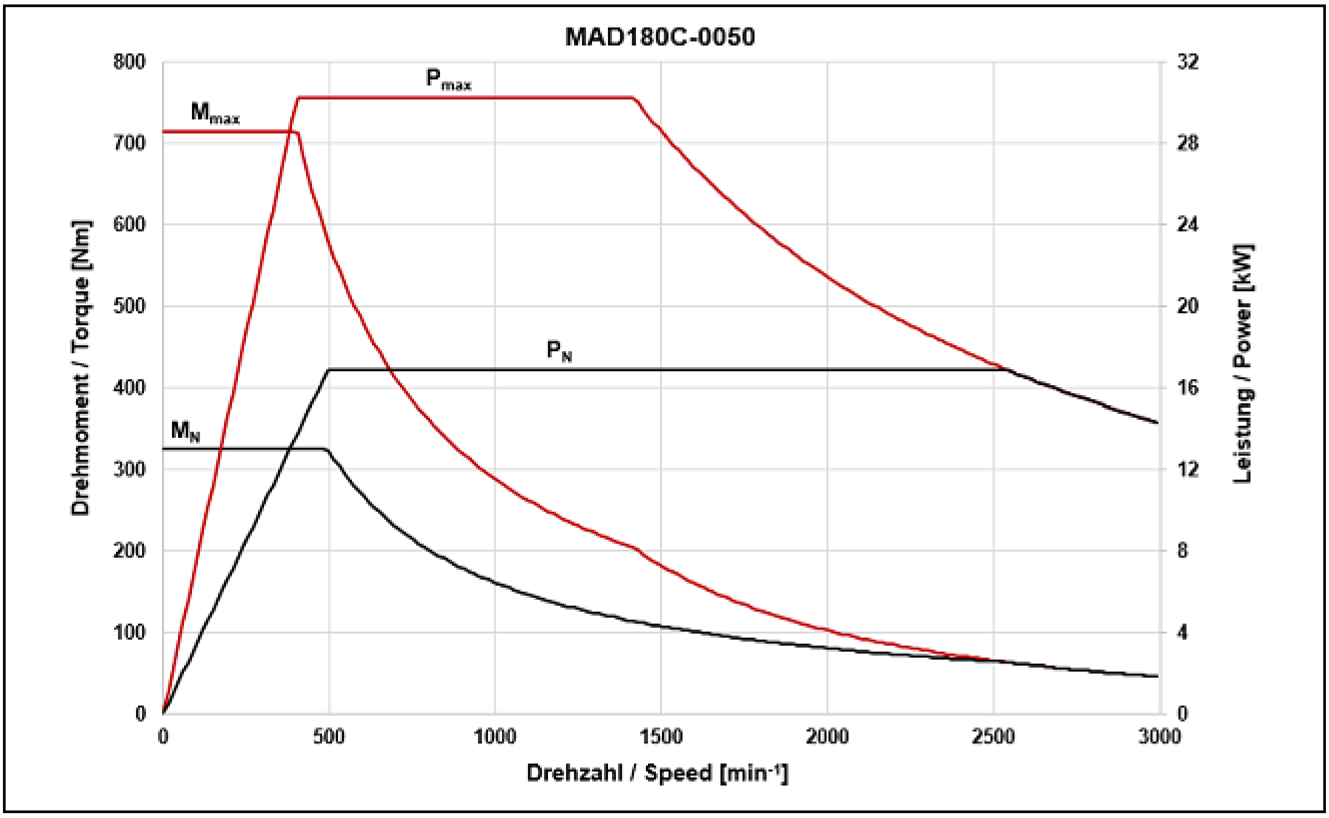


Fig. 4-45: Motor characteristic curve MAD180C-0050

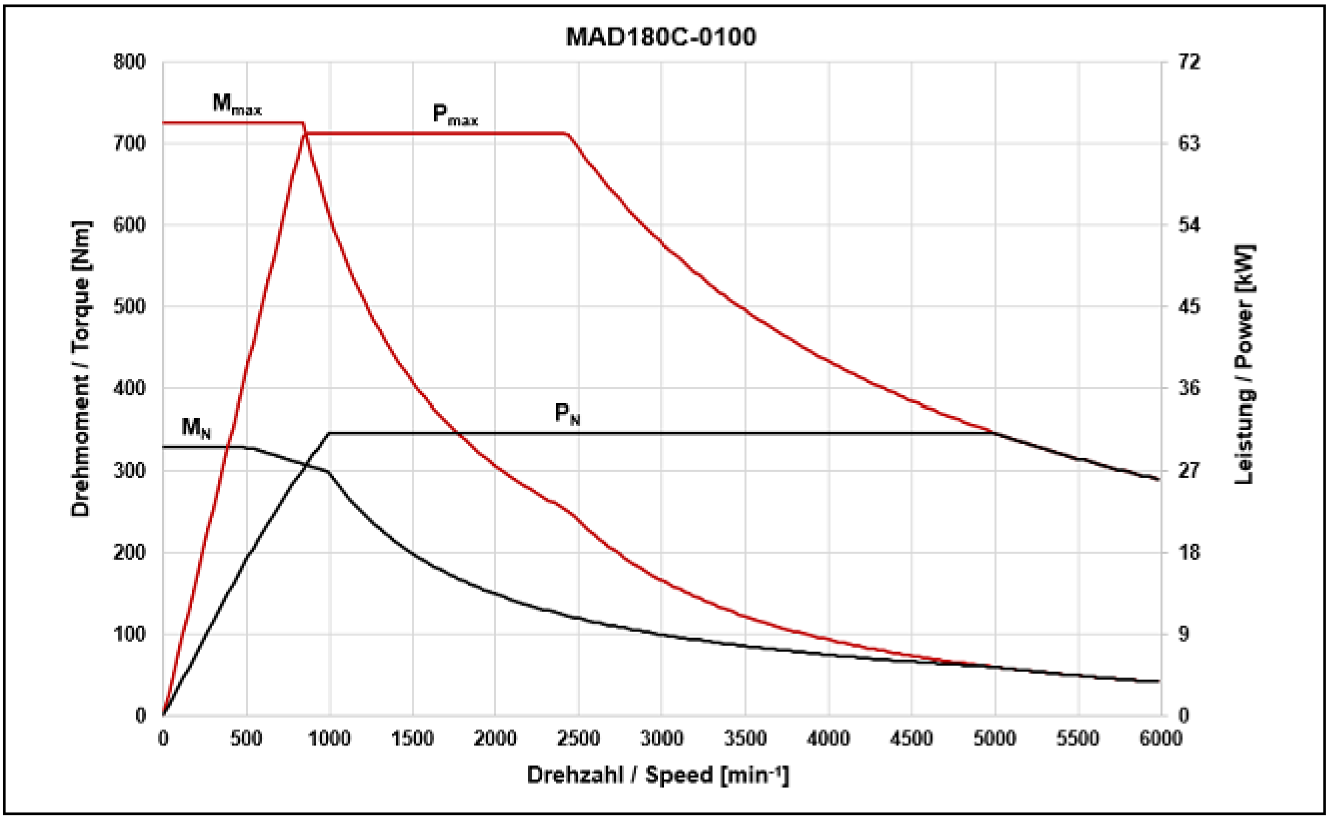


Fig. 4-46: Motor characteristic curve MAD180C-0100

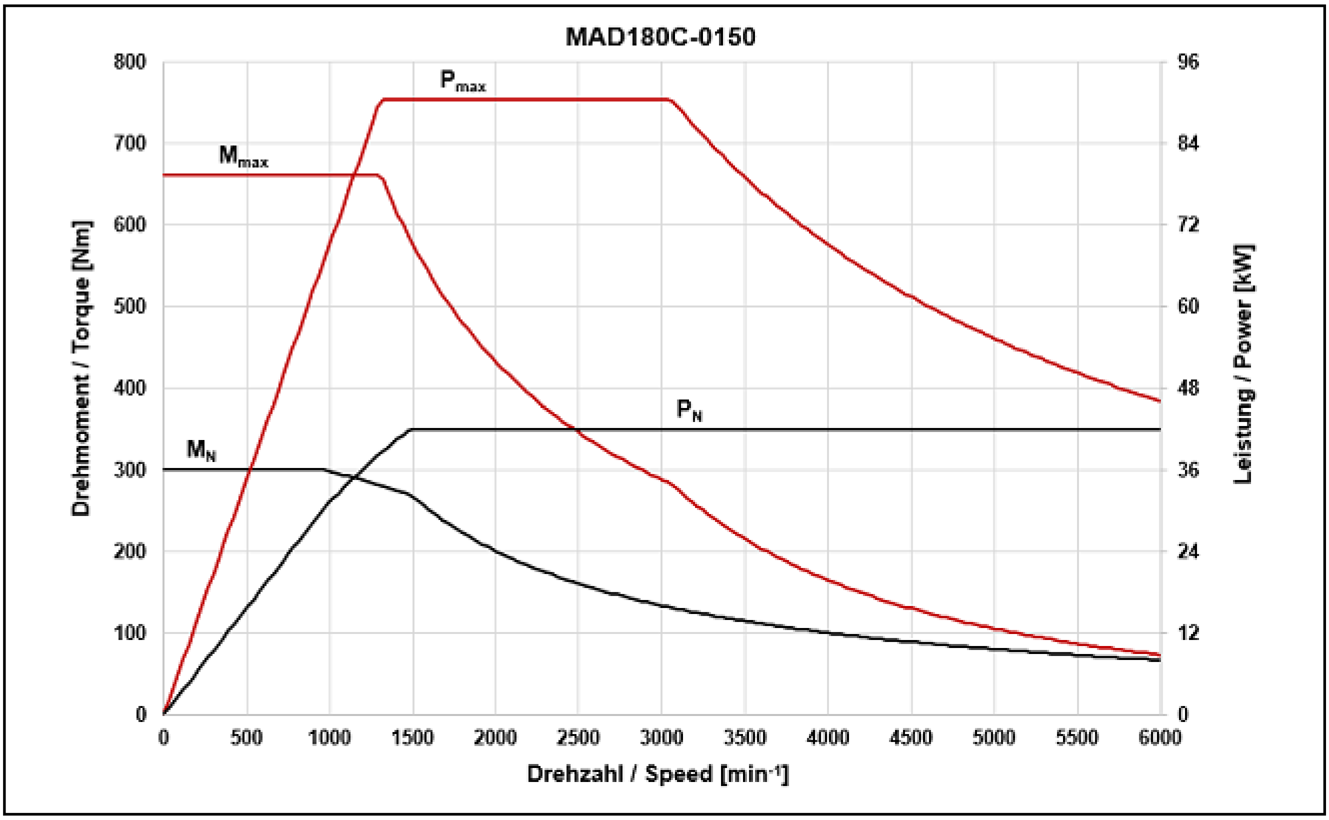


Fig. 4-47: Motor characteristic curve MAD180C-0150

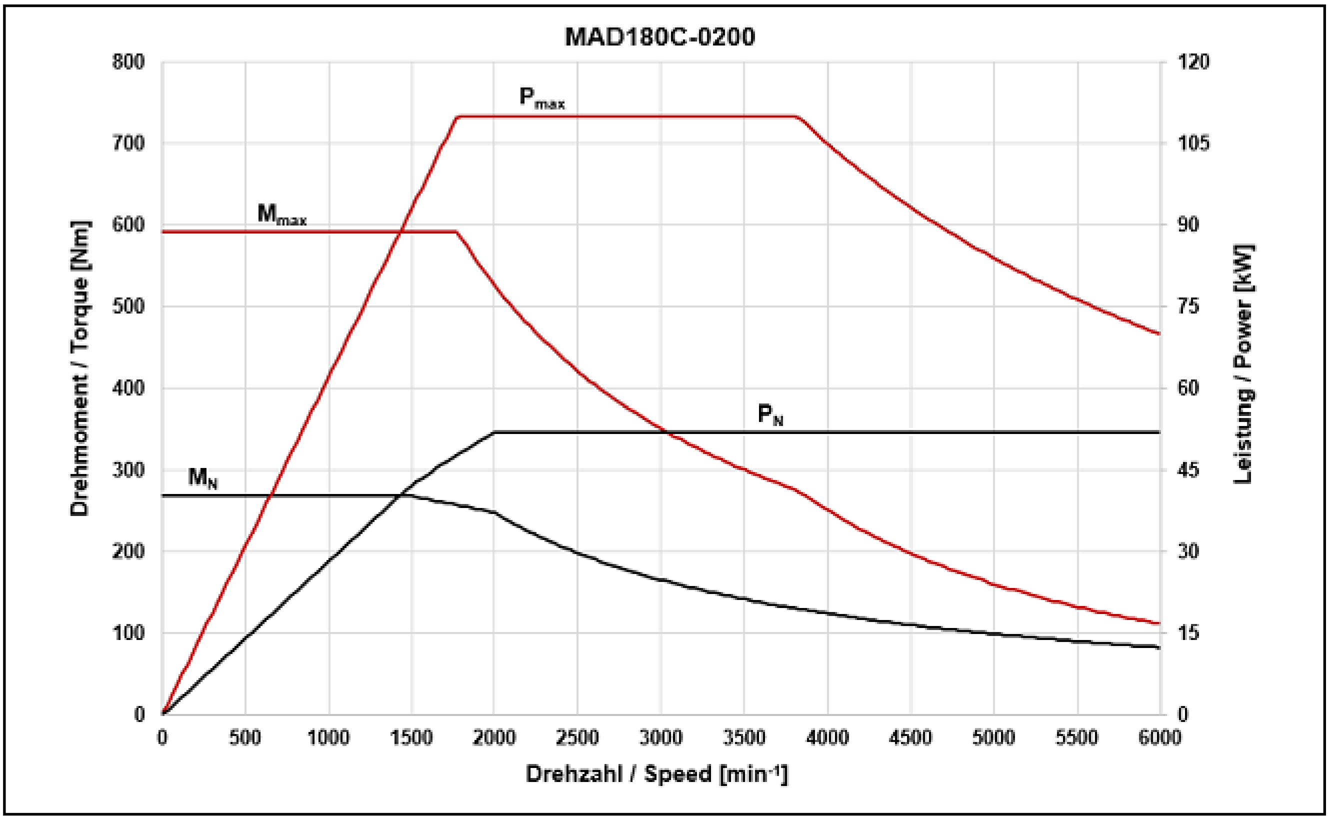


Fig. 4-48: Motor characteristic curve MAD180C-0200

4.6.3 Data sheet MAD180D

Parameter[1)]	Symbol	Unit	MAD180D			
			0050	0100	0150	0200
Rated torque	M_N	Nm	390.0	370.0	340.0	300.0
Rated power	P_N	kW	20.40	38.70	53.40	62.80
Rated current	I_N	A	39.7	82.4	107.4	117.4
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	5000		
Maximum torque	M_{max}	Nm	857.8	901.5	794.0	768.2
Maximum power	P_{S6max}	kW	41.82	79.34	109.48	128.74
Maximum current	$I_{max(eff)}$	A	78.4	188.0	220.8	269.7
Continuous torque at standstill	M_{n1}	Nm	390.0	410.0	370.0	330.0
Continuous current at standstill	I_{n1}	A	39.7	90.0	112.3	132.6
Torque constant at 20 °C	K_{M_N}	Nm/A	11.31	5.66	3.72	2.92
Thermal time constant	T_{th_nom}	min	45.0			
Cycle duration (S6 - 44%)	T_C	min	10			
Discharge capacity of the component	C_{dis}	nF	38.0	38.4	35.9	38.0
Number of pole pairs	p	-	2			
Power wire cross-section	A	mm^2	10.0	25.0	35.0	2 x 25.0
Mass	m_{mot}	kg	403.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.5940000			
Sound pressure level	L_P	dB[A]	78 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class (EN 60034-1)	T.CL.	-	155			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-16: MAD180D - Technical data

Technical data

4.6.4 Motor characteristic curves MAD180D

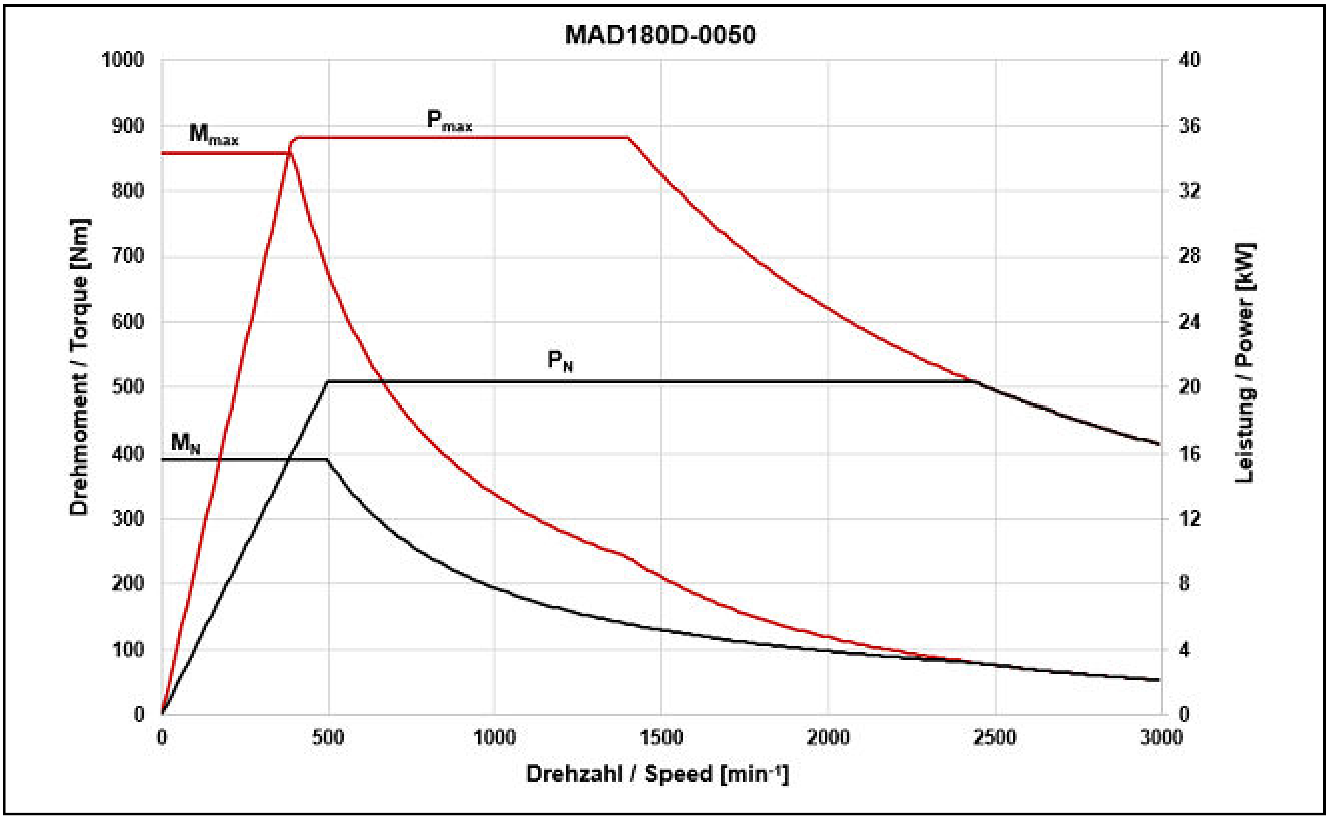


Fig. 4-49: Motor characteristic curve MAD180D-0050

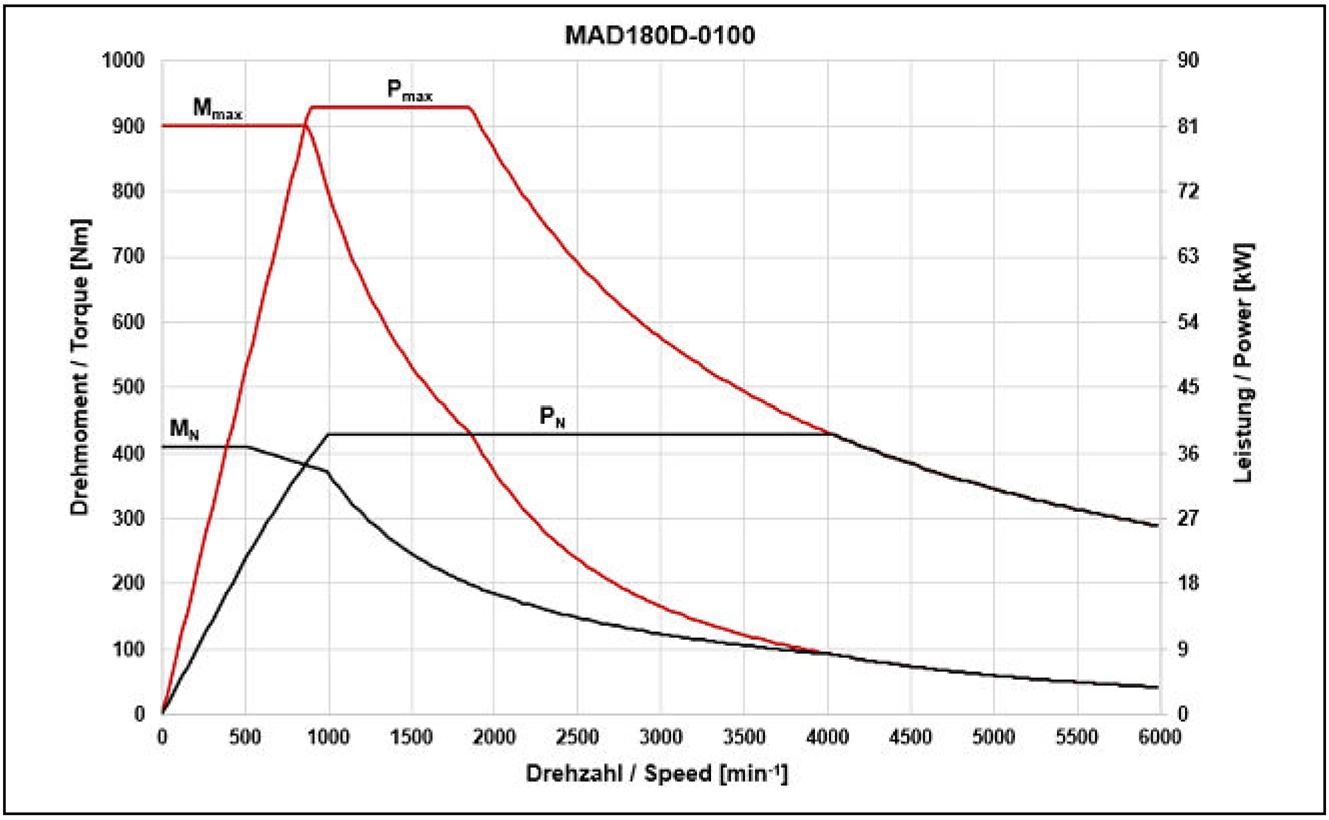


Fig. 4-50: Motor characteristic curve MAD180D-0100

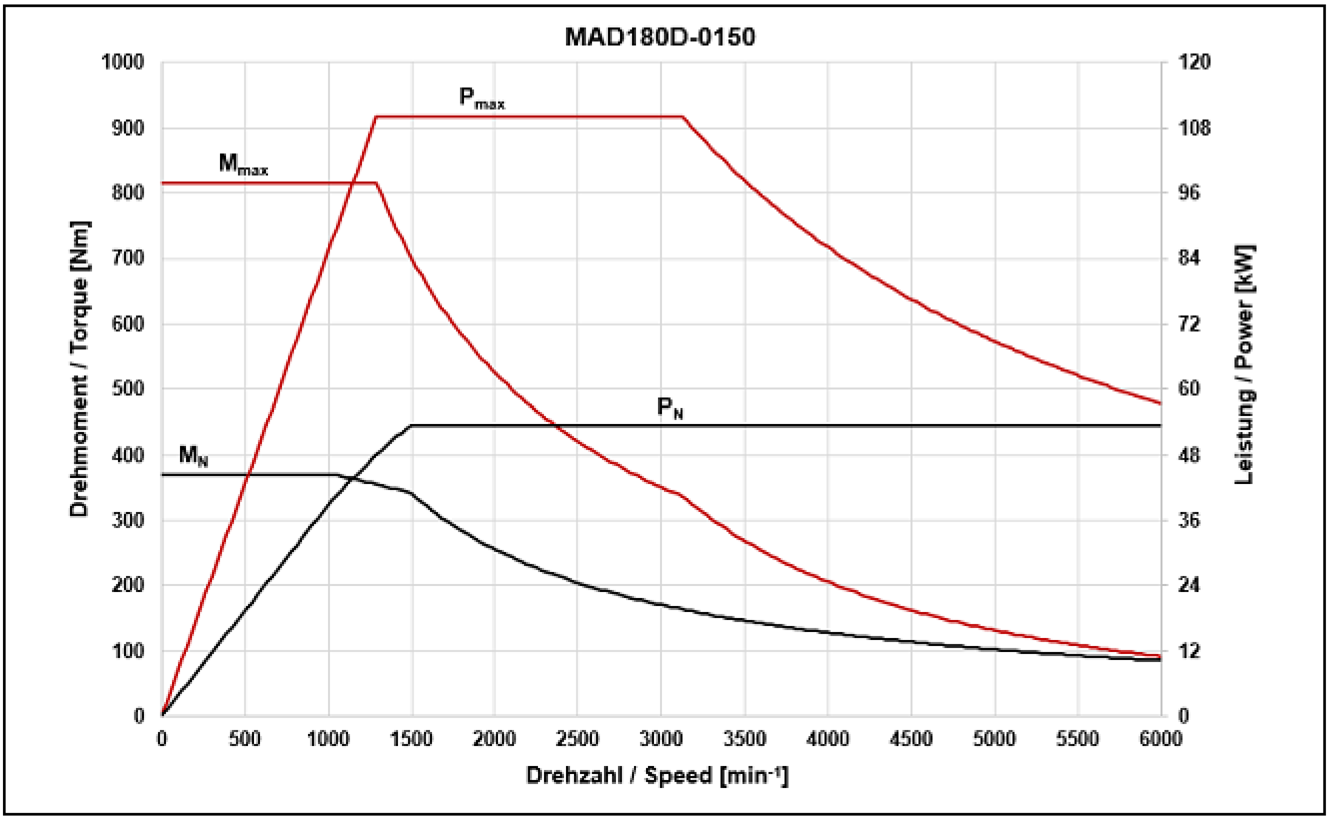


Fig. 4-51: Motor characteristic curve MAD180D-0150

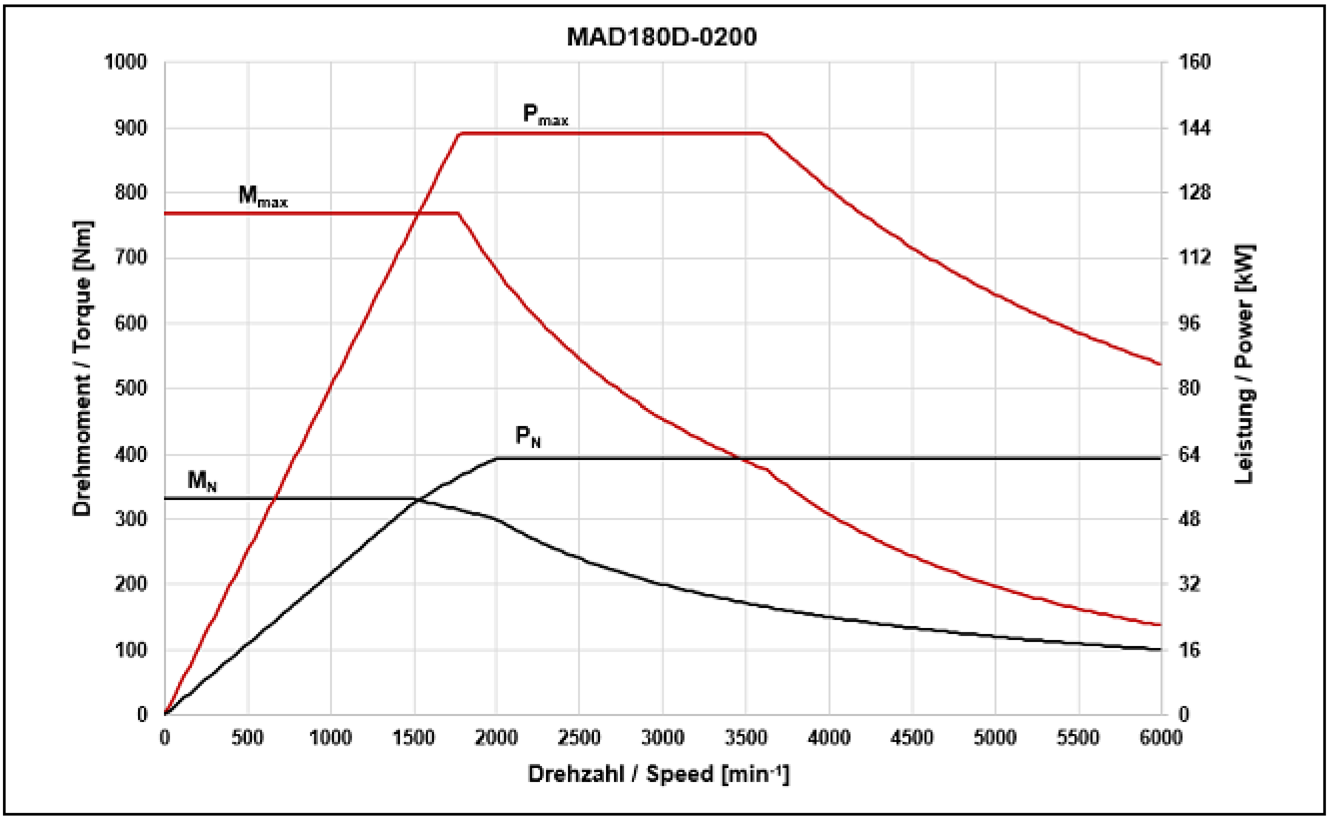


Fig. 4-52: Motor characteristic curve MAD180D-0200

4.6.5 Motor fan MAD180

Motor fan MAD180 - electrical data

Designation	Symbol	Unit	Value	
Voltage type		-	3~ AC	
Air flow direction		-	blowing	
Mean volume flow		m^3/h	700.0	
Nominal voltage	U_N	V	**400**	**480**
Nominal frequency	f	Hz	50 / 60	50 / 60
Fan current 1)	I_N	A	0.40 / 0.52	0.53 / 0.48
Blocking current	I_{block}	A	1.70 / 1.63	2.0 / 1.93
Power consumption	S_N	VA	277 / 360	440 / 399
Latest amendment: 2017-12-07				

1) Fan current monitoring should start at I_N + 20%.

Tab. 4-17: Data sheet of motor fan MAD180

4.6.6 Holding Brake MAD/MAF180 (Optional)

Data sheet - holding brake MAD/MAF180

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 2 Electrically releasing
Holding torque	M_4	Nm	300.0	240.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	2.00	1.87
Holding brake moment of inertia	J_{br}	$kg*m^2$	0.018800	
Connection time	t_1	ms	150	130
Disconnection time	t_2	ms	90	300
Maximum holding brake speed	n_{Br_max}	min^{-1}	6,000	
Last revision: 2006-10-20				

Tab. 4-18: Technical data of holding brake MAD/MAF180 (optional)

4.7 Technical data MAD225

4.7.1 Data sheet MAD225C

Parameter[1)]	Symbol	Unit	MAD225C		
			0050	0100	0150
Rated torque	M_N	Nm	660.0	640.0	593.0
Rated power	P_N	kW	34.56	67.00	93.10
Rated current	I_N	A	72.0	121.0	174.0
Rated speed	n_N	min^{-1}	500	1000	1500
Key speed	n_1	min^{-1}	500		1000
Maximum speed with bearing N	n_{max}	min^{-1}	3000	3750	
Maximum speed with bearing V	n_{max}	min^{-1}	3000	3750	
Maximum torque	M_{max}	Nm	1450.0		
Maximum power	P_{S6max}	kW	70.84	137.39	190.70
Maximum current	$I_{max(eff)}$	A	151.9	265.9	376.3
Continuous torque at standstill	M_{n1}	Nm	660.0	680.0	660.0
Continuous current at standstill	I_{n1}	A	72.0	126.3	187.0
Torque constant at 20 °C	K_{M_N}	Nm/A	10.22	5.98	3.90
Thermal time constant	T_{th_nom}	min	45.0		
Cycle duration (S6 - 44%)	T_C	min	5		
Discharge capacity of the component	C_{dis}	nF	120.0	48.5	126.0
Number of pole pairs	p	-	2		
Power wire cross-section	A	mm^2	25.0	2 x 25.0	2 x 35.0
Mass	m_{mot}	kg	610.0		
Moment of inertia of the rotor	J_{rot}	kg * m²	1.6500000		
Sound pressure level	L_P	dB[A]	78 (+3)		
Surrounding air temperature during operation	T_{amb}	°C	0...+40		
Thermal class (EN 60034-1)	T.CL.	-	155		

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-19: MAD225C - Technical data

4.7.2 Motor characteristic curves MAD225C

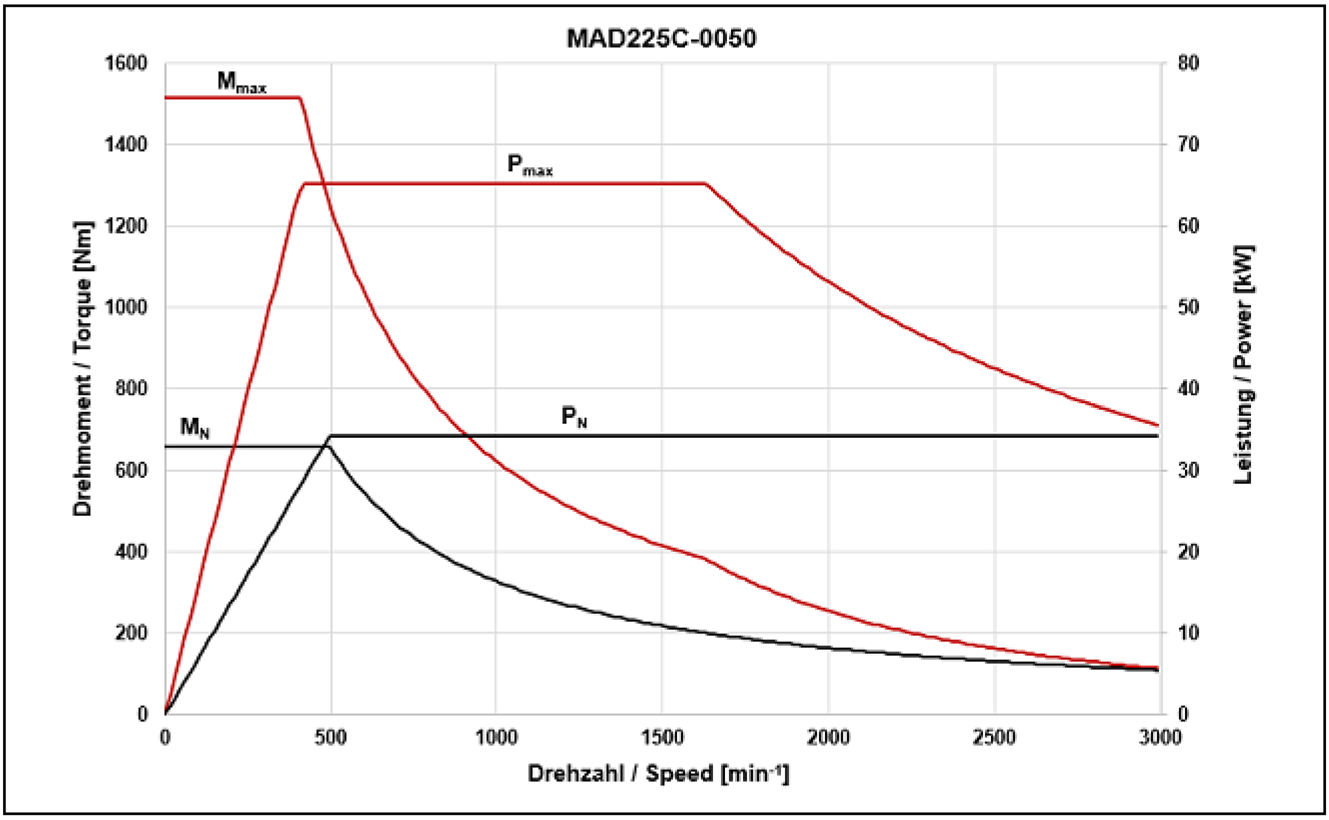


Fig. 4-53: Motor characteristic curve MAD225C-0050

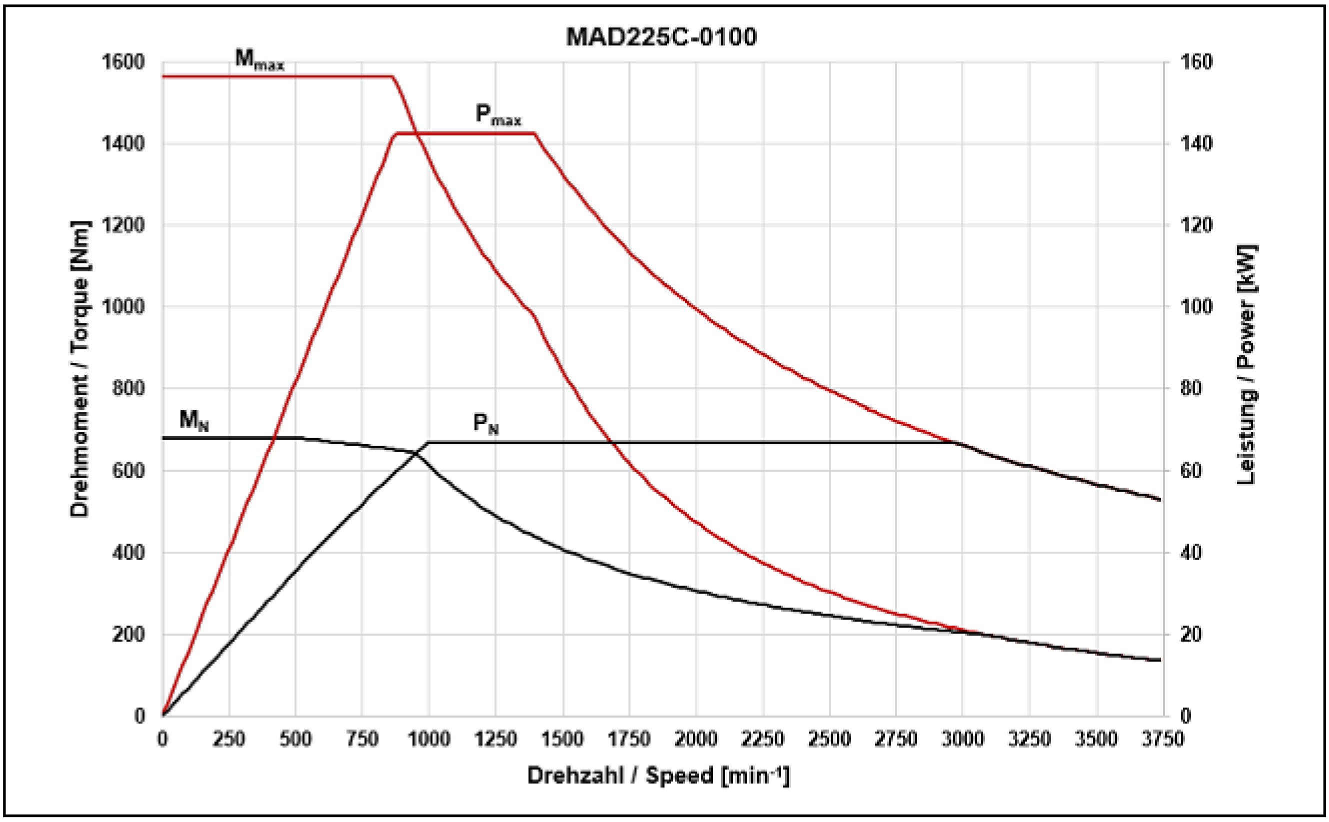


Fig. 4-54: Motor characteristic curve MAD225C-0100

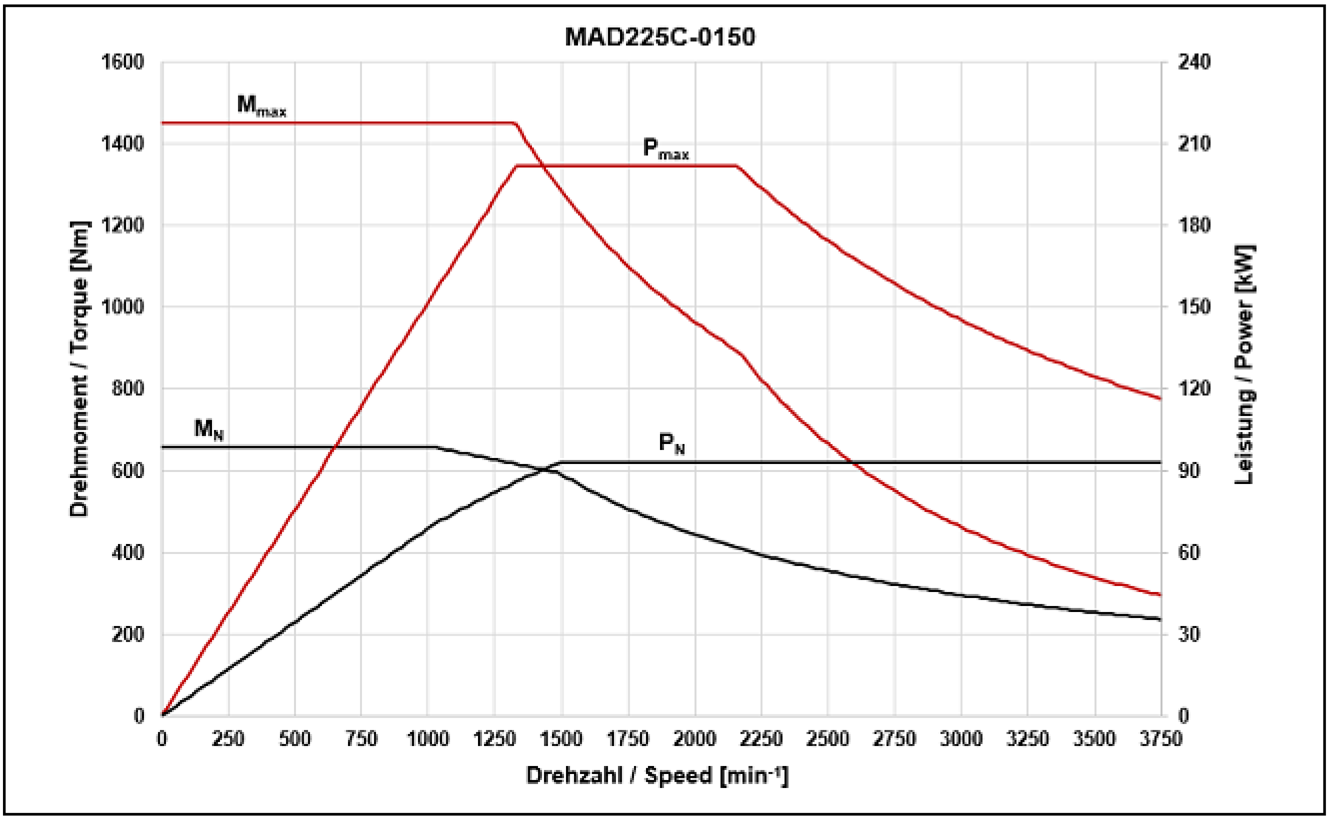


Fig. 4-55: Motor characteristic curve MAD225C-0150

4.7.3 Motor fan MAD225

Motor fan MAD225 - electrical data

Designation	Symbol	Unit	Value	
Voltage type		-	3~ AC	
Air flow direction		-	blowing	
Mean volume flow		m^3/h	700.0	
Nominal voltage	U_N	V	400	480
Nominal frequency	f	Hz	50 / 60	50 / 60
Fan current [1)]	I_N	A	0.35 / 0.49	0.38 / 0.45
Blocking current	I_{block}	A	1.13 / 1.02	1.38 / 1.25
Power consumption	S_N	VA	242 / 339	316 / 374
Latest amendment: 2017-12-07				

1) Fan current monitoring should start at I_N + 20%.

Tab. 4-20: Data sheet of motor fan MAD225

4.8 Technical data MAF100

4.8.1 Data sheet MAF100B

Parameter	Symbol	Unit	MAF100B				
			0050	0100	0150	0200	0250
Rated torque [1)]	M_N	Nm	50.0	46.0	42.0	38.0	33.0
Rated power	P_N	kW	2.60	4.82	6.60	8.00	8.64
Rated current	I_N	A	8.5	15.2	18.1	23.9	26.0
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	109.7	110.0	101.4	92.4	83.6
Maximum power	P_{S6max}	kW	5.33	9.88	13.53	16.40	17.71
Maximum current	$I_{max(eff)}$	A	20.3	33.3	46.2	51.7	50.7
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Continuous torque at standstill	M_{n1}	Nm	49.9	47.0	46.1	42.0	38.0
Continuous current at standstill	I_{n1}	A	9.9	15.4	22.7	25.8	26.0
Torque constant at 20 °C	K_{M_N}	Nm/A	6.68	3.42	2.76	1.84	1.49
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	2				
Discharge capacity of the component	C_{dis}	nF	6.0	6.6	6.0		
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	1.5		2.5	4.0	
Mass	m_{mot}	kg	38.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0190000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	1.00	1.15	1.18	1.20	1.25
Coolant inlet temperature	T_{in}	°C	10 ... 40				
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				

Parameter	Symbol	Unit	MAF100B				
			0050	0100	0150	0200	0250
Pressure loss at Q_{min}	Δp	bar	0.2		0.3		
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.10				
Necessary coolant flow at P_V	Q_{min}	l/min	1.4	1.6	1.7		1.8
Volume of coolant duct	V_{cool}	l	0.06				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-21: MAF100B - Technical data

4.8.2 Motor characteristic curves MAF100B

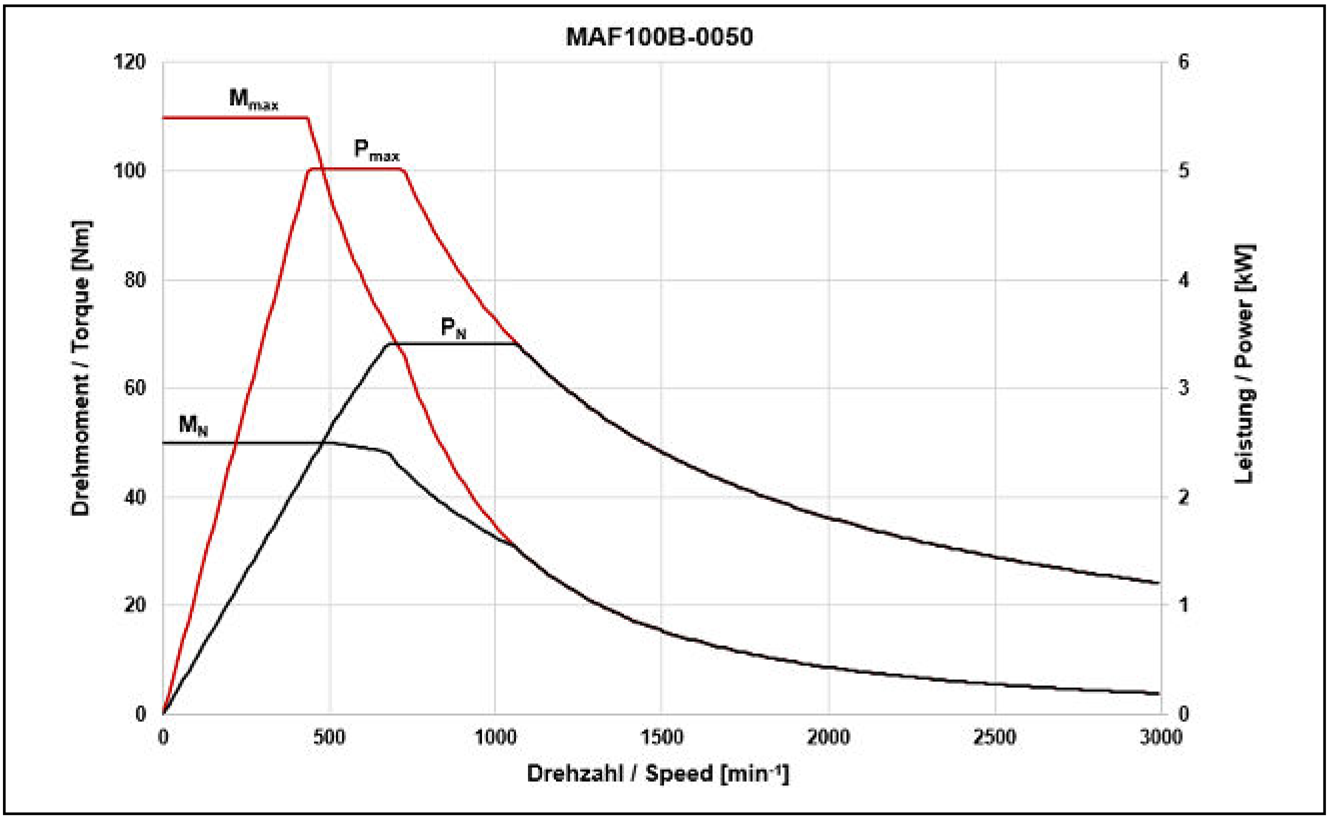


Fig. 4-56: Motor characteristic curve MAF100B-0050

Technical data

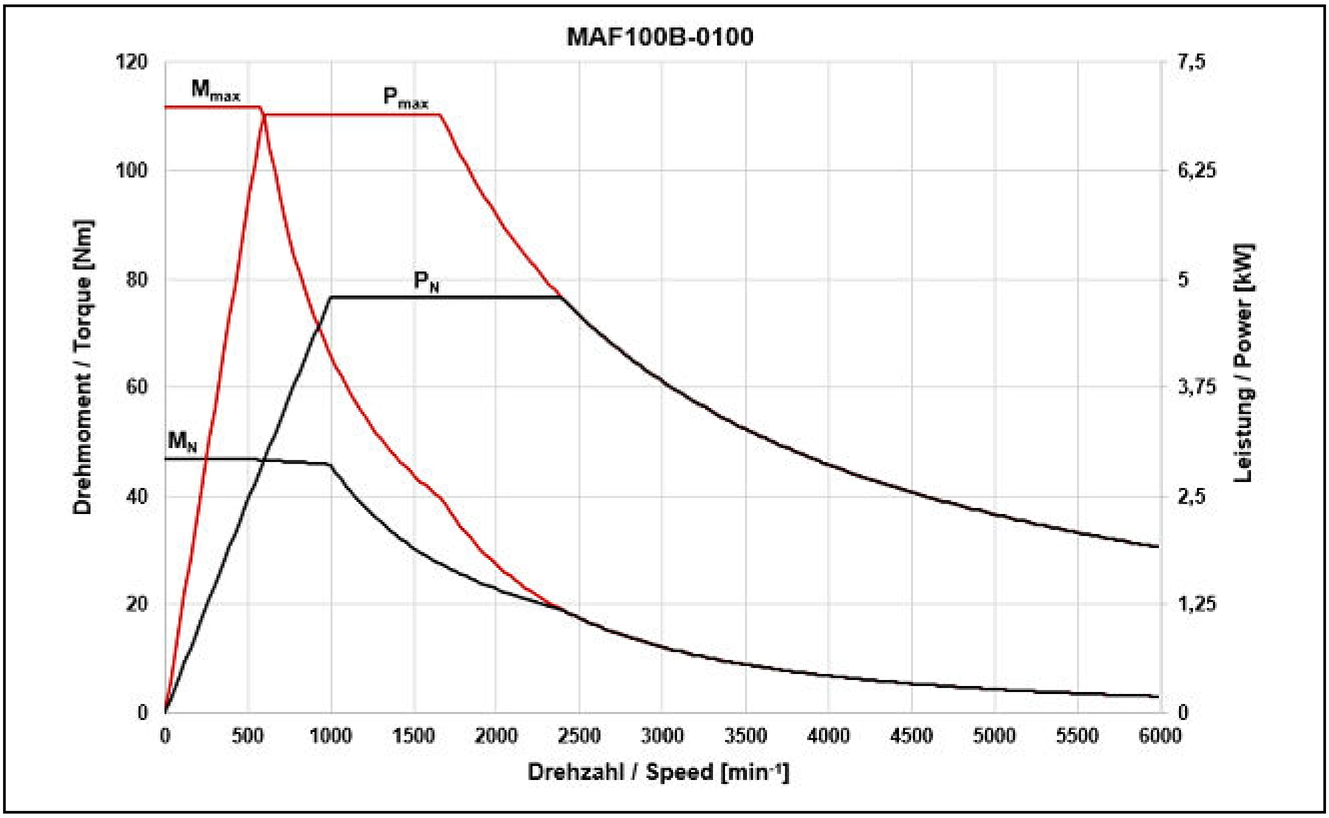


Fig. 4-57: Motor characteristic curve MAF100B-0100

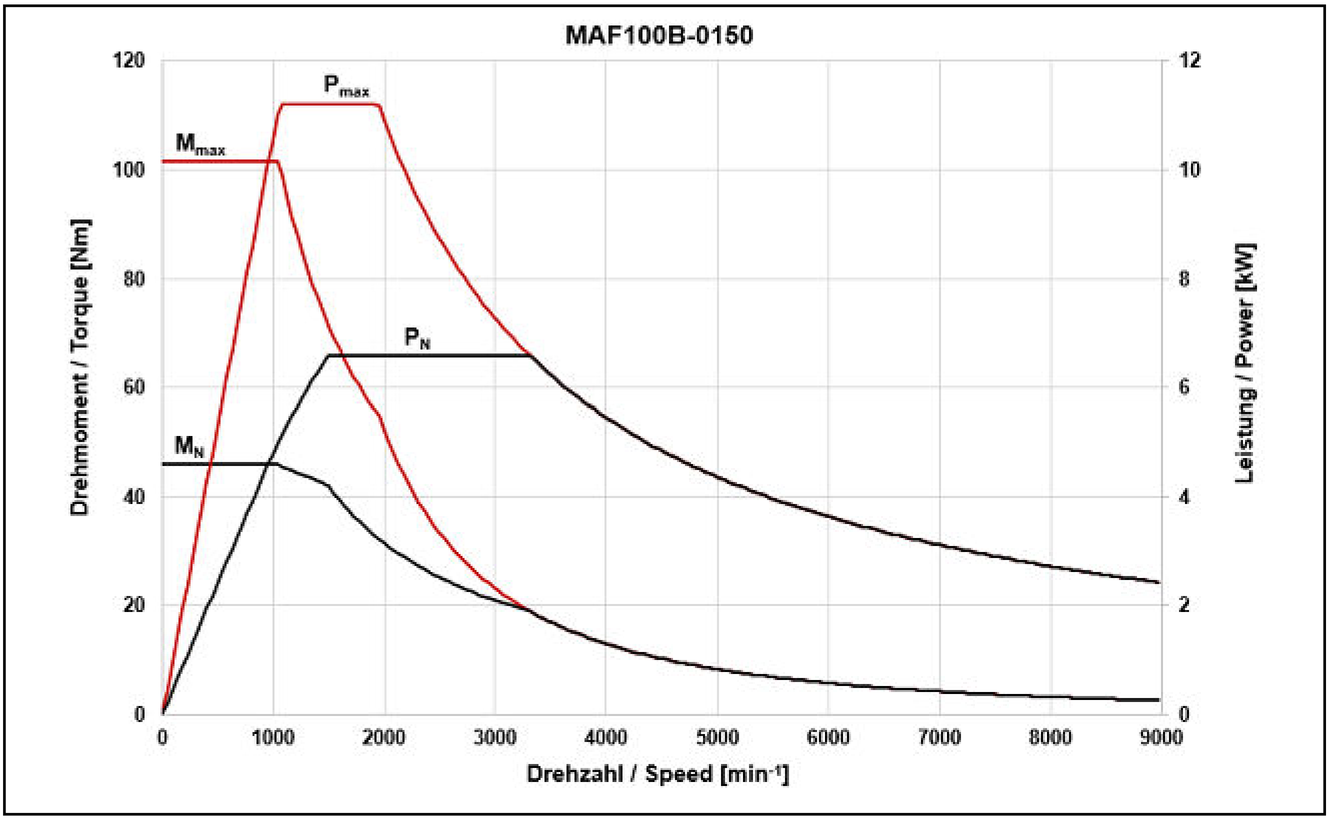


Fig. 4-58: Motor characteristic curve MAF100B-0150

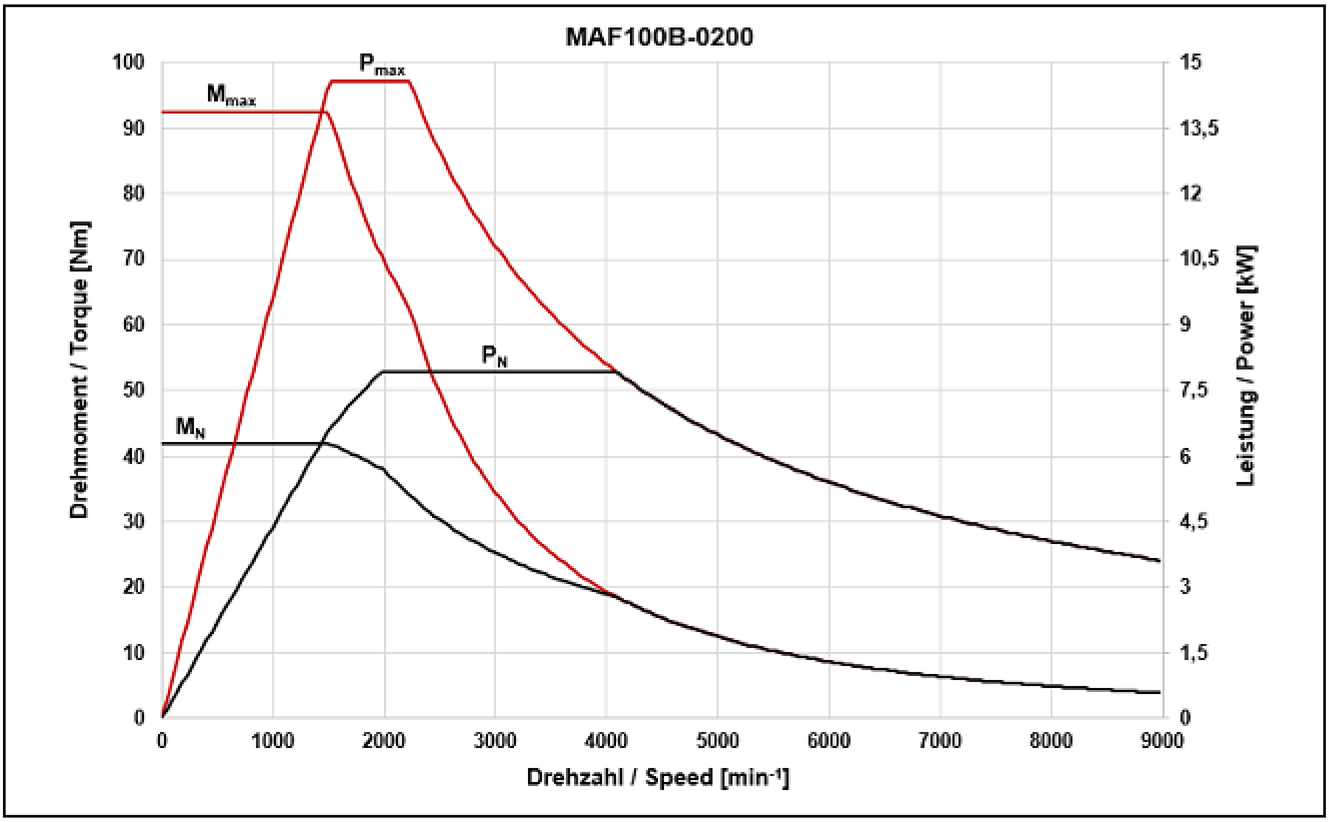


Fig. 4-59: Motor characteristic curve MAF100B-0200

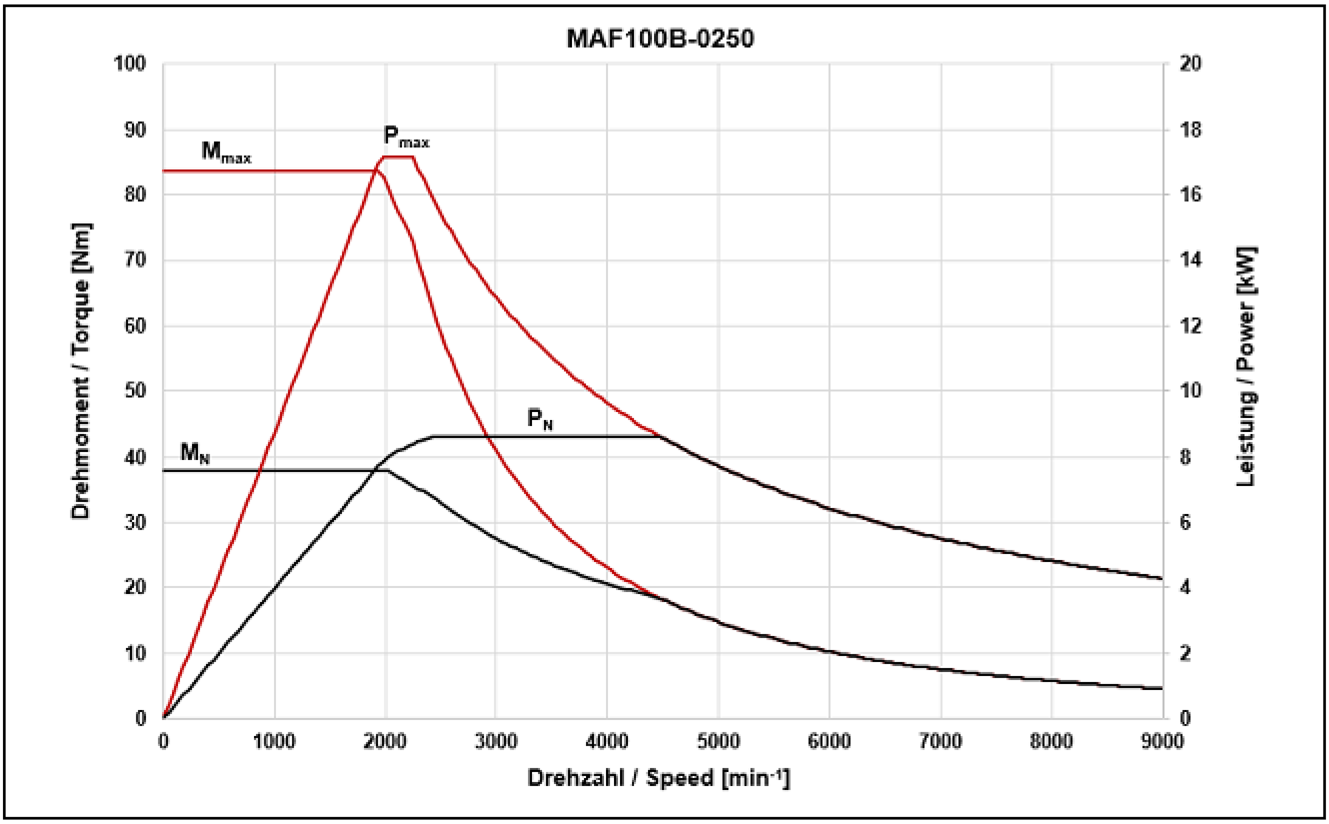


Fig. 4-60: Motor characteristic curve MAF100B-0250

4.8.3 Data sheet MAF100C

Parameter	Symbol	Unit	MAF100C				
			0050	0100	0150	0200	0250
Rated torque 1)	M_N	Nm	70.0	68.0	66.0	64.0	62.0
Rated power	P_N	kW	3.90	7.50	10.40	13.40	16.23
Rated current	I_N	A	12.1	19.0	27.9	36.7	40.2
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	153.7	154.0	149.5	145.2	138.1
Maximum power	P_{S6max}	kW	8.00	15.38	21.32	27.47	33.27
Maximum current	$I_{max(eff)}$	A	25.6	41.4	60.4	77.5	85.8
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Continuous torque at standstill	M_{n1}	Nm	70.0		68.0	66.0	64.0
Continuous current at standstill	I_{n1}	A	12.1	19.5	28.6	37.6	38.5
Torque constant at 20 °C	K_{M_N}	Nm/A	6.06	3.77	2.50	1.91	1.55
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	5				
Discharge capacity of the component	C_{dis}	nF	8.5		8.6	8.5	9.4
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	1.5	2.5	4.0	6.0	10.0
Mass	m_{mot}	kg	52.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0284000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	1.10		1.20	1.30	1.97
Coolant inlet temperature	T_{in}	°C	10 ... 40				
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				
Pressure loss at Q_{min}	Δp	bar	0.2		0.3		0.6

Parameter	Symbol	Unit	MAF100C				
			0050	0100	0150	0200	0250
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.10				
Necessary coolant flow at P_V	Q_{min}	l/min	1.6		1.7	1.9	2.8
Volume of coolant duct	V_{cool}	l	0.08				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-22: MAF100C - Technical data

4.8.4 Motor characteristic curves MAF100C

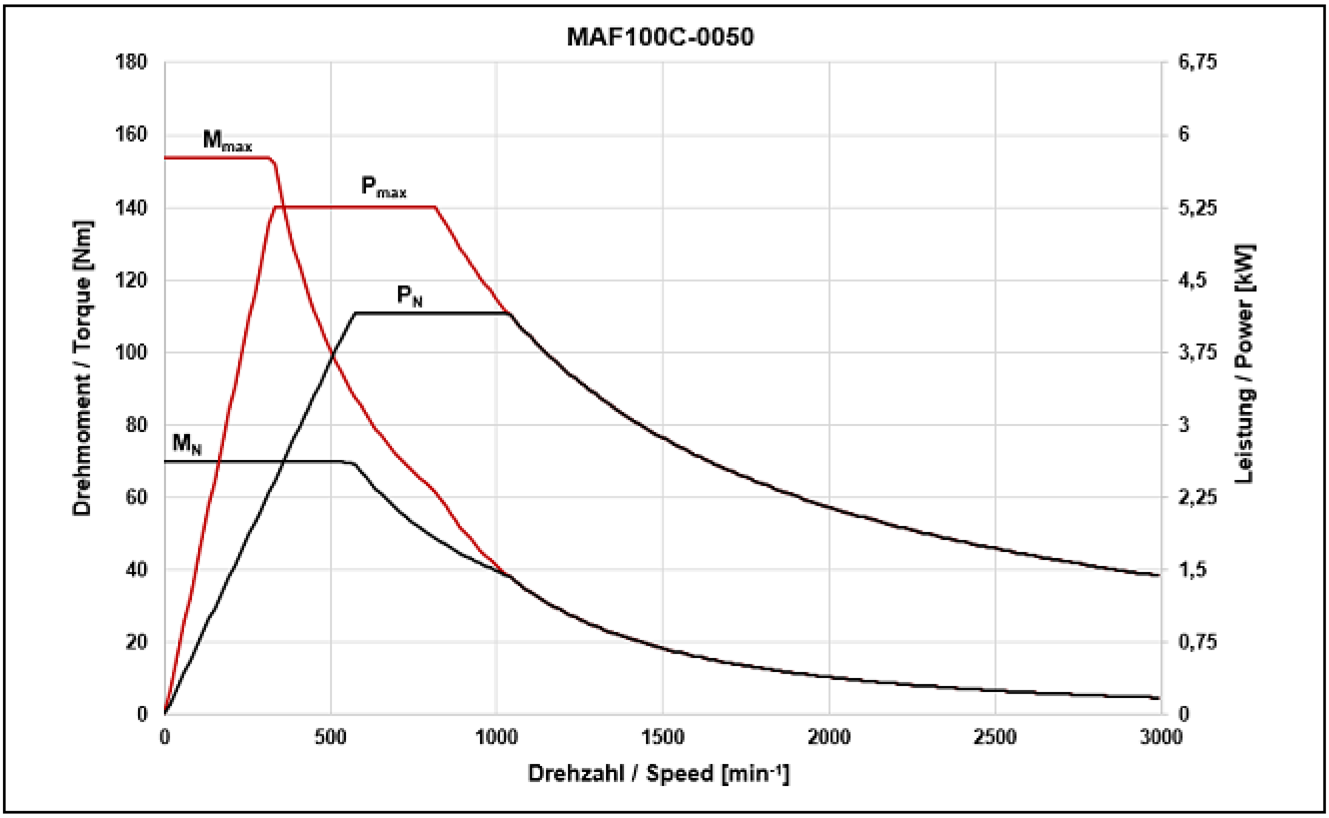


Fig. 4-61: Motor characteristic curve MAF100C-0050

Technical data

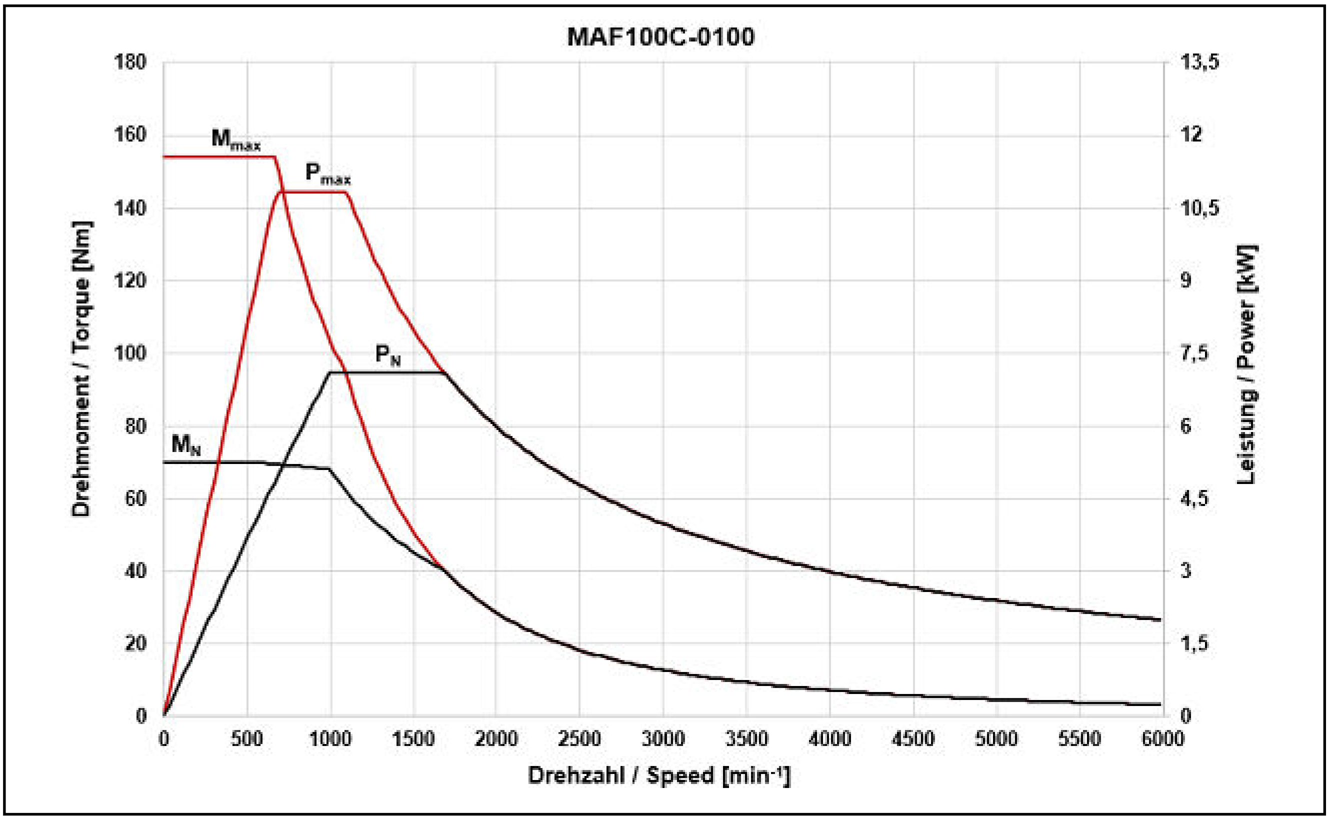


Fig. 4-62: Motor characteristic curve MAF100C-0100

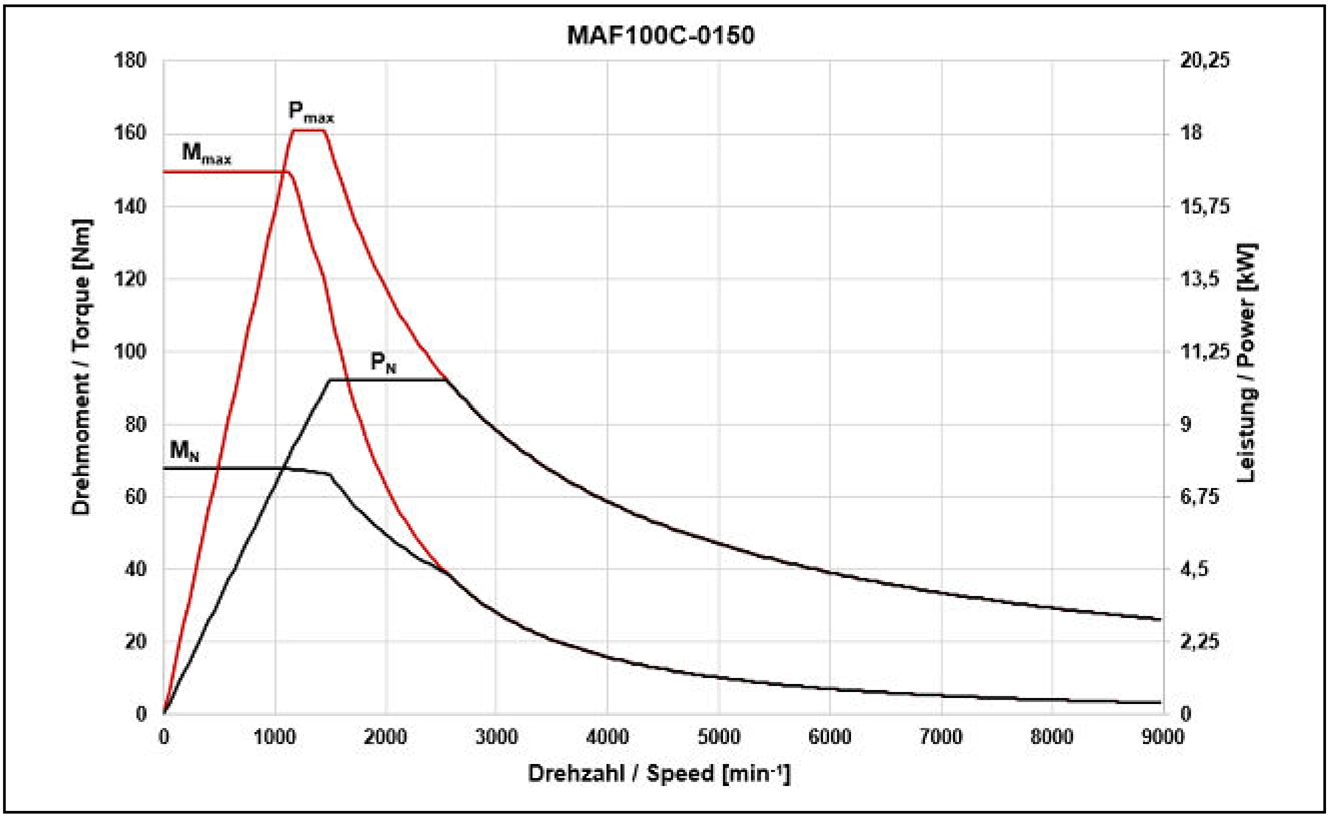


Fig. 4-63: Motor characteristic curve MAF100C-0150

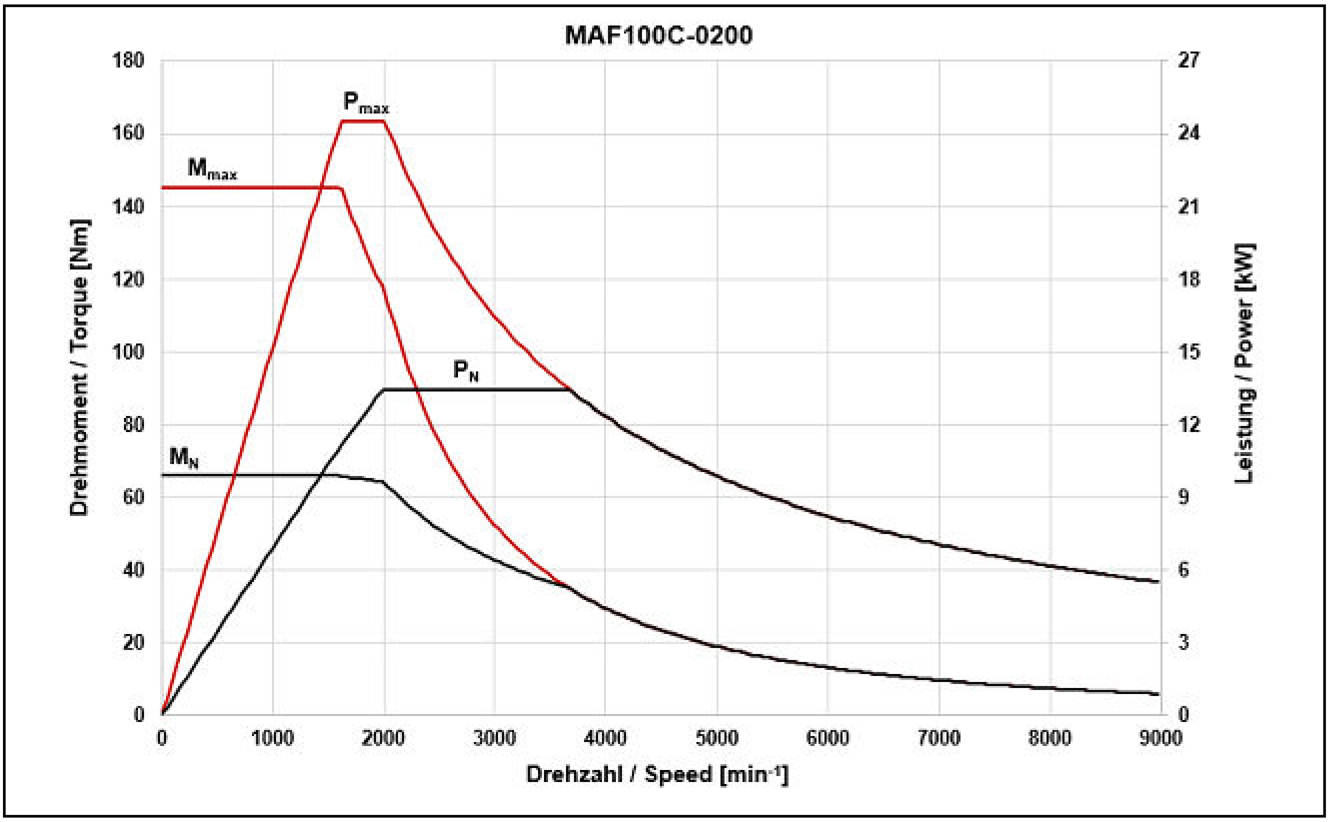


Fig. 4-64: Motor characteristic curve MAF100C-0200

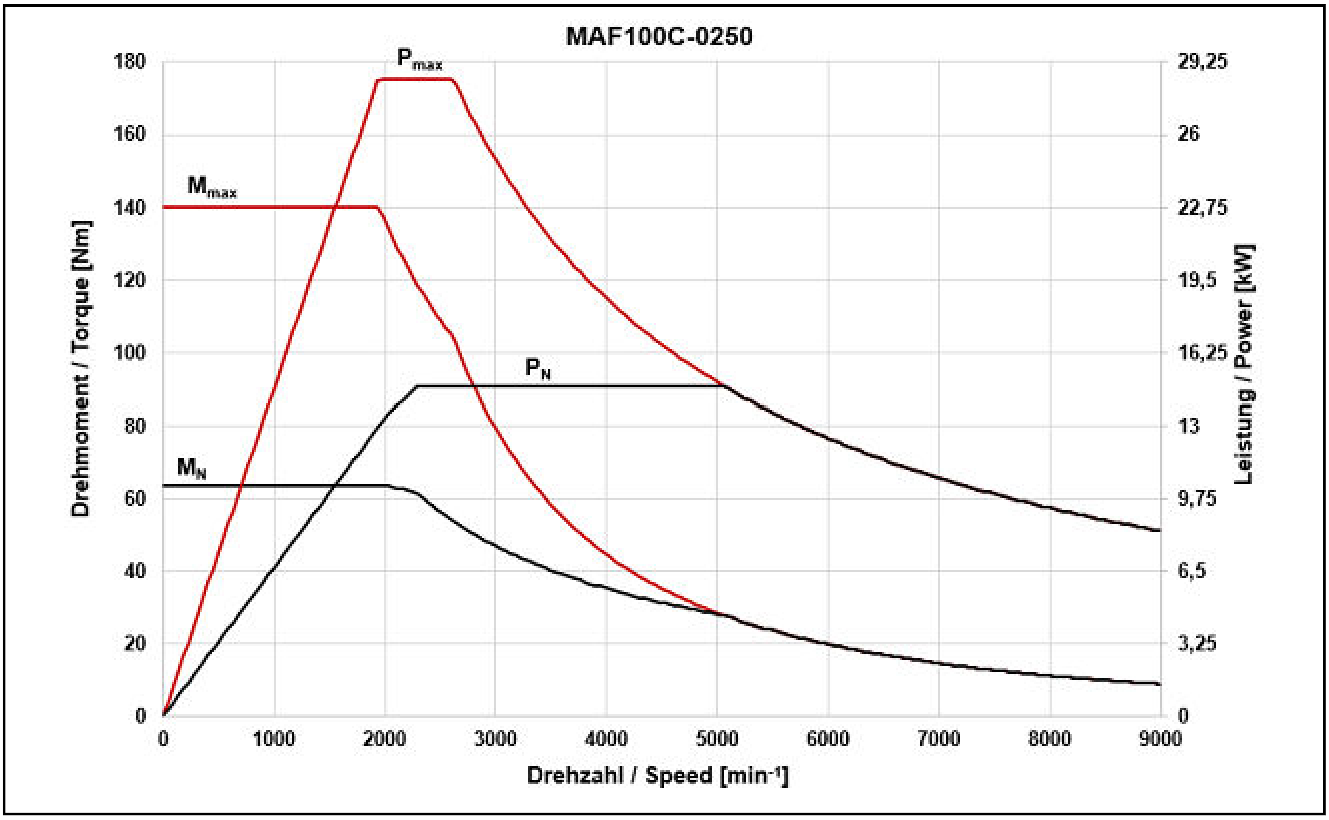


Fig. 4-65: Motor characteristic curve MAF100C-0250

4.8.5 Data sheet MAF100D

Parameter	Symbol	Unit	MAF100D				
			0050	0100	0150	0200	0250
Rated torque [1)]	M_N	Nm	88.0	84.0	79.0	80.0	75.0
Rated power	P_N	kW	4.60	8.80	12.40	16.76	19.63
Rated current	I_N	A	14.5	27.1	32.7	43.1	42.8
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	193.3	190.0	185.3	182.3	177.5
Maximum power	P_{S6max}	kW	9.43	18.00	25.42	34.35	40.24
Maximum current	$I_{max(eff)}$	A	29.2	58.0	68.7	91.3	100.4
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	9000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	11000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	9000		
Continuous torque at standstill	M_{n1}	Nm	87.8	88.1	84.3	83.0	80.0
Continuous current at standstill	I_{n1}	A	14.5	27.7	34.3	44.4	56.1
Torque constant at 20 °C	K_{M_N}	Nm/A	6.79	3.51	2.77	2.04	1.55
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	5				
Discharge capacity of the component	C_{dis}	nF	11.0	11.2	11.0	10.0	9.2
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	1.5	4.0	6.0	10.0	
Mass	m_{mot}	kg	64.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0320000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	1.40	1.65	1.70	1.74	1.94
Coolant inlet temperature	T_{in}	°C	10 ... 40				
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				
Pressure loss at Q_{min}	Δp	bar	0.5	0.6	0.7		0.8

Parameter	Symbol	Unit	MAF100D				
			0050	0100	0150	0200	0250
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.14				
Necessary coolant flow at P_V	Q_{min}	l/min	2.0	2.4		2.5	2.8
Volume of coolant duct	V_{cool}	l	0.11				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-23: MAF100D - Technical data

4.8.6 Motor characteristic curves MAF100D

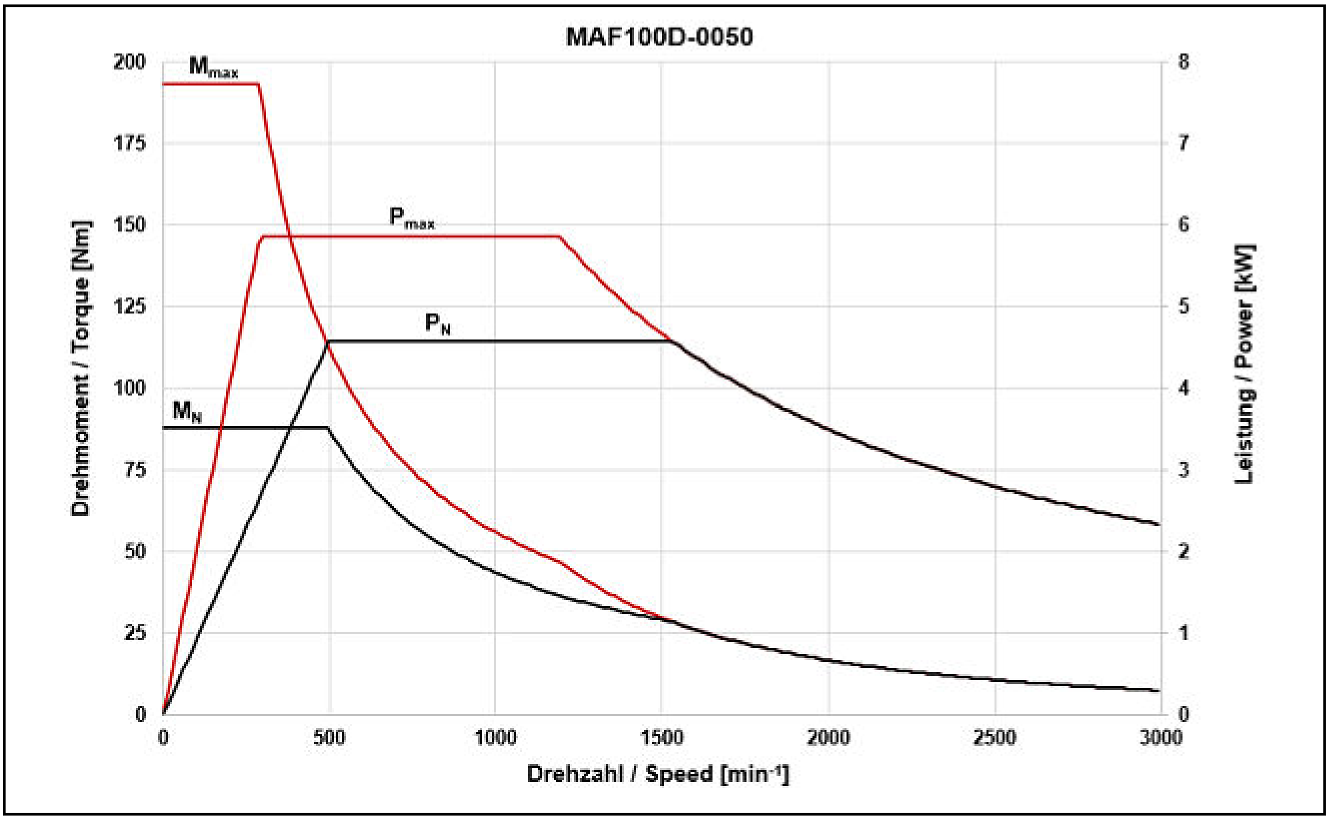


Fig. 4-66: Motor characteristic curve MAF100D-0050

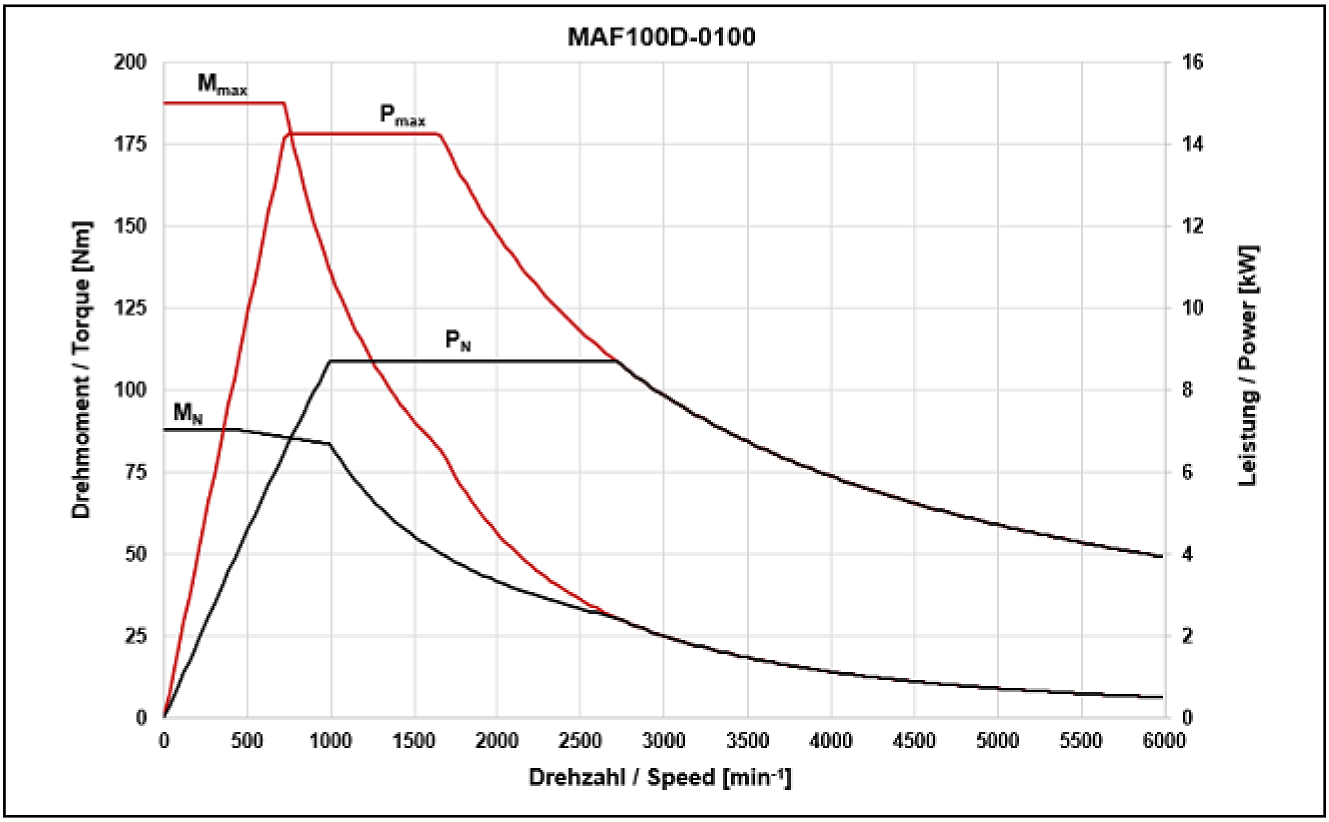


Fig. 4-67: Motor characteristic curve MAF100D-0100

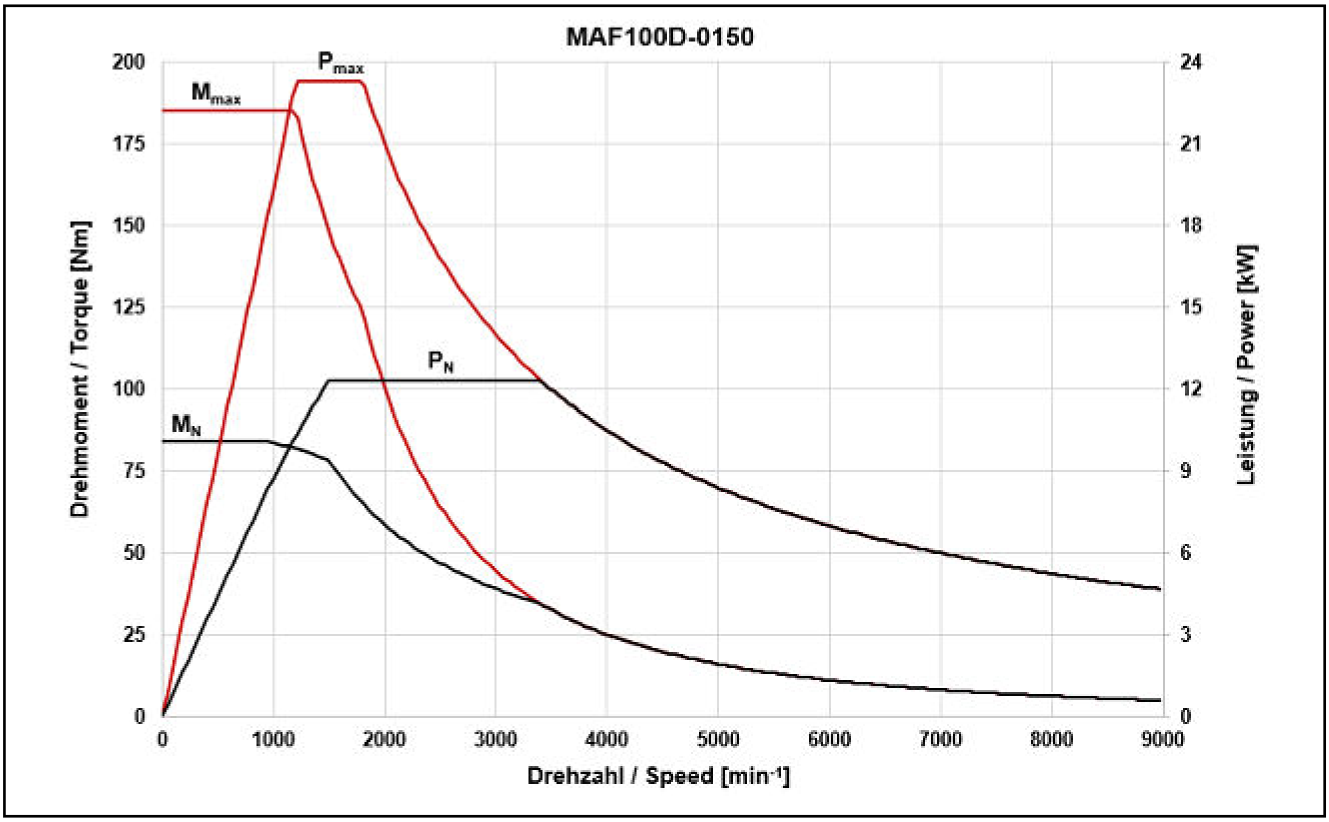


Fig. 4-68: Motor characteristic curve MAF100D-0150

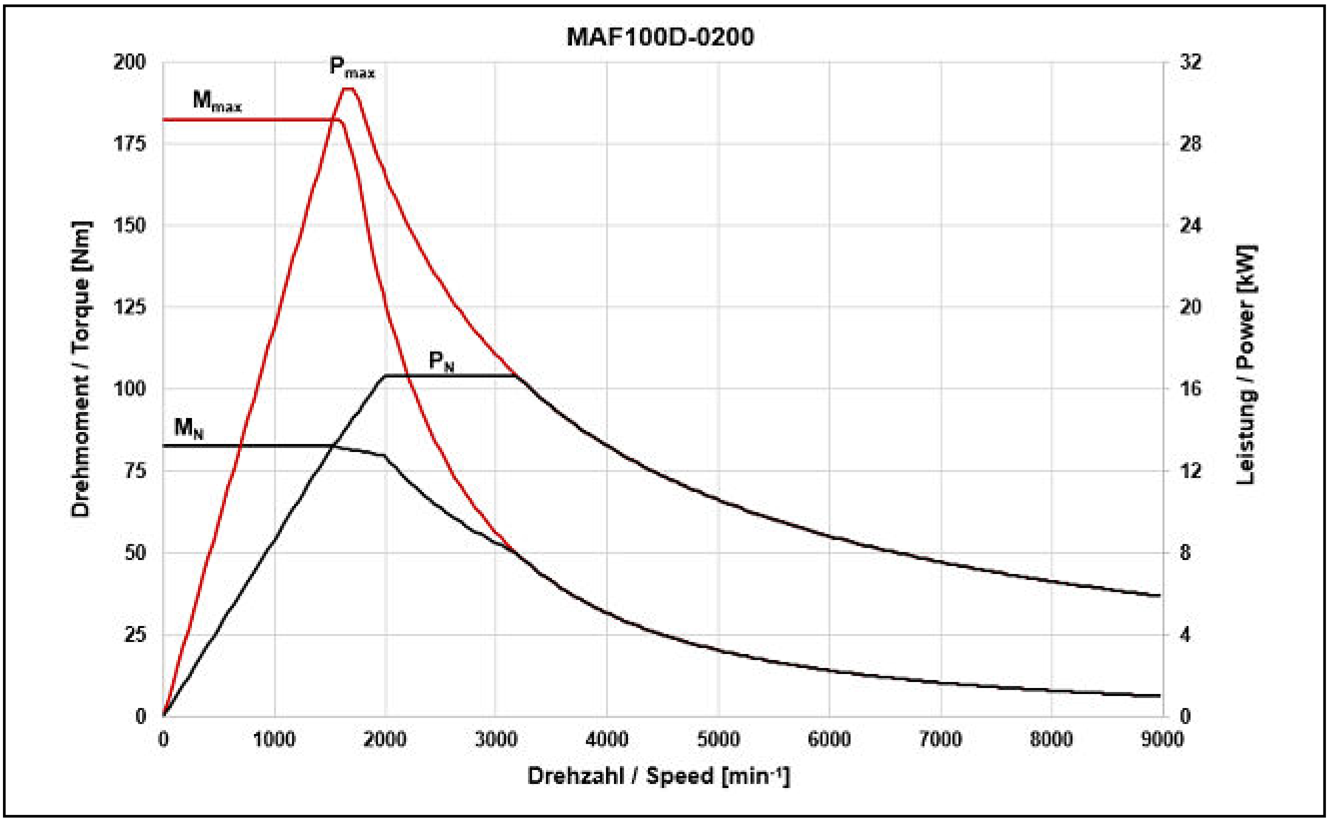


Fig. 4-69: Motor characteristic curve MAF100D-0200

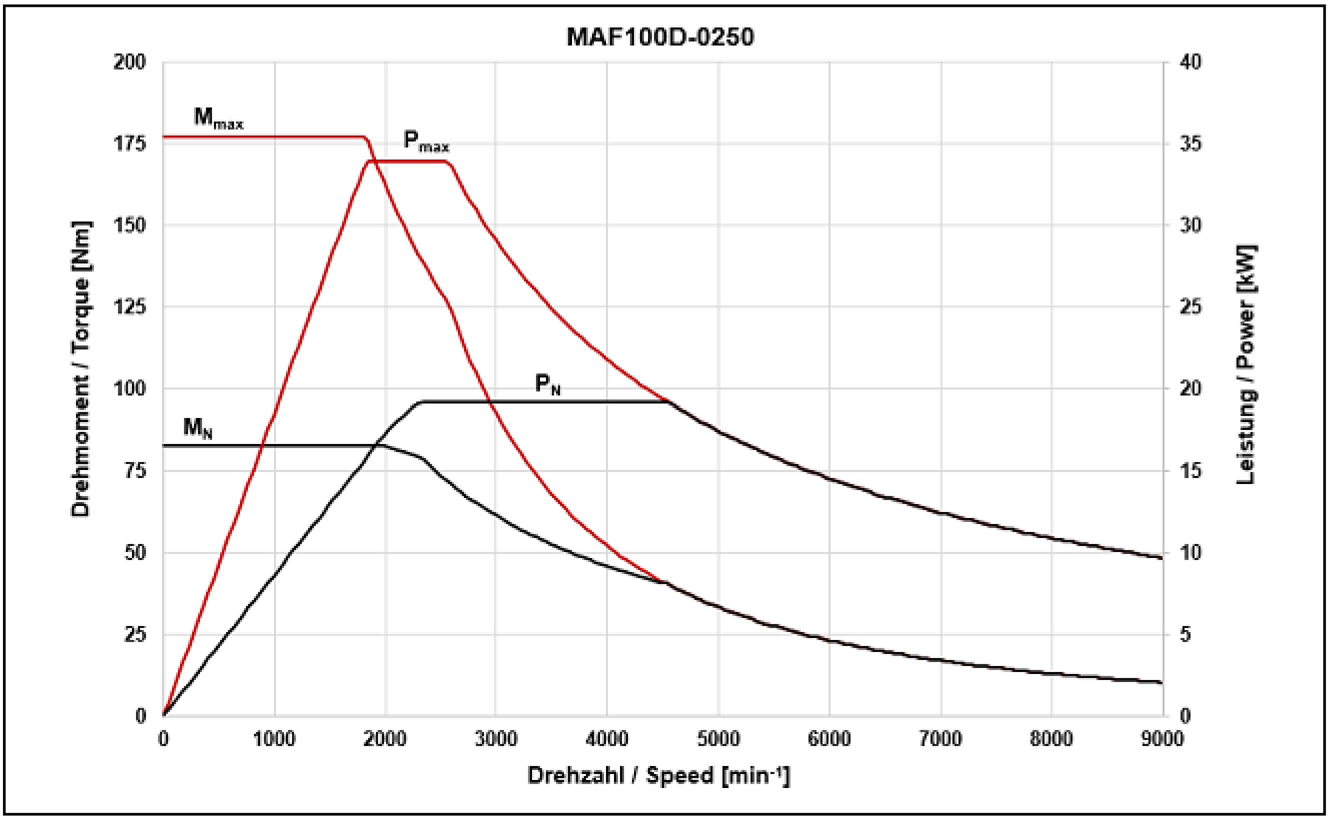


Fig. 4-70: Motor characteristic curve MAF100D-0250

4.8.7 Holding brake MAD/MAF100 (optional)

Data sheet - holding brake MAD/MAF100

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	30.0	24.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	0.90	1.10
Moment of inertia of the holding brake	J_{br}	kg*m^2	0.000529	0.000556
Connection time	t_1	ms	42	30
Disconnection time	t_2	ms	50	90
Maximum holding brake speed	n_{Br_max}	min^{-1}	10000	

Tab. 4-24: Technical data of holding brake MAD/MAF100 (optional)

4.9 Technical data MAF130

4.9.1 Data sheet MAF130B

Parameter	Symbol	Unit	MAF130B				
			0050	0100	0150	0200	0250
Rated torque [1)]	M_N	Nm	116.0	112.0	115.0	100.0	90.0
Rated power	P_N	kW	6.10	11.70	18.10	20.90	23.56
Rated current	I_N	A	14.7	28.4	43.7	52.7	58.8
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	254.7		264.0	220.0	210.0
Maximum power	P_{S6max}	kW	12.51	23.99	37.11	42.85	48.30
Maximum current	$I_{max(eff)}$	A	30.5	61.0	94.7	108.9	126.6
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000	7500		
Continuous torque at standstill	M_{n1}	Nm	115.8		120.0	108.0	95.0
Continuous current at standstill	I_{n1}	A	14.6	29.3	45.3	53.0	61.2
Torque constant at 20 °C	K_{M_N}	Nm/A	8.46	4.25	2.83	2.07	1.77
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	5				
Discharge capacity of the component	C_{dis}	nF	16.0			11.6	13.2
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	1.5	4.0	10.0		16.0
Mass	m_{mot}	kg	82.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.0790000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	1.80	1.90	2.00	2.23	
Coolant inlet temperature	T_{in}	°C	10 ... 40				

Parameter	Symbol	Unit	MAF130B				
			0050	0100	0150	0200	0250
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				
Pressure loss at Q_{min}	Δp	bar	0.1				
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.02				
Necessary coolant flow at P_V	Q_{min}	l/min	2.6	2.7	2.9	3.2	
Volume of coolant duct	V_{cool}	l	0.15				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-25: MAF130B - Technical data

4.9.2 Motor characteristic curves MAF130B

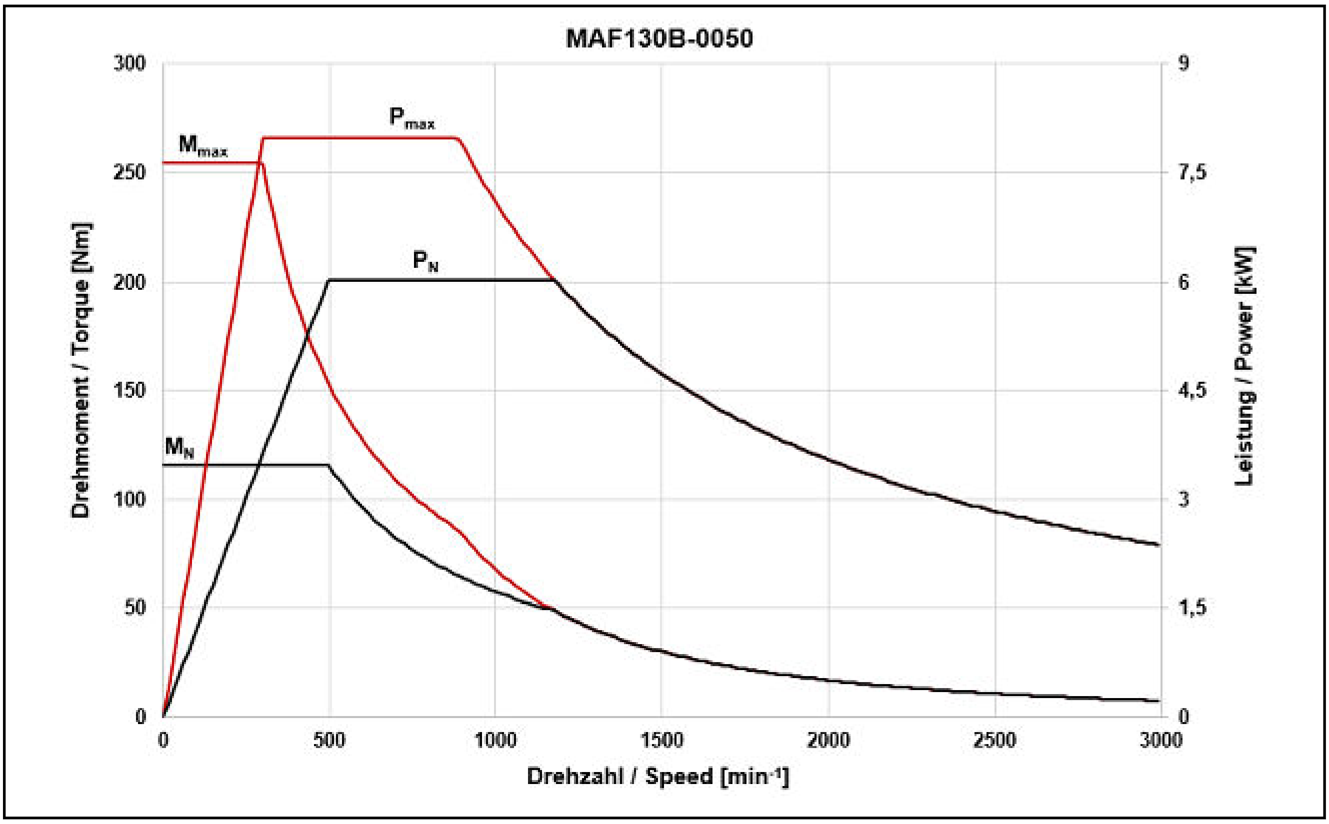


Fig. 4-71: Motor characteristic curve MAF130B-0050

Technical data

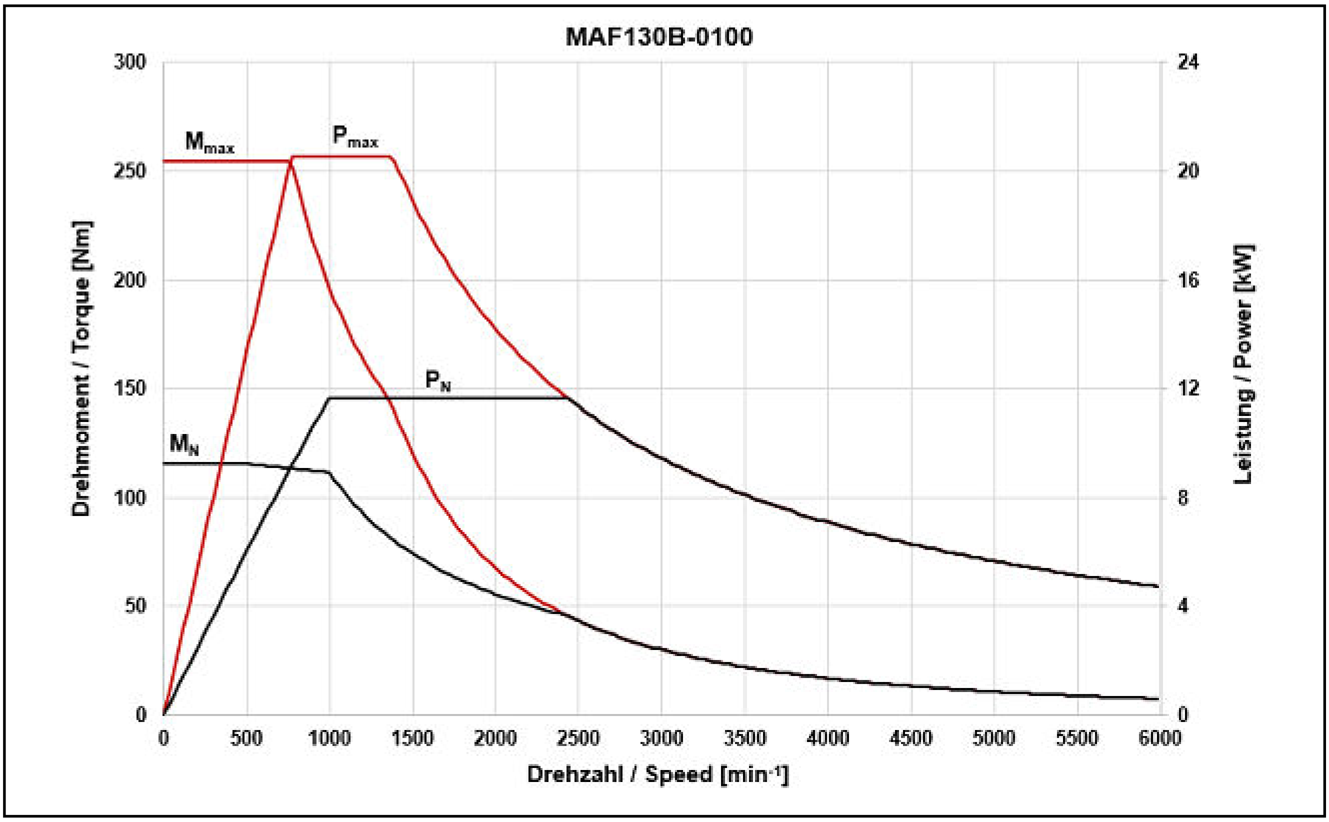


Fig. 4-72: Motor characteristic curve MAF130B-0100

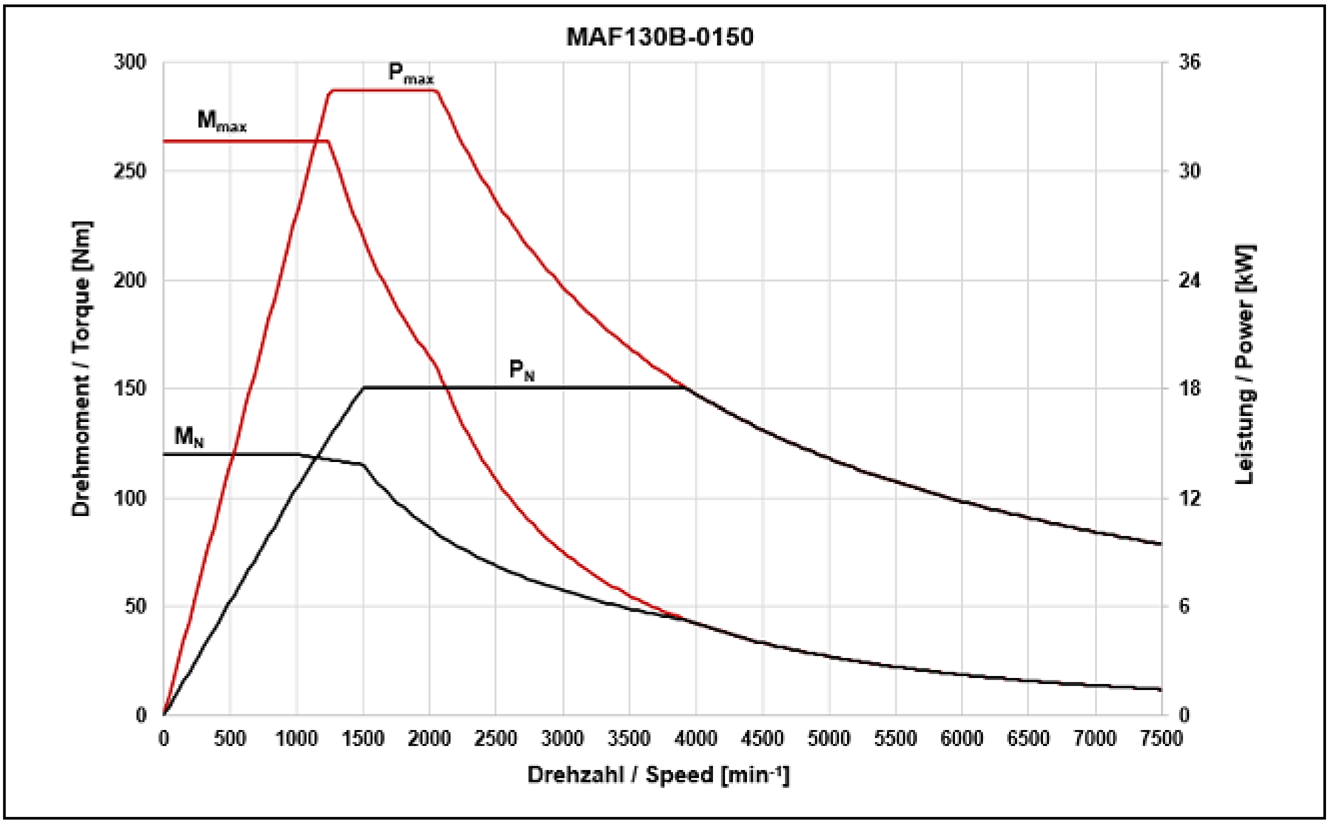


Fig. 4-73: Motor characteristic curve MAF130B-0150

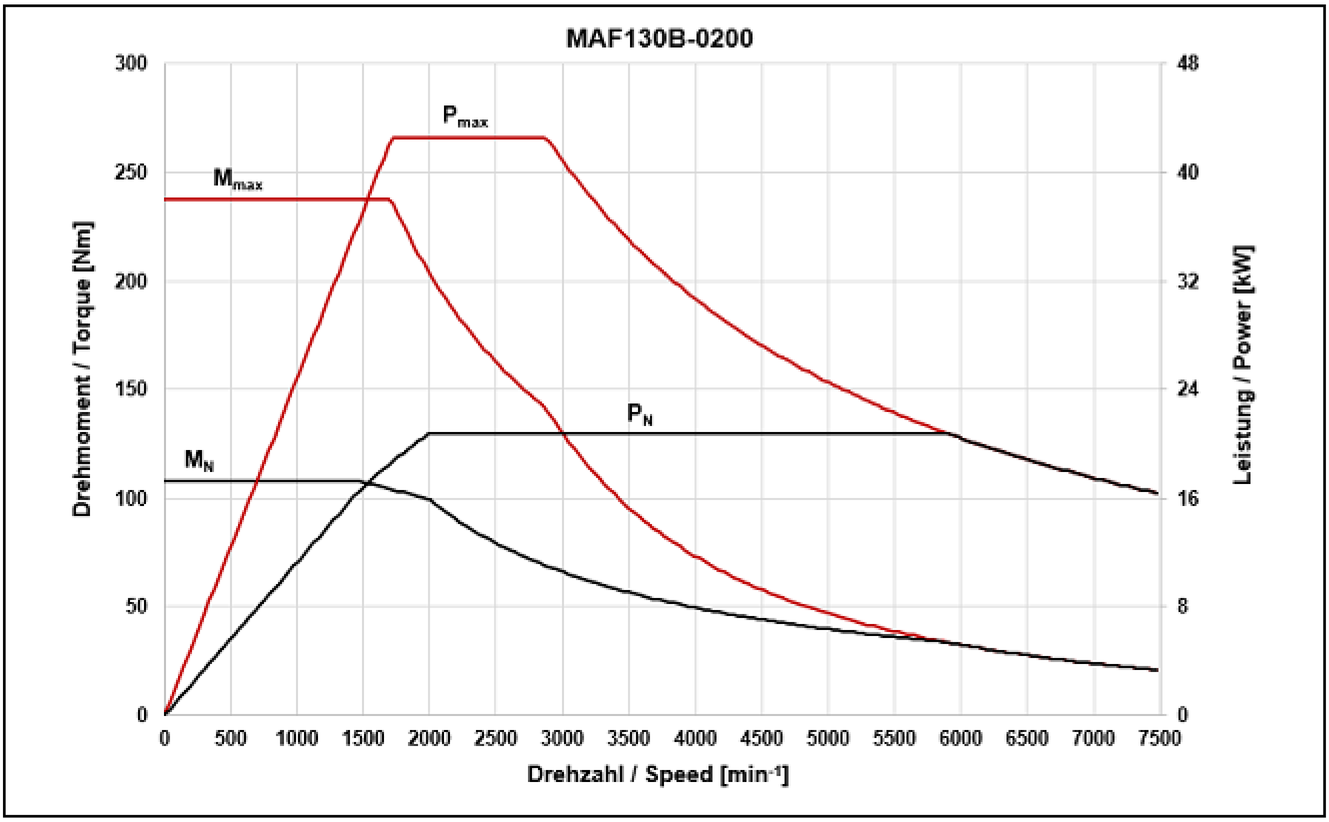


Fig. 4-74: Motor characteristic curve MAF130B-0200

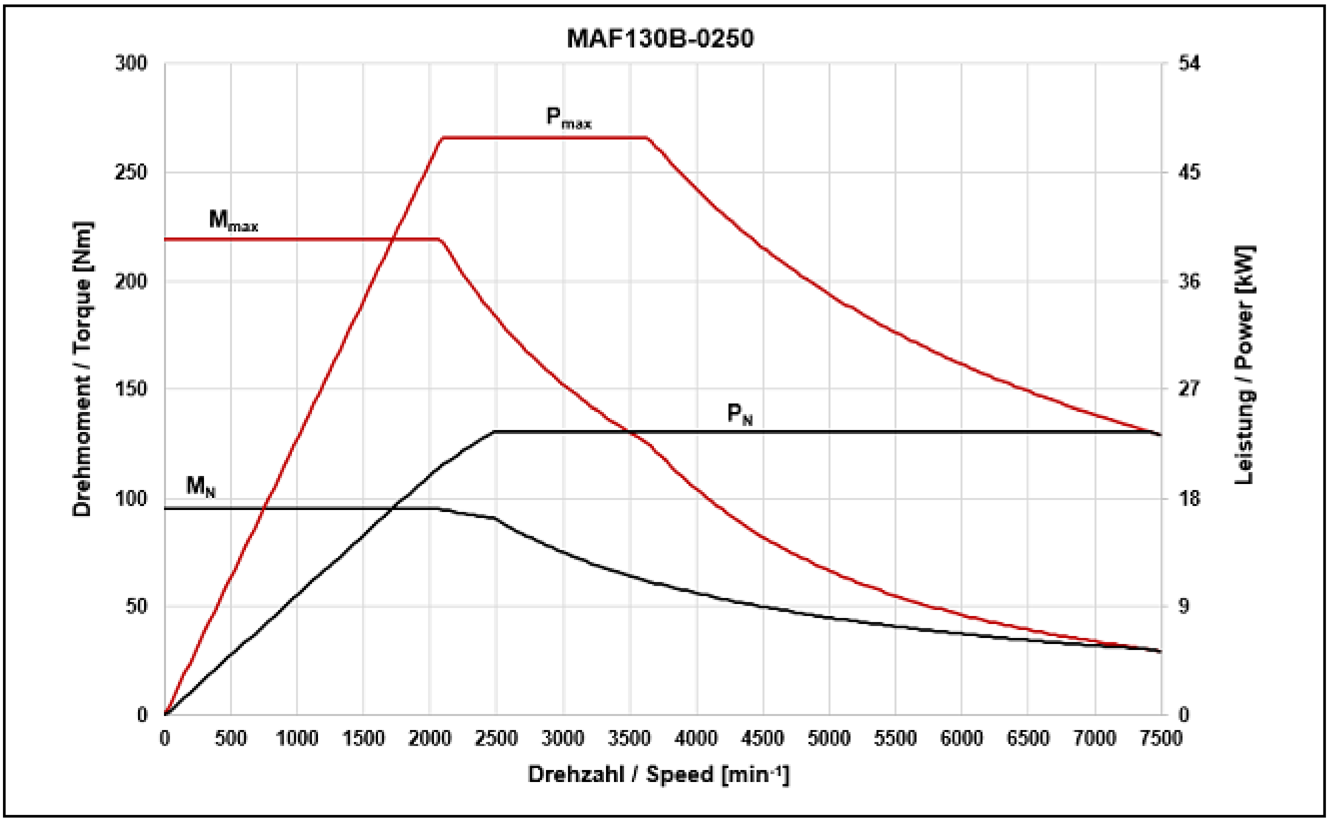


Fig. 4-75: Motor characteristic curve MAF130B-0250

Technical data

4.9.3 Data sheet MAF130C

Parameter	Symbol	Unit	MAF130C				
			0050	0100	0150	0200	0250
Rated torque [1)]	M_N	Nm	155.0	150.0	145.0	135.0	125.0
Rated power	P_N	kW	8.10	15.70	22.80	28.30	32.72
Rated current	I_N	A	21.0	38.0	53.2	69.8	75.5
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	340.0	330.0	329.8	314.7	298.4
Maximum power	P_{S6max}	kW	16.61	32.19	46.74	58.02	67.08
Maximum current	$I_{max(eff)}$	A	42.6	71.8	111.0	142.9	150.8
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000	7500		
Continuous torque at standstill	M_{n1}	Nm	154.7		149.9	143.0	135.0
Continuous current at standstill	I_{n1}	A	20.8	39.0	54.7	71.2	75.5
Torque constant at 20 °C	K_{M_N}	Nm/A	8.04	5.09	3.04	2.19	1.88
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	5				
Discharge capacity of the component	C_{dis}	nF	20.0	15.4	20.0	16.8	20.0
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	2.5	6.0	16.0		25.0
Mass	m_{mot}	kg	106.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.1010000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	2.20	2.28	2.30		2.35
Coolant inlet temperature	T_{in}	°C	10 ... 40				
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				

Parameter	Symbol	Unit	MAF130C				
			0050	0100	0150	0200	0250
Pressure loss at Q_{min}	Δp	bar	0.2				
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.02				
Necessary coolant flow at P_V	Q_{min}	l/min	3.1	3.3			3.4
Volume of coolant duct	V_{cool}	l	0.20				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-26: MAF130C - Technical data

4.9.4 Motor characteristic curves MAF130C

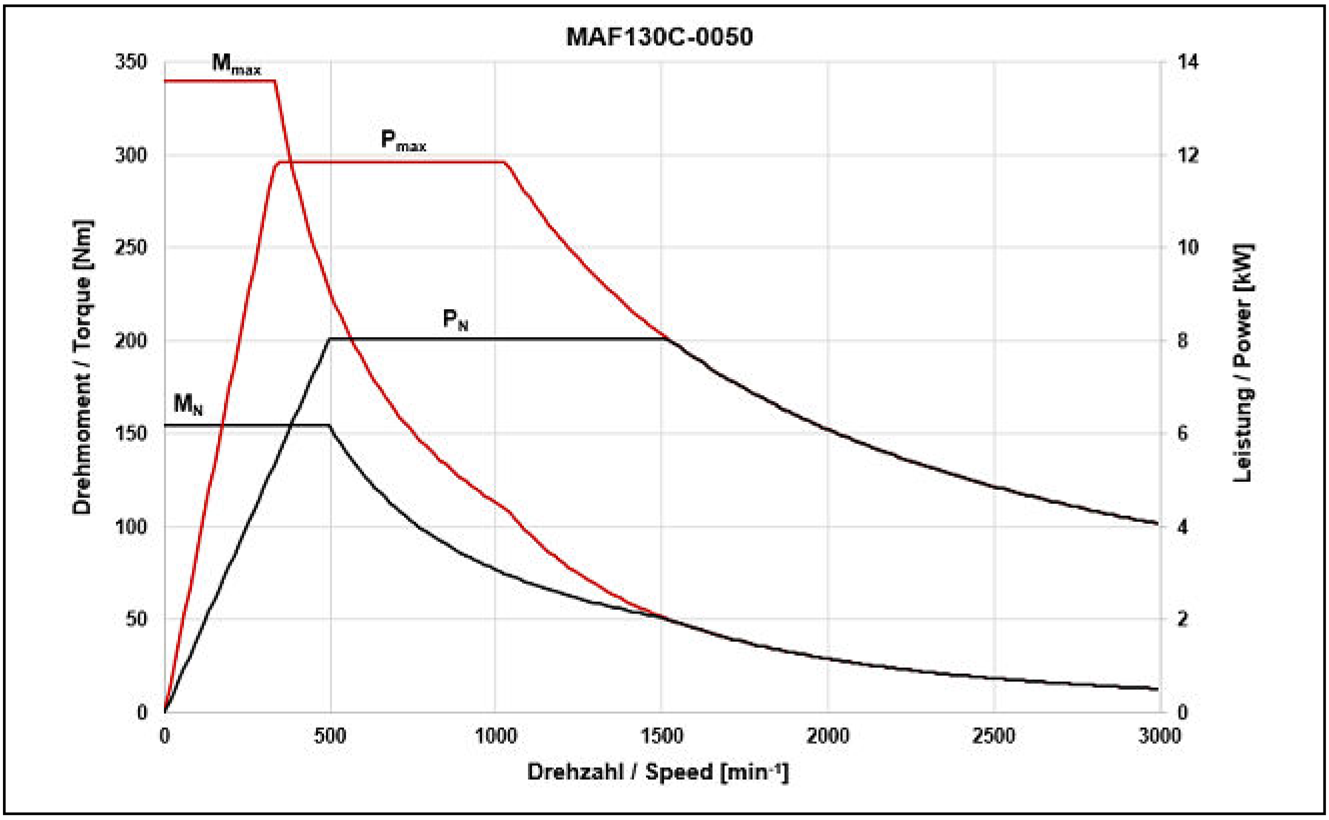


Fig. 4-76: Motor characteristic curve MAF130C-0050

Technical data

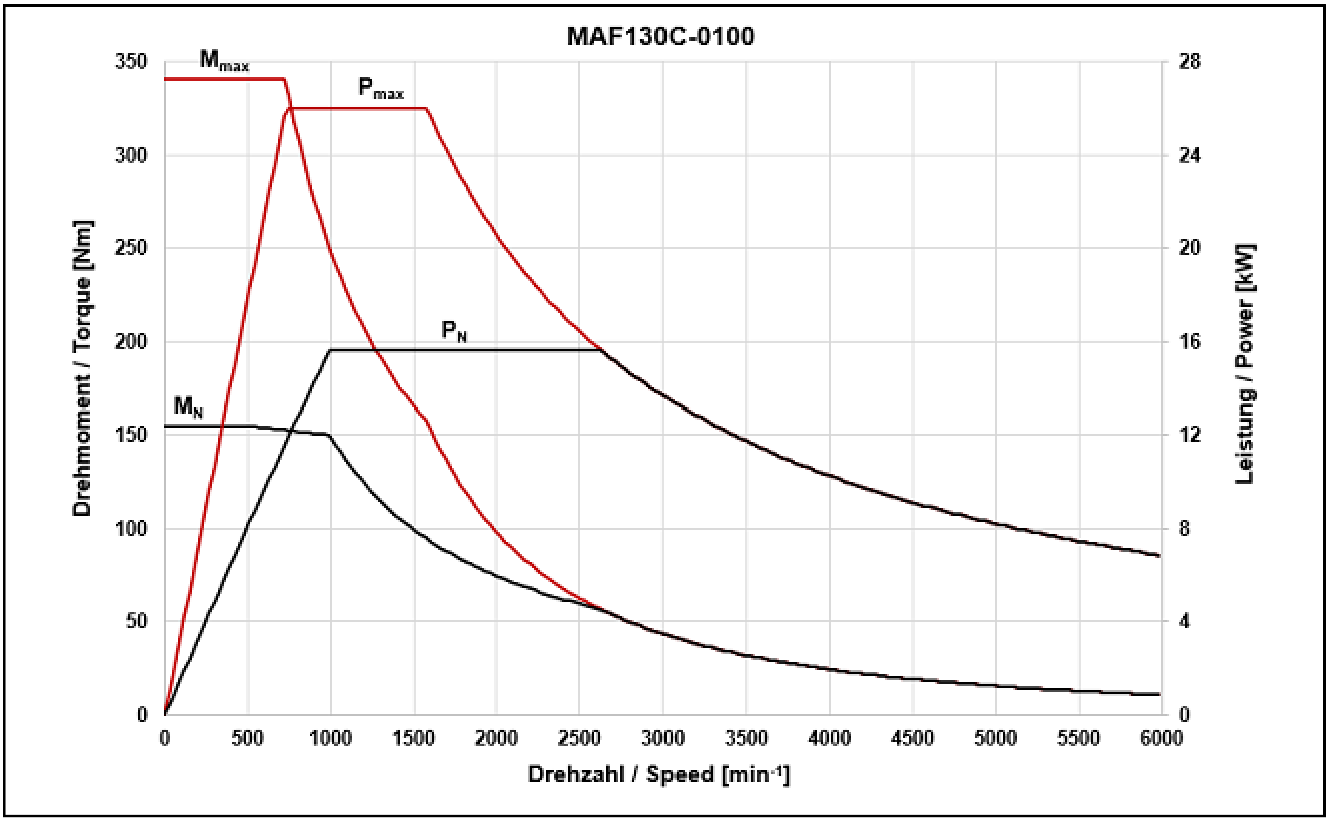


Fig. 4-77: Motor characteristic curve MAF130C-0100

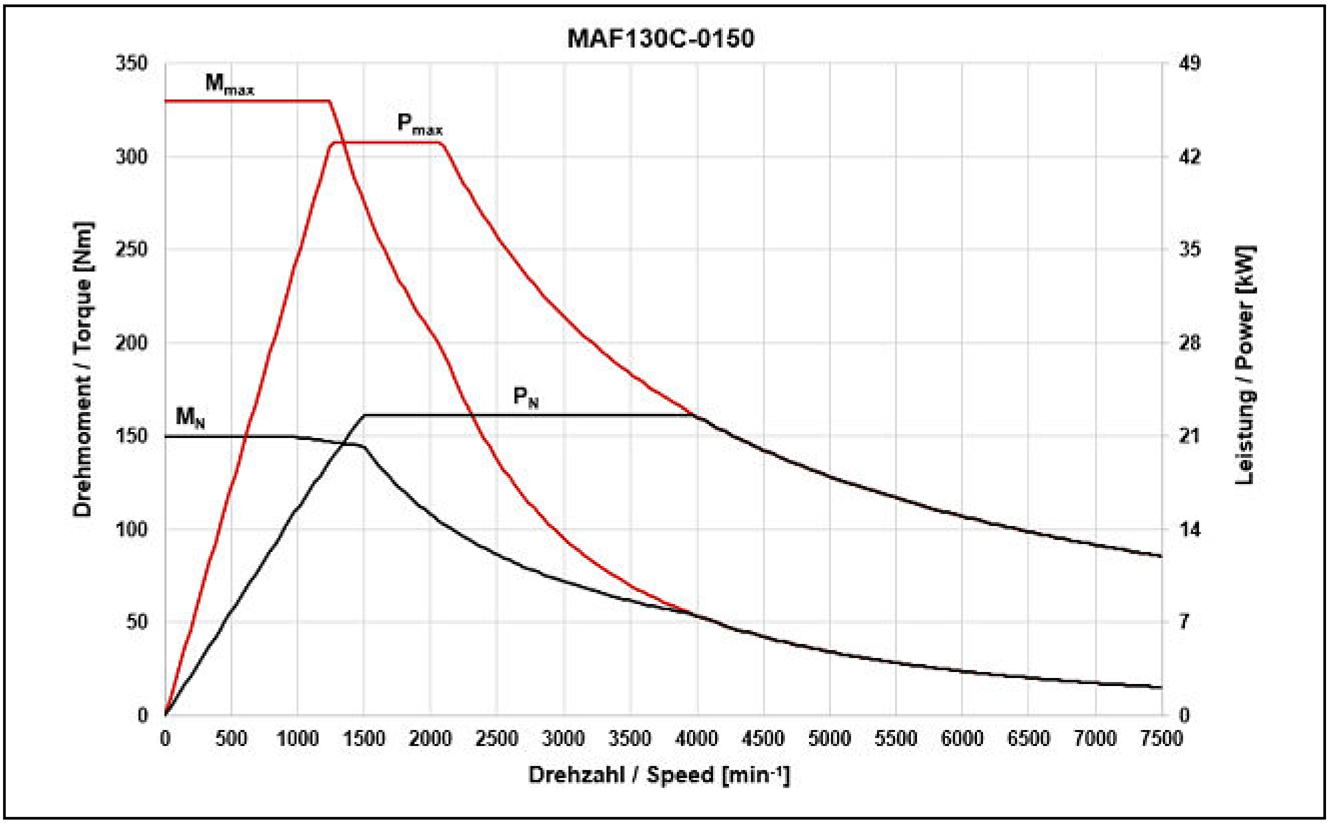


Fig. 4-78: Motor characteristic curve MAF130C-0150

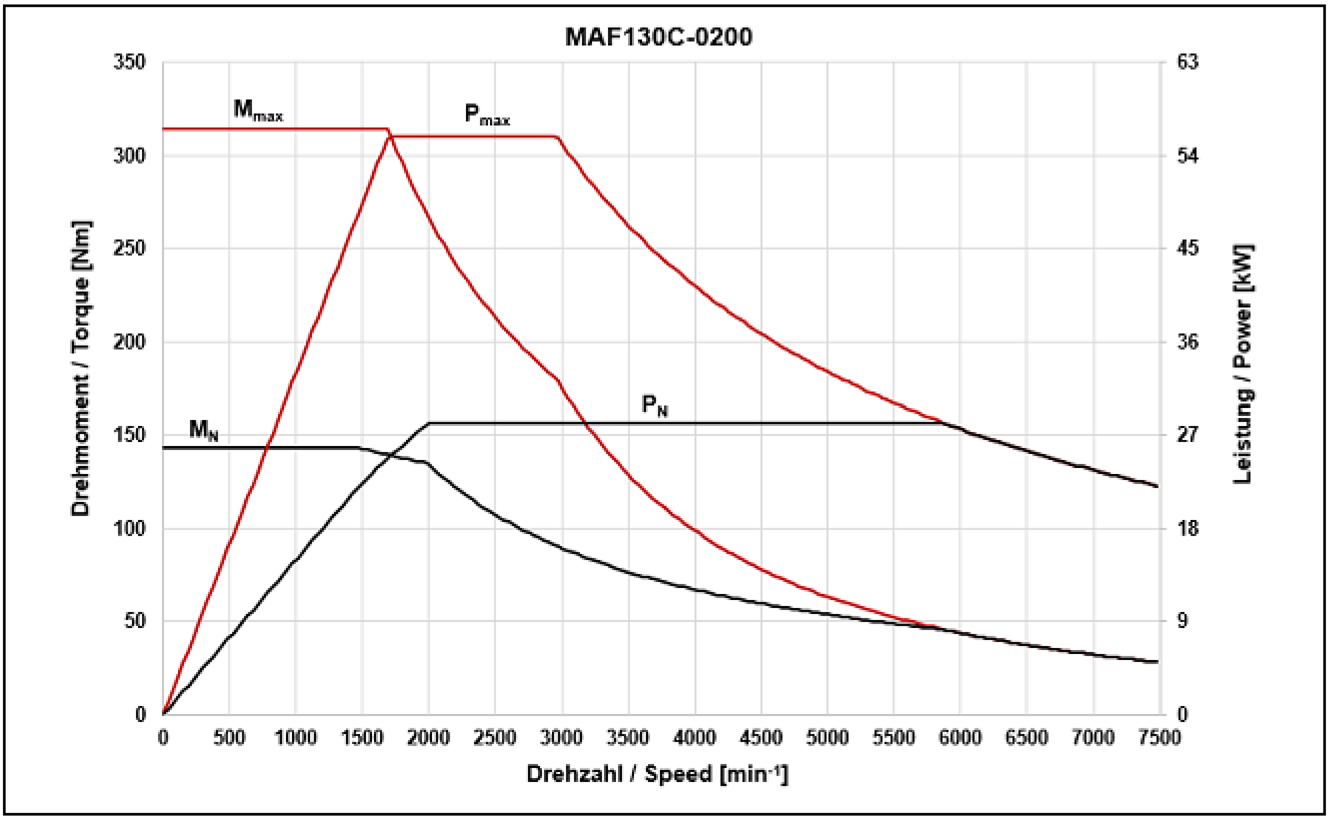


Fig. 4-79: Motor characteristic curve MAF130C-0200

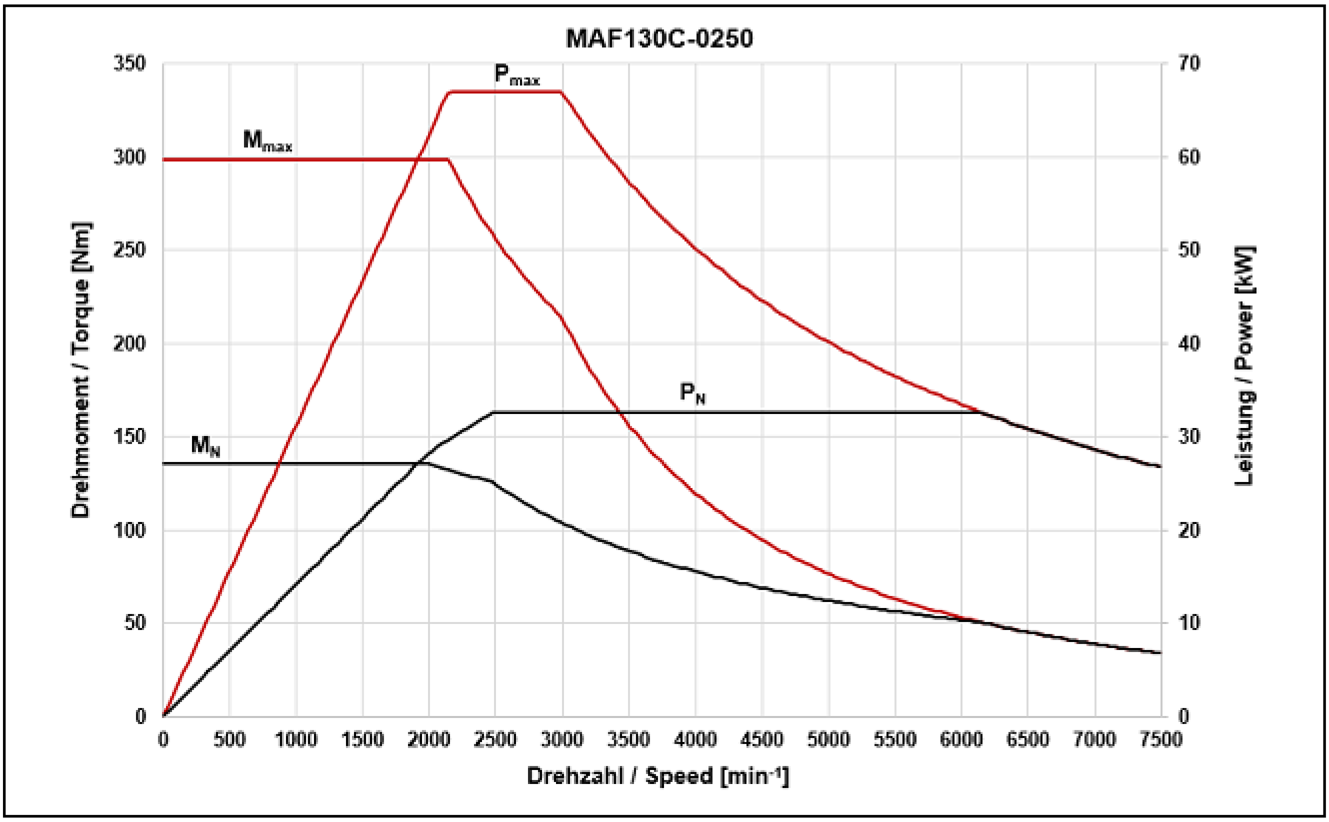


Fig. 4-80: Motor characteristic curve MAF130C-0250

4.9.5 Data sheet MAF130D

Parameter	Symbol	Unit	MAF130D				
			0050	0100	0150	0200	0250
Rated torque [1)]	M_N	Nm	230.0	220.0	200.0		190.0
Rated power	P_N	kW	12.00	23.04	31.40	41.90	49.74
Rated current	I_N	A	32.3	50.7	72.6	93.9	113.0
Rated speed	n_N	min^{-1}	500	1000	1500	2000	2500
Key speed	n_1	min^{-1}	500		1000	1500	2000
Maximum torque	M_{max}	Nm	506.3	500.0	484.4	461.4	450.0
Maximum power	P_{S6max}	kW	24.60	47.23	64.37	85.90	140.00
Maximum current	$I_{max(eff)}$	A	64.3	103.5	155.4	190.9	263.5
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	9000	10000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000	7500		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000	7500		
Continuous torque at standstill	M_{n1}	Nm	230.0	229.8	220.2	210.0	195.0
Continuous current at standstill	I_{n1}	A	31.3	52.4	78.0	97.5	113.0
Torque constant at 20 °C	K_{M_N}	Nm/A	7.71	4.97	3.21	2.51	1.71
Thermal time constant	T_{th}	min	3.5				
Cycle duration (S6 - 44%)	T_C	min	5				
Discharge capacity of the component	C_{dis}	nF	27.5	26.7	27.5	25.1	28.6
Number of pole pairs	p	--	3				
Power wire cross-section	A	mm^2	6.0	10.0	25.0		35.0
Mass	m_{mot}	kg	147.0				
Moment of inertia of the rotor	J_{rot}	kg * m²	0.1510000				
Sound pressure level	L_P	dB[A]	70 (+3)				
Surrounding air temperature during operation	T_{amb}	°C	0...+40				
Thermal class according to DIN EN 60034-1	I.CL.	-	155				
Details about liquid cooling							
Power loss to be dissipated	P_V	kW	3.25	3.21	3.30	3.35	3.49
Coolant inlet temperature	T_{in}	°C	10 ... 40				
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10				

Parameter	Symbol	Unit	MAF130D				
			0050	0100	0150	0200	0250
Pressure loss at Q_{min}	Δp	bar	0.3		0.4		
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.02				
Necessary coolant flow at P_V	Q_{min}	l/min	4.6		4.7	4.8	5.0
Volume of coolant duct	V_{cool}	l	0.29				
Maximum allowed inlet pressure	p_{max}	bar	6.0				

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-27: MAF130D - Technical data

4.9.6 Motor characteristic curves MAF130D

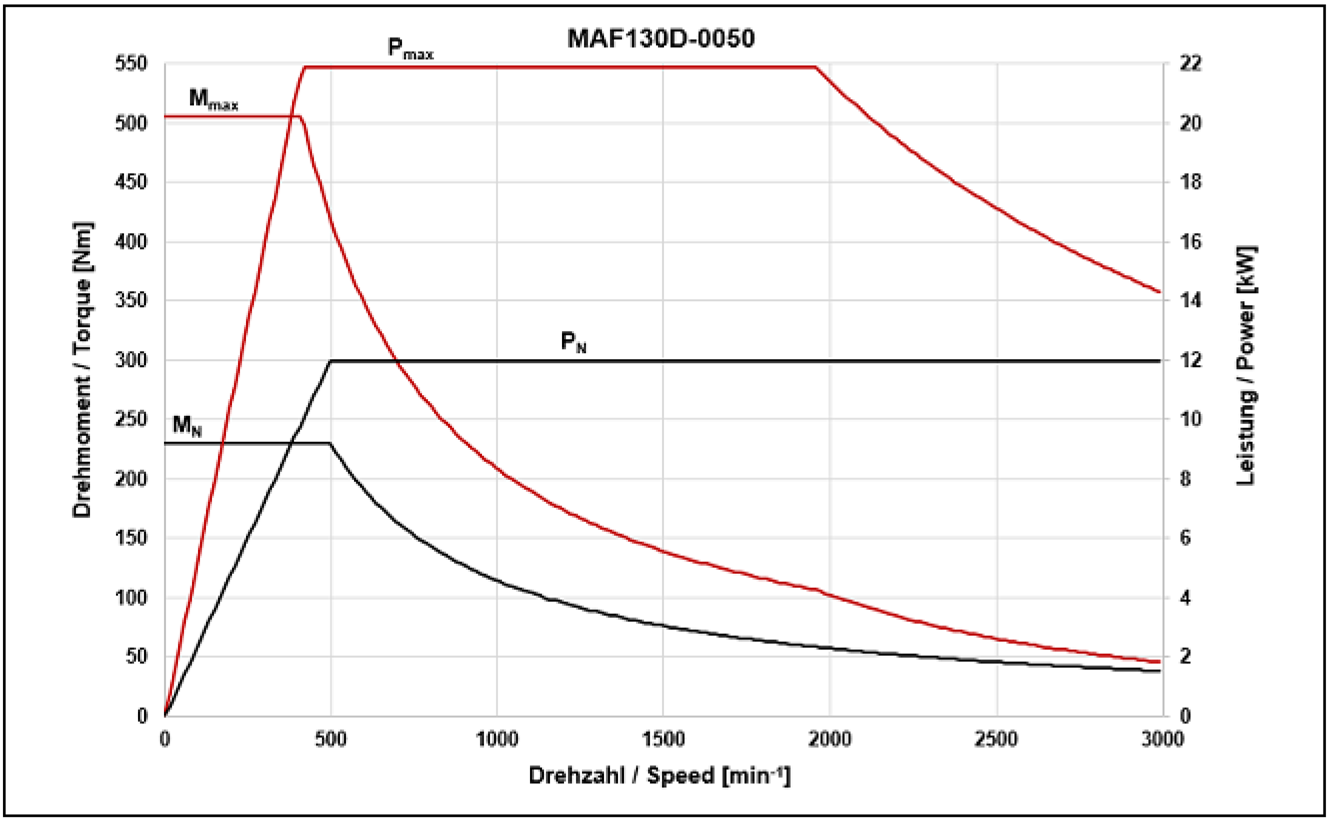


Fig. 4-81: Motor characteristic curve MAF130D-0050

Technical data

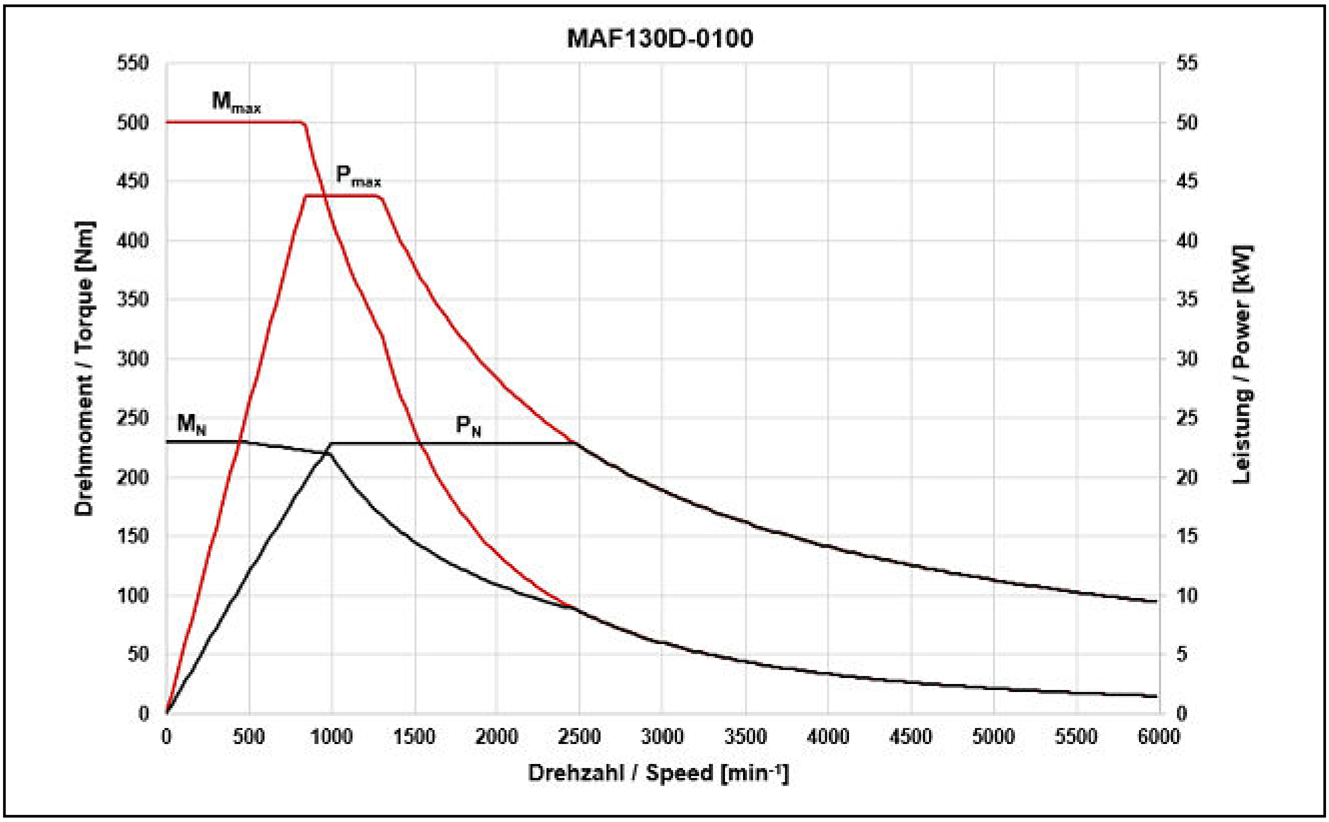


Fig. 4-82: Motor characteristic curve MAF130D-0100

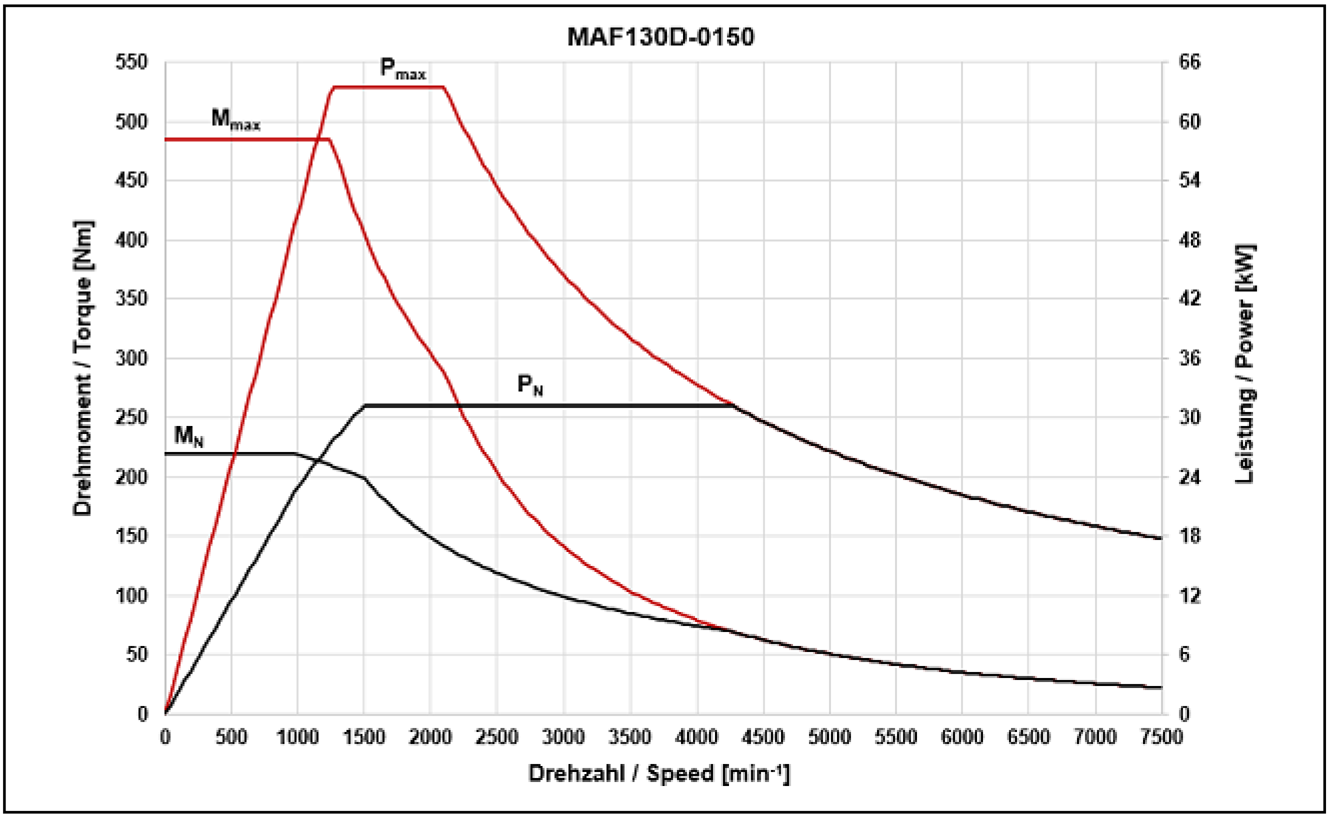


Fig. 4-83: Motor characteristic curve MAF130D-0150

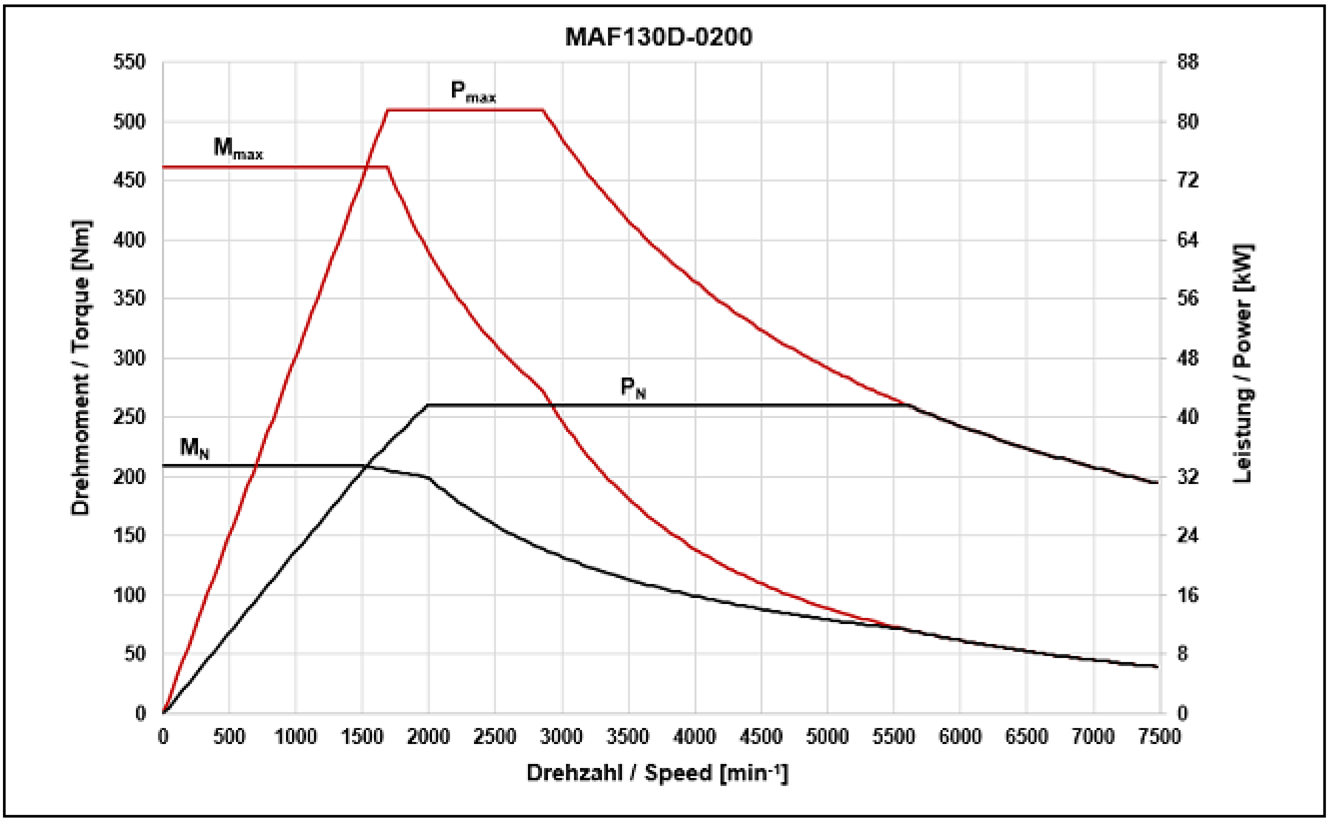


Fig. 4-84: Motor characteristic curve MAF130D-0200

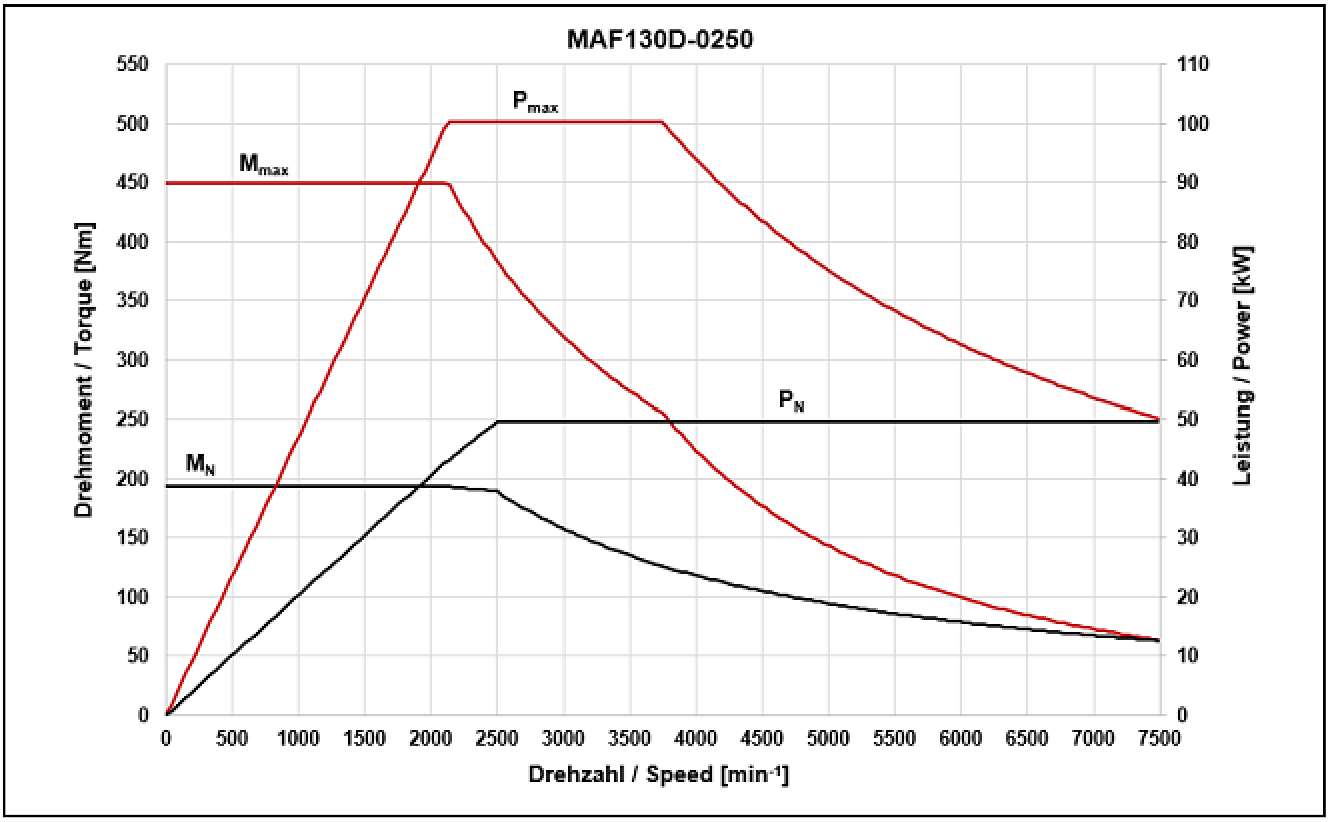


Fig. 4-85: Motor characteristic curve MAF130D-0250

4.9.7 Holding Brake MAD/MAF130 (Optional)

Data sheet - holding brake MAD/MAF130

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	100.0	80.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	1.50	1.60
Moment of inertia of the holding brake	J_{br}	$kg*m^2$	0.003180	0.001710
Connection time	t_1	ms	110	50
Disconnection time	t_2	ms	65	140
Maximum holding brake speed	n_{Br_max}	min^{-1}	8000	

Tab. 4-28: Technical data of holding brake MAD/MAF130 (optional)

4.10 Technical data MAF160

4.10.1 Data sheet MAF160B

<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Symbol</th><th rowspan="2">Unit</th><th colspan="4">MAF160B</th></tr>
<tr><th>0050</th><th>0100</th><th>0150</th><th>0200</th></tr>
<tr><td>Rated torque [1)]</td><td>M_N</td><td>Nm</td><td>270.0</td><td>260.0</td><td>250.0</td><td>240.0</td></tr>
<tr><td>Rated power</td><td>P_N</td><td>kW</td><td>14.10</td><td>27.20</td><td>39.30</td><td>50.30</td></tr>
<tr><td>Rated current</td><td>I_N</td><td>A</td><td>34.2</td><td>73.7</td><td>89.5</td><td>108.5</td></tr>
<tr><td>Rated speed</td><td>n_N</td><td>min^{-1}</td><td>500</td><td>1000</td><td>1500</td><td>2000</td></tr>
<tr><td>Key speed</td><td>n_1</td><td>min^{-1}</td><td colspan="2">500</td><td>1000</td><td>1500</td></tr>
<tr><td>Maximum torque</td><td>M_{max}</td><td>Nm</td><td>594.5</td><td>592.7</td><td>570.8</td><td>550.1</td></tr>
<tr><td>Maximum power</td><td>P_{S6max}</td><td>kW</td><td>28.91</td><td>55.76</td><td>80.57</td><td>103.12</td></tr>
<tr><td>Maximum current</td><td>$I_{max(eff)}$</td><td>A</td><td>65.4</td><td>149.0</td><td>179.7</td><td>232.7</td></tr>
<tr><td>Maximum speed with bearing A</td><td>n_{max}</td><td>min^{-1}</td><td>3000</td><td colspan="3">6000</td></tr>
<tr><td>Maximum speed with bearing H</td><td>n_{max}</td><td>min^{-1}</td><td>3000</td><td>6000</td><td colspan="2">8000</td></tr>
<tr><td>Maximum speed with bearing N</td><td>n_{max}</td><td>min^{-1}</td><td>3000</td><td colspan="3">6000</td></tr>
<tr><td>Maximum speed with bearing V</td><td>n_{max}</td><td>min^{-1}</td><td>3000</td><td colspan="3">6000</td></tr>
<tr><td>Continuous torque at standstill</td><td>M_{n1}</td><td>Nm</td><td colspan="2">270.0</td><td>260.0</td><td>250.0</td></tr>
<tr><td>Continuous current at standstill</td><td>I_{n1}</td><td>A</td><td>34.2</td><td>75.8</td><td>92.1</td><td>112.3</td></tr>
<tr><td>Torque constant at 20 °C</td><td>K_{M_N}</td><td>Nm/A</td><td>9.50</td><td>4.13</td><td>3.30</td><td>2.40</td></tr>
<tr><td>Thermal time constant</td><td>T_{th}</td><td>min</td><td colspan="4">3.5</td></tr>
<tr><td>Cycle duration (S6 - 44%)</td><td>T_C</td><td>min</td><td colspan="4">5</td></tr>
<tr><td>Discharge capacity of the component</td><td>C_{dis}</td><td>nF</td><td>26.9</td><td colspan="2">35.0</td><td>21.7</td></tr>
<tr><td>Number of pole pairs</td><td>p</td><td>--</td><td colspan="4">3</td></tr>
<tr><td>Power wire cross-section</td><td>A</td><td>mm^2</td><td>6.0</td><td colspan="2">25.0</td><td>35.0</td></tr>
<tr><td>Mass</td><td>m_{mot}</td><td>kg</td><td colspan="4">197.0</td></tr>
<tr><td>Moment of inertia of the rotor</td><td>J_{rot}</td><td>kg * m²</td><td colspan="4">0.2300000</td></tr>
<tr><td>Sound pressure level</td><td>L_P</td><td>dB[A]</td><td colspan="4">72 (+3)</td></tr>
<tr><td>Surrounding air temperature during operation</td><td>T_{amb}</td><td>°C</td><td colspan="4">0...+40</td></tr>
<tr><td>Thermal class according to DIN EN 60034-1</td><td>I.CL.</td><td>-</td><td colspan="4">155</td></tr>
<tr><td>Details about liquid cooling</td><td></td><td></td><td colspan="4"></td></tr>
<tr><td>Power loss to be dissipated</td><td>P_V</td><td>kW</td><td>3.10</td><td colspan="2">4.00</td><td>4.50</td></tr>
<tr><td>Coolant inlet temperature</td><td>T_{in}</td><td>°C</td><td colspan="4">10 ... 40</td></tr>
</table>

Parameter	Symbol	Unit	MAF160B			
			0050	0100	0150	0200
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10			
Pressure loss at Q_{min}	Δp	bar	0.05	0.1		
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.004			
Necessary coolant flow at P_V	Q_{min}	l/min	4.4	5.7		6.4
Volume of coolant duct	V_{cool}	l	0.82			
Maximum allowed inlet pressure	p_{max}	bar	6.0			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-29: Technical data MAF160

4.10.2 Motor characteristic curves MAF160B

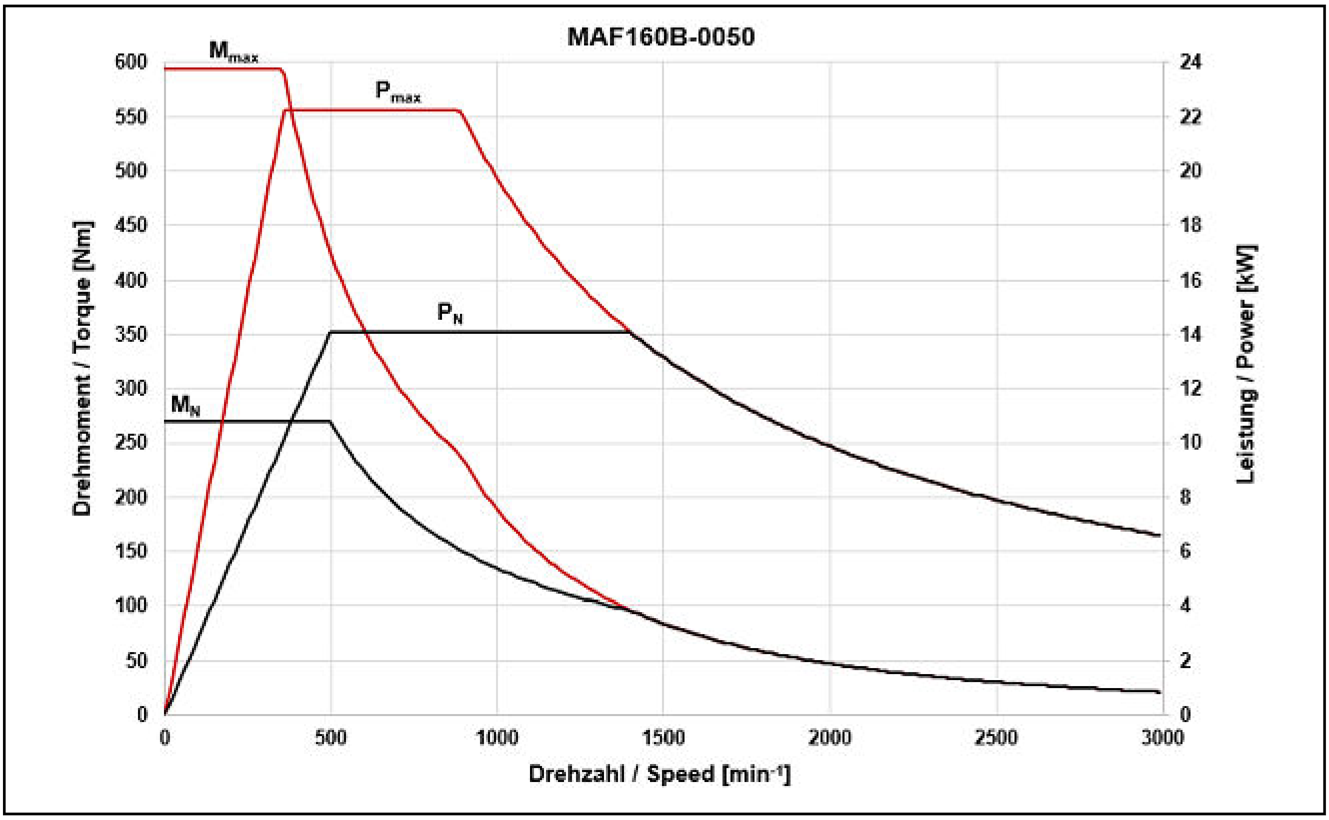


Fig. 4-86: Motor characteristic curve MAF160B-0050

Technical data

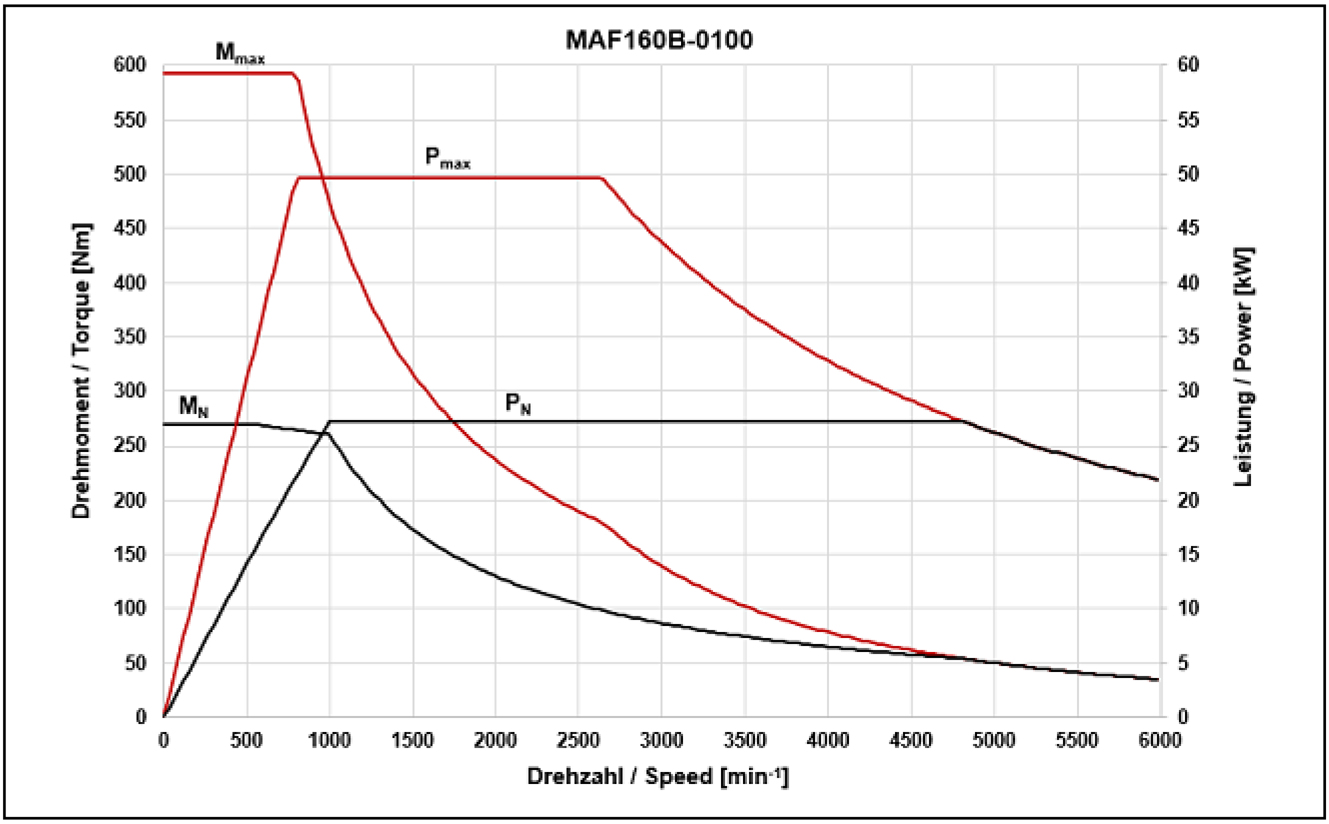


Fig. 4-87: Motor characteristic curve MAF160B-0100

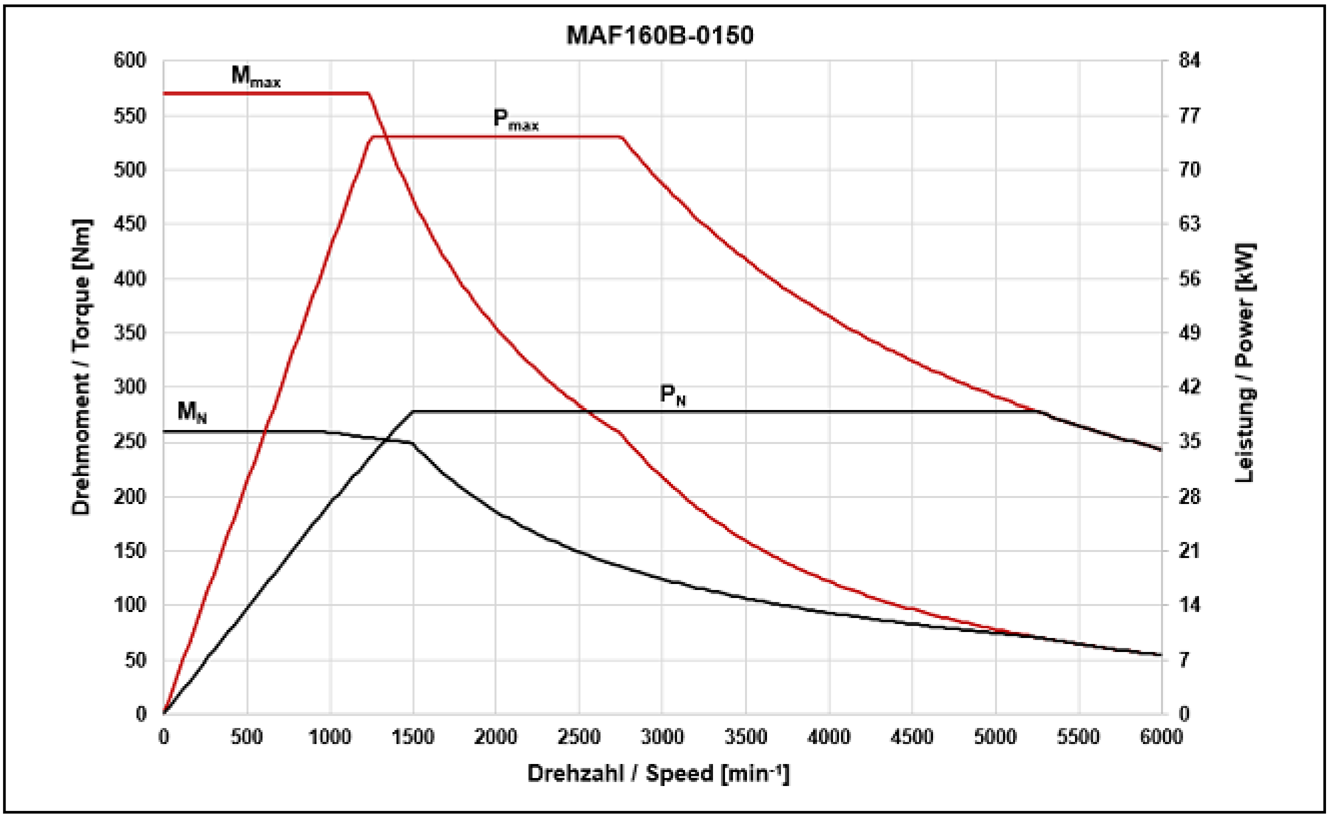


Fig. 4-88: Motor characteristic curve MAF160B-0150

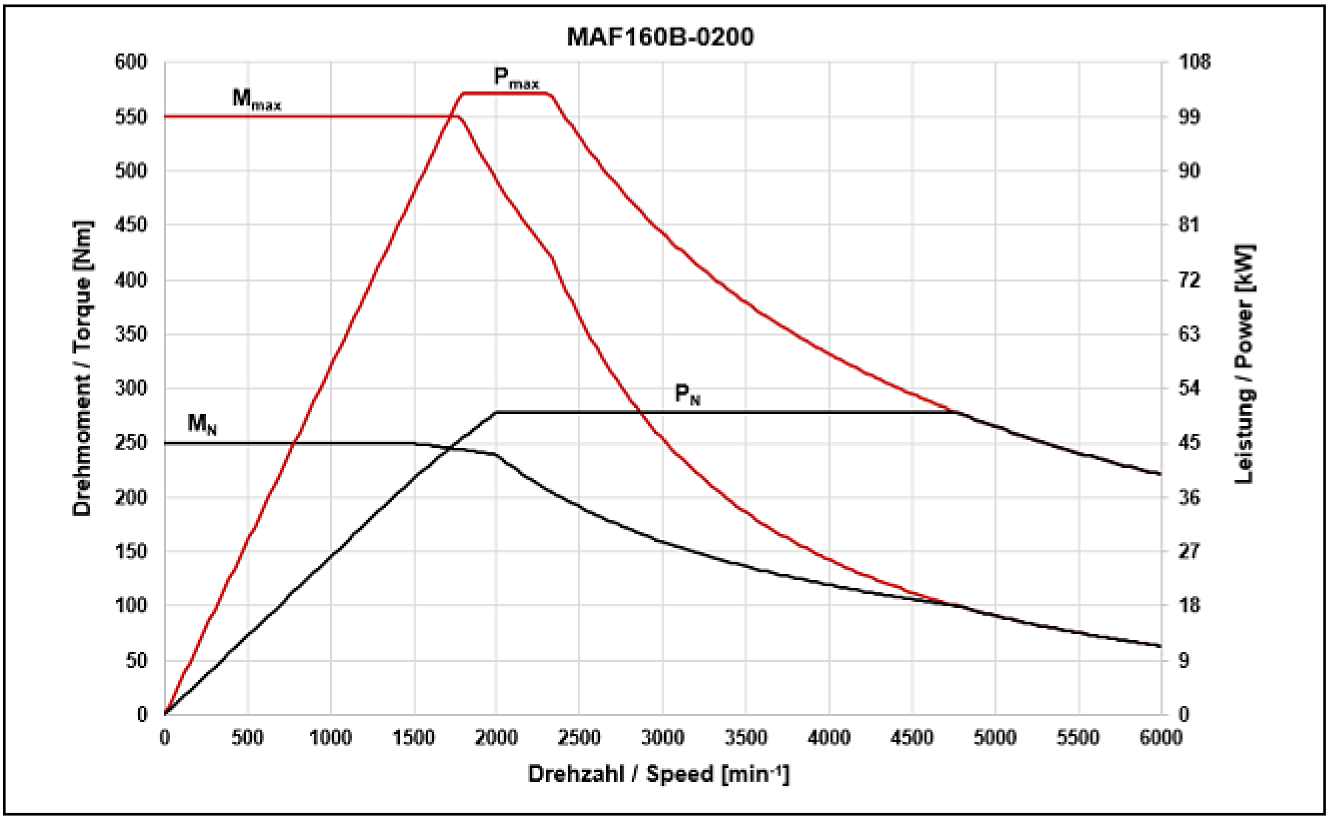


Fig. 4-89: Motor characteristic curve MAF160B-0200

4.10.3 Data sheet MAF160C

Parameter	Symbol	Unit	MAF160C			
			0050	0100	0150	0200
Rated torque [1)]	M_N	Nm	340.0	325.0	300.0	285.0
Rated power	P_N	kW	17.80	34.00	47.10	59.70
Rated current	I_N	A	47.4	91.2	109.5	123.7
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum torque	M_{max}	Nm	747.8	746.4	681.4	677.4
Maximum power	P_{S6max}	kW	36.49	69.70	96.56	122.39
Maximum current	$I_{max(eff)}$	A	98.0	196.0	212.2	290.7
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing H	n_{max}	min^{-1}	3000	6000	8000	
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000		
Continuous torque at standstill	M_{n1}	Nm	340.0		310.0	295.0
Continuous current at standstill	I_{n1}	A	47.4	94.8	111.9	141.4
Torque constant at 20 °C	K_{M_N}	Nm/A	7.76	3.88	3.37	2.30
Thermal time constant	T_{th}	min	3.5			
Cycle duration (S6 - 44%)	T_C	min	5			
Discharge capacity of the component	C_{dis}	nF	28.0		28.8	25.3
Number of pole pairs	p	--	3			
Power wire cross-section	A	mm^2	10.0	25.0	35.0	2 x 25.0
Mass	m_{mot}	kg	227.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.2600000			
Sound pressure level	L_P	dB[A]	72 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class according to DIN EN 60034-1	I.CL.	-	155			
Details about liquid cooling						
Power loss to be dissipated	P_V	kW	3.50	3.70	3.76	4.20
Coolant inlet temperature	T_{in}	°C	10 ... 40			
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10			

Parameter	Symbol	Unit	MAF160C			
			0050	0100	0150	0200
Pressure loss at Q_{min}	Δp	bar	0.1			
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.01		0.004	
Necessary coolant flow at P_V	Q_{min}	l/min	5.0	5.3	5.4	6.0
Volume of coolant duct	V_{cool}	l	0.99			
Maximum allowed inlet pressure	p_{max}	bar	6.0			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-30: Technical data MAF160C

4.10.4 Motor characteristic curves MAF160C

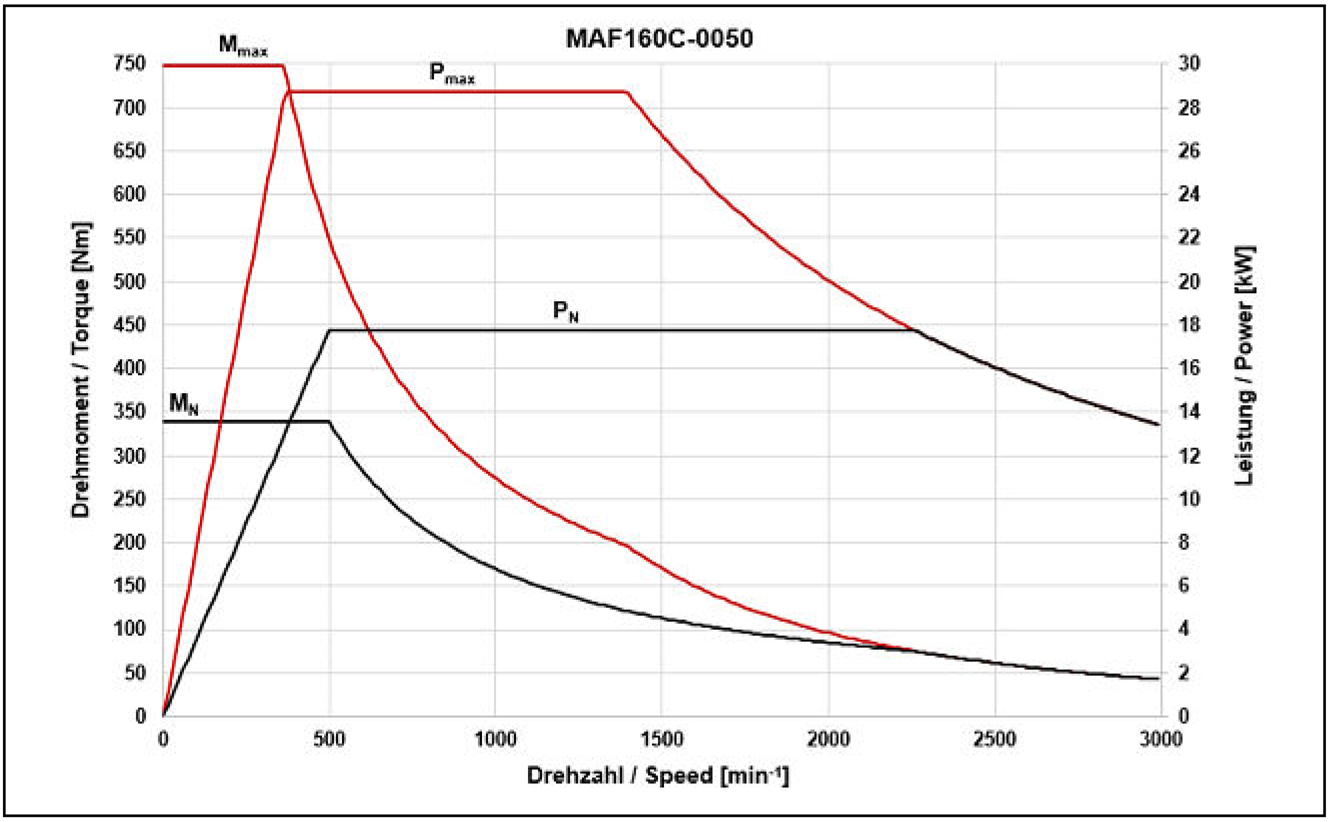


Fig. 4-90: Motor characteristic curve MAF160C-0050

Technical data

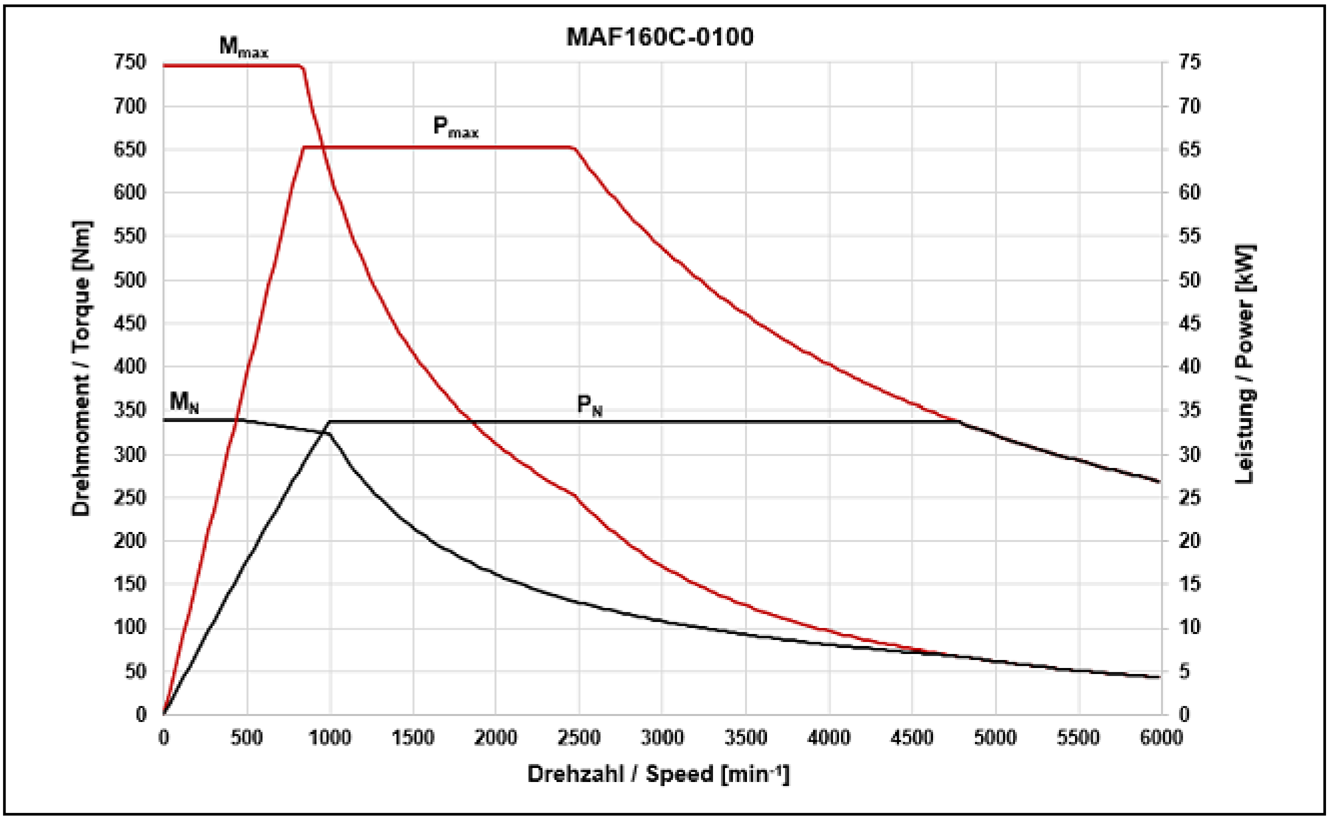


Fig. 4-91: Motor characteristic curve MAF160C-0100

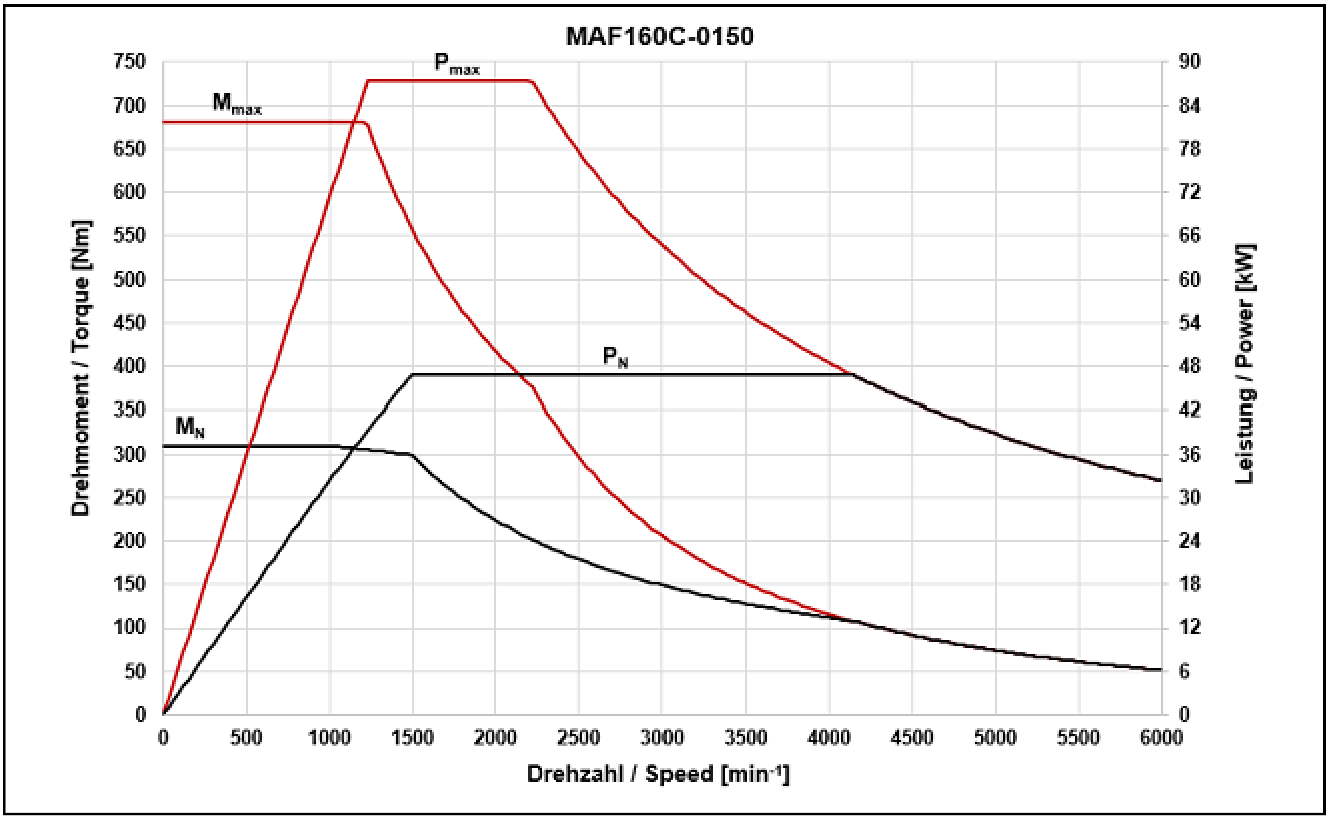


Fig. 4-92: Motor characteristic curve MAF160C-0150

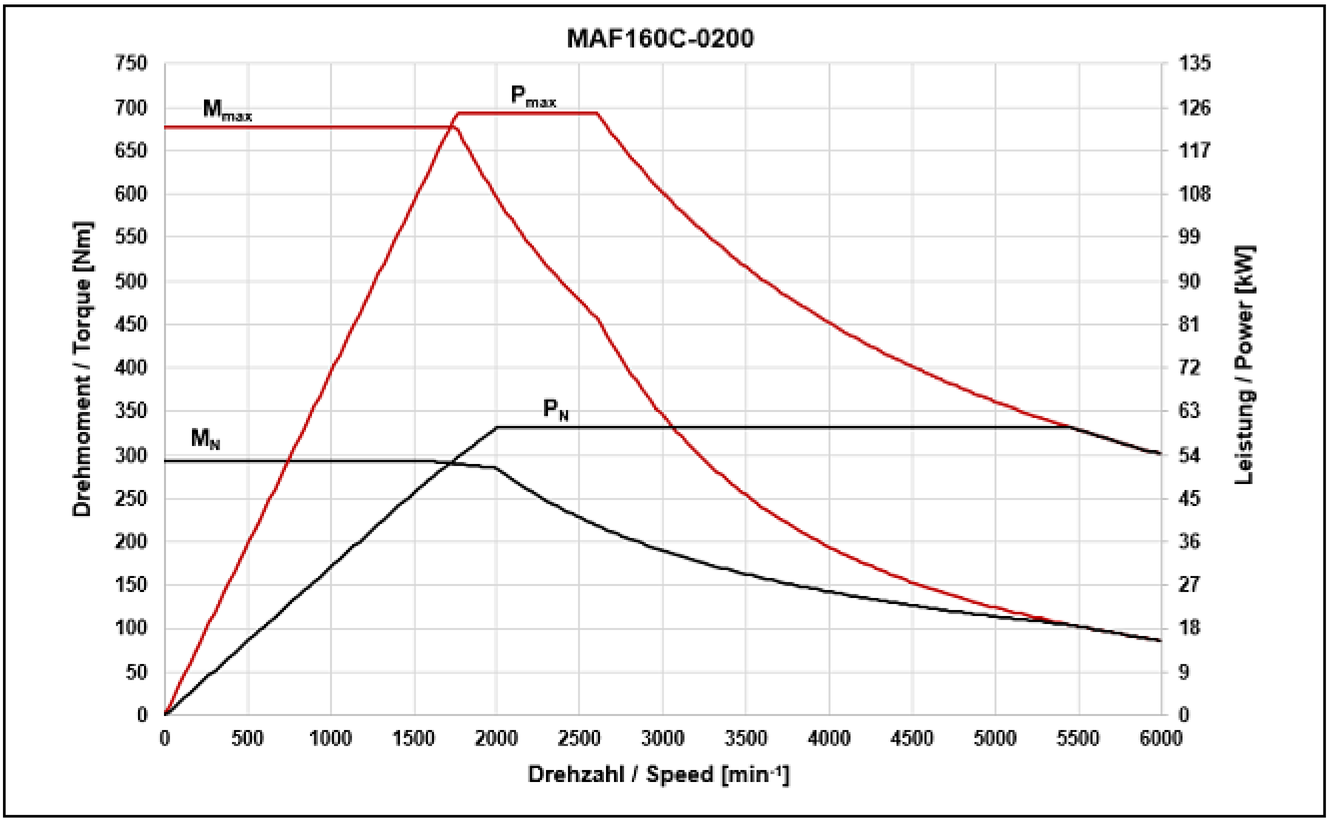


Fig. 4-93: Motor characteristic curve MAF160C-0200

4.10.5 Holding Brake MAD/MAF160 (Optional)

Data sheet - holding brake MAD/MAF160

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 3 (MAD only) Electrically releasing, reinforced design	BRAKE 1 Electrically releasing
Holding torque	M_4	Nm	100.0	240.0	100.0
Rated voltage	U_N	V	24		
Rated current	I_N	A	1.80	1.87	2.00
Holding brake moment of inertia	J_{br}	kg*m^2	0.005010	0.018800	0.005300
Connection time	t_1	ms	85	130	70
Disconnection time	t_2	ms	100	300	190
Maximum holding brake speed	n_{Br_max}	min^{-1}	8,000	6,000	8,000
					Last revision: 2006-10-23

Tab. 4-31: Technical data of holding brake MAD/MAF160 (optional)

4.11 Technical data MAF180

4.11.1 Data sheet MAF180C

Parameter	Symbol	Unit	MAF180C			
			0050	0100	0150	0200
Rated torque [1)]	M_N	Nm	435.0	400.0	365.0	318.0
Rated power	P_N	kW	22.80	41.90	57.33	66.60
Rated current	I_N	A	50.0	93.5	128.8	154.0
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum torque	M_{max}	Nm	986.2	957.0	858.1	739.2
Maximum power	P_{S6max}	kW	46.74	82.00	117.53	136.53
Maximum current	$I_{max(eff)}$	A	104.7	191.4	280.9	318.9
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000		
Continuous torque at standstill	M_{n1}	Nm	435.0		390.0	336.0
Continuous current at standstill	I_{n1}	A	51.2	97.6	136.1	160.5
Torque constant at 20 °C	K_{M_N}	Nm/A	9.61	5.04	3.11	2.39
Thermal time constant	T_{th}	min	3.5			
Cycle duration (S6 - 44%)	T_C	min	5			
Discharge capacity of the component	C_{dis}	nF	32.5	35.9	30.0	38.9
Number of pole pairs	p	--	3			
Power wire cross-section	A	mm^2	10.0	25.0	2 x 25.0	2 x 35.0
Mass	m_{mot}	kg	322.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.4900000			
Sound pressure level	L_P	dB[A]	75 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class according to DIN EN 60034-1	I.CL.	-	155			
Details about liquid cooling						
Power loss to be dissipated	P_V	kW	3.90	4.00	4.50	
Coolant inlet temperature	T_{in}	°C	10 ... 40			
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10			

Parameter	Symbol	Unit	MAF180C			
			0050	0100	0150	0200
Pressure loss at Q_{min}	Δp	bar	0.1		0.2	
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.01			
Necessary coolant flow at P_V	Q_{min}	l/min	5.6	5.7	6.4	
Volume of coolant duct	V_{cool}	l	1.25			
Maximum allowed inlet pressure	p_{max}	bar	6.0			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-32: MAF180C - Technical data

4.11.2 Motor characteristic curves MAF180C

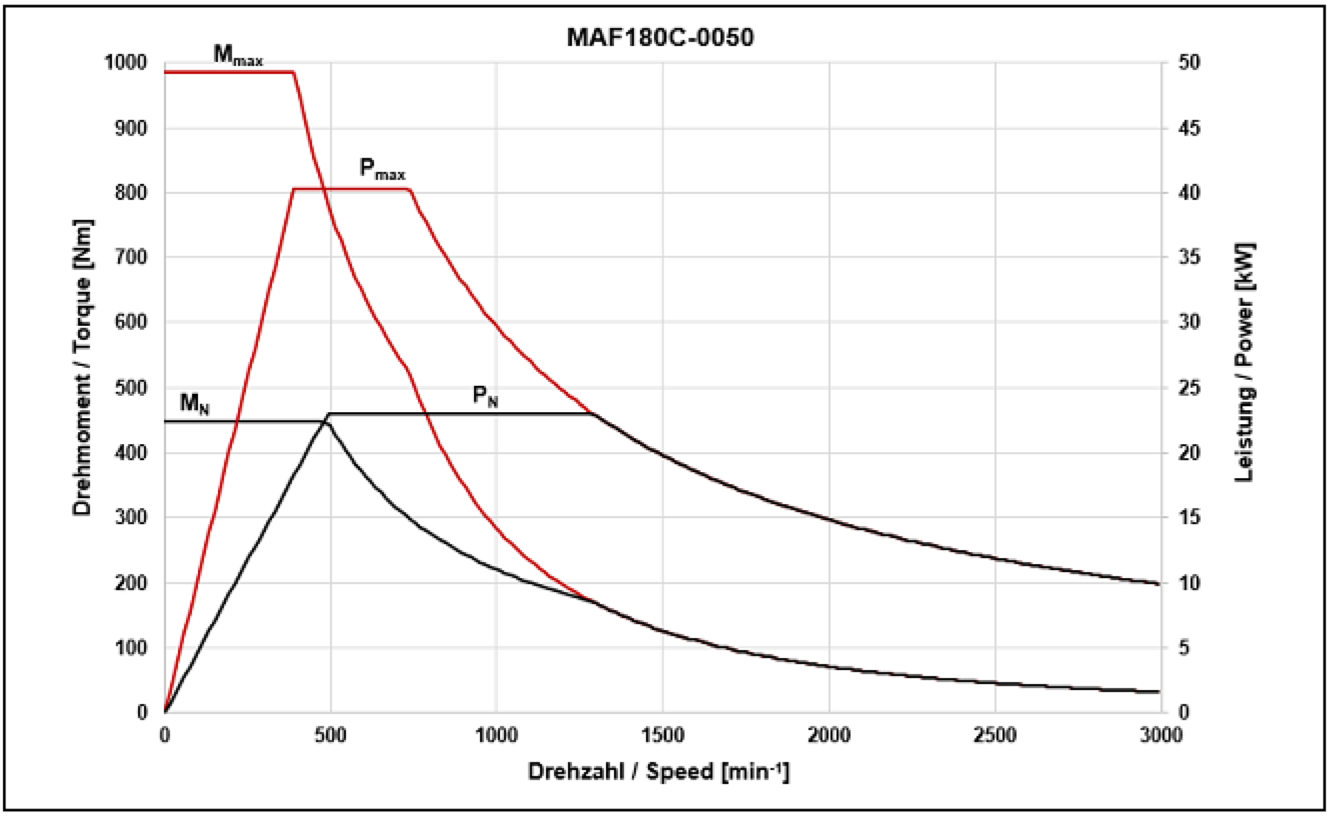


Fig. 4-94: Motor characteristic curve MAF180C-0050

Technical data

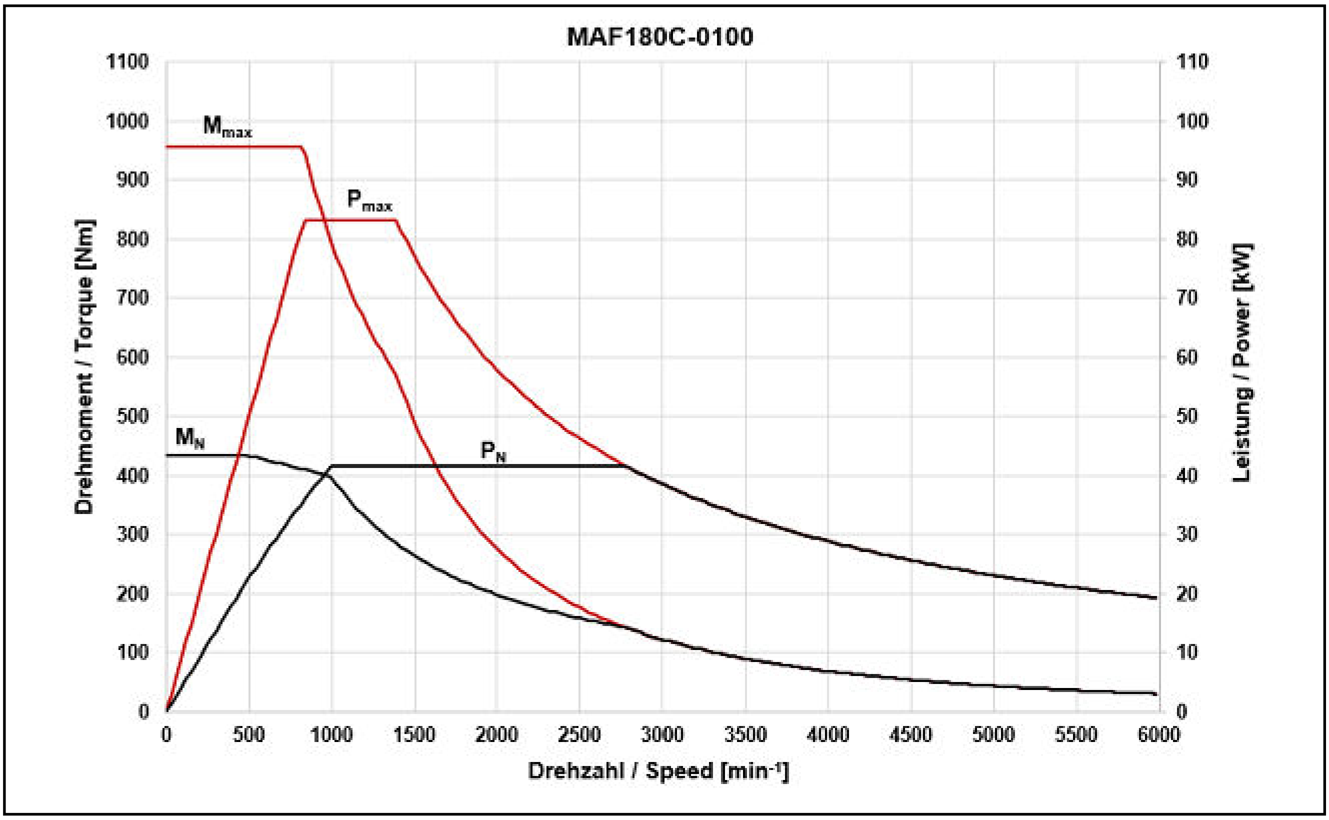


Fig. 4-95: Motor characteristic curve MAF180C-0100

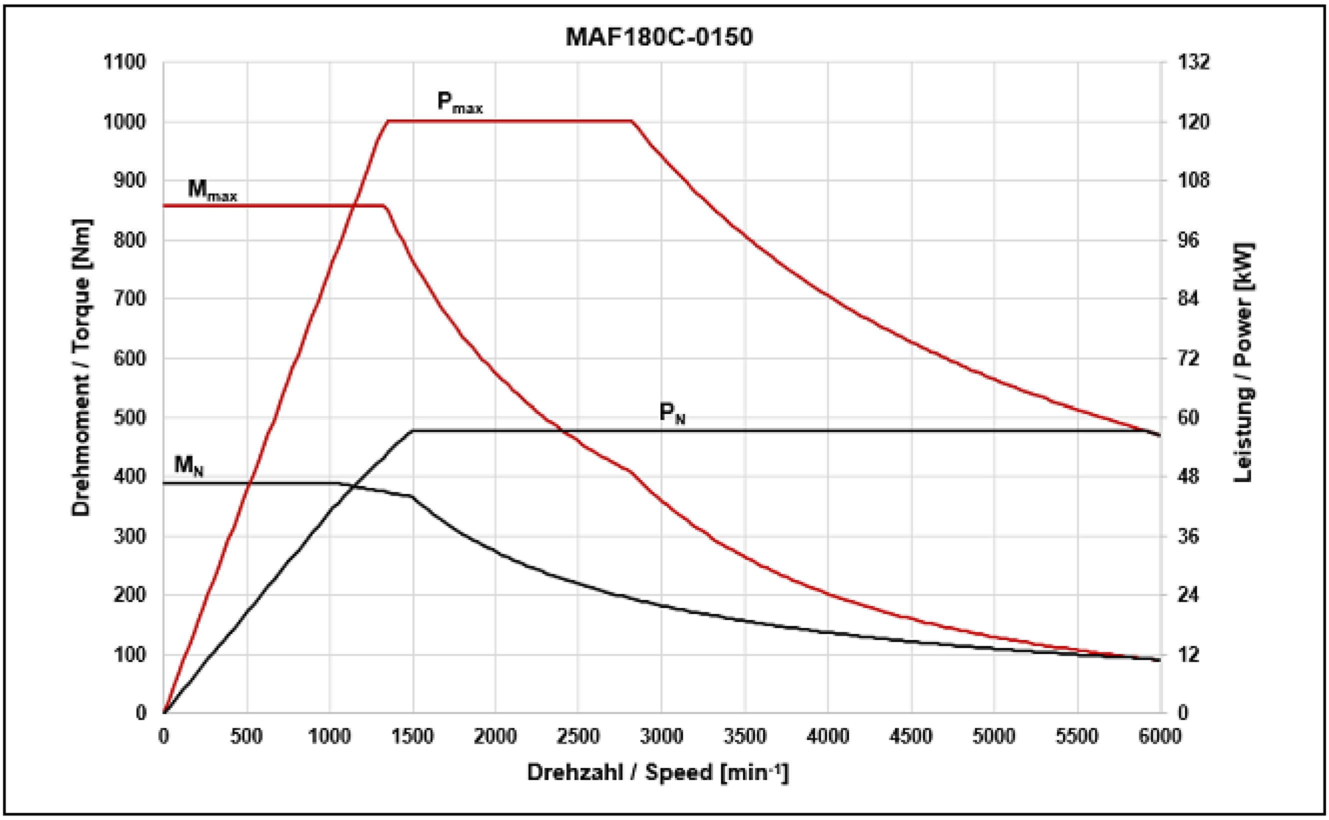


Fig. 4-96: Motor characteristic curve MAF180C-0150

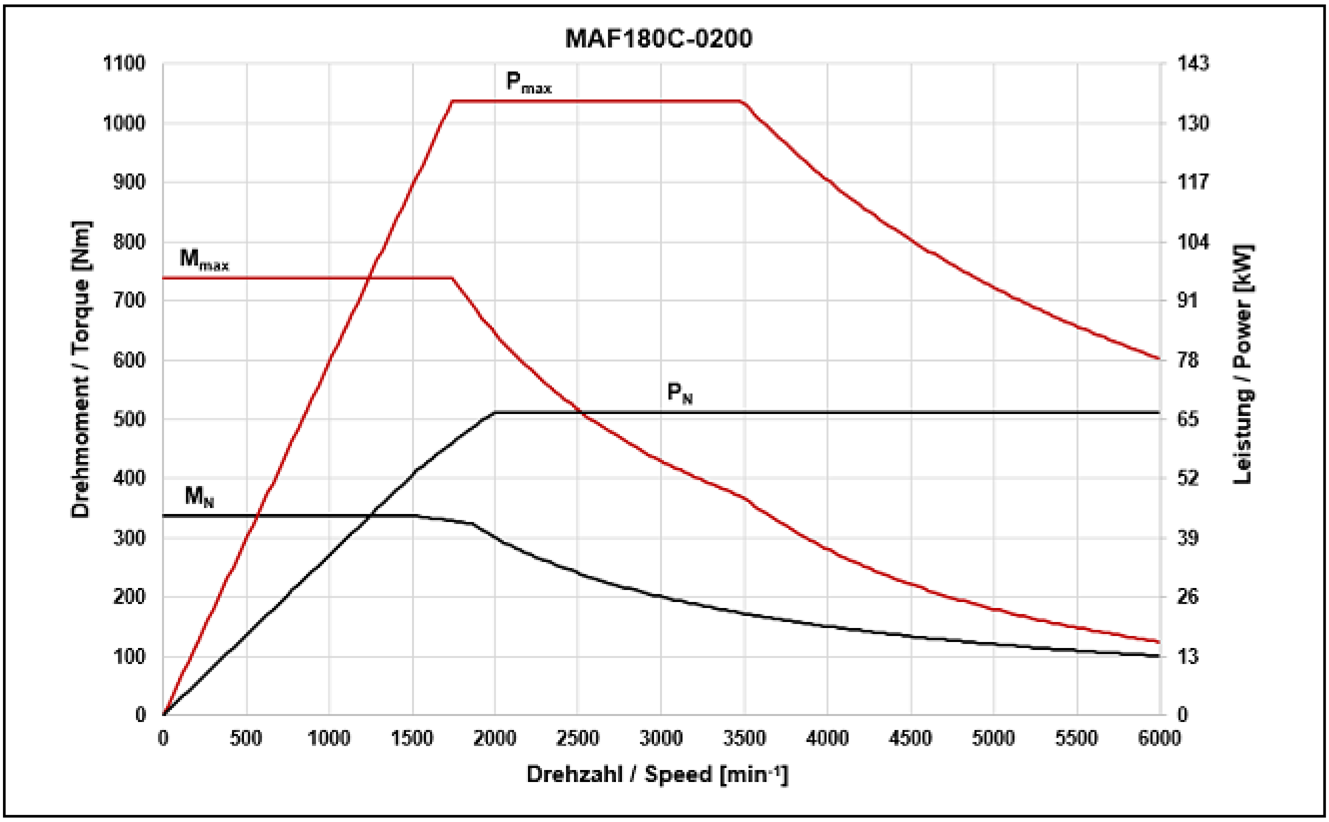


Fig. 4-97: Motor characteristic curve MAF180C-0200

4.11.3 Data sheet MAF180D

Parameter	Symbol	Unit	MAF180D			
			0050	0100	0150	0200
Rated torque [1)]	M_N	Nm	500.0		435.0	400.0
Rated power	P_N	kW	26.20	52.36	68.33	83.80
Rated current	I_N	A	60.4	106.5	146.1	168.5
Rated speed	n_N	min^{-1}	500	1000	1500	2000
Key speed	n_1	min^{-1}	500		1000	1500
Maximum torque	M_{max}	Nm	1100.2	1100.0	1013.0	1008.0
Maximum power	P_{S6max}	kW	53.71	120.00	140.08	171.79
Maximum current	$I_{max(eff)}$	A	117.3	208.2	296.2	377.1
Maximum speed with bearing A	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing N	n_{max}	min^{-1}	3000	6000		
Maximum speed with bearing V	n_{max}	min^{-1}	3000	6000		
Continuous torque at standstill	M_{n1}	Nm	500.0	525.0	460.0	
Continuous current at standstill	I_{n1}	A	60.4	109.5	146.1	187.3
Torque constant at 20 °C	K_{M_N}	Nm/A	10.00	4.98	3.31	2.75
Thermal time constant	T_{th}	min	9.1			
Cycle duration (S6 - 44%)	T_C	min	5	1	5	
Discharge capacity of the component	C_{dis}	nF	37.4	34.1	30.3	50.0
Number of pole pairs	p	--	3			
Power wire cross-section	A	mm^2	16.0	35.0	2 x 25.0	2 x 35.0
Mass	m_{mot}	kg	382.0			
Moment of inertia of the rotor	J_{rot}	kg * m²	0.6100000			
Sound pressure level	L_P	dB[A]	75 (+3)			
Surrounding air temperature during operation	T_{amb}	°C	0...+40			
Thermal class according to DIN EN 60034-1	I.CL.	-	155			
Details about liquid cooling						
Power loss to be dissipated	P_V	kW	3.50	4.39	3.62	5.40
Coolant inlet temperature	T_{in}	°C	10 ... 40			
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10			
Pressure loss at Q_{min}	Δp	bar	0.1	0.5	0.1	0.2

Parameter	Symbol	Unit	MAF180D			
			0050	0100	0150	0200
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.01	0.02	0.01	
Necessary coolant flow at P_V	Q_{min}	l/min	5.0	6.3	5.2	7.7
Volume of coolant duct	V_{cool}	l	1.45			
Maximum allowed inlet pressure	p_{max}	bar	6.0			

1) Please note the information on the specified parameters at the beginning of this chapter

Tab. 4-33: MAF180D - Technical data

4.11.4 Motor characteristic curves MAF180D

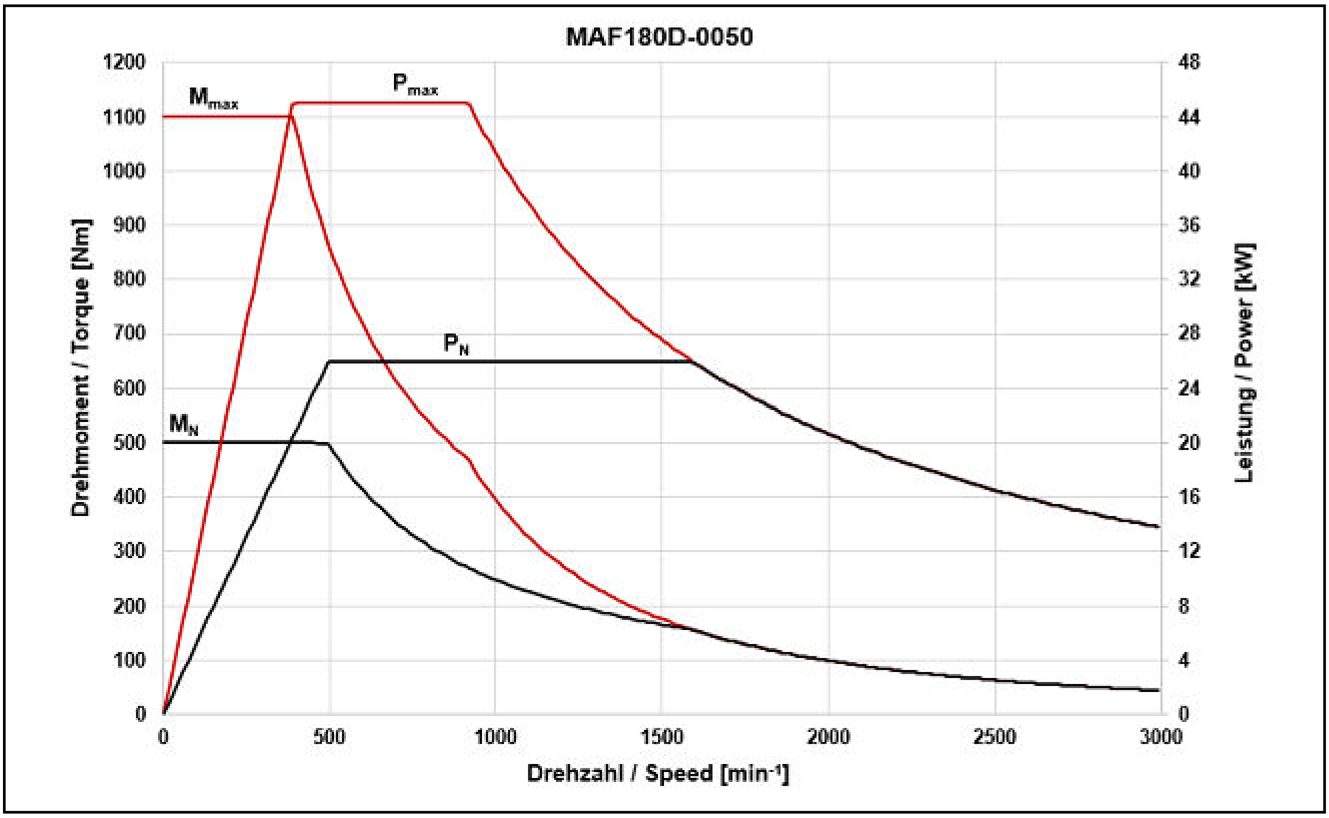


Fig. 4-98: Motor characteristic curve MAF180D-0050

Technical data

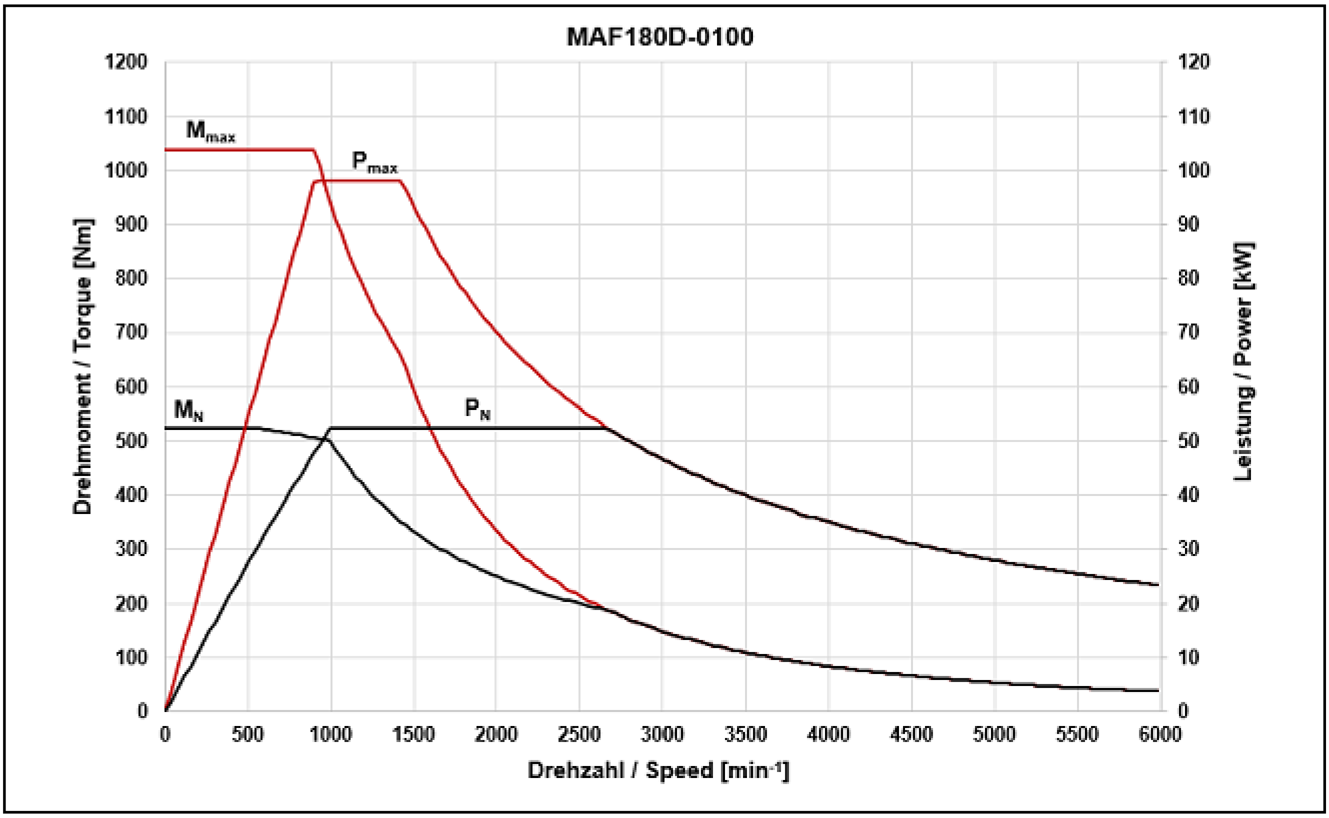


Fig. 4-99: Motor characteristic curve MAF180D-0100

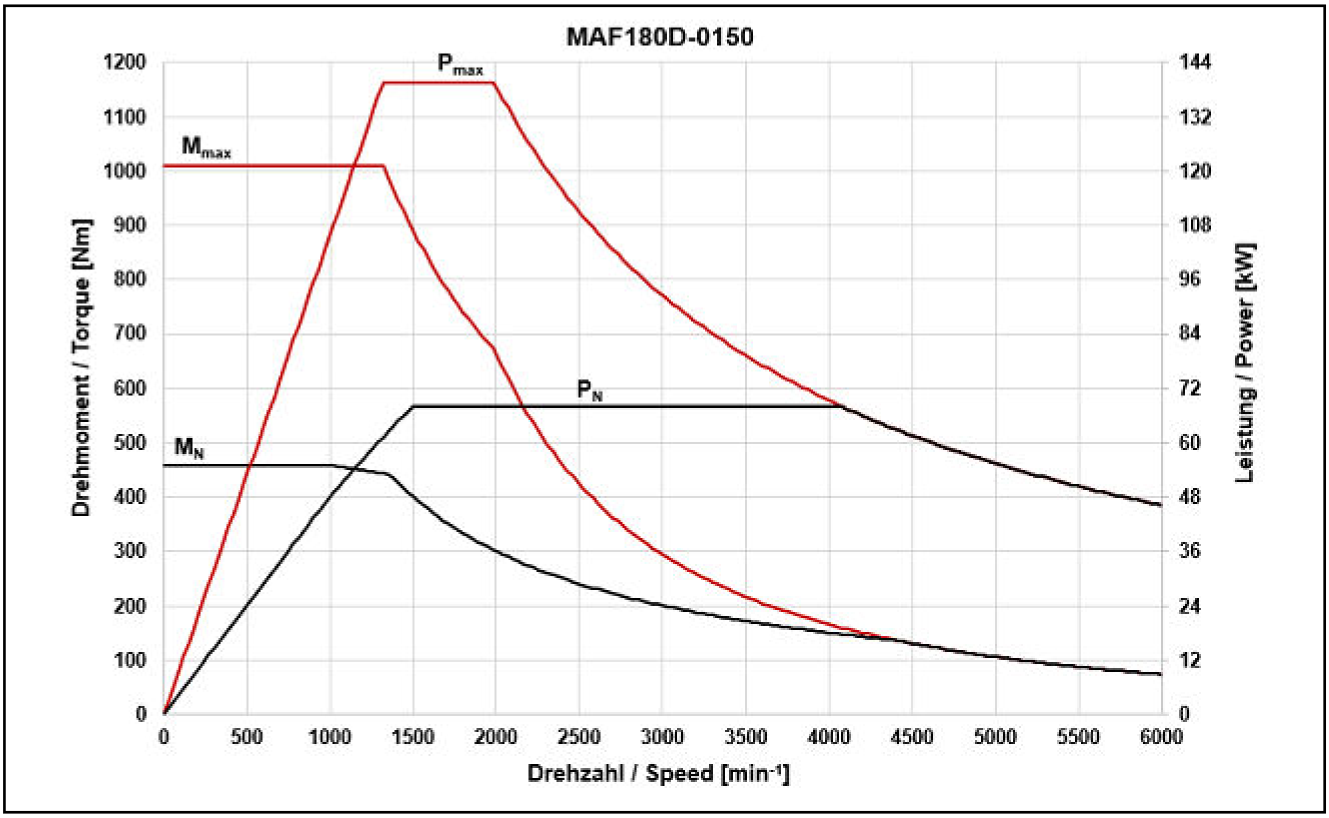


Fig. 4-100: Motor characteristic curve MAF180D-0150

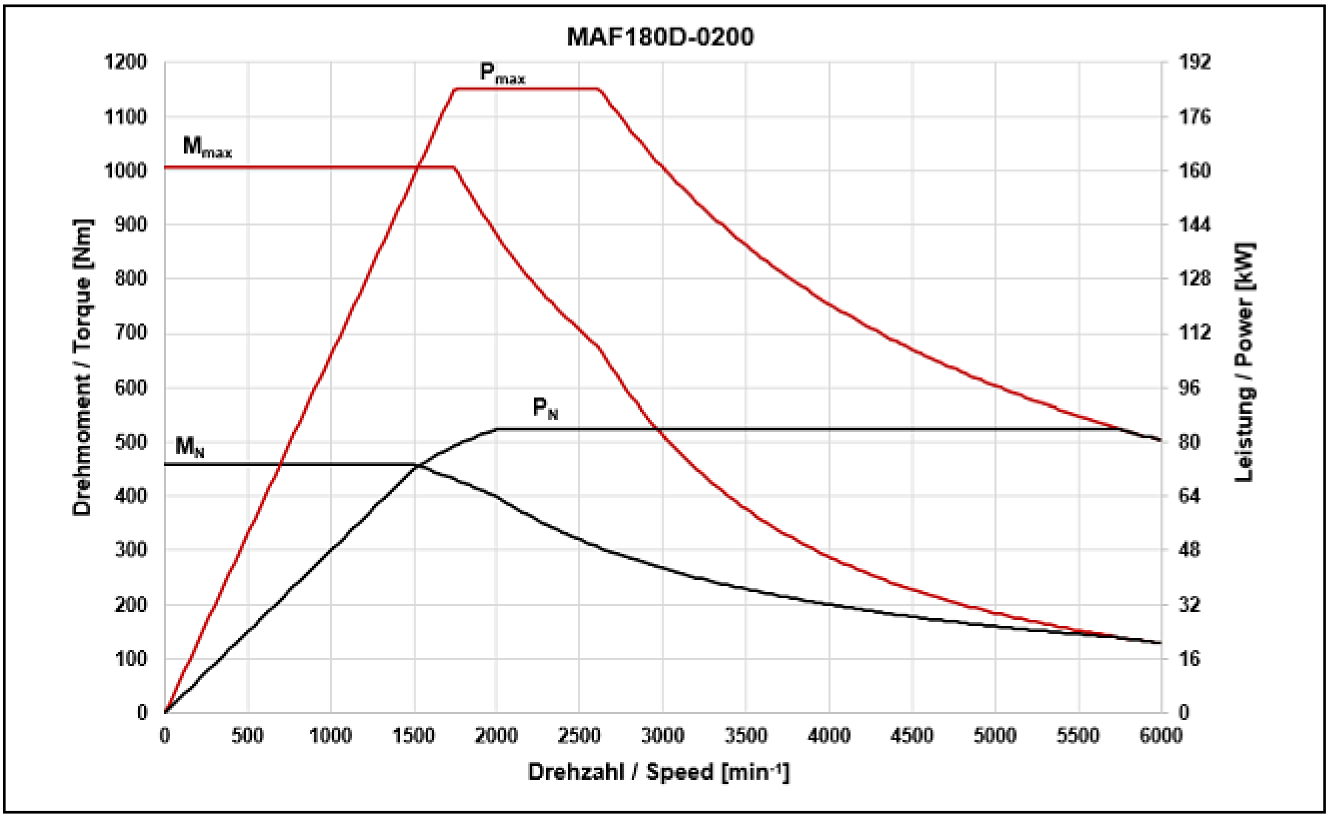


Fig. 4-101: Motor characteristic curve MAF180D-0200

4.11.5 Holding Brake MAD/MAF180 (Optional)

Data sheet - holding brake MAD/MAF180

Designation	Symbol	Unit	BRAKE 5 Electrically clamping	BRAKE 2 Electrically releasing
Holding torque	M_4	Nm	300.0	240.0
Rated voltage	U_N	V	24	
Rated current	I_N	A	2.00	1.87
Holding brake moment of inertia	J_{br}	kg*m²	0.018800	
Connection time	t_1	ms	150	130
Disconnection time	t_2	ms	90	300
Maximum holding brake speed	n_{Br_max}	min^{-1}	6,000	
Last revision: 2006-10-20				

Tab. 4-34: Technical data of holding brake MAD/MAF180 (optional)

4.12 Technical data MAF225

4.12.1 Data sheet MAF225C

Data sheet MAF225C

Parameter	Symbol	Unit	MAF225C		
			0050*	0100	0150
Rated torque [1)]	M_N	Nm	860.0	820.0	764.0
Rated power	P_N	kW	45.03	85.90	120.01
Rated current	I_N	A	98.0	165.0	211.2
Rated speed	n_N	min^{-1}	500	1000	1500
Key speed	n_1	min^{-1}	500		1000
Maximum torque	M_{max}	Nm	1750.0		1814.0
Maximum power	P_{S6max}	kW	92.31	200.00	246.02
Maximum current	$I_{max(eff)}$	A	207.6	355.0	489.2
Maximum speed with bearing N	n_{max}	min^{-1}	3000	3750	
Maximum speed with bearing V	n_{max}	min^{-1}	3000	3750	
Continuous torque at standstill	M_{n1}	Nm	860.0	950.0	825.0
Continuous current at standstill	I_{n1}	A	98.0	183.0	228.0
Torque constant at 20 °C	K_{M_N}	Nm/A	9.74	5.21	3.75
Thermal time constant	T_{th}	min	3.5		
Cycle duration (S6 - 44%)	T_C	min	5		
Discharge capacity of the component	C_{dis}	nF	40.0	39.7	43.9
Number of pole pairs	p	--	3		
Power wire cross-section	A	mm^2	35.0	2 x 35.0	2 x 50.0
Mass	m_{mot}	kg	587.0		
Moment of inertia of the rotor	J_{rot}	kg * m²	1.6500000		
Sound pressure level	L_P	dB[A]	75 (+3)		
Surrounding air temperature during operation	T_{amb}	°C	0...+40		
Insulation class according to DIN EN 60034-1	---	-	155		
Details about liquid cooling					
Power loss to be dissipated	P_V	kW	6.40	6.62	8.02
Coolant inlet temperature	T_{in}	°C	10 ... 40		
Allowed coolant temperature rise at P_V	ΔT_{max}	K	10		
Pressure loss at Q_{min}	Δp	bar	0.4		0.6

Parameter	Symbol	Unit	MAF225C		
			0050*	0100	0150
Constant for determining the pressure drop with water as cooling medium	$K_{\Delta p}$	-	0.01		
Necessary coolant flow at P_V	Q_{min}	l/min	9.2	9.5	11.5
Volume of coolant duct	V_{cool}	l	1.86		
Maximum allowed inlet pressure	p_{max}	bar	6.0		

1) Please note the information on the specified parameters at the beginning of this chapter

* Provisional values

Tab. 4-35: Technical data of MAF225

4.12.2 Motor characteristic curves MAF225C

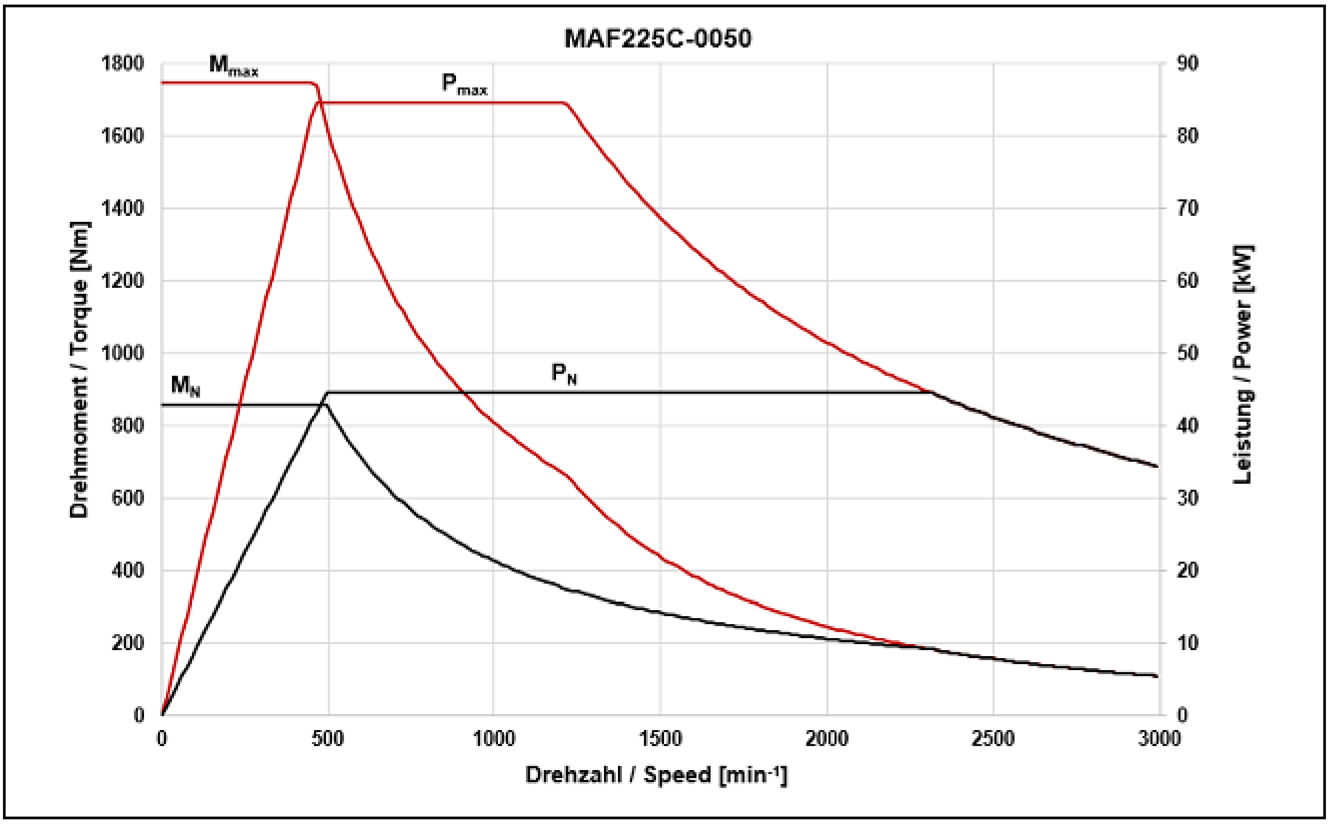


Fig. 4-102: Motor characteristic curves MAF225C-0050

Technical data

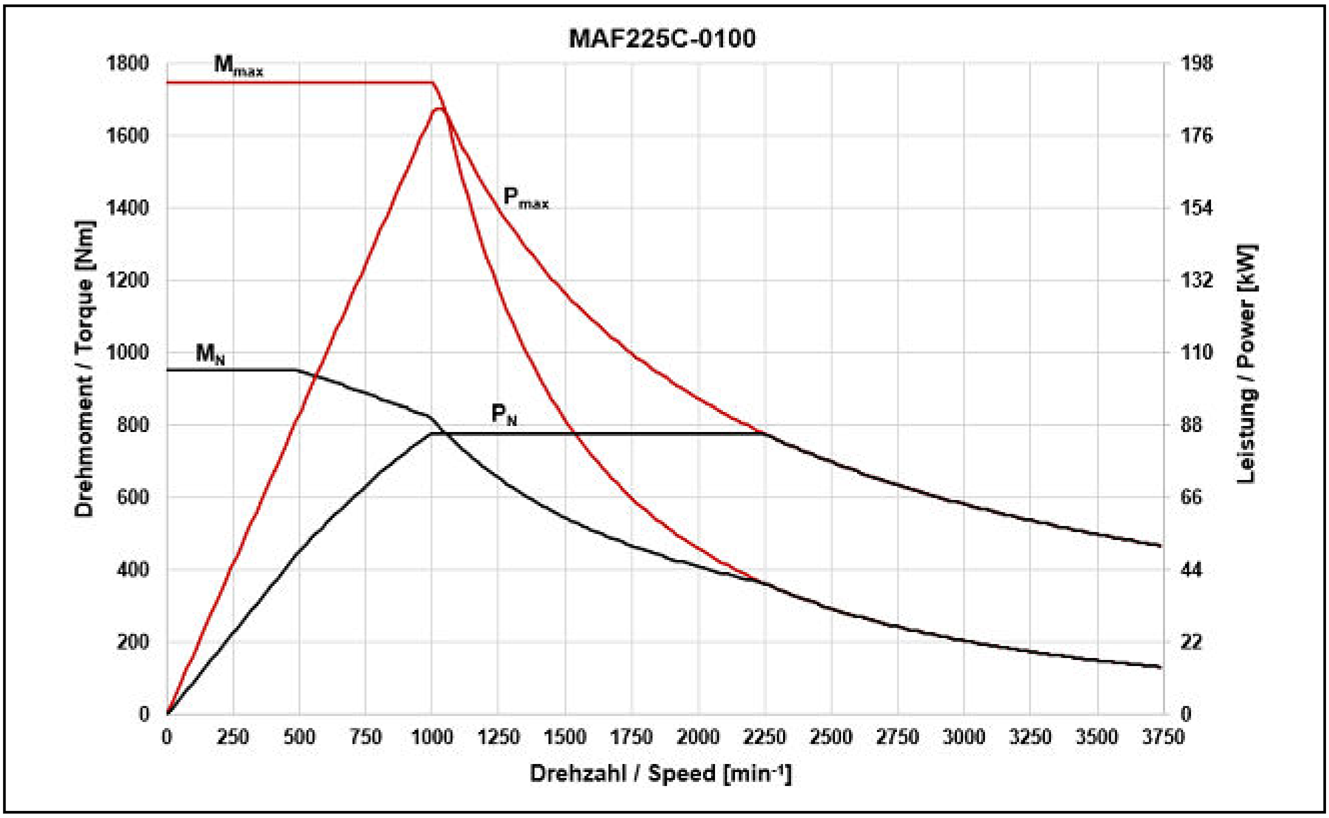


Fig. 4-103: Motor characteristic curve MAF225C-0100

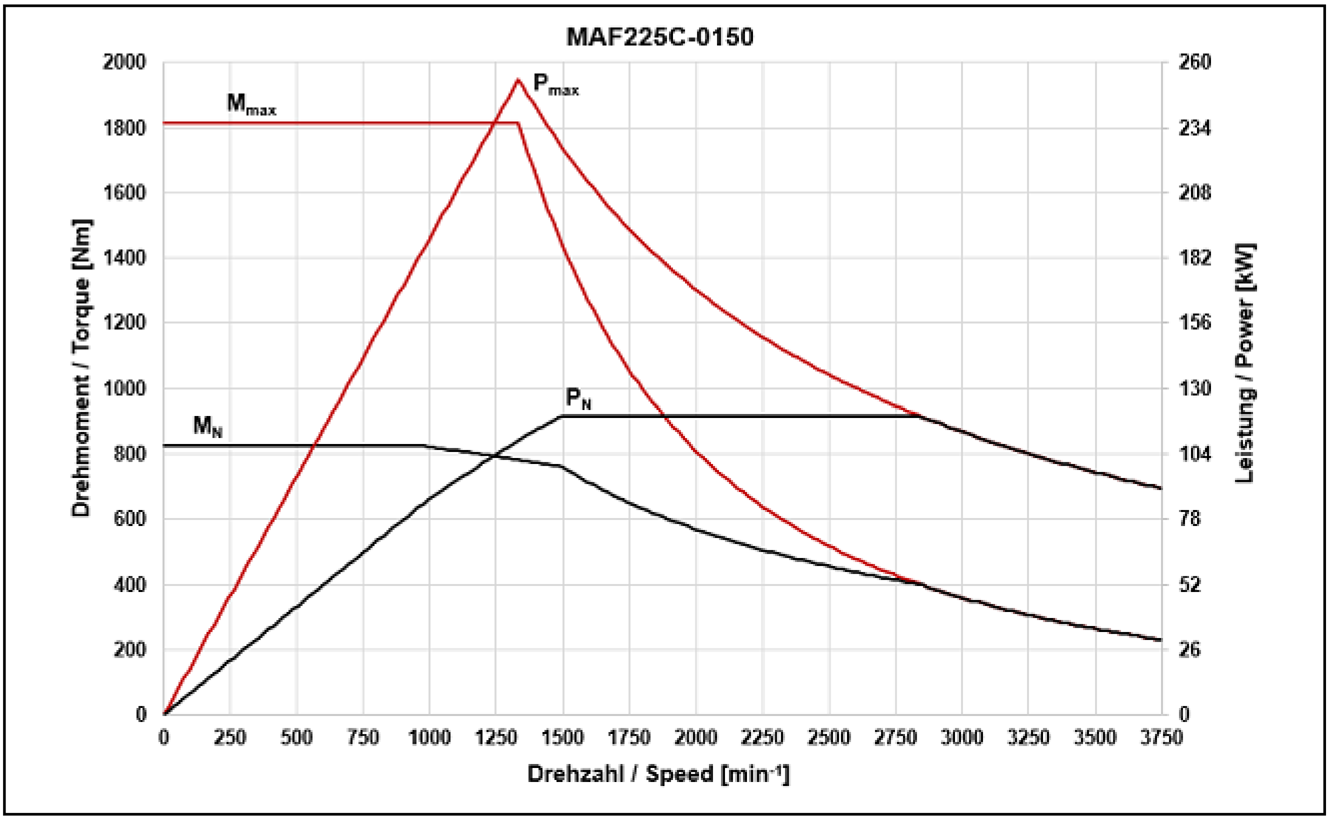
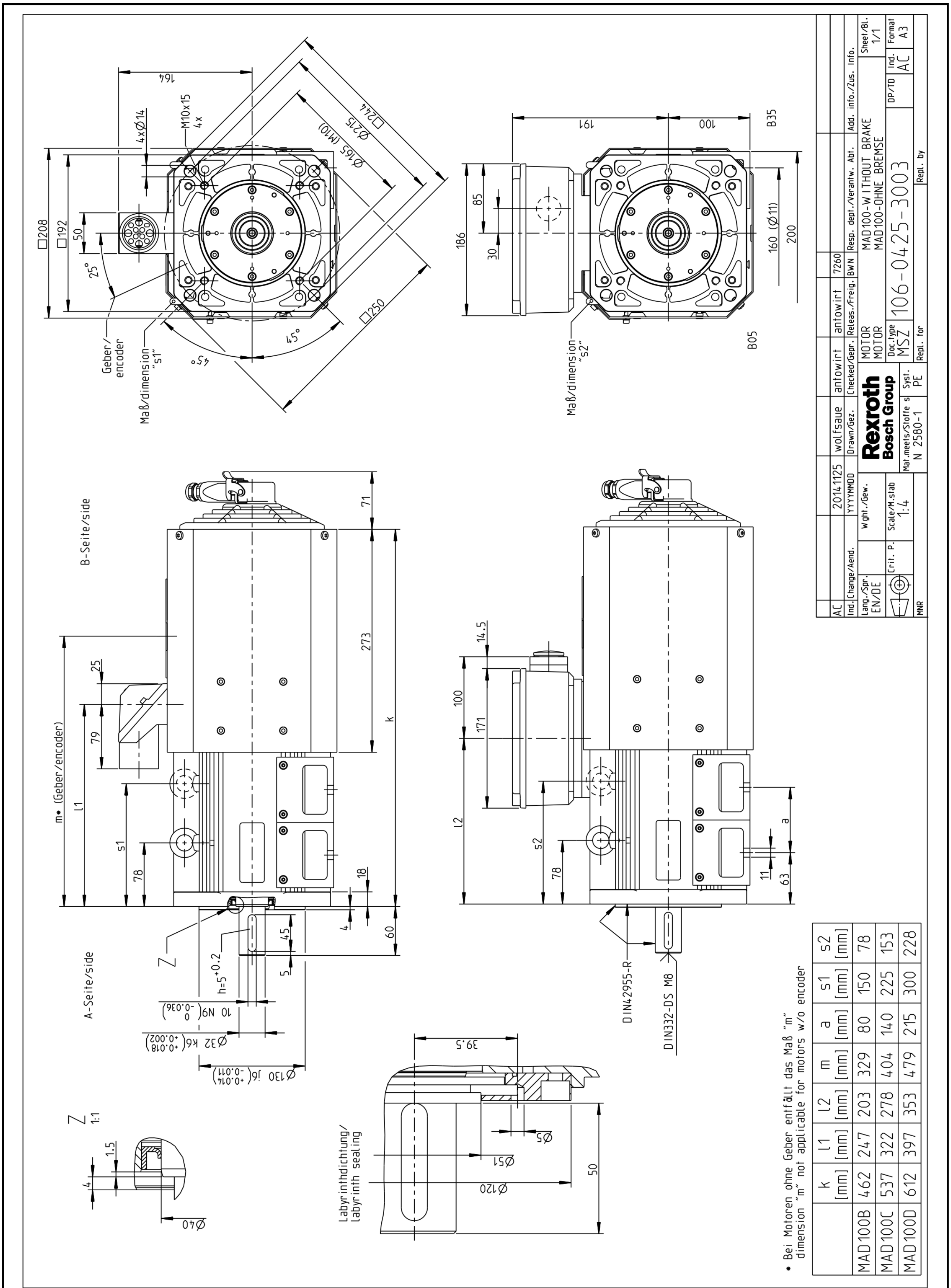


Fig. 4-104: Motor characteristic curve MAF225C-0150

5 Dimension drawings IndraDyn A

5.1 Frame size MAD100

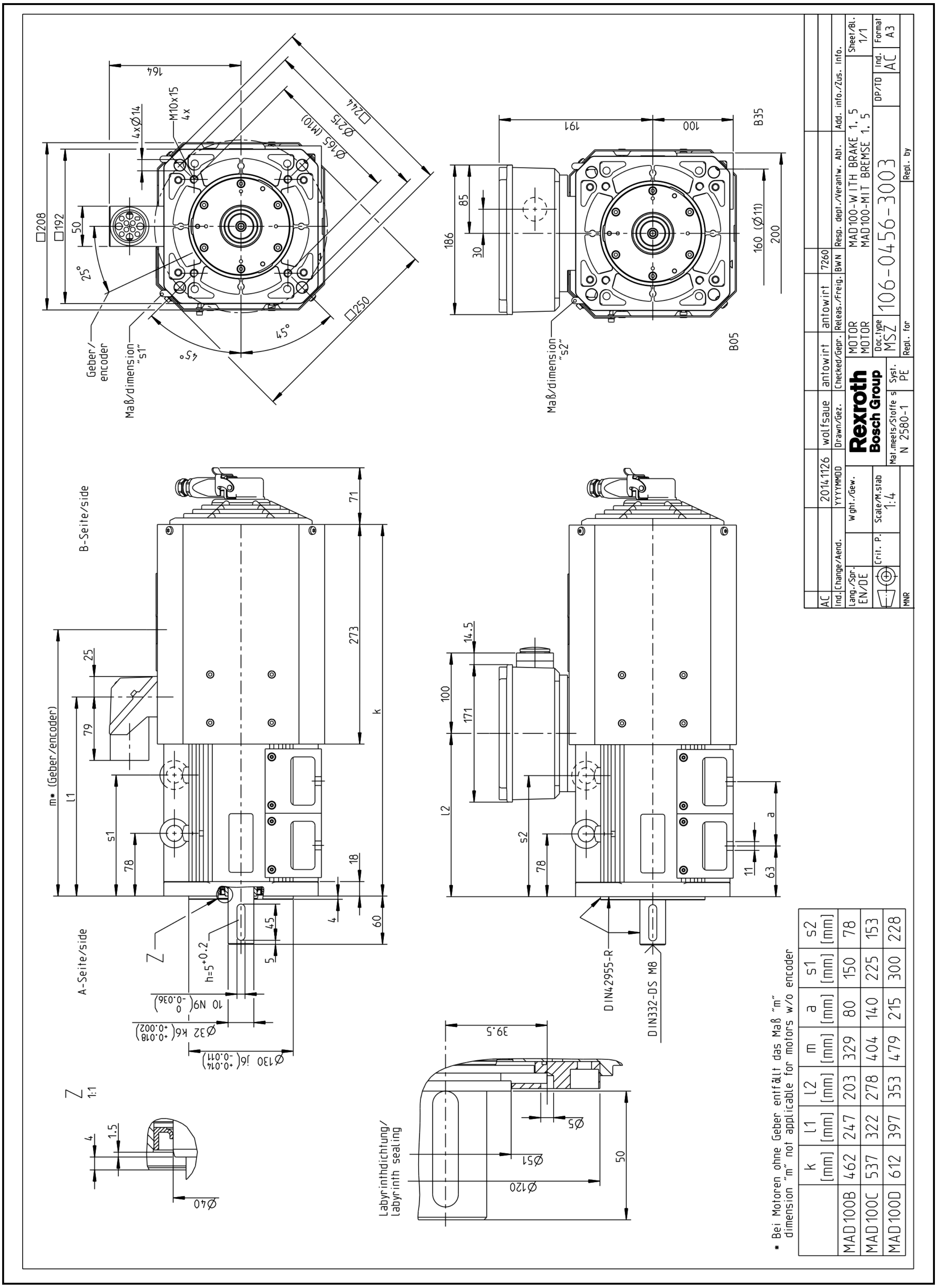
5.1.1 MAD100 without brake



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	s1 [mm]	s2 [mm]
MAD100B	462	247	203	329	80	150	78
MAD100C	537	322	278	404	140	225	153
MAD100D	612	397	353	479	215	300	228

Dimension drawings IndraDyn A

5.1.2 MAD100 with brake 1 or 5



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	s1 [mm]	s2 [mm]
MAD100B	462	247	203	329	80	150	78
MAD100C	537	322	278	404	140	225	153
MAD100D	612	397	353	479	215	300	228

* Bei Motoren ohne Geber entfällt das Maß "m"
dimension "m" not applicable for motors w/o encoder

Fig. 5-2: MAD100 with brake 1/5

5.1.3 MAD100 with fan shroud, without brake

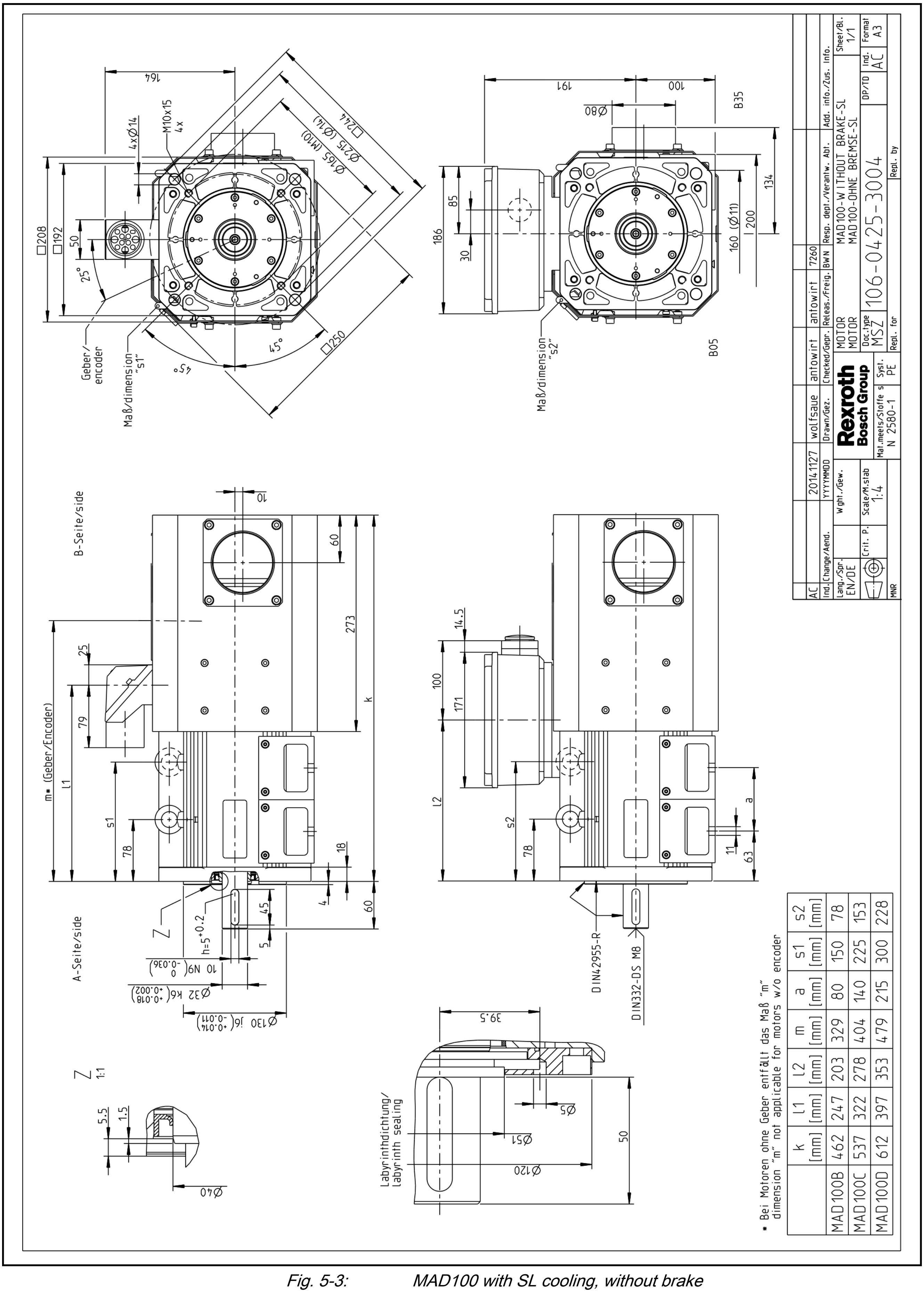
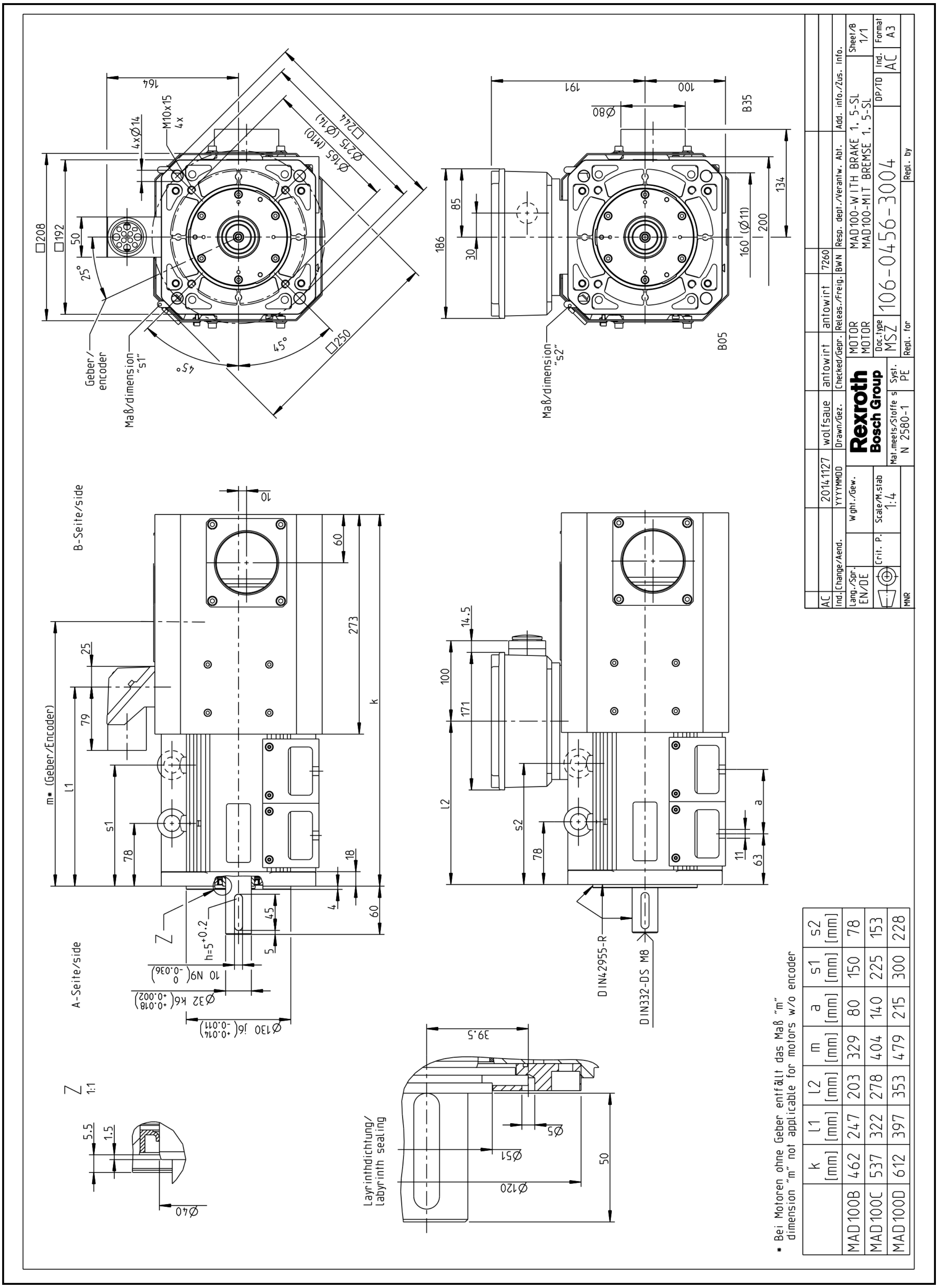


Fig. 5-3: MAD100 with SL cooling, without brake

Dimension drawings IndraDyn A

5.1.4 MAD100 with fan shroud, brake 1 or 5



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	s1 [mm]	s2 [mm]
MAD100B	462	247	203	329	80	150	78
MAD100C	537	322	278	404	140	225	153
MAD100D	612	397	353	479	215	300	228

Fig. 5-4: MAD100 with SL cooling, brake 1/5

5.1.5 MAD100 in ex-type design with M6 or S6 encoder, without brake

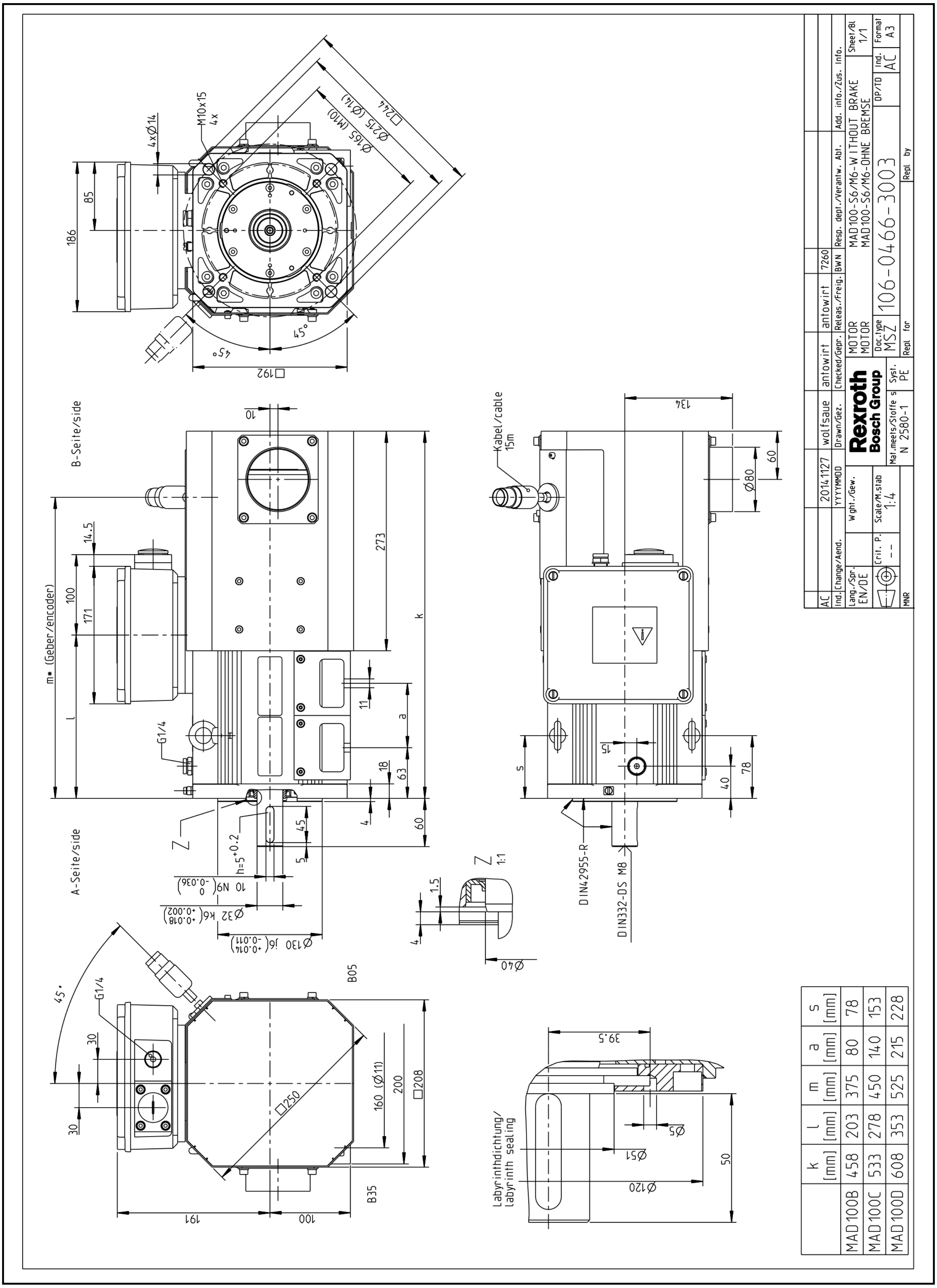
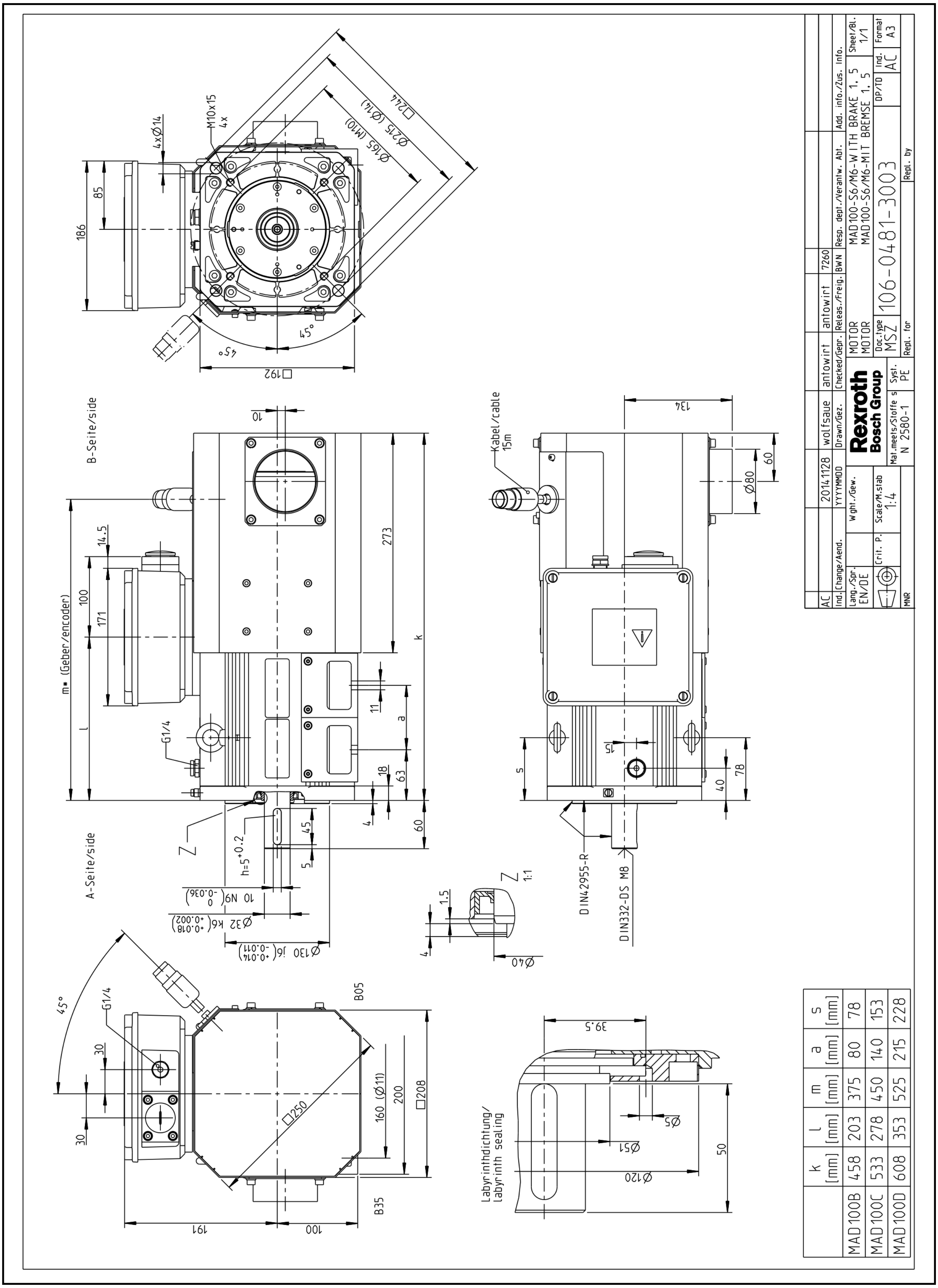


Fig. 5-5: MAD100 with M6/S6 encoder, without brake

5.1.6 MAD100 in ex-type design with M6 or S6 encoder, brake 1 or 5

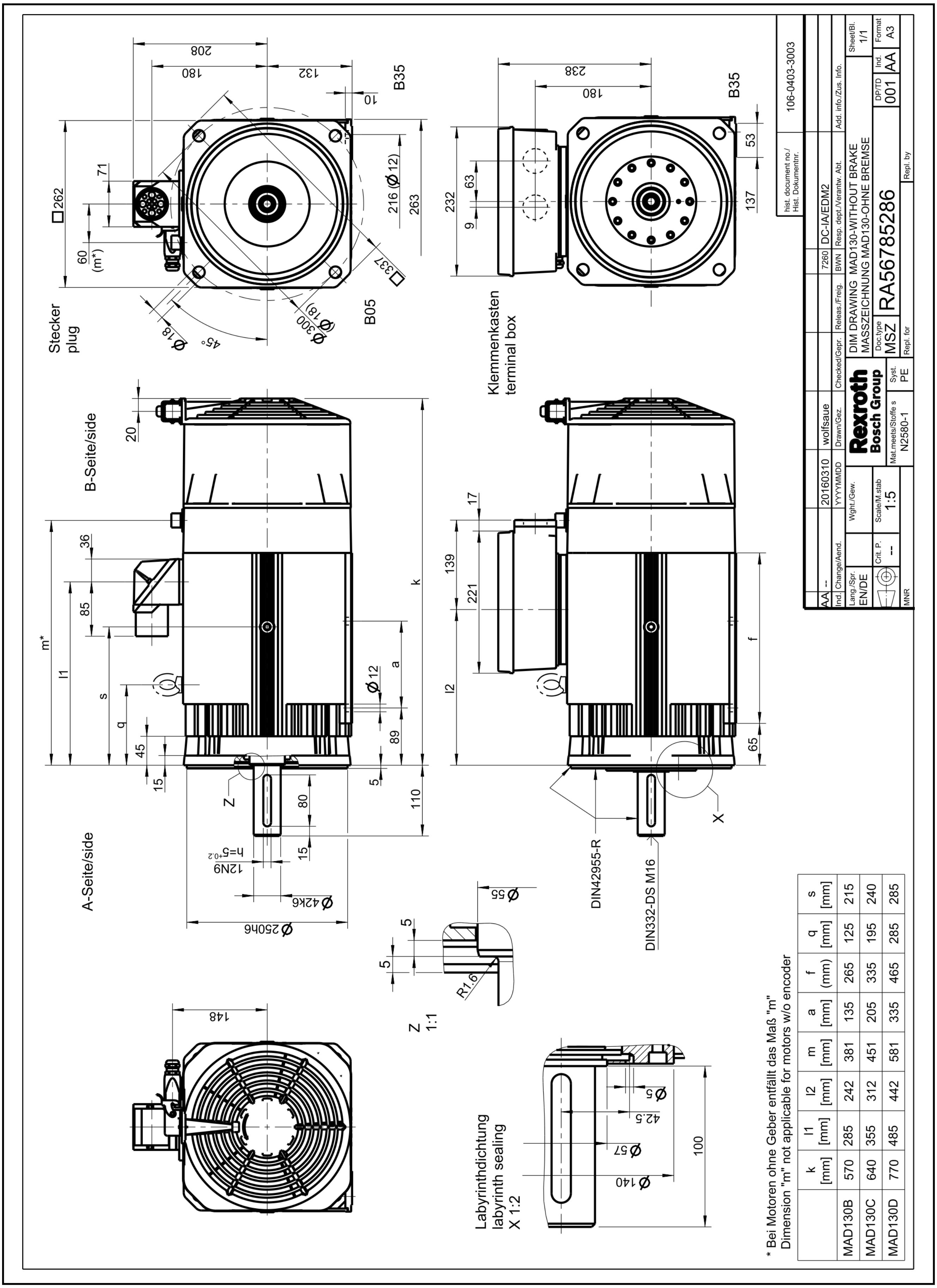


	k [mm]	l [mm]	m [mm]	a [mm]	s [mm]
MAD100B	458	203	375	80	78
MAD100C	533	278	450	140	153
MAD100D	608	353	525	215	228

Fig. 5-6: MAD100 with M6/S6 encoder, brake 1/5

5.2 Frame size MAD130

5.2.1 MAD130 without brake



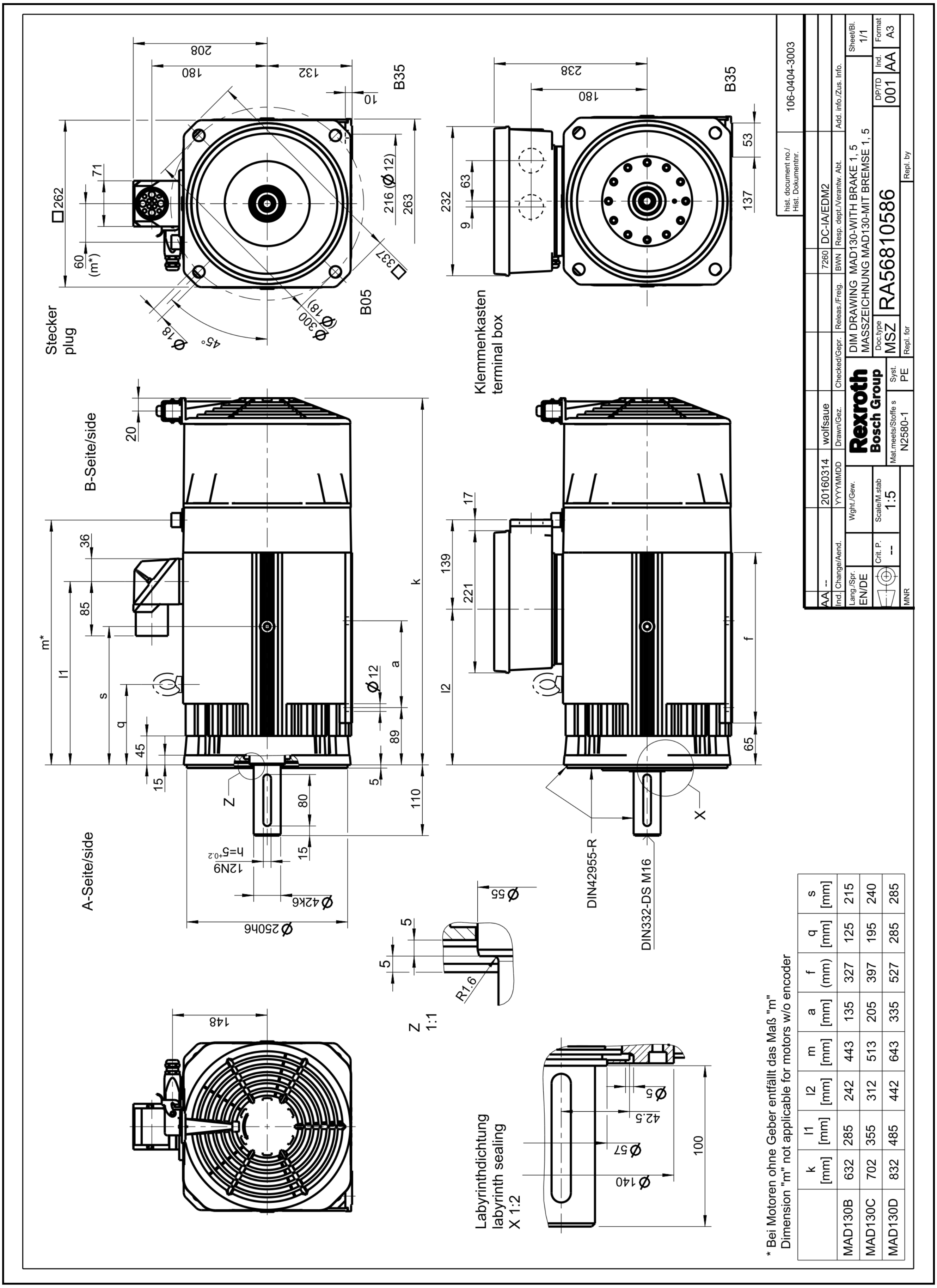
	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	f (mm)	q [mm]	s [mm]
MAD130B	570	285	242	381	135	265	125	215
MAD130C	640	355	312	451	205	335	195	240
MAD130D	770	485	442	581	335	465	285	285

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-7: MAD130 without brake

Dimension drawings IndraDyn A

5.2.2 MAD130 with brake 1 or 5

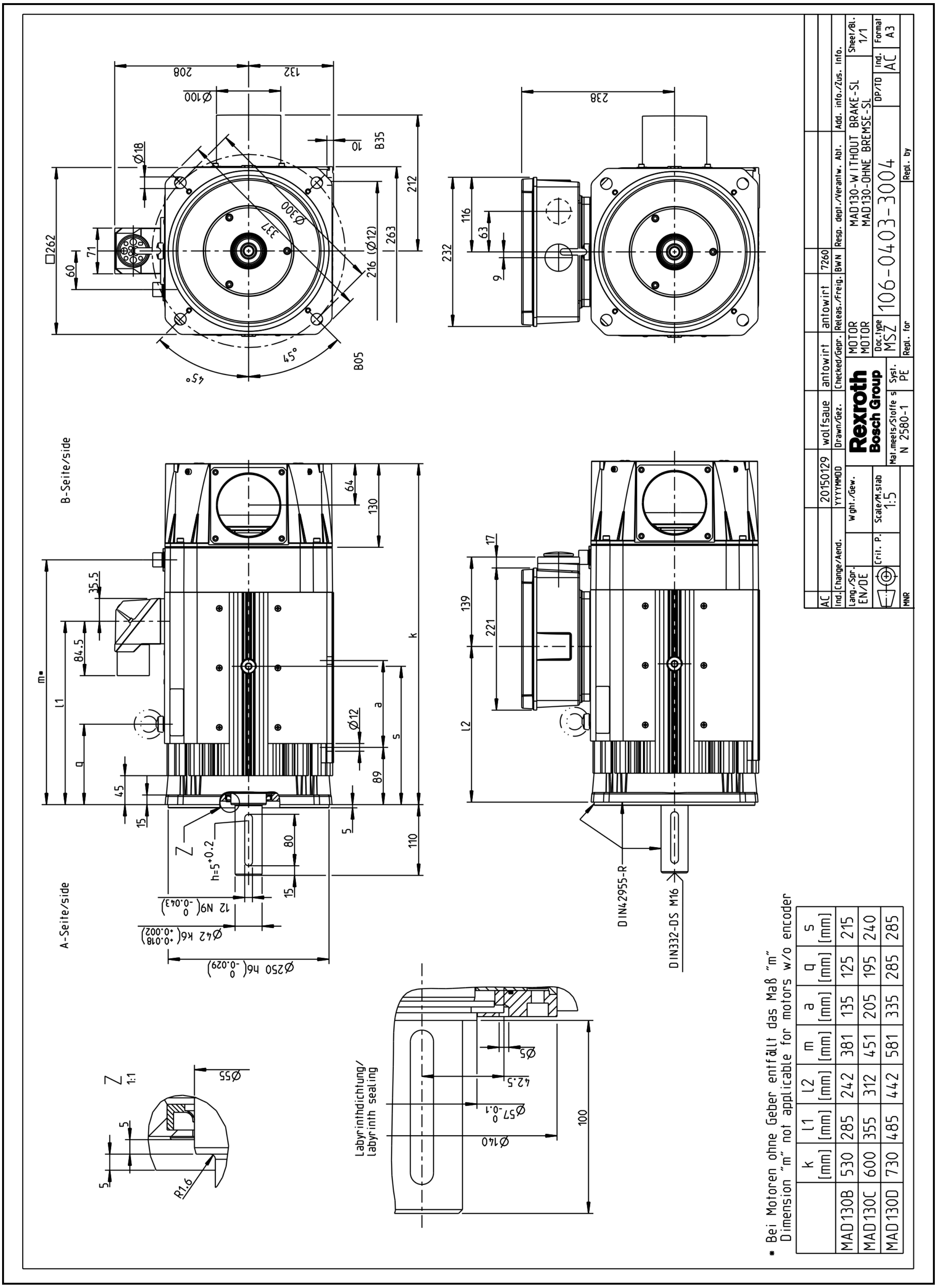


	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	f (mm)	q [mm]	s [mm]
MAD130B	632	285	242	443	135	327	125	215
MAD130C	702	355	312	513	205	397	195	240
MAD130D	832	485	442	643	335	527	285	285

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-8: MAD130 with brake 1/5

5.2.3 MAD130 with fan shroud, without brake



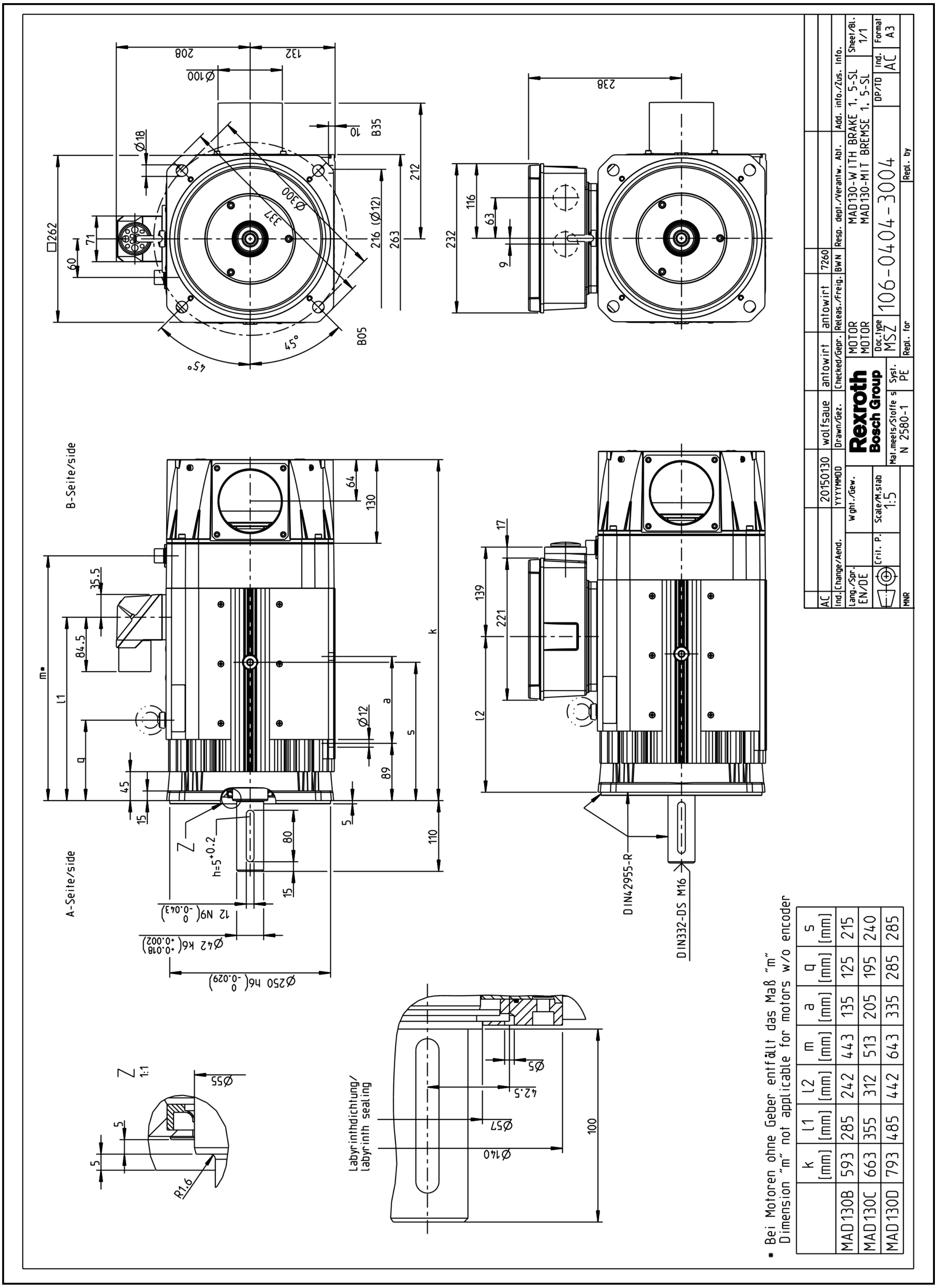
	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAD130B	530	285	242	381	135	125	215
MAD130C	600	355	312	451	205	195	240
MAD130D	730	485	442	581	335	285	285

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-9: MAD130 with SL cooling, without brake

Dimension drawings IndraDyn A

5.2.4 MAD130 with fan shroud, brake 1 or 5

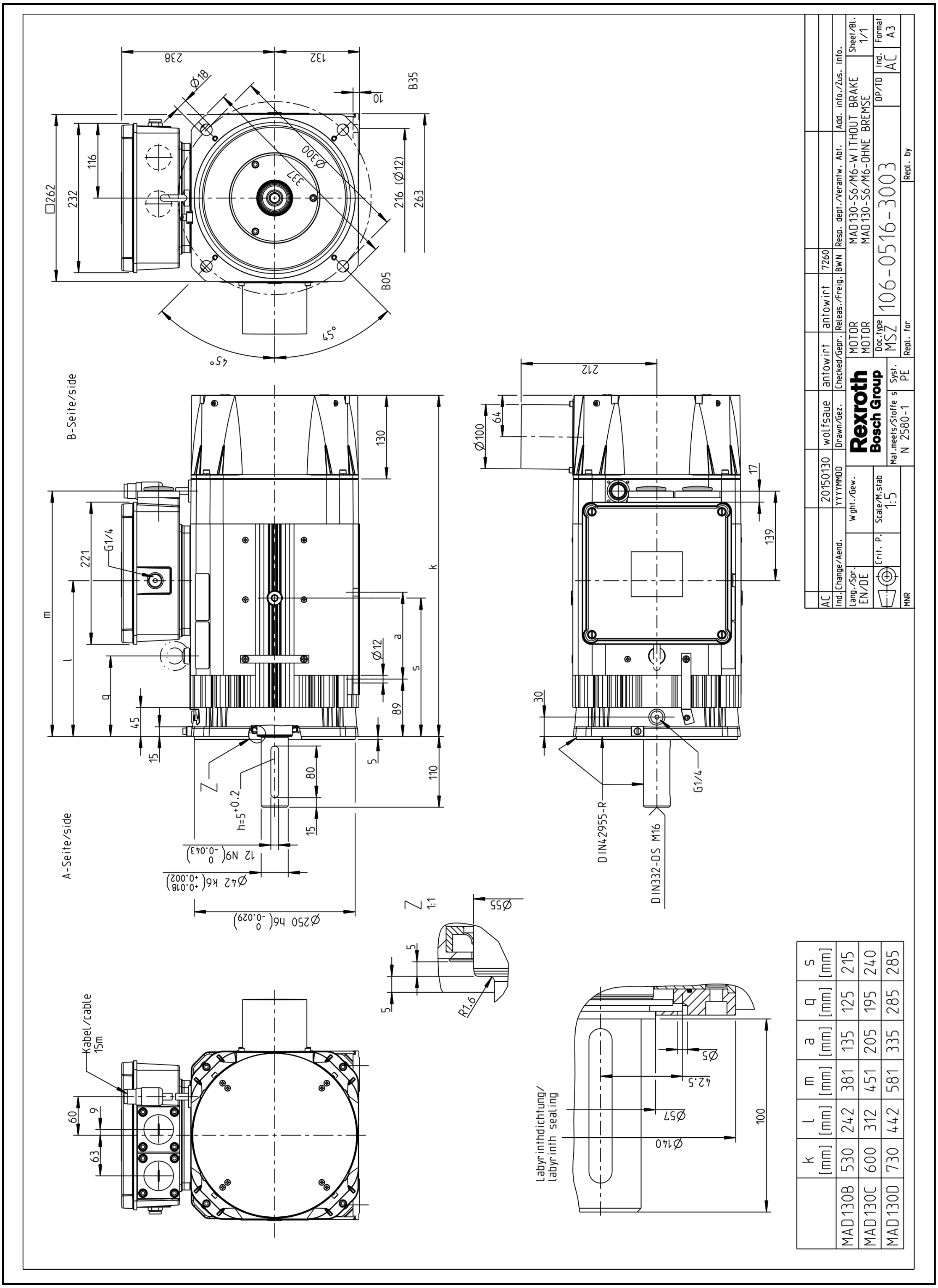


	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAD130B	593	285	242	443	135	125	215
MAD130C	663	355	312	513	205	195	240
MAD130D	793	485	442	643	335	285	285

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-10: MAD130 with SL cooling, brake 1/5

5.2.5 MAD130 in ex-type design with M6 or S6 encoder, without brake

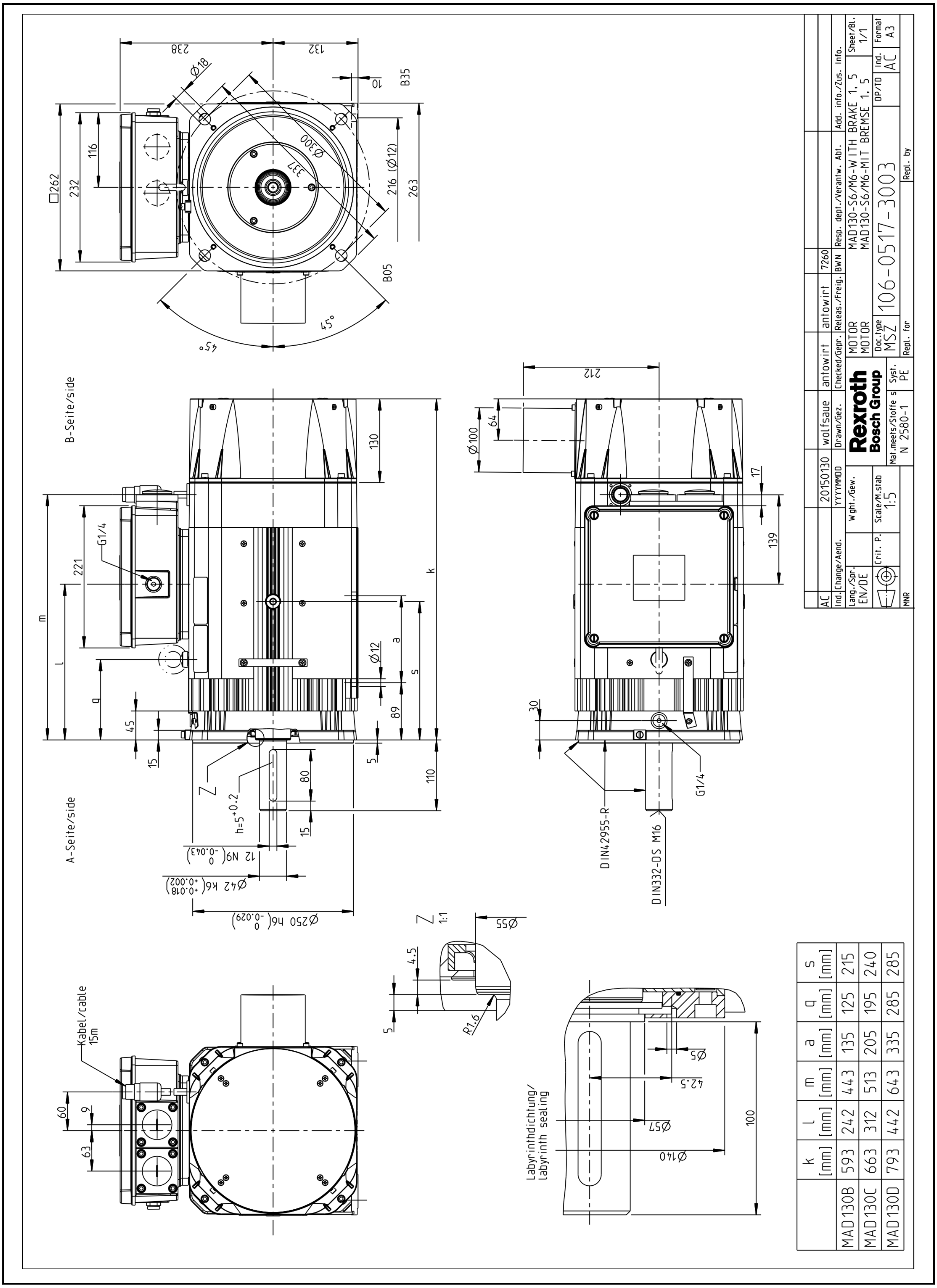


	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAD130B	530	242	381	135	125	215
MAD130C	600	312	451	205	195	240
MAD130D	730	442	581	335	285	285

Fig. 5-11: MAD130 with M6/S6 encoder, without brake

Dimension drawings IndraDyn A

5.2.6 MAD130 in ex-type design with M6 or S6 encoder, brake 1 or 5

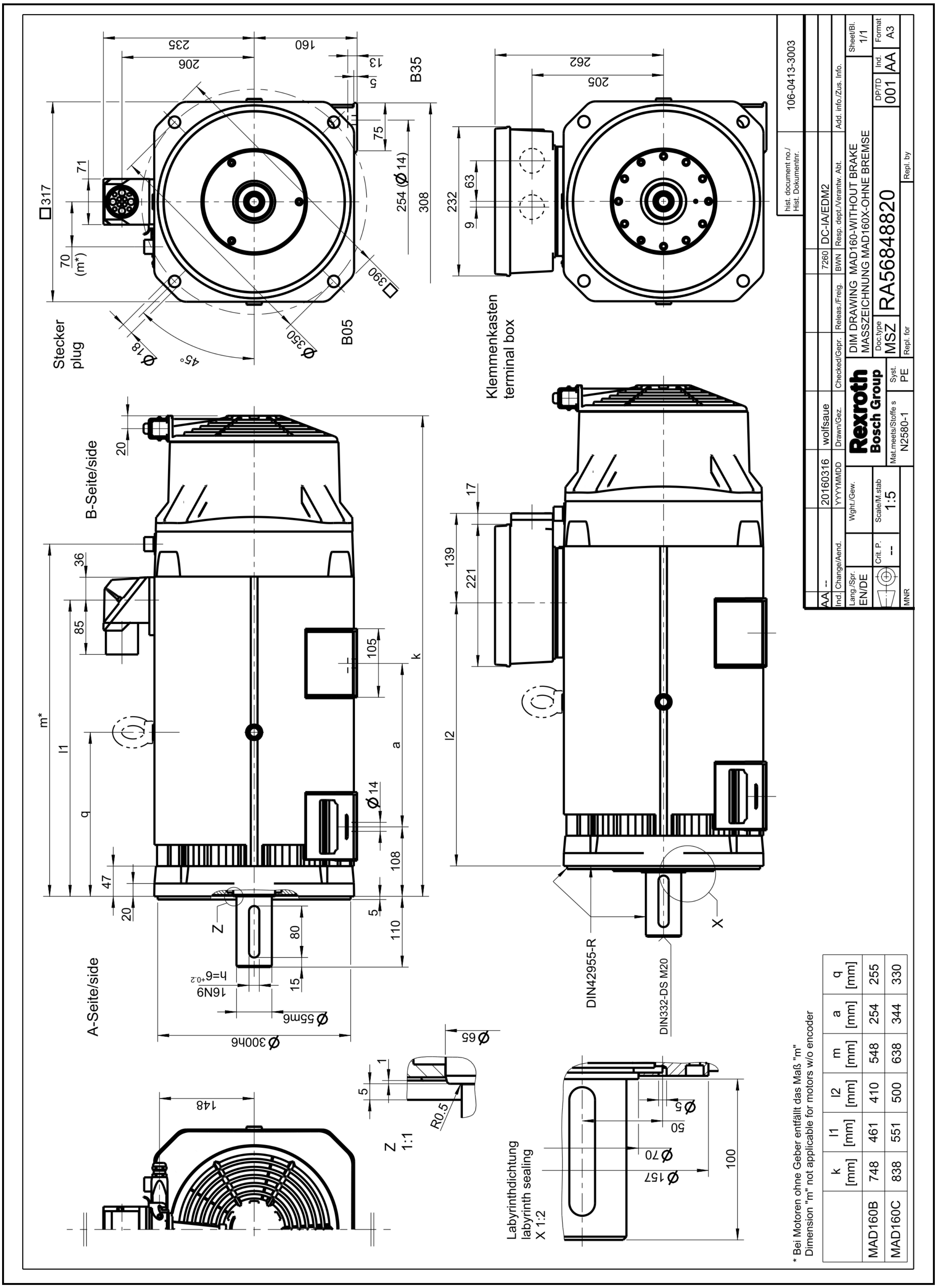


	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAD130B	593	242	443	135	125	215
MAD130C	663	312	513	205	195	240
MAD130D	793	442	643	335	285	285

Fig. 5-12: MAD130 with M6/S6 encoder, brake 1/5

5.3 Frame size MAD160

5.3.1 MAD160 without brake



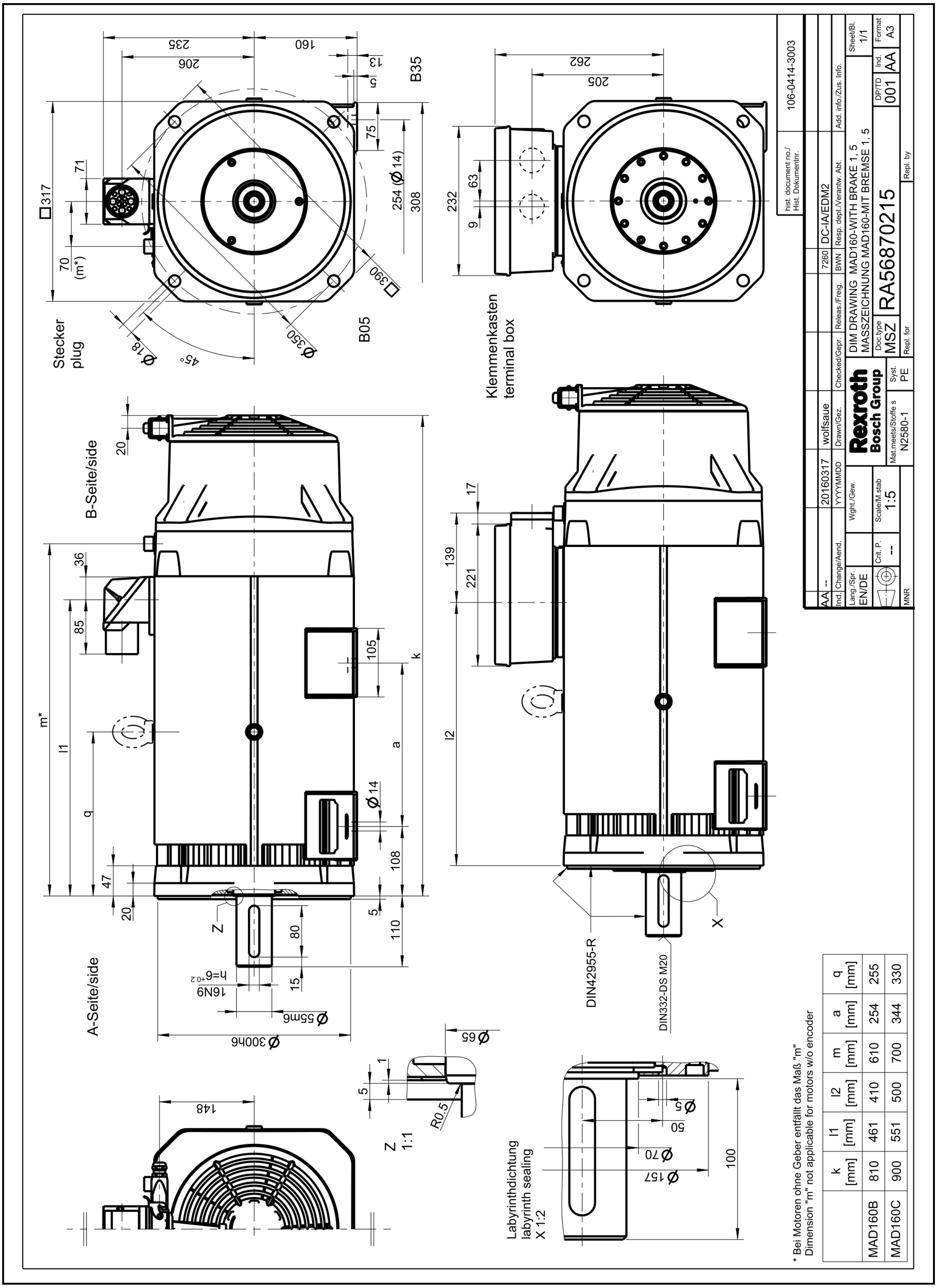
	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]
MAD160B	748	461	410	548	254	255
MAD160C	838	551	500	638	344	330

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-13: MAD160 without brake (rotating terminal box)

Dimension drawings IndraDyn A

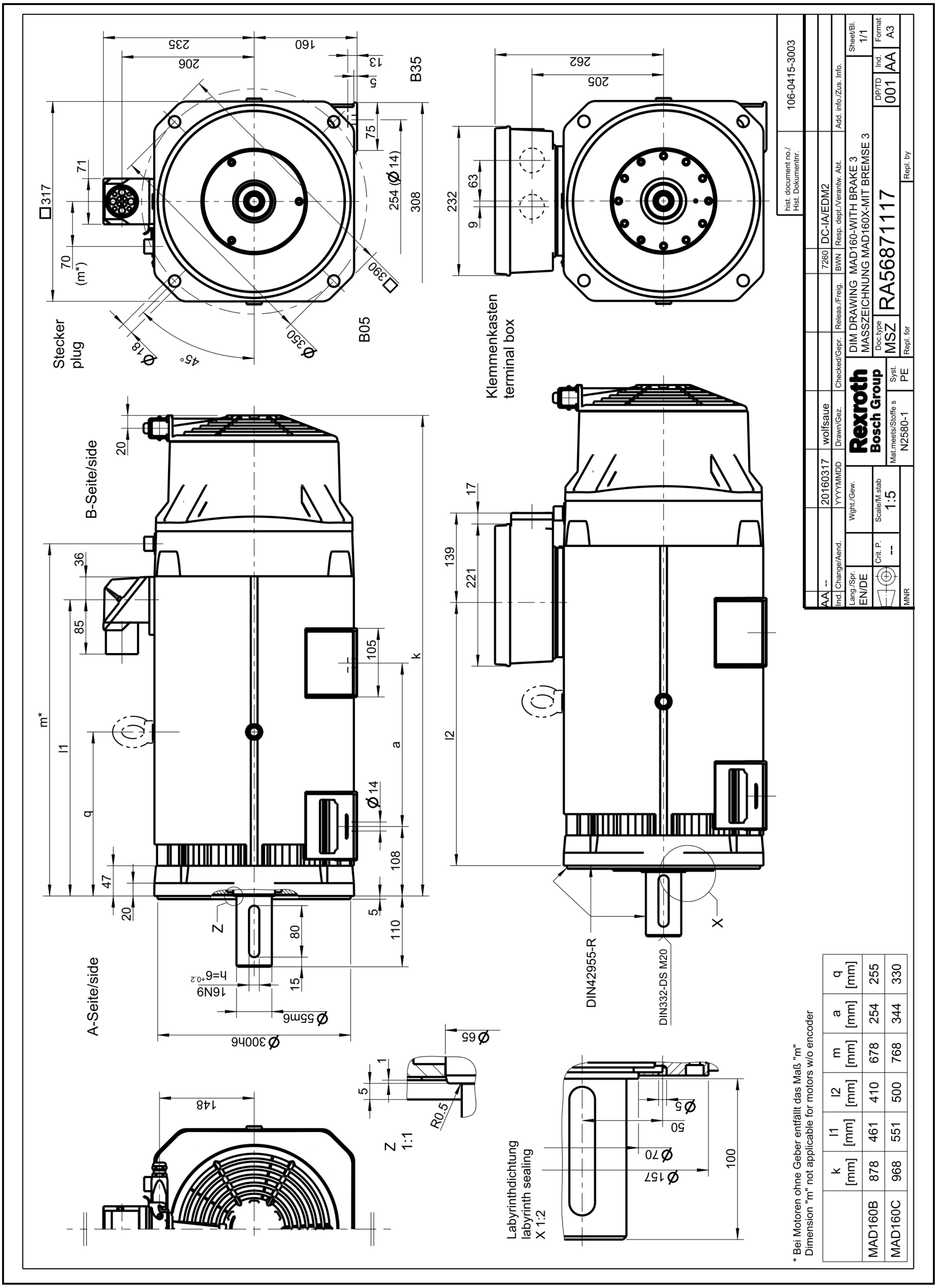
5.3.2 MAD160 with brake 1 or 5



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]
MAD160B	810	461	410	610	254	255
MAD160C	900	551	500	700	344	330

Fig. 5-14: MAD160 with brake 1/5

5.3.3 MAD160 with brake 3



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]
MAD160B	878	461	410	678	254	255
MAD160C	968	551	500	768	344	330

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-15: MAD160 with brake 3

Dimension drawings IndraDyn A

5.3.4 MAD160 with fan shroud, without brake

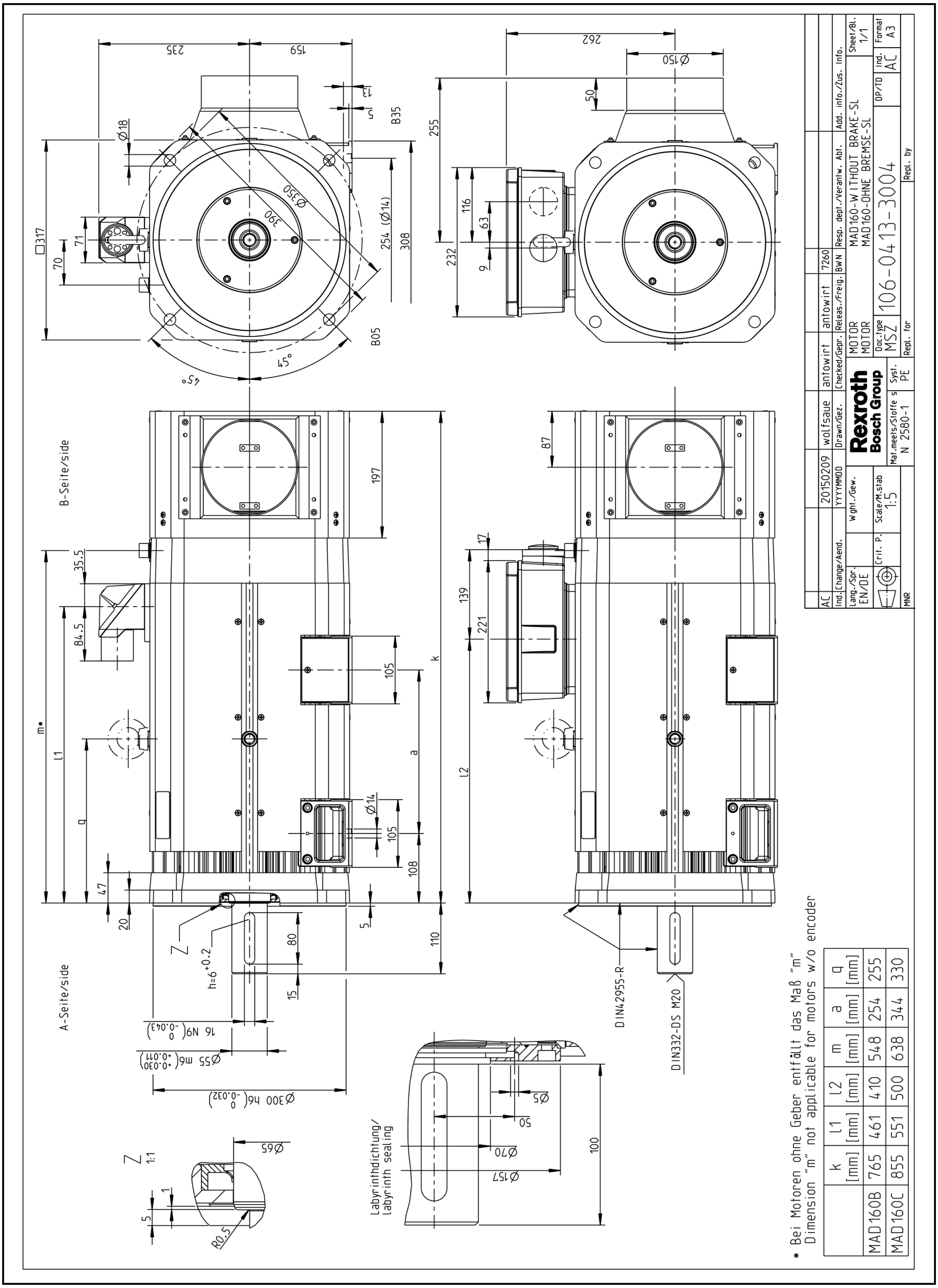


Fig. 5-16: MAD160 with SL cooling, without brake

5.3.5 MAD160 with fan shroud, brake 1 or 5

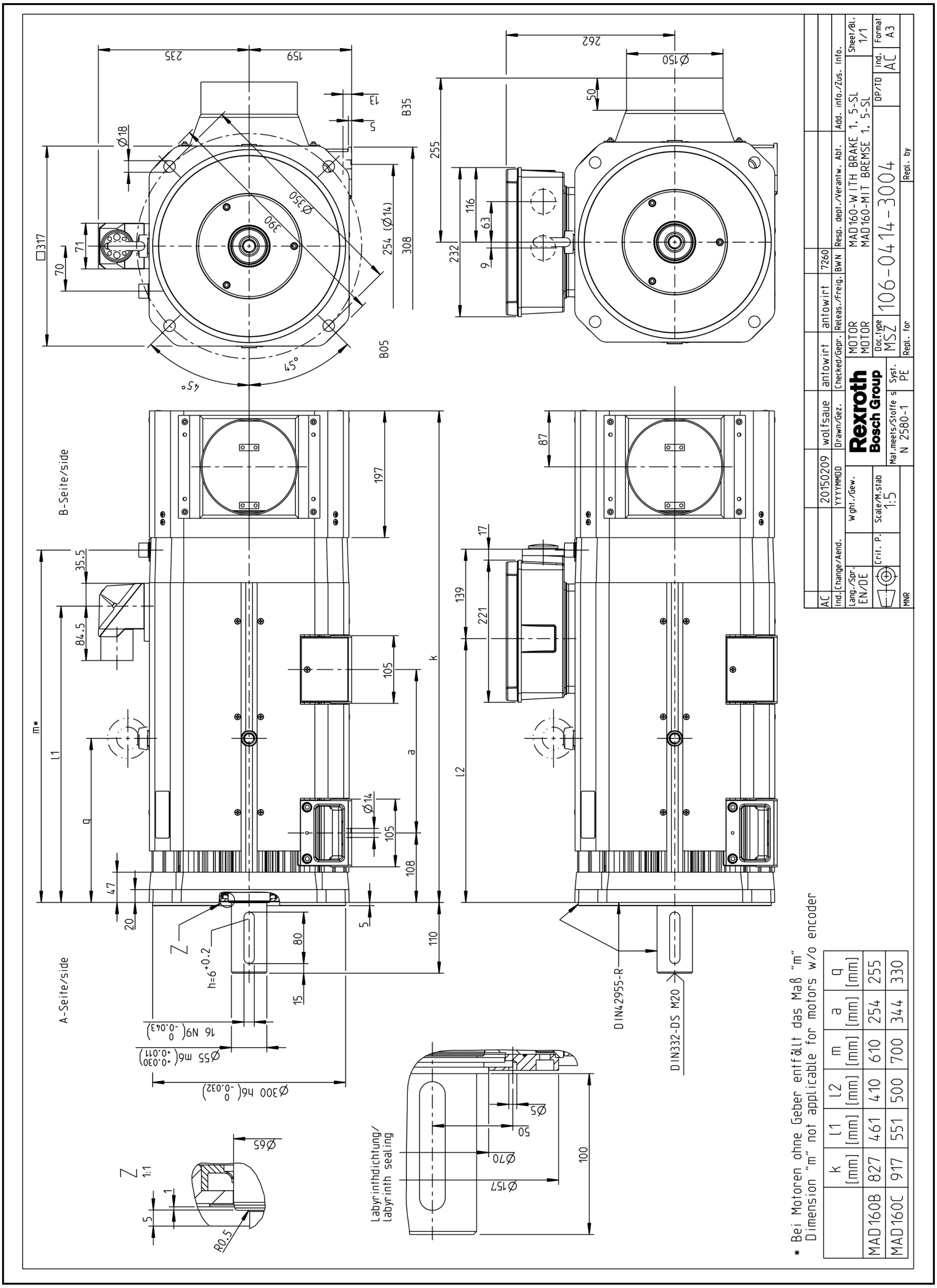


Fig. 5-17: MAD160 with SL cooling, brake 1/5

Dimension drawings IndraDyn A

5.3.6 MAD160 with fan shroud and brake 3

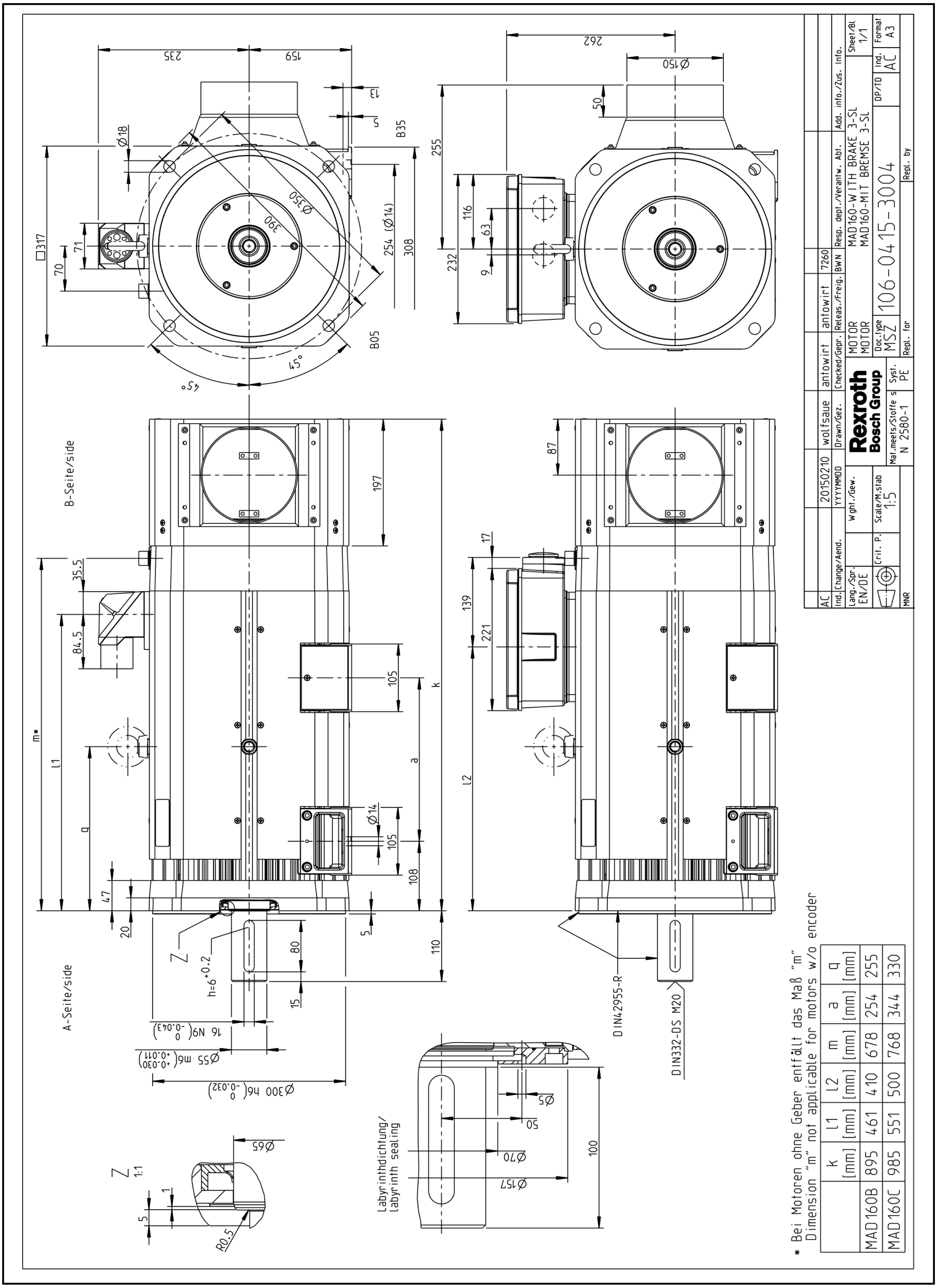


Fig. 5-18: MAD160 with SL cooling, brake 3

5.3.7 MAD160 in ex-type design with M6 or S6 encoder, without brake

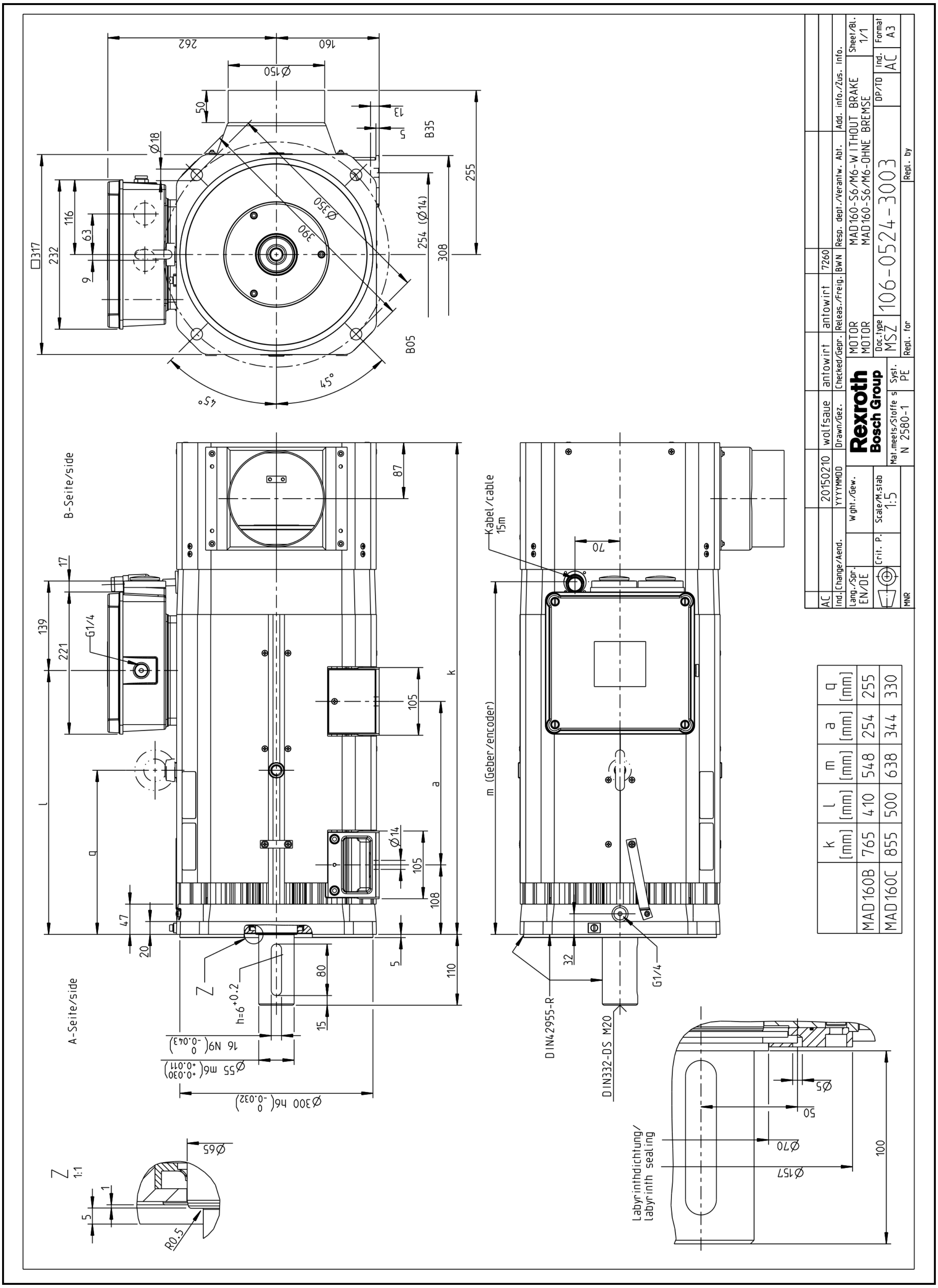
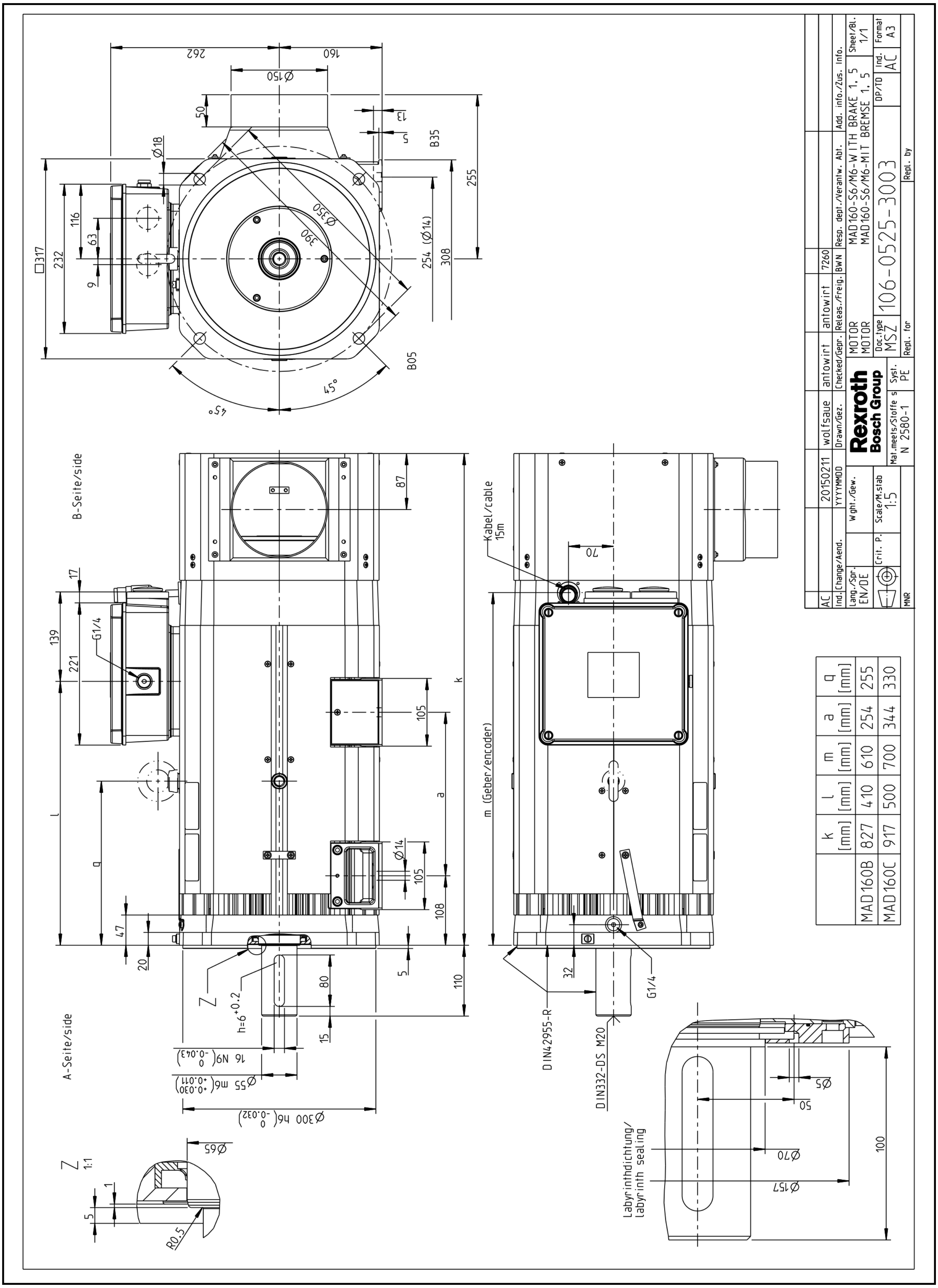


Fig. 5-19: MAD160 with M6/S6 encoder, without brake

Dimension drawings IndraDyn A

5.3.8 MAD160 in ex-type design with M6 or S6 encoder, brake 1 or 5



	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]
MAD160B	827	410	610	254	255
MAD160C	917	500	700	344	330

Fig. 5-20: MAD160 with M6/S6 encoder, brake 1/5

5.3.9 MAD160 in ex-type design with M6 or S6 encoder, brake 3

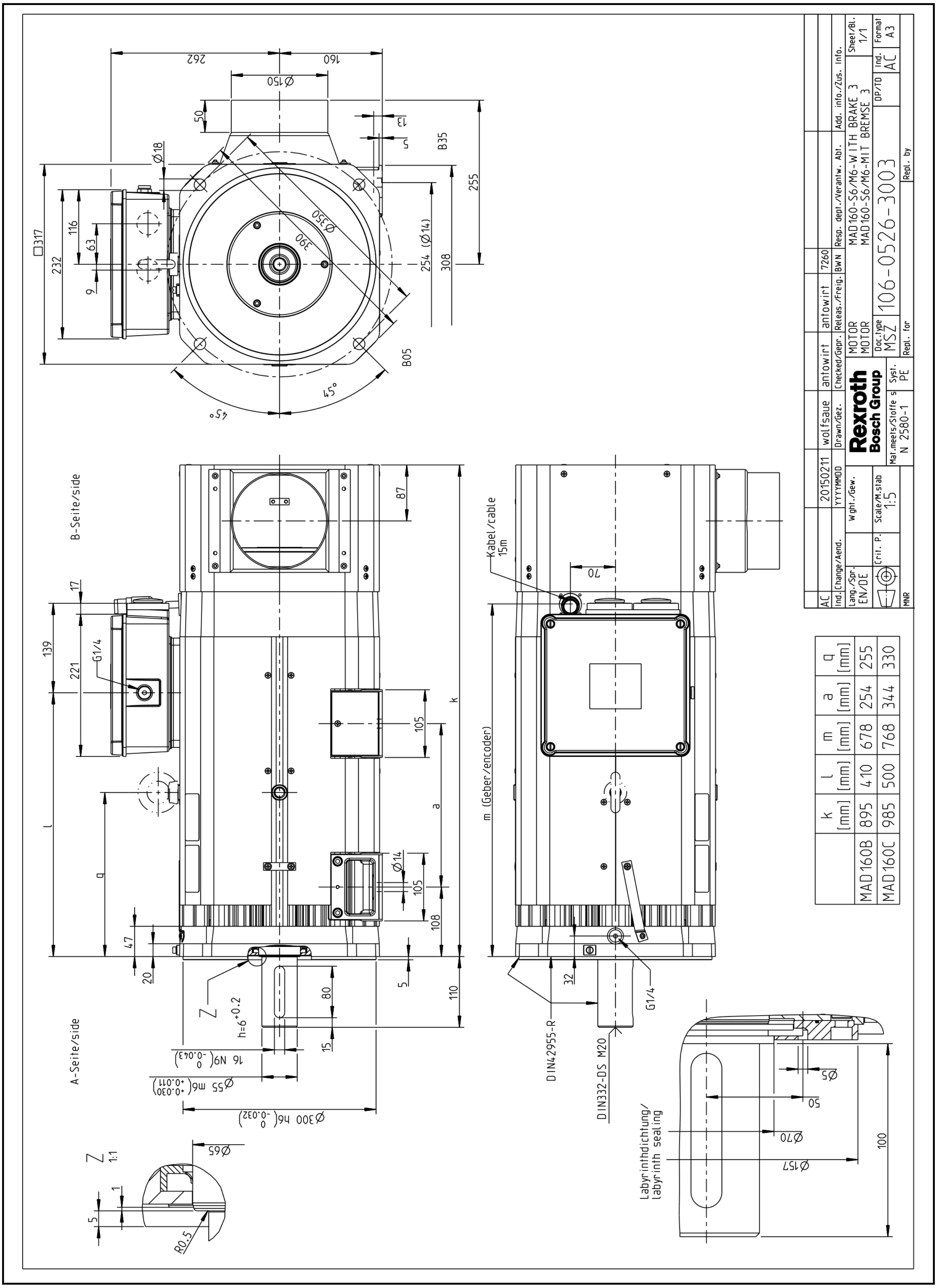


Fig. 5-21: MAD160 with M6/S6 encoder, brake 3

Dimension drawings IndraDyn A

5.4 Frame size MAD180

5.4.1 MAD180 without brake

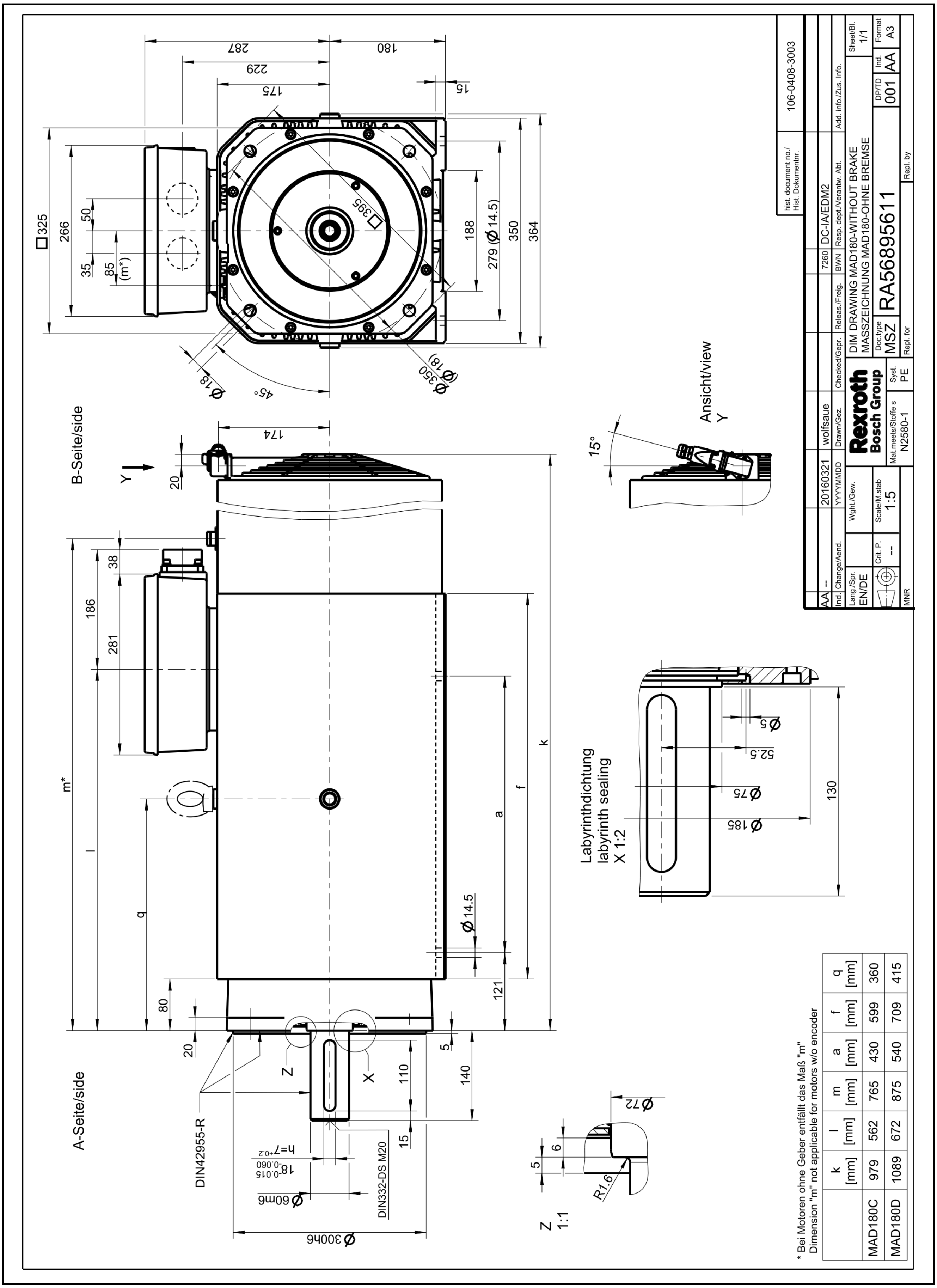


Fig. 5-22: MAD180 without brake

	k [mm]	l [mm]	m [mm]	a [mm]	f [mm]	q [mm]
MAD180C	979	562	765	430	599	360
MAD180D	1089	672	875	540	709	415

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

5.4.2 MAD180 with brake 2 or 5

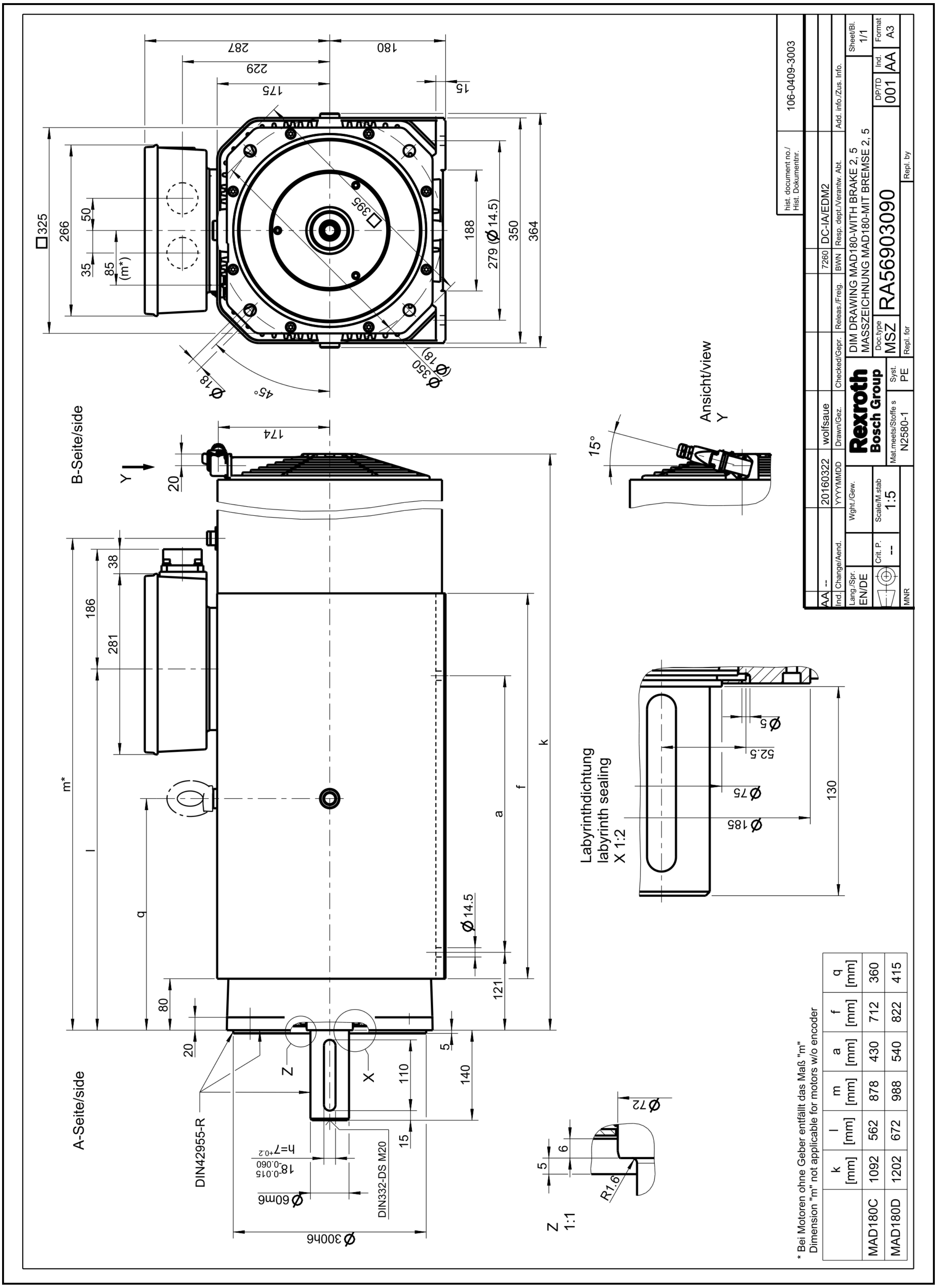


Fig. 5-23: MAD180 with brake 2 or 5

5.4.3 MAD180 with fan shroud, without brake

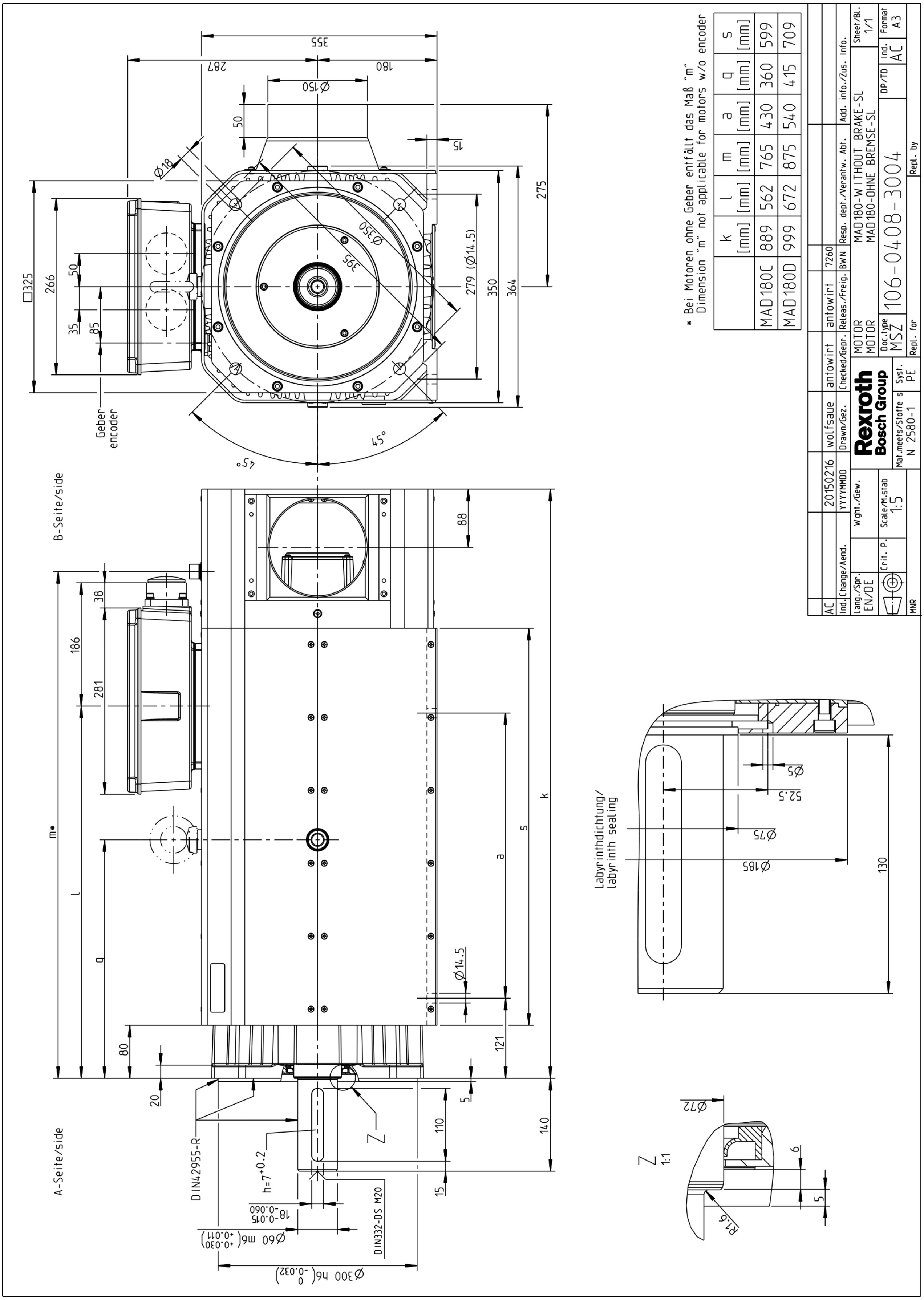


Fig. 5-24: MAD180 with SL cooling, without brake

5.4.4 MAD180 with fan shroud, brake 2 or 5

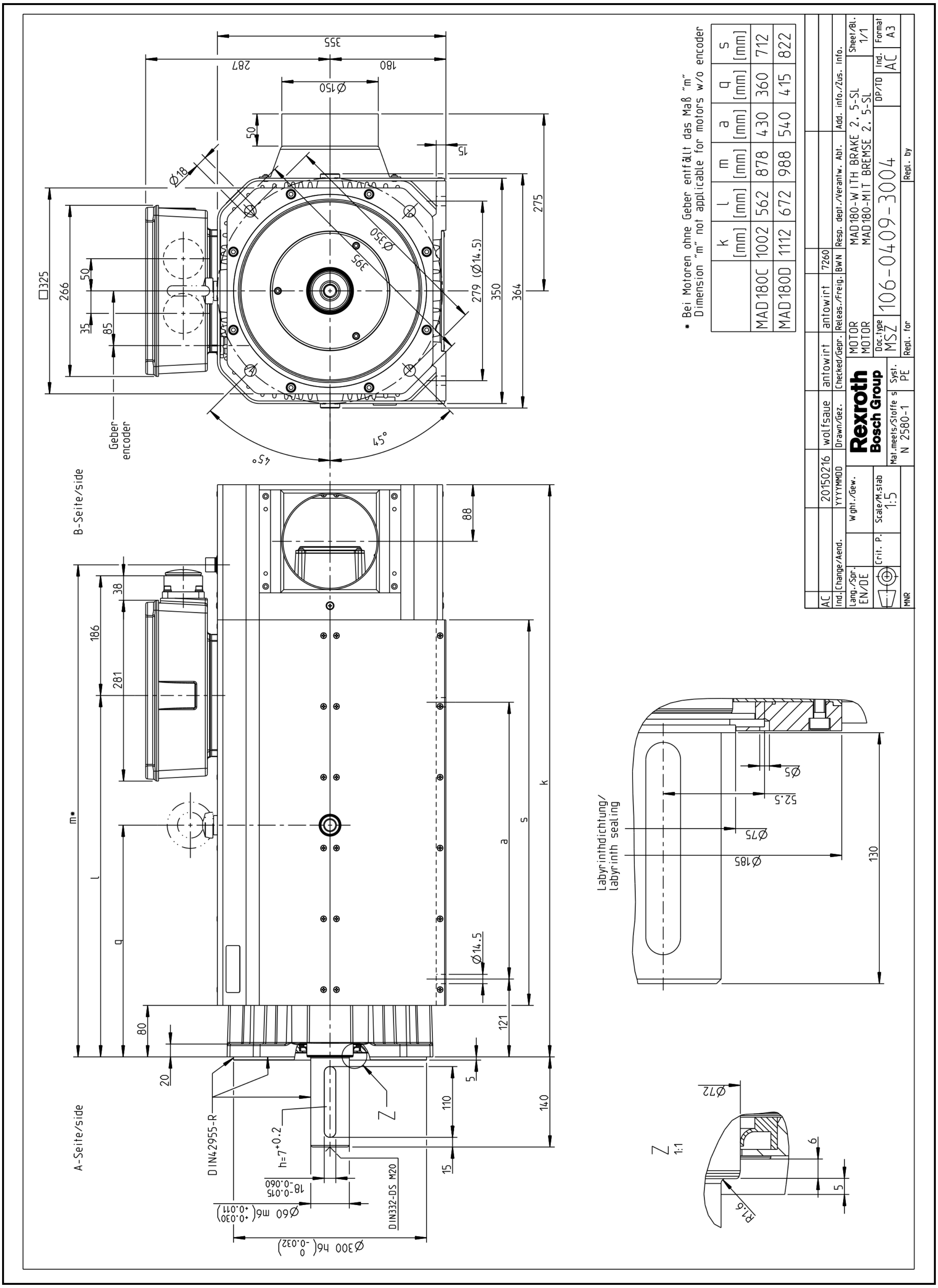


Fig. 5-25: MAD180 with SL cooling, brake 2/5

Dimension drawings IndraDyn A

5.4.5 MAD180 in ex-type design with M6 or S6 encoder, without brake

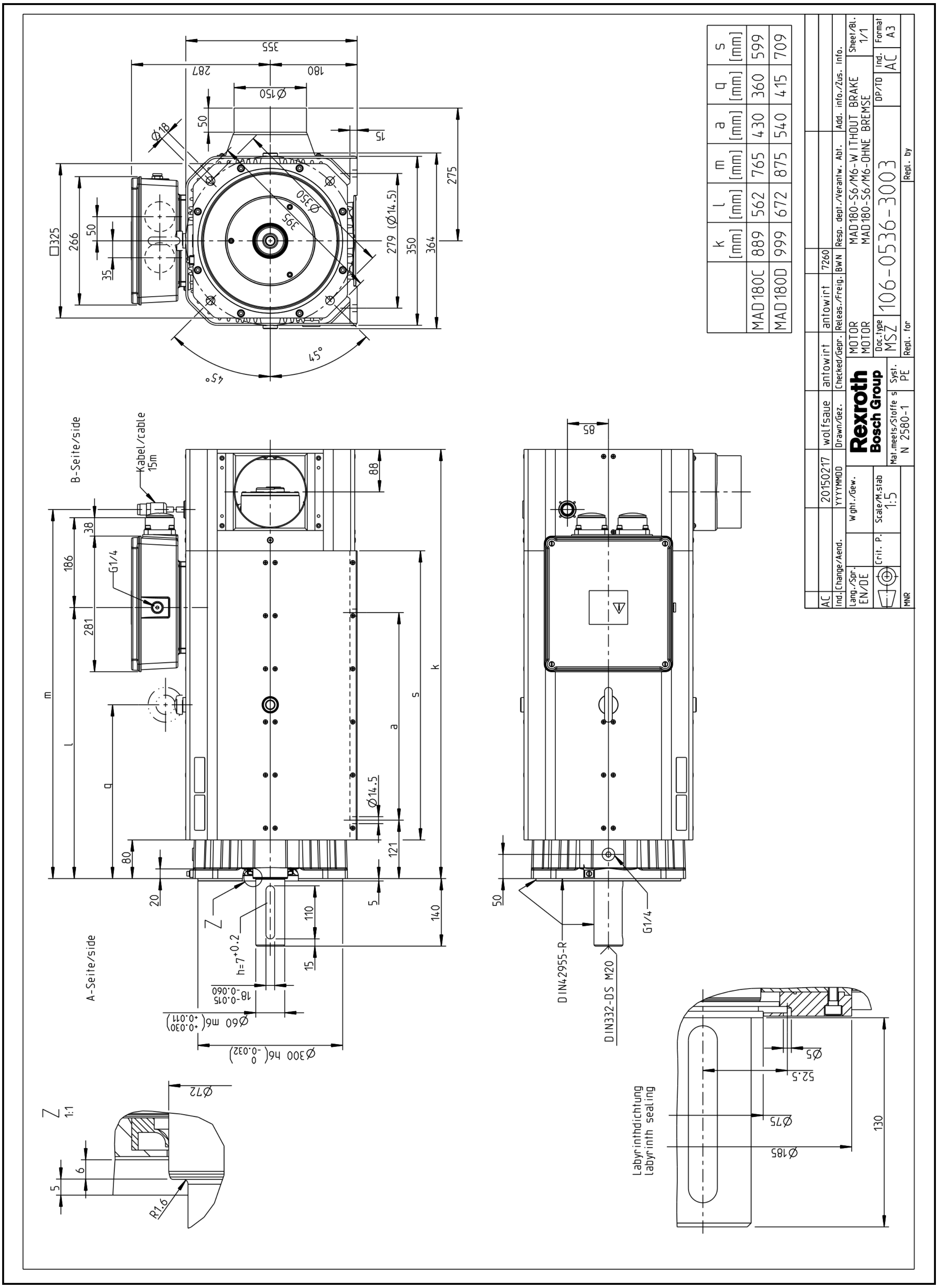
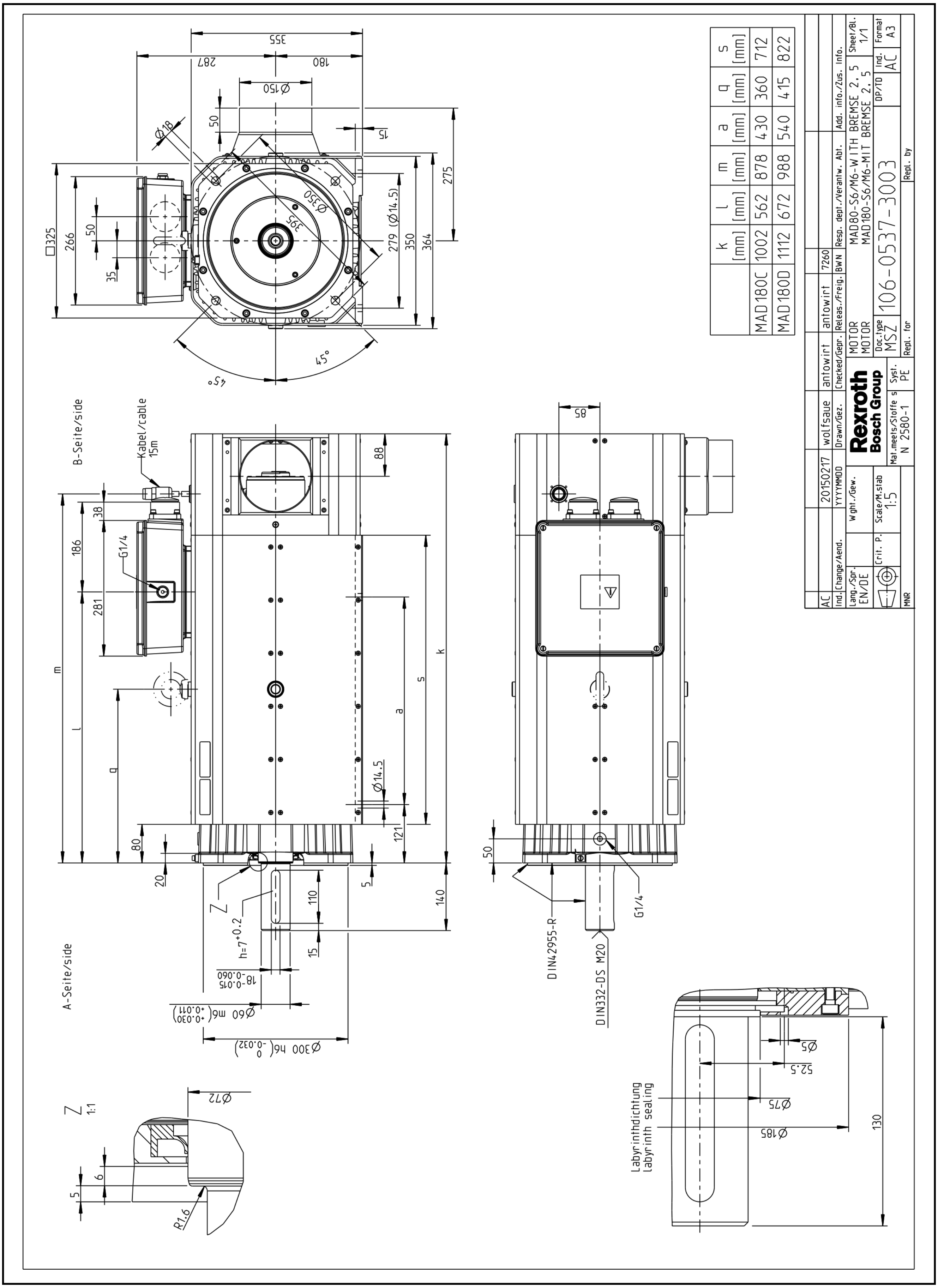


Fig. 5-26: MAD180 with M6/S6 encoder, without brake

5.4.6 MAD180 in ex-type design with M6 or S6 encoder, brake 2 or 5



	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAD180C	1002	562	878	430	360	712
MAD180D	1112	672	988	540	415	822

Fig. 5-27: MAD180 with M6/S6 encoder, brake 2/5

5.5 Frame size MAD225

5.5.1 MAD225 without brake

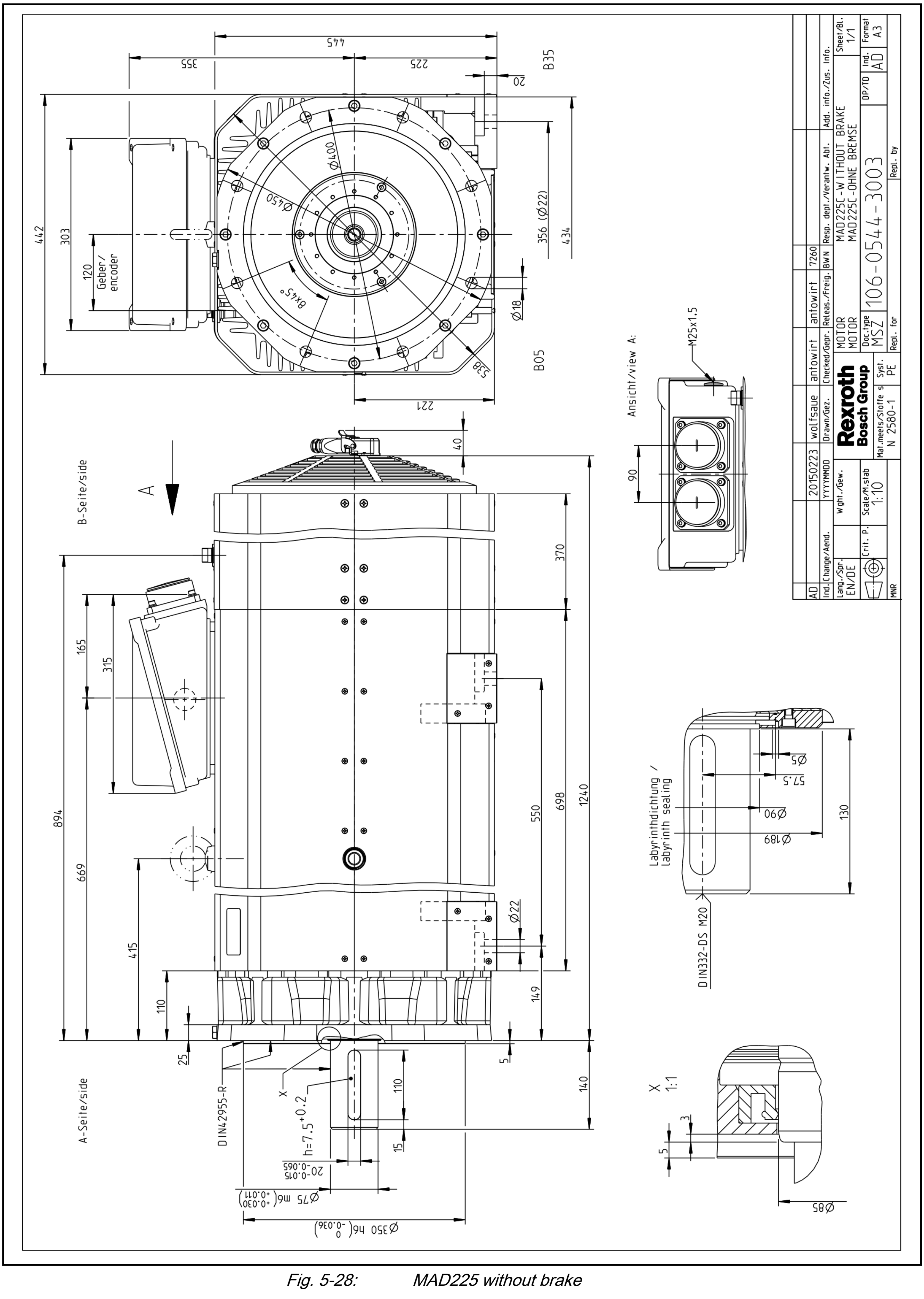


Fig. 5-28: MAD225 without brake

5.5.2 MAD225 with fan shroud, without brake

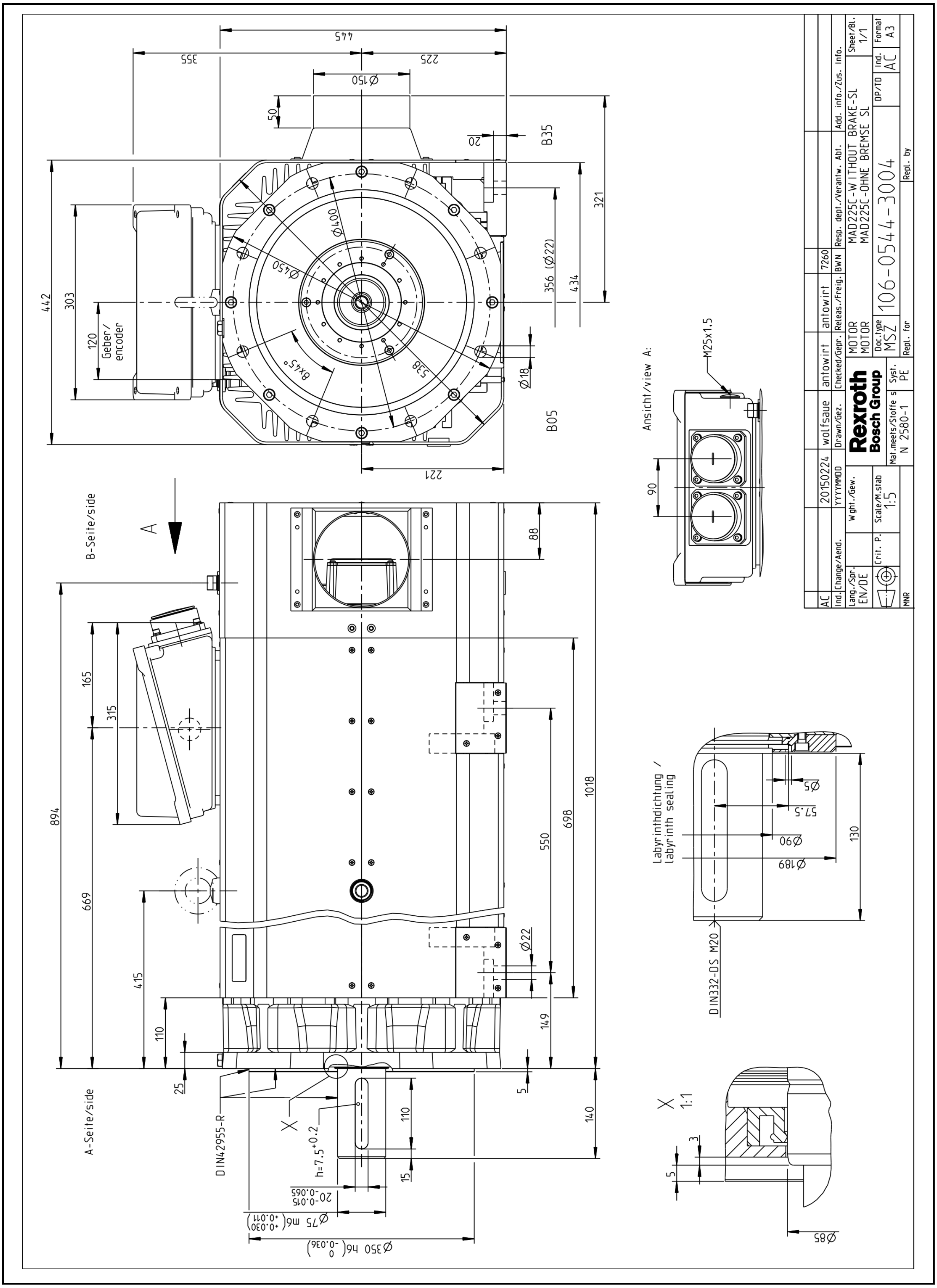


Fig. 5-29: MAD225 with SL cooling, without brake

Dimension drawings IndraDyn A

5.5.3 MAD225 in ex-type design, M6 or S6 encoder, without brake

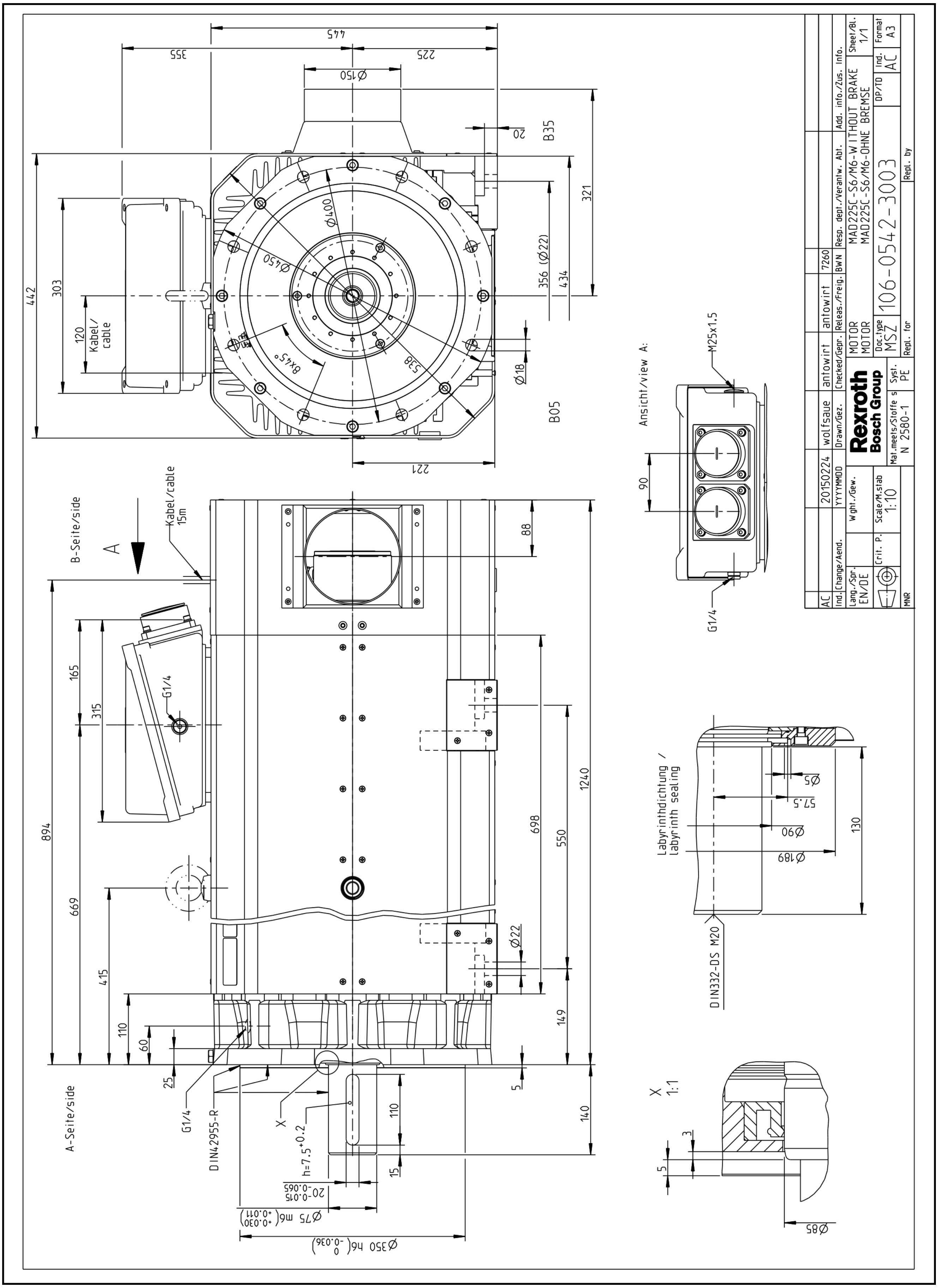


Fig. 5-30: MAD225 with M6/S6 encoder, without brake

5.6 Frame size MAF100

5.6.1 MAF100 without brake

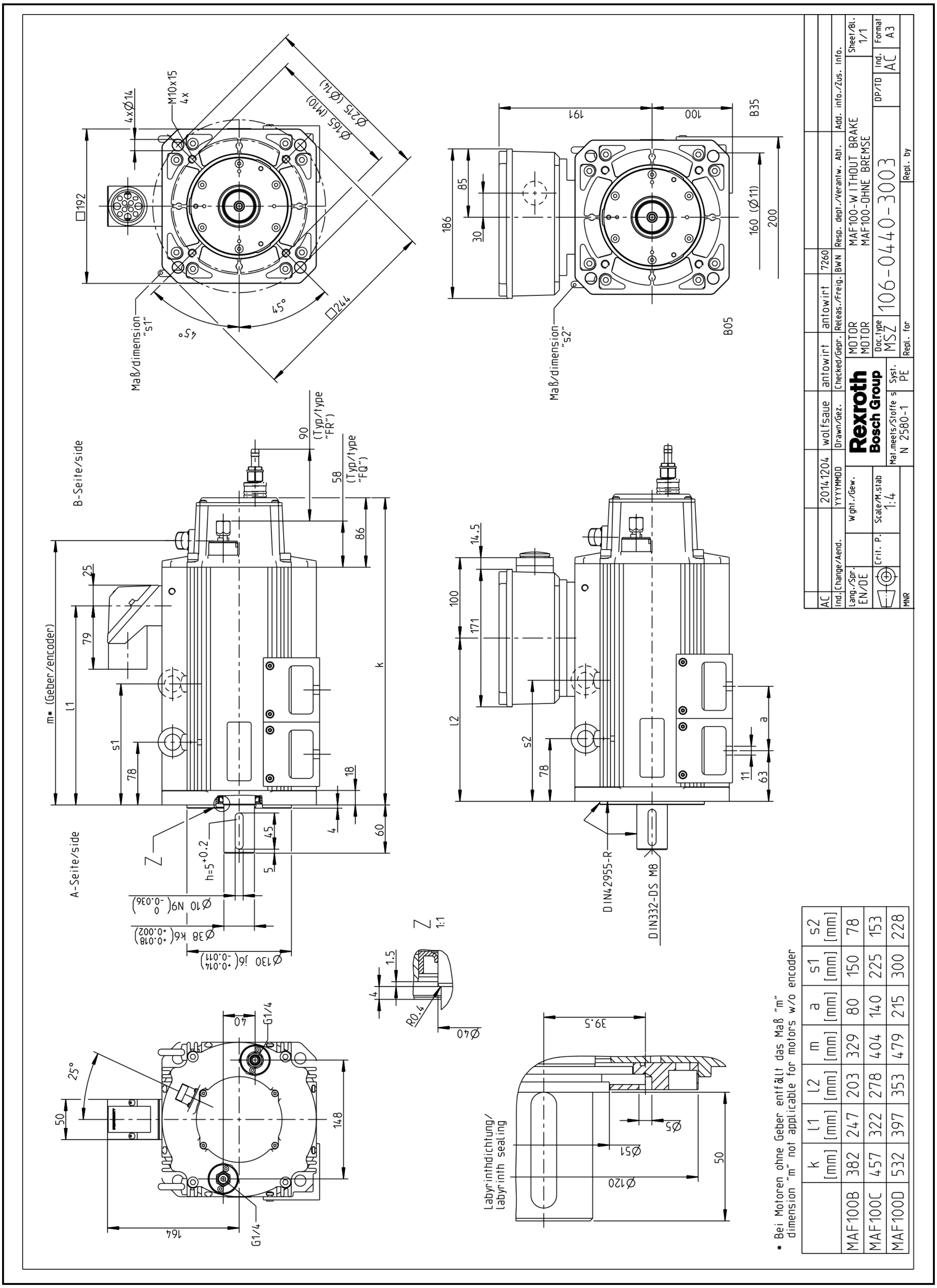
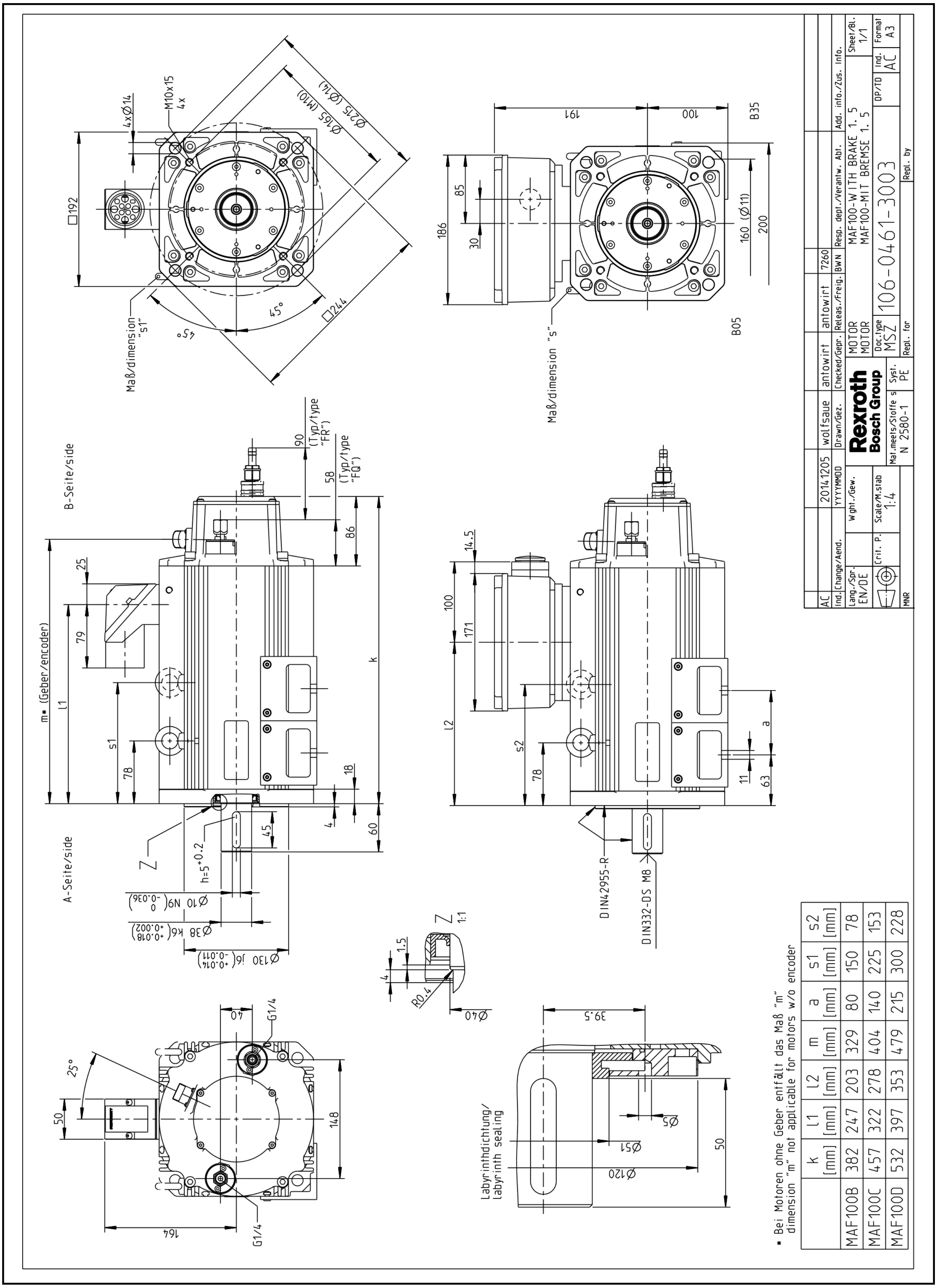


Fig. 5-31: MAF100 without brake

Dimension drawings IndraDyn A

5.6.2 MAF100 with brake 1 or 5



	k [mm]	L1 [mm]	L2 [mm]	m [mm]	a [mm]	s1 [mm]	s2 [mm]
MAF100B	382	247	203	329	80	150	78
MAF100C	457	322	278	404	140	225	153
MAF100D	532	397	353	479	215	300	228

* Bei Motoren ohne Geber entfällt das Maß "m"
dimension "m" not applicable for motors w/o encoder

Fig. 5-32: MAF100 with brake 1 or 5

5.6.3 MAF100 in ex-type design with M6 or S6 encoder, without brake

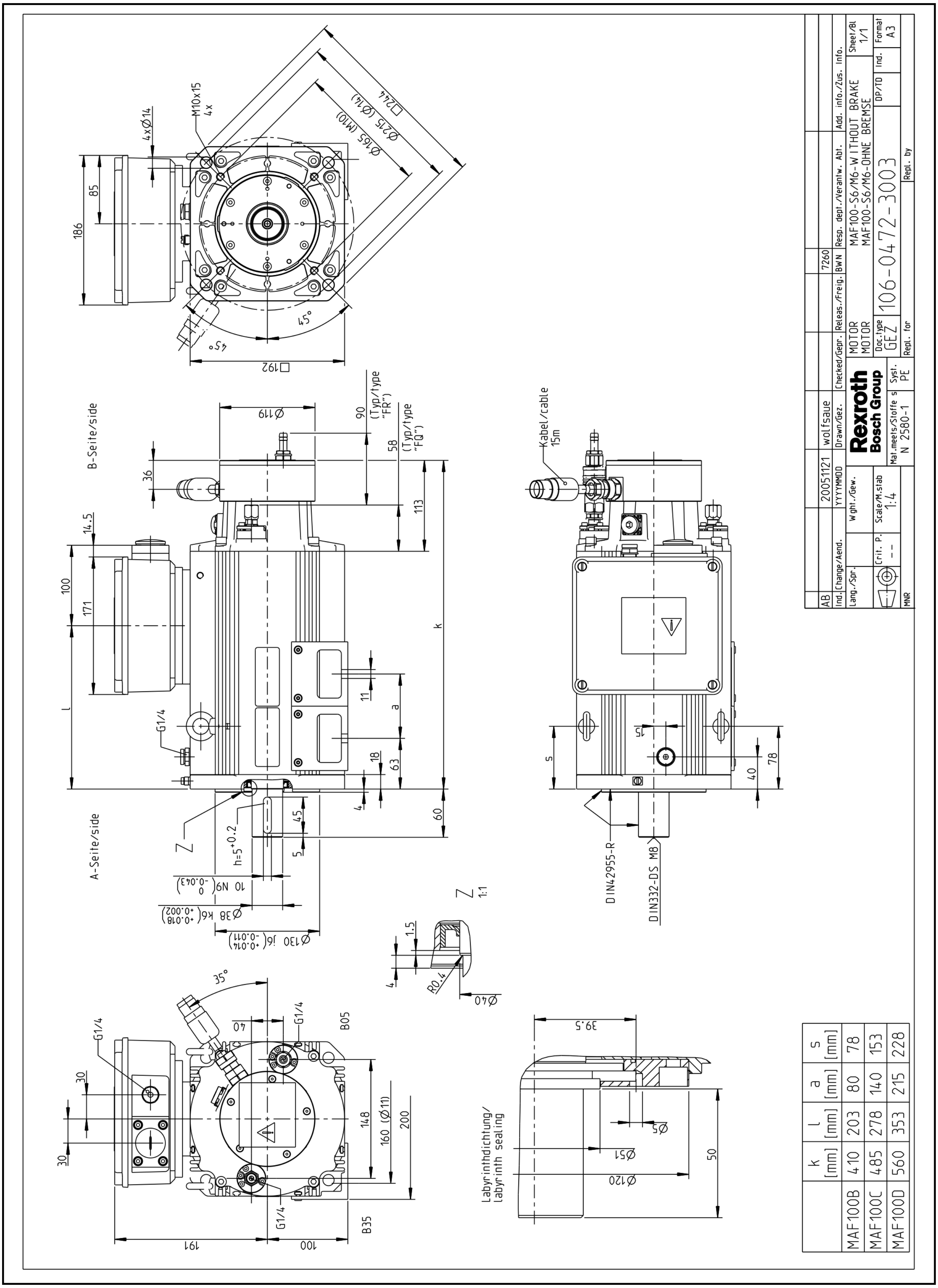
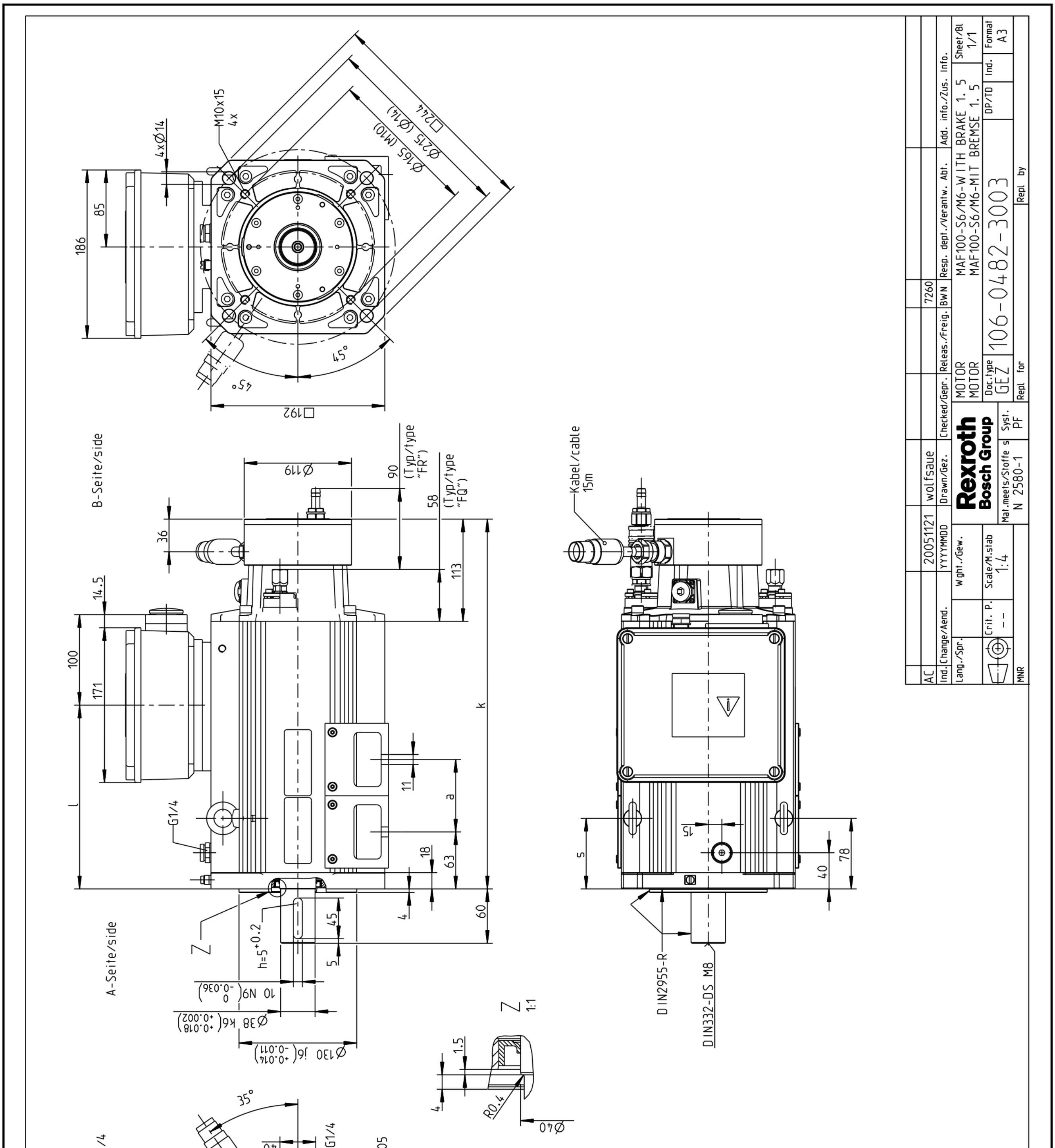


Fig. 5-33: MAF100 with M6/S6 encoder, without brake

5.6.4 MAF100 in ex-type design with M6 or S6 encoder, brake 1 or 5



	k [mm]	l [mm]	a [mm]	s [mm]
MAF100B	410	203	80	78
MAF100C	485	278	140	153
MAF100D	560	353	215	228

Fig. 5-34: MAF100 with M6/S6 encoder, brake 1/5

5.7 Frame size MAF130

5.7.1 MAF130 without brake

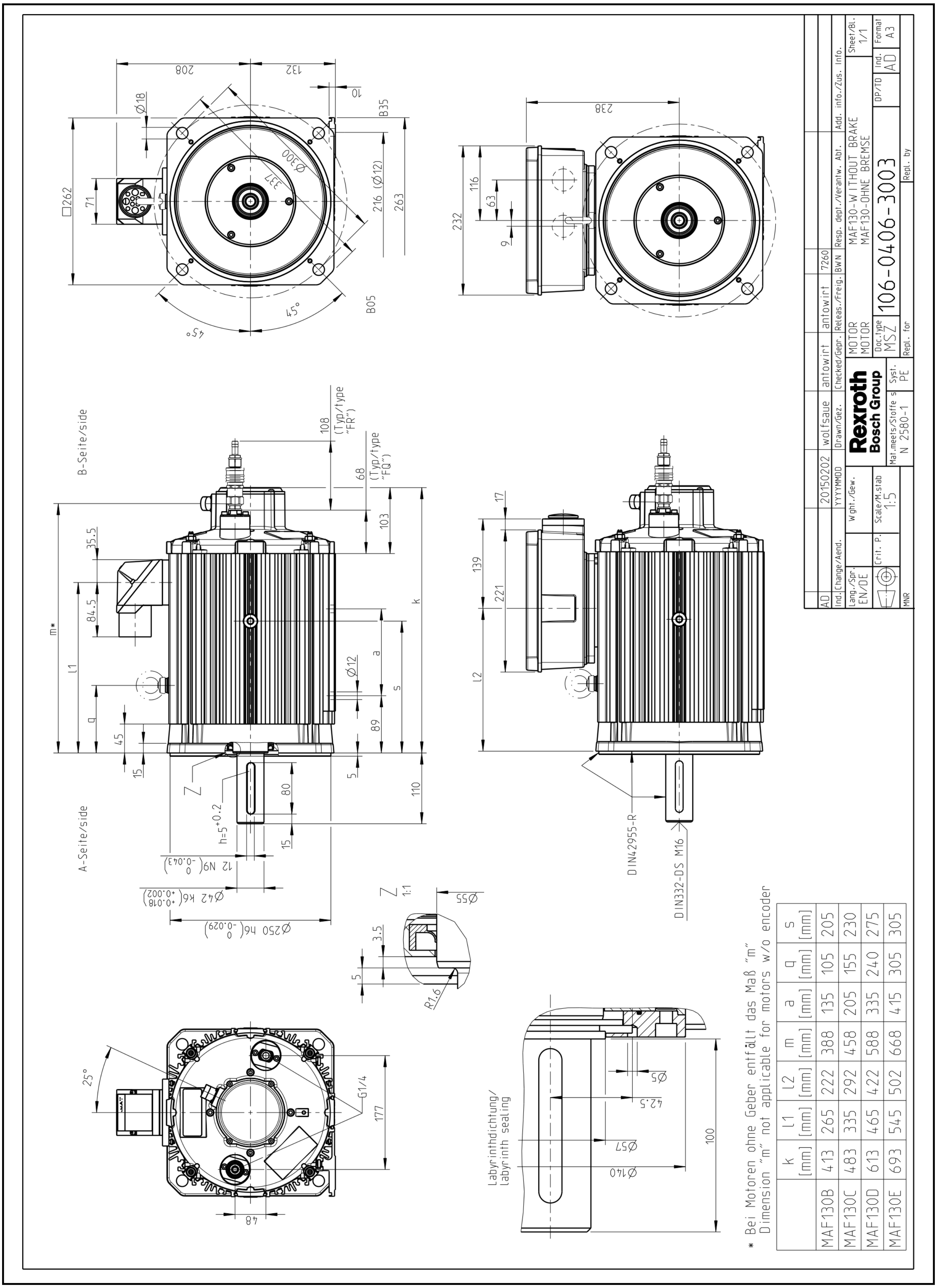
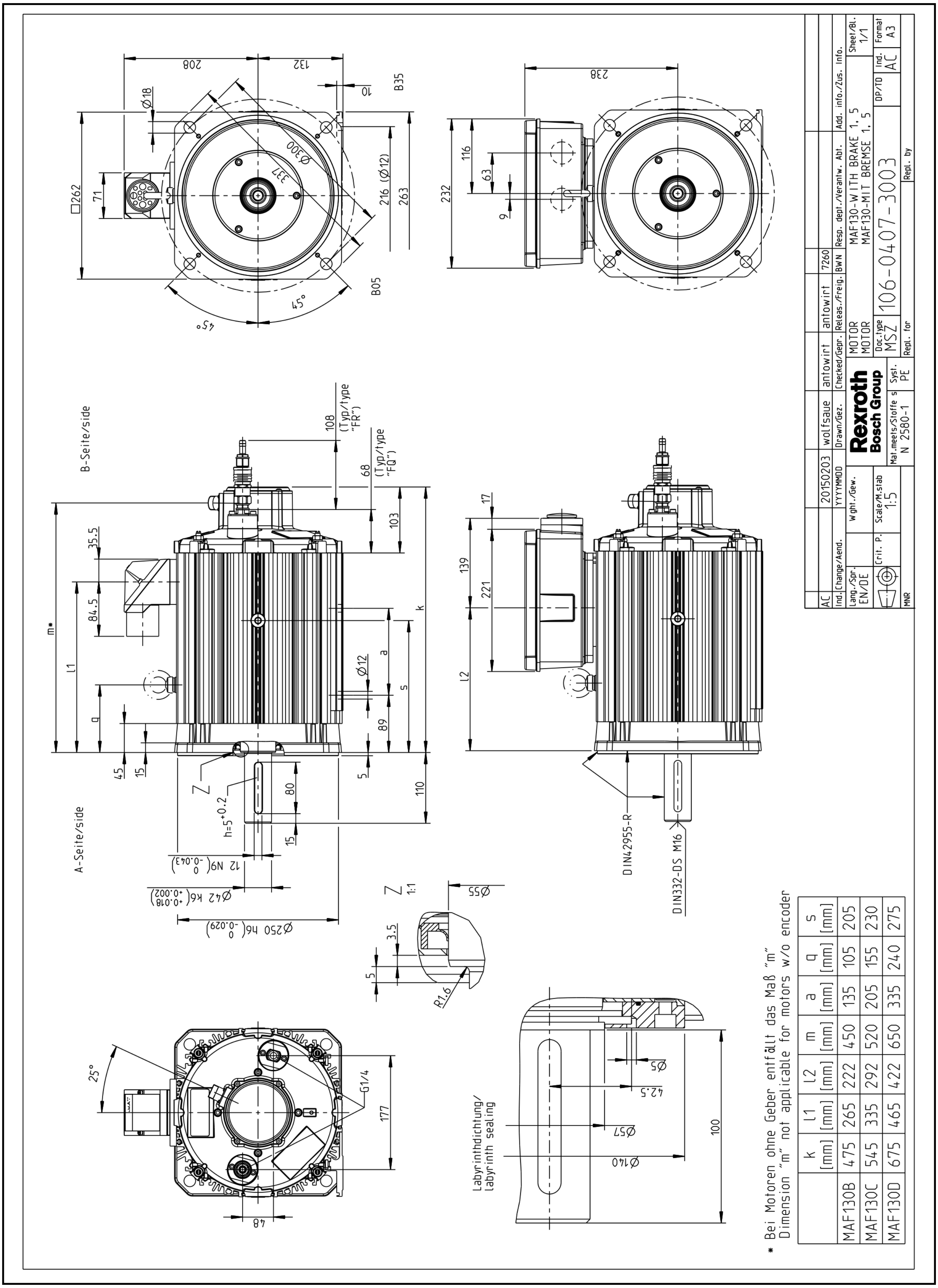


Fig. 5-35: MAF130 without brake

Dimension drawings IndraDyn A

5.7.2 MAF130 with brake 1 or 5



	k [mm]	l1 [mm]	l2 [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAF130B	475	265	222	450	135	105	205
MAF130C	545	335	292	520	205	155	230
MAF130D	675	465	422	650	335	240	275

* Bei Motoren ohne Geber entfällt das Maß "m"
Dimension "m" not applicable for motors w/o encoder

Fig. 5-36: MAF130 with brake 1 or 5

5.7.3 MAF130 in ex-type design with M6 or S6 encoder, without brake

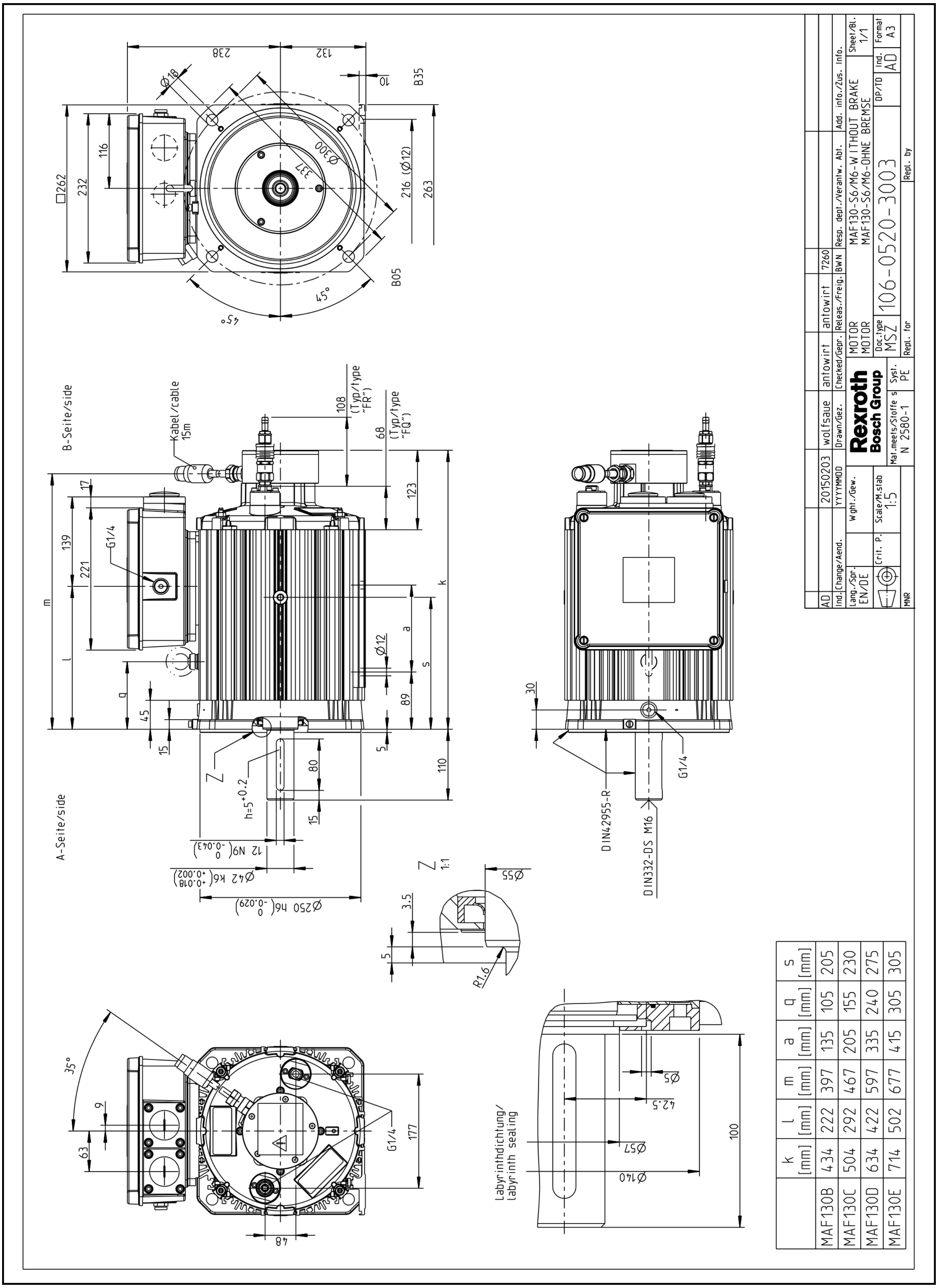
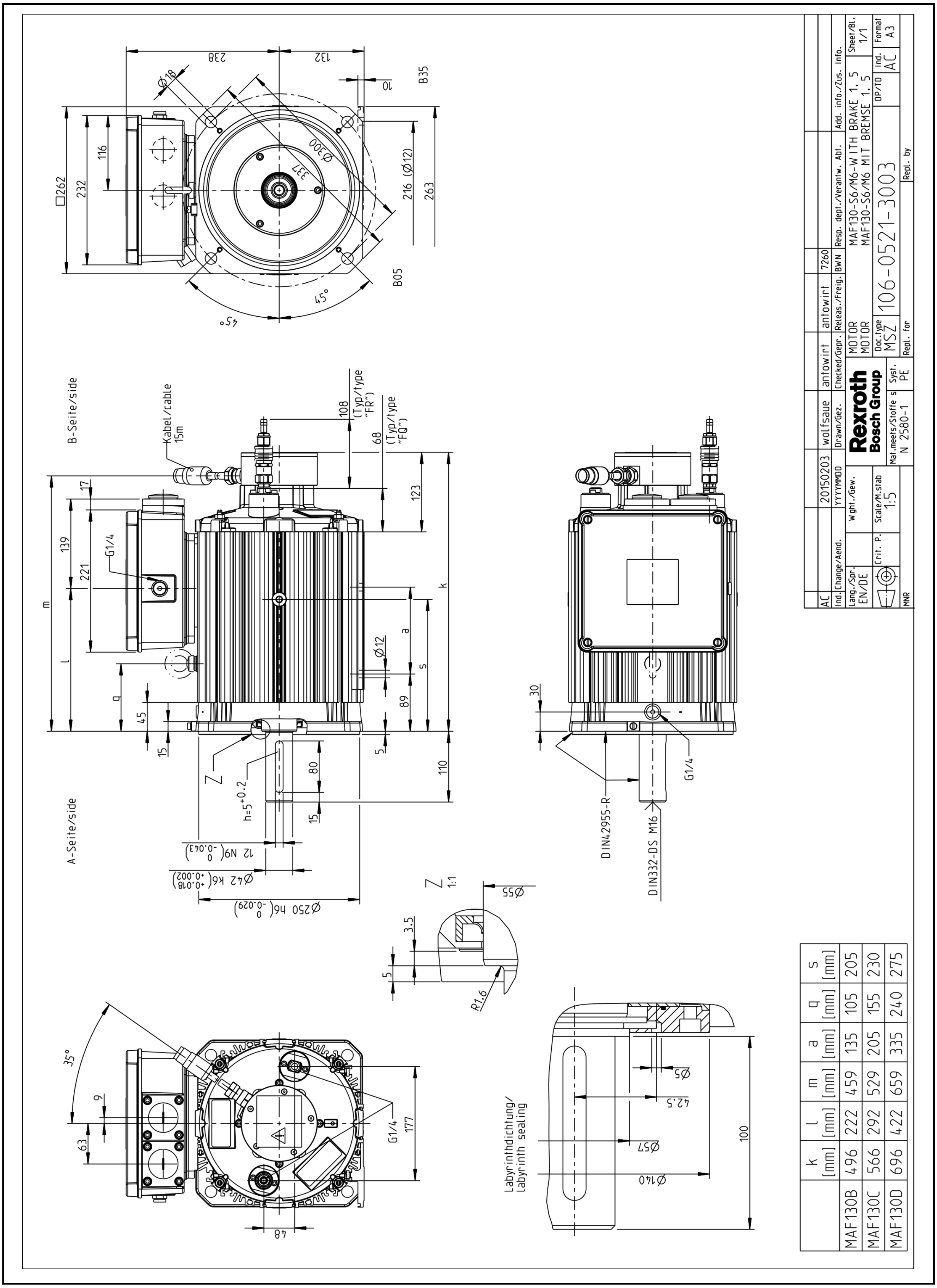


Fig. 5-37: MAF130 with M6/S6 encoder, without brake

Dimension drawings IndraDyn A

5.7.4 MAF130 in ex-type design with M6 or S6 encoder, brake 1 or 5



	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAF130B	496	222	459	135	105	205
MAF130C	566	292	529	205	155	230
MAF130D	696	422	659	335	240	275

Fig. 5-38: MAF130 with M6/S6 encoder, brake 1/5

5.8 Frame size MAF160

5.8.1 MAF160 without brake

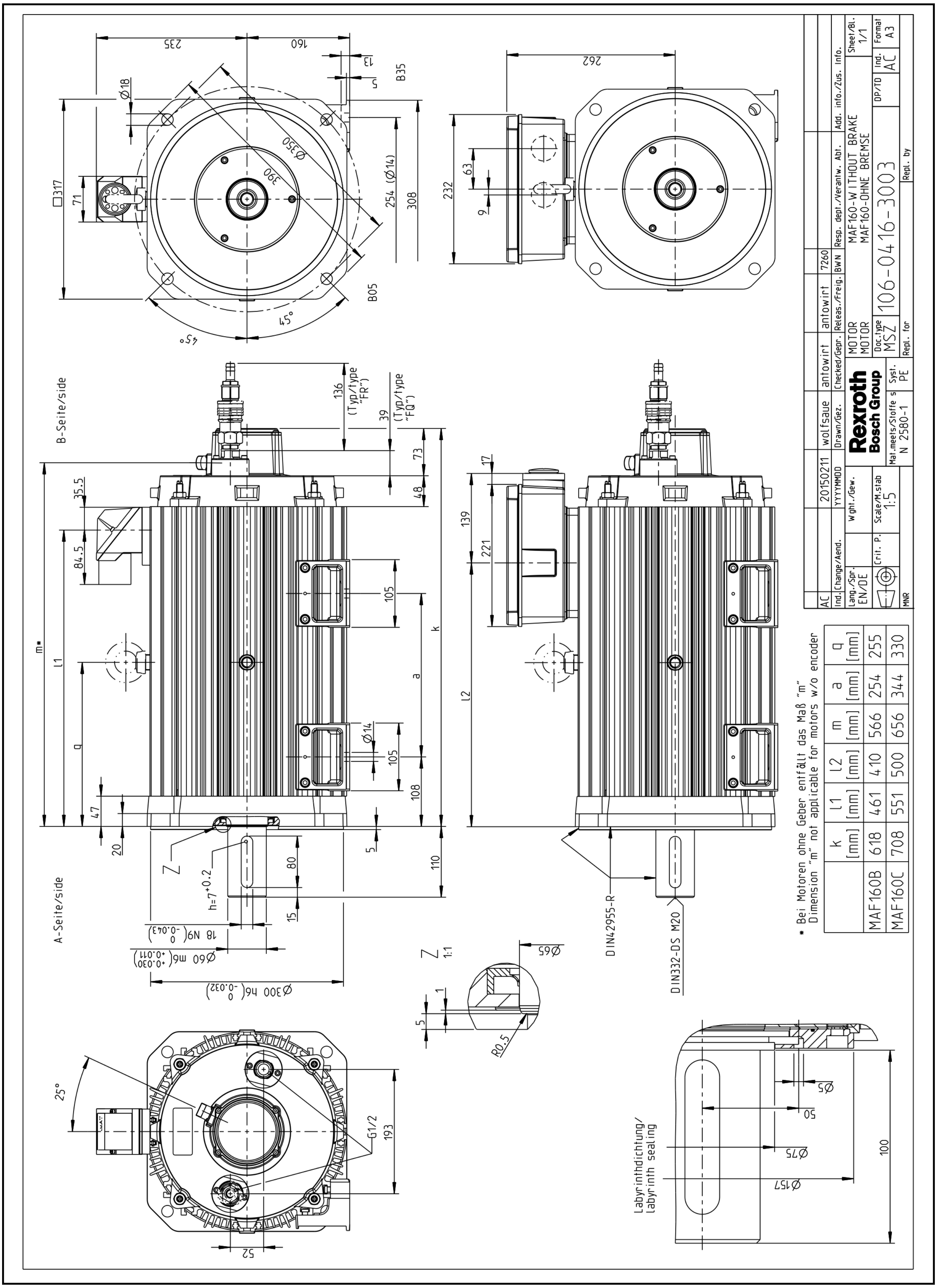


Fig. 5-39: MAF160 without brake

Dimension drawings IndraDyn A

5.8.2 MAF160 with brake 1 or 5

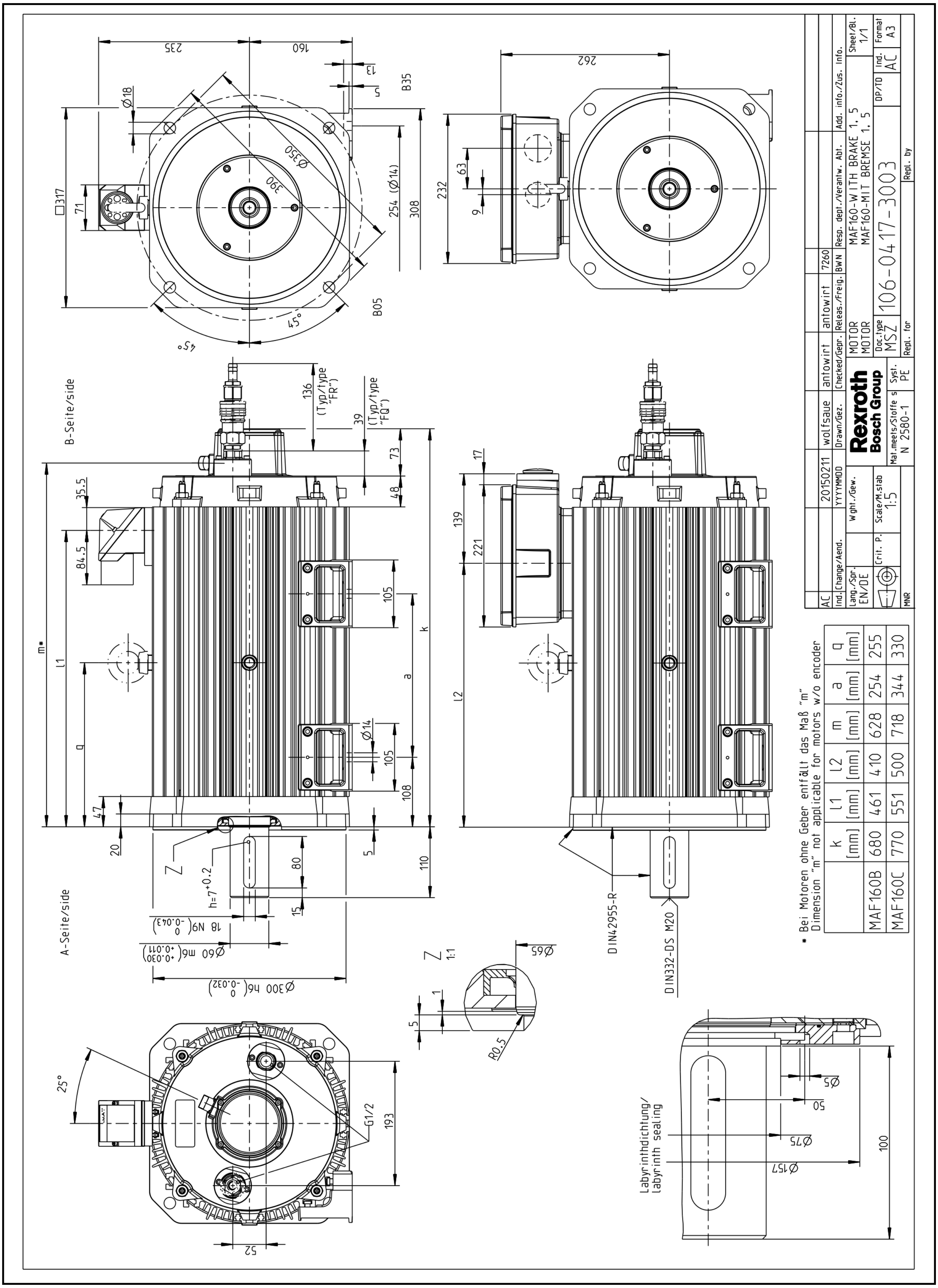
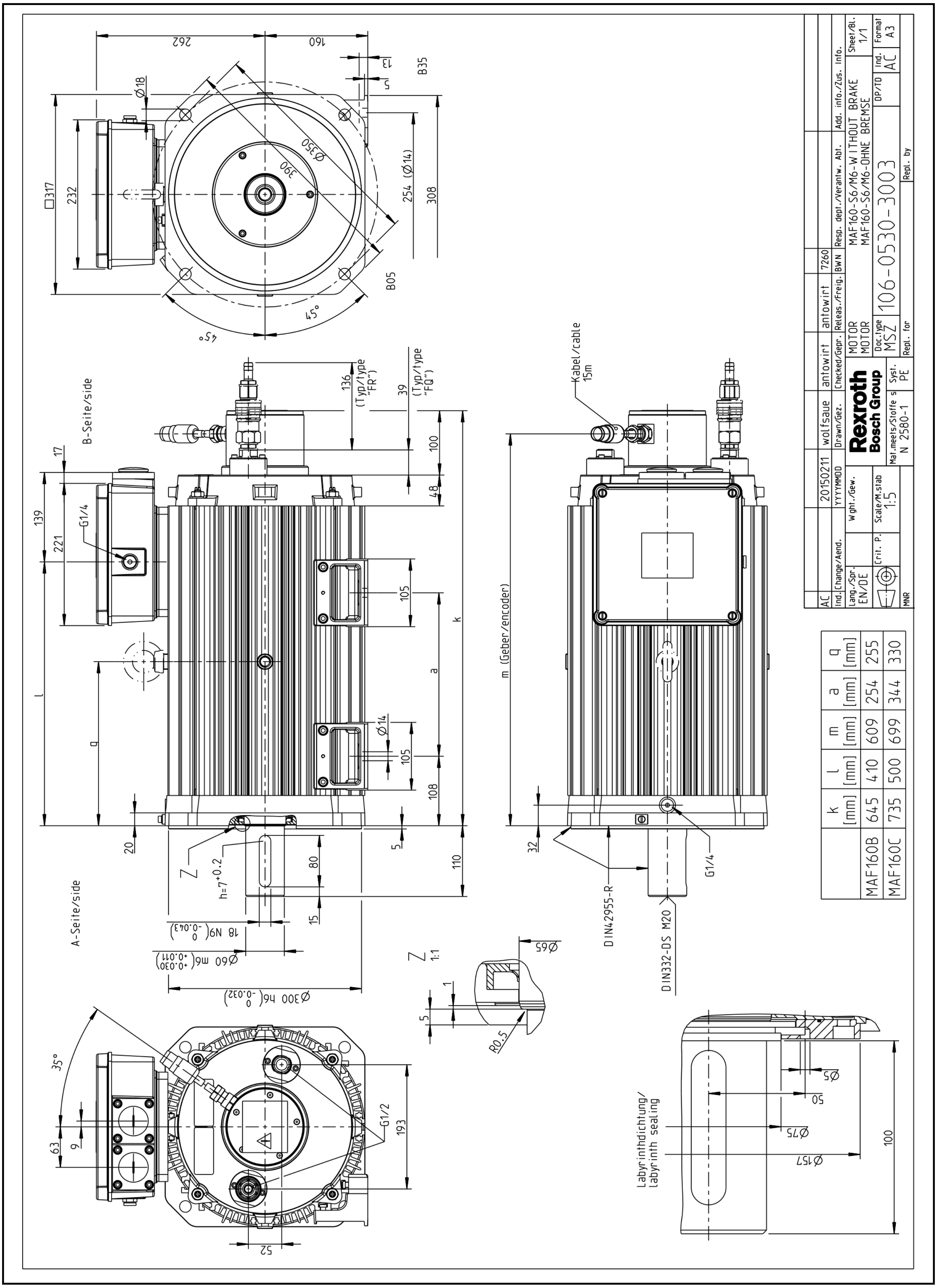


Fig. 5-40: MAF160 with brake 1 or 5

5.8.3 MAF160 in ex-type design with M6 or S6 encoder, without brake



	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]
MAF160B	645	410	609	254	255
MAF160C	735	500	699	344	330

Fig. 5-41: MAF160 with M6/S6 encoder, without brake

5.8.4 MAF160 in ex-type design with M6 or S6 encoder, brake 1 or 5

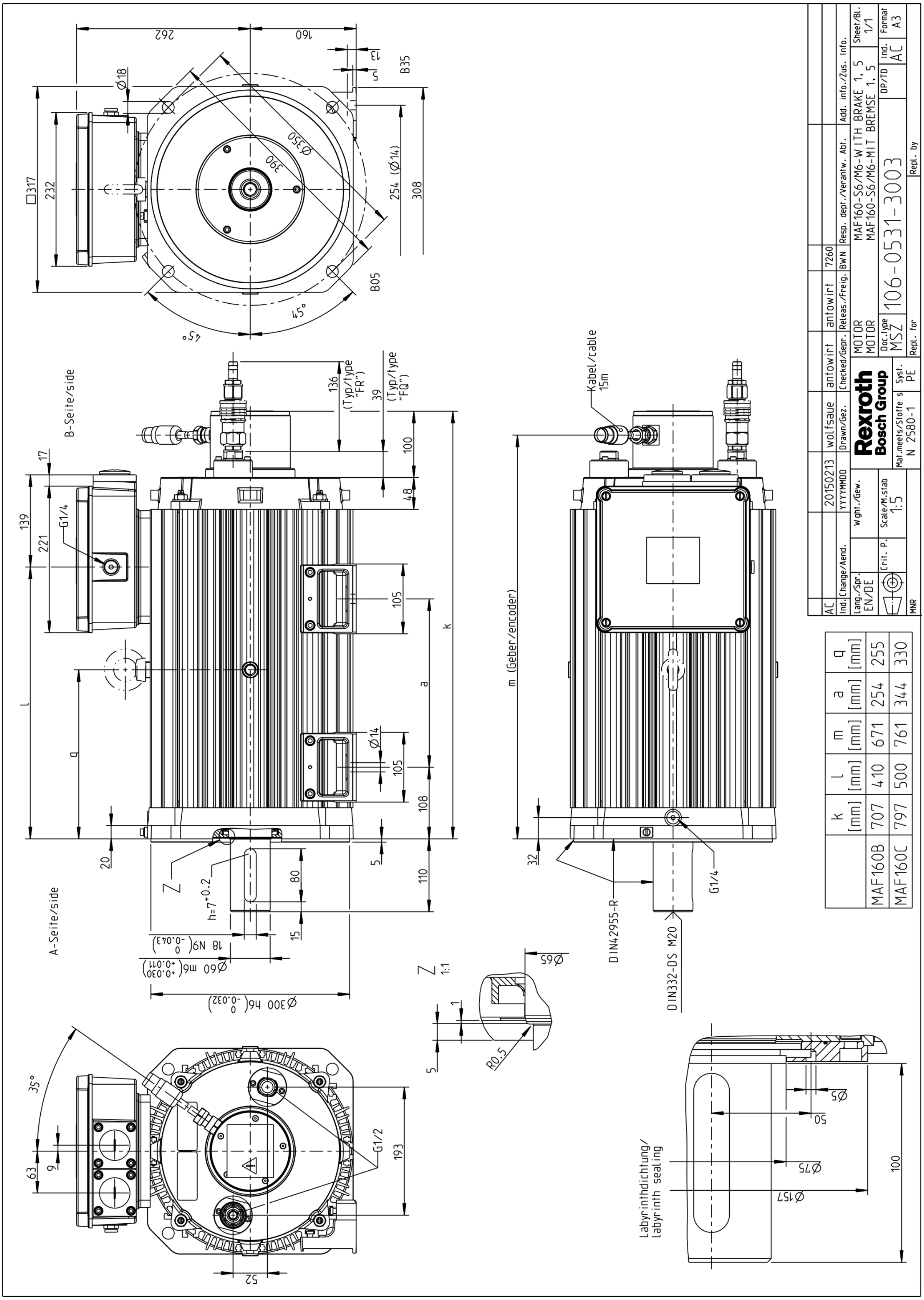


Fig. 5-42: MAF160 with M6/S6 encoder, brake 1/5

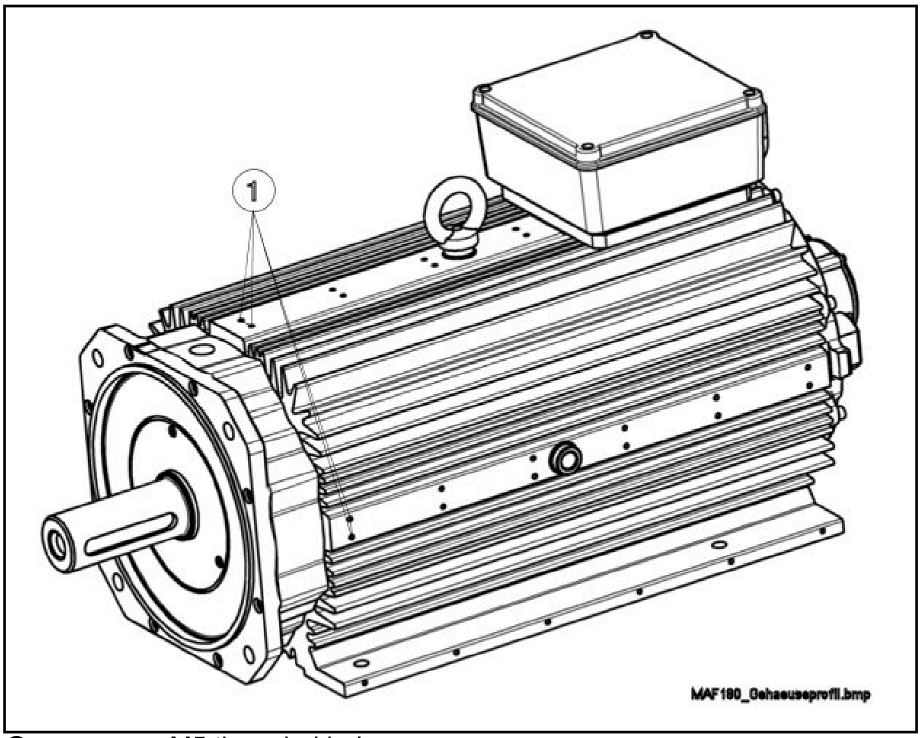
5.9 Frame size MAF180

5.9.1 Threaded holes in MAF180 motor housing

The MAF180 is provided with M5 threaded holes centrally along the longitudinal sides on the motor housing profile. After having mounted the motor, the user can use these threaded holes as required.

However, there are the following restrictions:

- The maximum allowed screw-in depth is 10 mm.
- The maximum allowed tightening torque is 5.5...6 Nm (with a screw-in depth of 8-10 mm and screws of property class 8.8).



① M5 threaded holes

Fig. 5-43: Threaded holes in MAF180 motor housing

5.9.2 MAF180 without brake

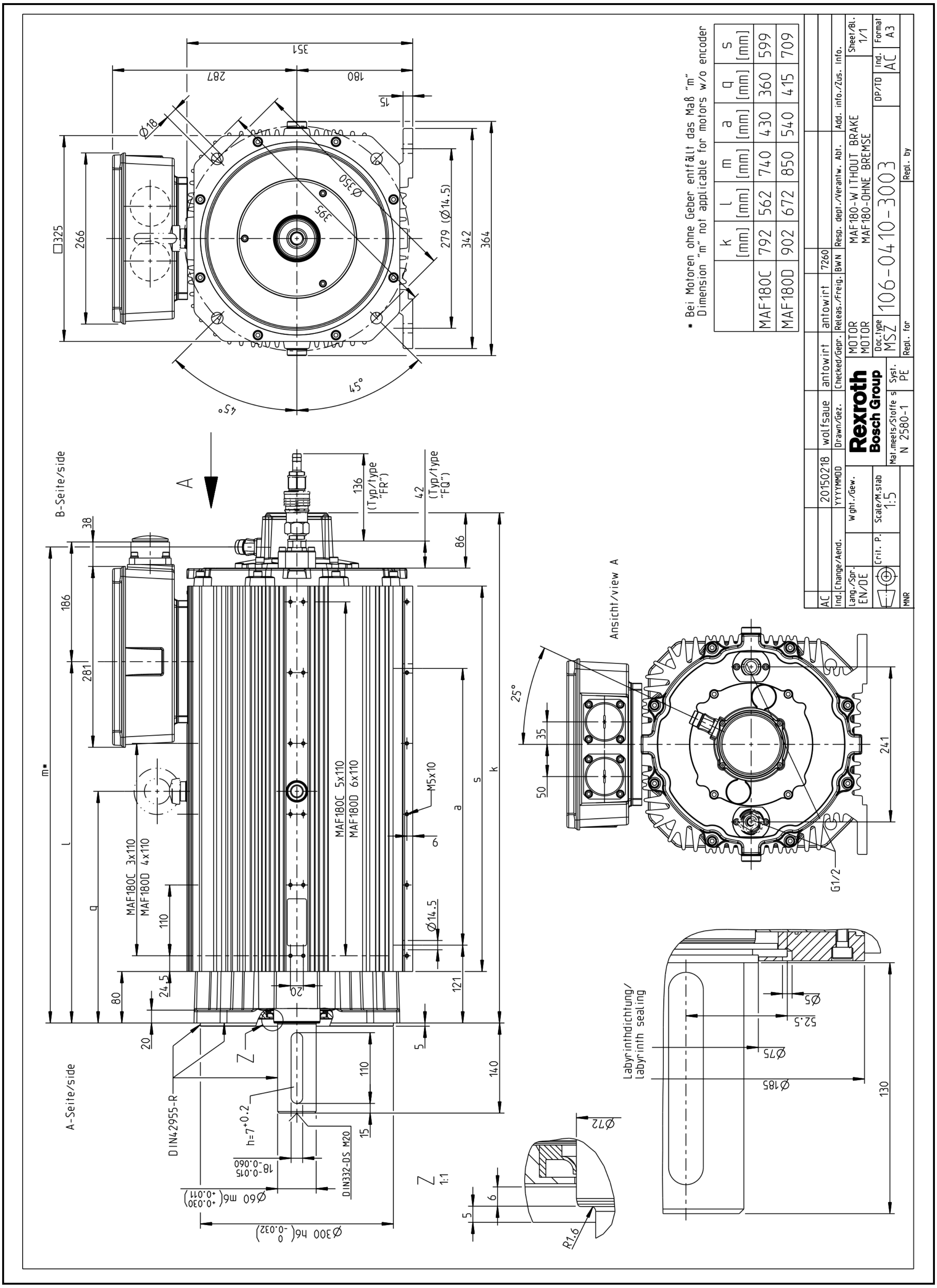


Fig. 5-44: MAF180 without brake

5.9.3 MAF180 with brake 2 or 5

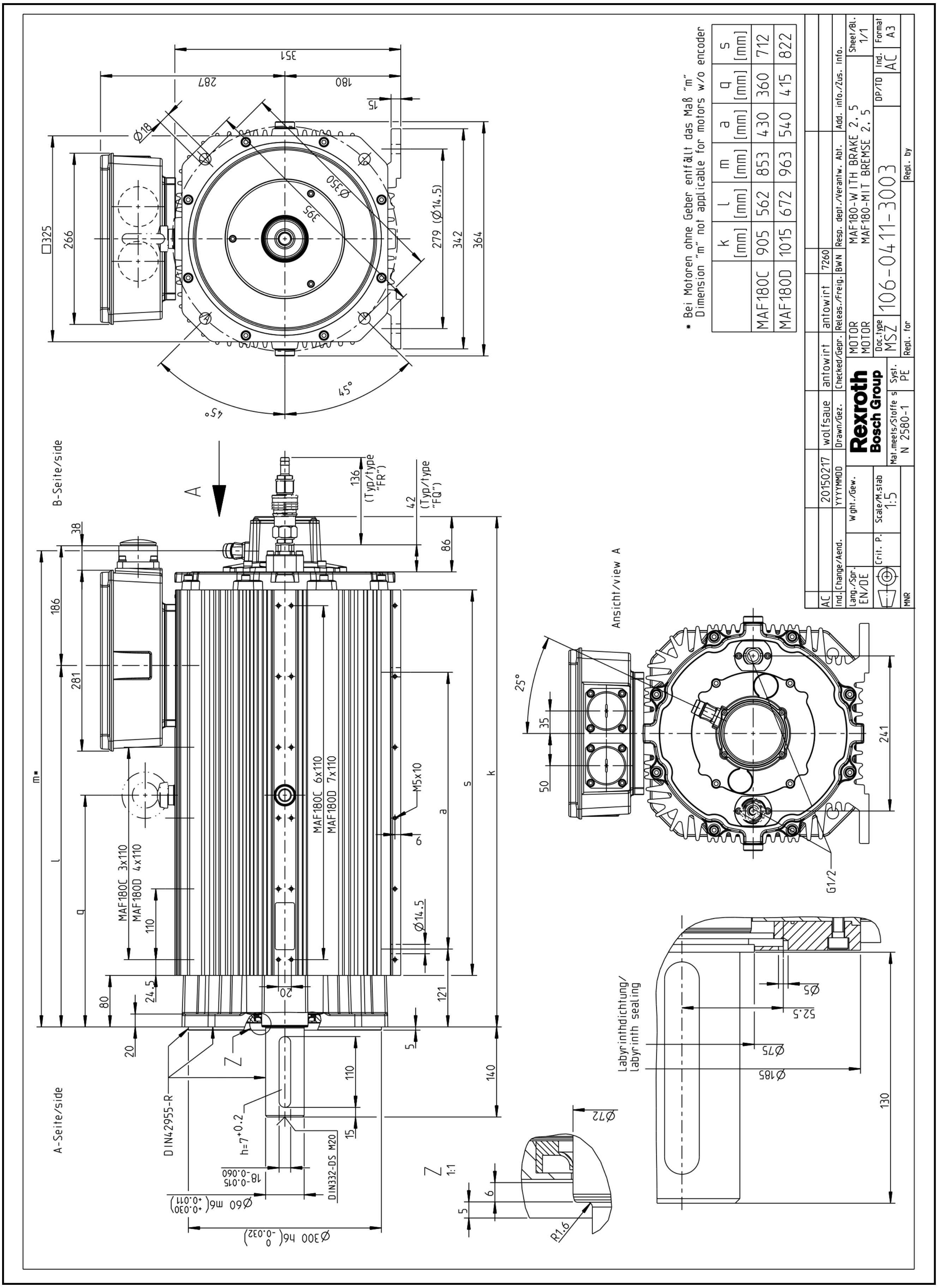


Fig. 5-45: MAF180 with brake 2 or 5

5.9.4 MAF180 in ex-type design with M6 or S6 encoder, without brake

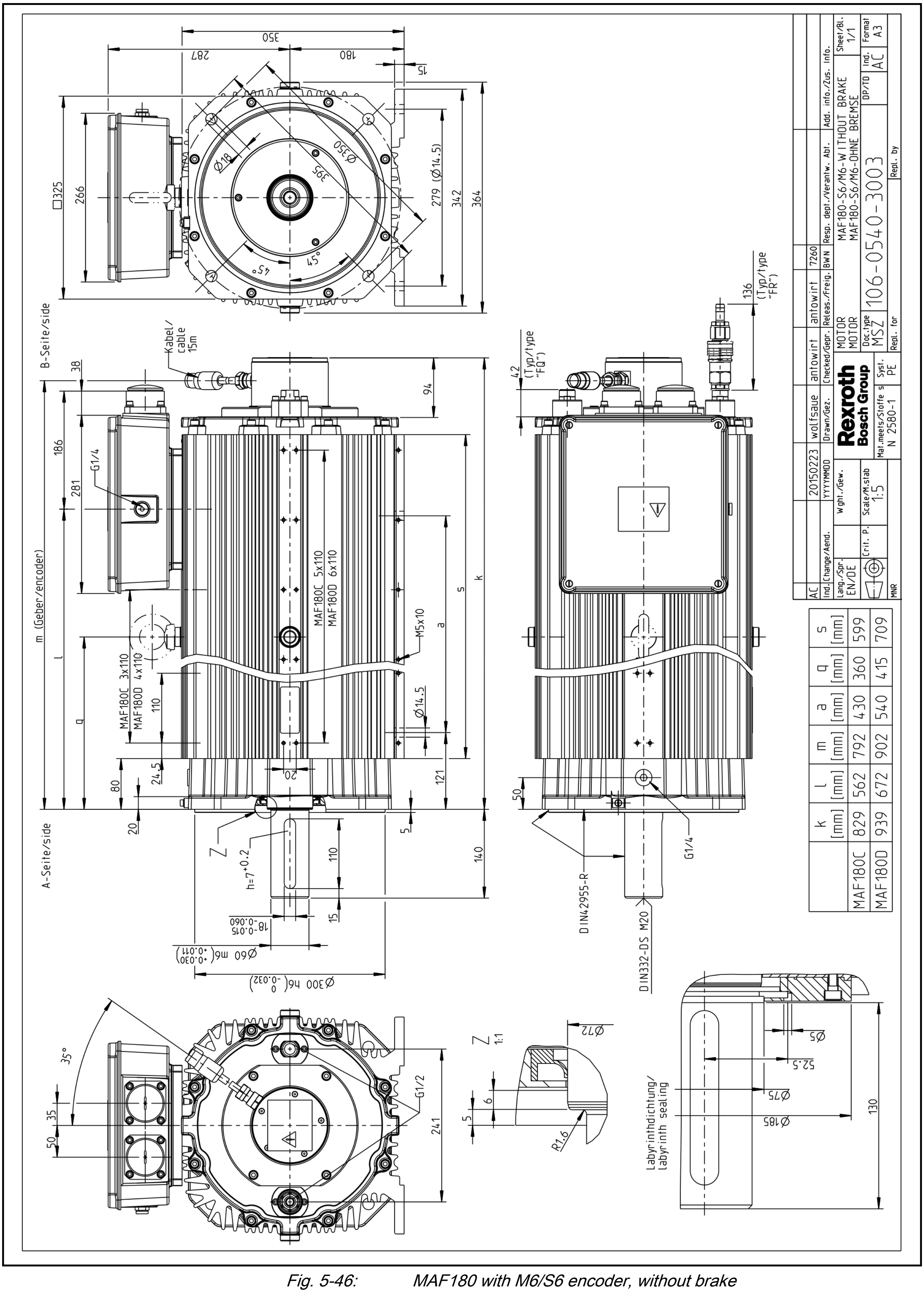
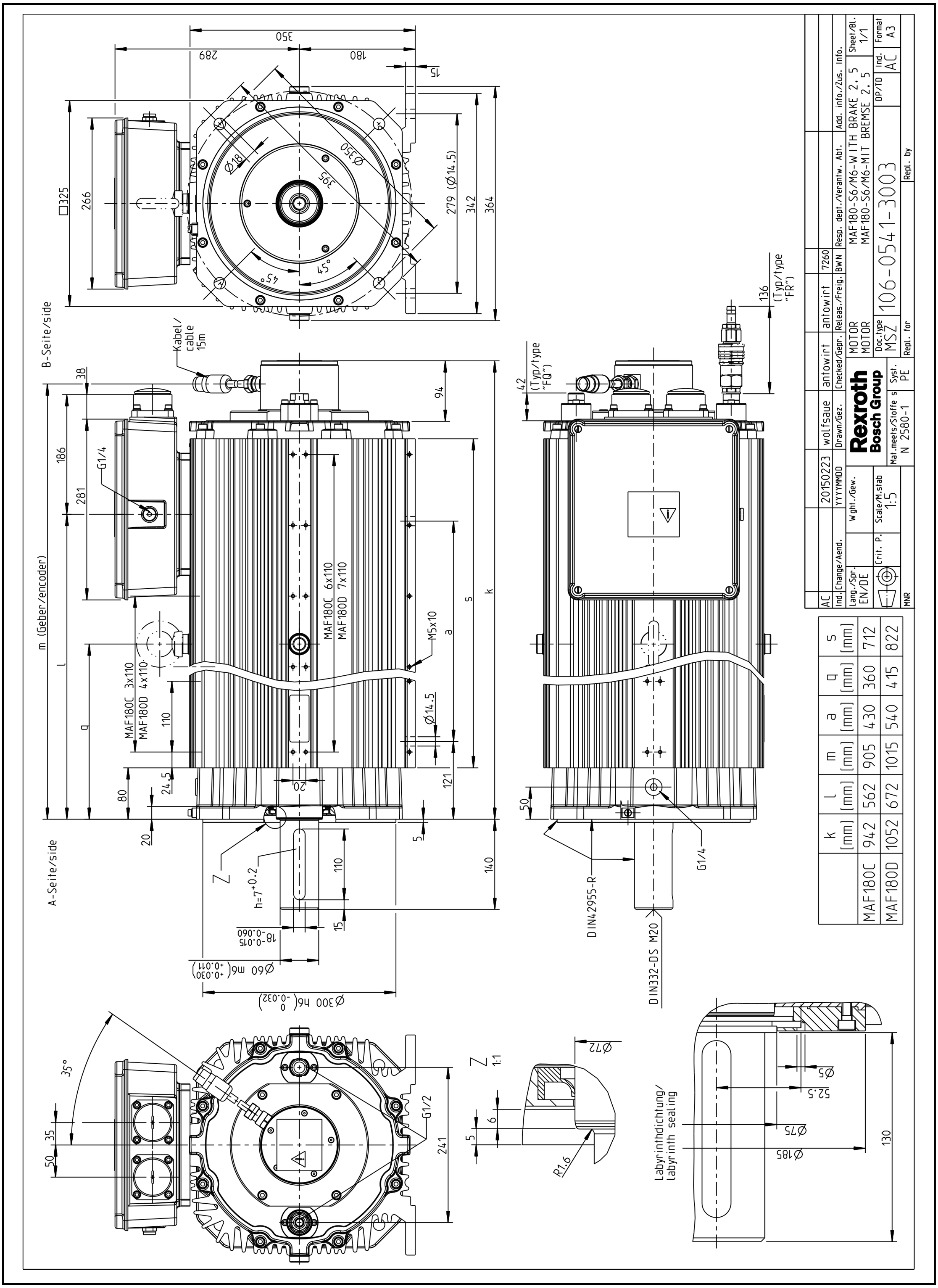


Fig. 5-46: MAF180 with M6/S6 encoder, without brake

5.9.5 MAF180 in ex-type design with M6 or S6 encoder, brake 2 or 5



	k [mm]	l [mm]	m [mm]	a [mm]	q [mm]	s [mm]
MAF180C	942	562	905	430	360	712
MAF180D	1052	672	1015	540	415	822

Fig. 5-47: *MAF180 with M6/S6 encoder, brake 2/5*

5.10 Frame size MAF225

5.10.1 Threaded holes in MAF225 motor housing

As is the case with the MAF180, the MAF225 is also provided with M5 threaded holes centrally along the longitudinal sides on the motor housing profile. After having mounted the motor, the user can use these threaded holes as required.

However, there are the restrictions described in chapter 5.9.1 "Threaded holes in MAF180 motor housing" on page 161.

5.10.2 MAF225C without brake

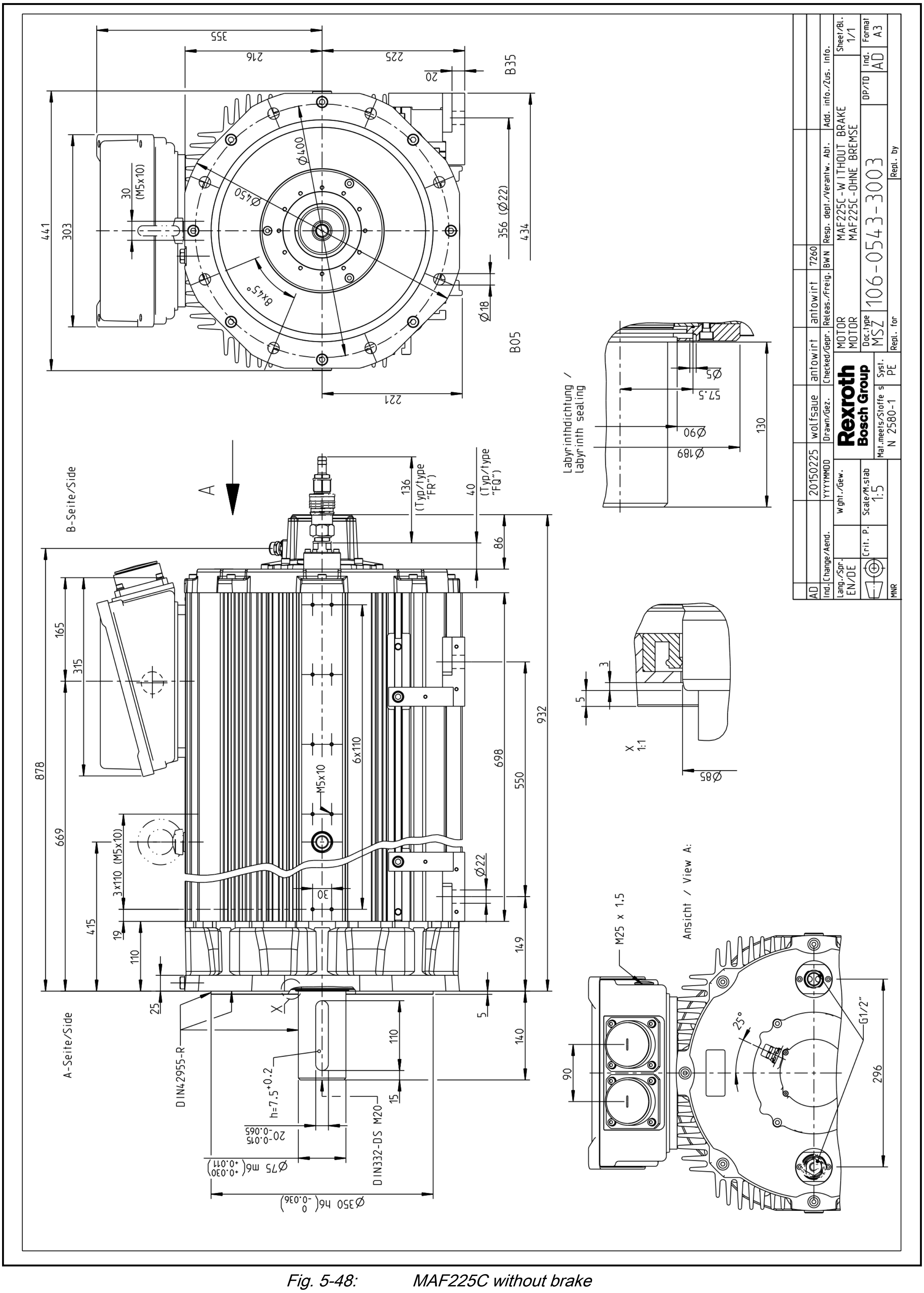


Fig. 5-48: MAF225C without brake

Dimension drawings IndraDyn A

5.10.3 MAF225 in ex-type design with M6 or S6 encoder, without brake

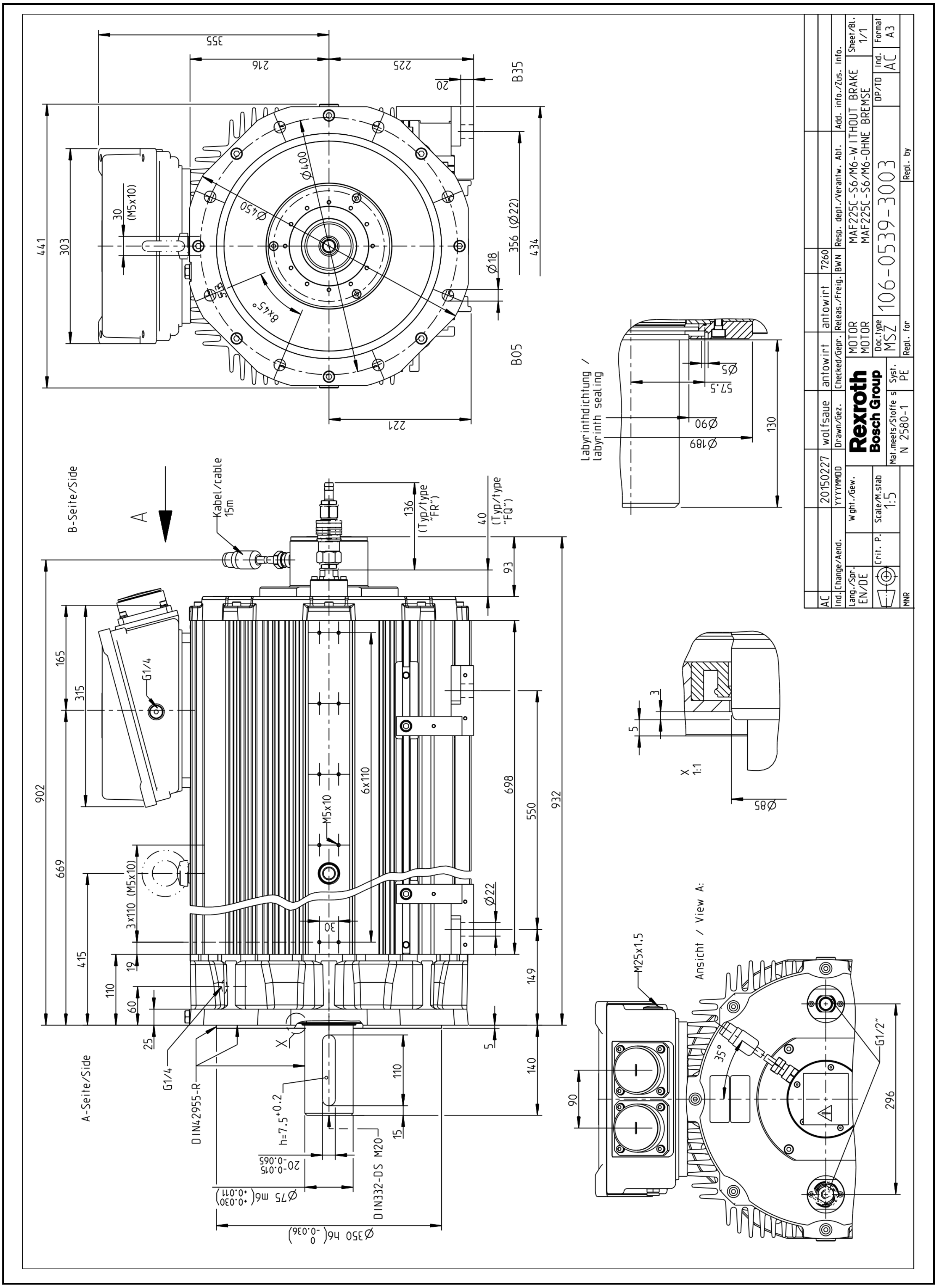


Fig. 5-49: MAF225 with M6/S6 encoder, without brake

6 Type codes IndraDyn A

6.1 Introduction

6.1.1 General

IndraDyn A is the general product name for the new asynchronous housing motors by REXROTH.

The type code describes the deliverable motor variants. It is the basis for selecting and ordering products from Bosch Rexroth. This applies to new products as well as to spare parts and repairs.

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

☞ When selecting a product, please also take the detailed information in the following chapters into account: chapter 4 "Technical Data"; chapter 9 "Application Guidelines"; chapter 13 "Motors for Potentially Explosive Atmospheres".

6.1.2 Definition

1. Product

Short-text columns 1-2-3

MAD is the name of the series of air-cooled asynchronous housing motors.

MAF is the name of the series of liquid-cooled asynchronous housing motors.

2. Motor frame size

Short-text columns 4-5-6

The motor frame size is derived from the mechanical dimensions of the flange on the output side and represents different power ranges.

3. Motor length

Abbrev. column 7

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

For example, frame lengths can be **B**, **C** and **E**.

4. Winding code

Short-text columns 9-10-11-12

The four-digit numerical sequence indicates the rated speed which is valid for the respective winding variant. Thereby, the last number is excluded. Example: Winding designation 0200 means 2000 min^{-1} rated speed.

5. Cooling mode

Short-text columns 14-15

MAD motors must always be operated with a fan. Air baffles guide the air currents of this fan over the surface of the motor ("surface cooling").

Operation without cooling is prohibited.

There are two options to cool MAD motors:

- Option "**SA**": Cooling via the mounted axial fan. The air current is defined as "blowing" according to the following figure.

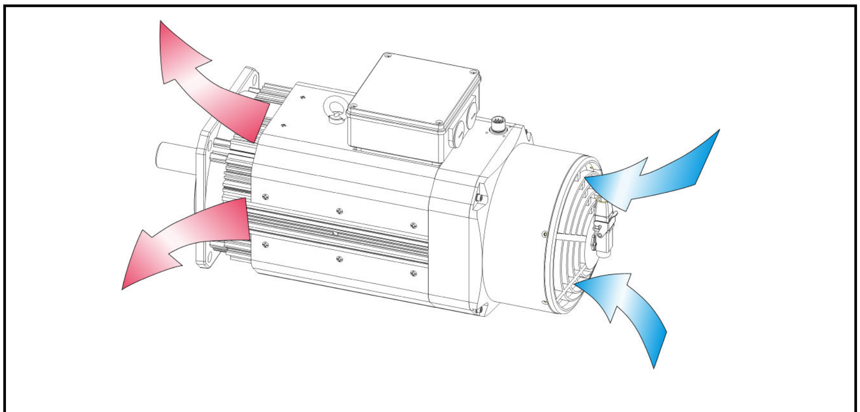


Fig. 6-1: MAD, blowing axial fan

The fan unit can be dismounted for maintenance purposes.

- Option "**SL**": There are certain applications where MAD motors can also be operated with an external fan (chapter 9.8 "Motor cooling" on page 222), e.g., in heavily soiled environments. This is achieved by equipping the motors with a fan cowl and a fan shroud for connecting an air tube.

MAF motors may only be operated in connection with an external cooling system (not included in the Rexroth delivery).

There are two options to connect MAF motors to the cooling system:

- Option "**FQ**“: Coolant port via the connecting threads on the motor (for dimension, refer to the type code or dimension drawing).
- Option "**FR**": Coolant port via the enclosed quick coupling.

  If connection with quick coupling (option "FR") is selected, the quick coupling must be screwed into the coolant port thread on the motor beforehand. Please also observe the information provided in chapter 8.9.2 "Coolant connection " on page 211.

6. Motor encoder

Short-text columns 17-18

IndraDyn A motors are available with integrated rotary encoders .

Option	Type	Periods	Signal [1])	Interface	Supply voltage
S2	Singleturn absolute encoder	2048	1 V_{ss}	EnDat2.1	3.6 ... 14 V
M2	Multiturn absolute encoder	2048	1 V_{ss}	EnDat2.1	3.6 ... 14 V
S6	Single-turn absolute encoder for ex-type motors (connecting cable length 15 m)	2048	1 V_{ss}	EnDat2.1	3.6 ... 14 V
M6	Multi-turn absolute encoder for ex-type motors (connecting cable length 15 m)	2048	1 V_{ss}	EnDat2.1	3.6 ... 14 V
C0	Incremental encoder	2048	1 V_{ss}	-	5 V
N0	The motor is delivered without any factory-mounted encoder unit. The motor is closed with a cover on its rear.				
[1]) All encoder signals sinusoidal.					

Tab. 6-1: IndraDyn A motor encoders

7. Electrical connection

Abbrev. column 20

The electrical connection of the motors of frame size 100 ... 160 can be implemented either via a flange socket or a terminal box. Frame size 180 225 and ex-type motors can only be connected via a terminal box.

For more information, please refer to the type code of the motor and chapter 8 "Connection technique" on page 199.

8. Output shaft

Abbrev. column 21

IndraDyn A motors provide the following options to connect the machine elements to be driven to the motor shafts:

Output shaft			
	Plain shaft	With key	
		Complete key, balanced	Half key, balanced
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Tab. 6-2: Output shaft options

Motors which are provided with a keyway are always delivered with a key.

The motor drive shafts of frame sizes 130…225 have threaded centering holes on the end face in "DS" version in accordance with DIN 332, sheet 2. Details can be found in the dimension drawing of the particular motor.

Please also observe the supplementary notes about shaft sealing ring, output shaft and labyrinth seal in chapter 9.12 "Output shaft " on page 236.

9. Holding brake

Abbrev. column 22

Up to frame size 180, IndraDyn A motors are optionally available with integrated holding brake and different holding torques. Depending on the application, either an "**electrically clamping**" or an "**electrically releasing**" brake can be selected.

☞ The motor holding brake is not suitable for personal protection and cannot be used as a service brake. Please also observe the additional information on holding brakes in chapter 9.10 "Holding brake (option)" on page 230 and chapter 12.5.5 "Servicing and commissioning holding brakes " on page 281.

10. Frame size

Short-text columns 24-25

IndraDyn A motors are available in frame shape **05** (flanged attachment) or frame shape **35** (flanged and foot installation). The allowed installation types are explained under chapter 9.6 "Frame shape and Installation position " on page 219.

11. Bearing

Abbrev. column 27

- **Standard bearings** (option "**N**") consists of deep-groove ball bearings for all IndraDyn A motors.
- **A-sided fixed bearings** (option "**A**") also consist of deep-groove ball bearings. In contrast to other bearing models, however, fixed bearings are arranged on side A. This bearing is particularly suitable if circumferential radial forces must be expected during operation or if other attachment parts are to be connected to the motor shaft via a coupling.

- **Reinforced bearings** (option "**V**") can be used when high radial forces must be absorbed. Reinforced bearings feature a cylindrical roller bearing in addition to the deep-groove ball bearing on side A.
- **High-speed bearings** (option "**H**") allow higher speeds with reduced axial and radial load bearing capacity.

Please also observe the additional information on bearing models in the motor data sheet in chapter 4 "Technical data" on page 25 and chapter 9.13 "Bearing variants and shaft load" on page 240.

12. Oscillating quantity level

Abbrev. column 28

IndraDyn A motors are dynamically balanced in accordance with the requirements of EN 60034-14:2004. The standard oscillating quantity level of the motors is level "**A**". An additional oscillating quantity level "**B**" or "**C**" can be selected for various motor frame sizes. For more information on motor oscillating quantity levels, please refer to chapter 9.17 "Oscillating quantity level" on page 257.

Type codes IndraDyn A

6.2 Type code MAD100

Short text 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	A	D	1	0	0	C	-	0	1	0	0	-	S	A	-	S	0	-	B	H	0	-	0	5	-	N	1												

Product
MAD . . . . = MAD

Size
100 . . . . = 100

Length
Lengths . . . . = B, C, D

Winding
MAD100B = 0050, 0100, 0150, 0200, 0250
MAD100C = 0050, 0100, 0150, 0200, 0250
MAD100D = 0050, 0100, 0150, 0200, 0250

Cooling mode
Axial fan, blowing . . . . = SA
Fan top with fan cowl . . . . = SL

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . . = C0
Without motor encoder . . . . = N0

ZN-40001-100_NOR_N_EN_2012-01-13

Fig. 6-2: Type code MAD100 (1/2)

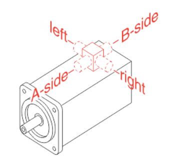
Type codes IndraDyn A

Short text column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	D	1	0	0	C	-	0	1	0	0	-	S	A	-	S	0	-	B	H	0	-	0	5	-	N	1												

Electrical connection see picture 1 ②

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	G

Position of power connection = top



Picture 1

Shaft ③

	plain shaft	With key: balanced with entire key	With key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake
Without holding brake . . . . = 0
Electrically-released, 24 Nm . . . . = 1
Electrically-clamped, 30 Nm . . . . = 5

Mounting style
Flange mounting . . . . = 05
Flange and foot mounting . . . . = 35

Bearing ④
Fixed bearing A-side . . . . = A
Standard . . . . = N
High Speed . . . . = H

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - documentation . . . . = 4 ⑤

Note:
① Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and S6" are only available with cooling "SL", not with el. connection "A", "B", "R" and "L" and only with shaft "G", "P" and "K" and bearing "A" and "N"
② According to DIN IEC 60204-1 and DIN IEC 60364-5-52
③ Shaft "F", "M" and "R" always available with shaft sealing ring
④ Bearing "A" is only available with holding brake "0" and vibration severity "1"
Bearing "H" is not available with encoder "S6" and "M6" and only with shaft "H" and holding brake "0"
⑤ Vibration severity "4" is only available with length "B" and "C" and bearing "N" and "H"

Normative reference

Standards	Edition	Title
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN IEC 60204-1	2002-09	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

ZN-40001-100_NOR_N_EN_2012-01-13

Fig. 6-3: Type code MAD100 (2/2)

Type codes IndraDyn A

6.3 Type code MAD130

Type short description	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	A	D	1	3	0	B	-	0	1	5	0	-	S	A	-	S	2	-	A	G	0	-	0	5	-	N	1												

01 **Product**

MAD.................. = MAD

02 **SIze**

130................................ = 130

03 **Lentgh**

Length............................. = B, C, D

04 **Winding**

MAD130B .....= 0050,0100,0150,0200,0250
MAD130C .....= 0050,0100,0150,0200,0250
MAD130D .....= 0050,0100,0150,0200,0250

05 **Cooling mode**

Axial fan, blowing.. = SA
Fan top with fan cowl...................................... = SL

06 **Encoder** [1)]

Singleturn absolute encoder, EnDat2.1,
2048 increments ....= S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas......................................= S6
Multiturn absolute encoder, EnDat2.1,
2048 increments ....= M2
Multiturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas......................................= M6
Incremental encoder, 2048 increments ....= C0
Without motor encoder ....= N0

07 **Electrical connection see picture** [2)]

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	G

08 **Shaft** [3)]

	plain shaft	With key: balanced with entire key	With key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

DCCS-40001-130_TCO_N_EN_2015-12-03_1v2

Fig. 6-4: Type code MAD130 (1/2)

Type short description	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	A	D	1	3	0	B	-	0	1	5	0	-	S	A	-	S	2	-	A	G	0	-	0	5	-	N	1												

09 Holding brake

Without holding brake .... = 0
Electrically-released, 80 Nm .... = 1
Electrically-clamped, 100 Nm .... = 5

10 Mounting style

Flange mounting .... = 05
Flange and foot mounting .... = 35

11 Bearing [4)]

Fixed bearing A-Side .... = A
High speed .... = H
Standard .... = N
Reinforced bearing .... = V

12 Vibration severtity

A, according to DIN EN 60034-14 .... = 1
B, according to DIN EN 60034-14 .... = 3
C, spezification according to IndraDyn A - documentation .... = 4 [5)]

DCCS-40001-130_TCO_N_EN_2015-12-03_2v2

Note:

1) Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff Encoder “M6” or “S6” are only available with Cooling mode “SL”, not with Electrical connection “A”, “B”, “R” and “L” and only with Shaft “G”, “P” or “K” and Bearing “A”, “N” or “V”
2) According to DIN IEC 60204-1 and DIN IEC 60364-5-52
3) Shaft “F”, “M” and “R” are only available with shaft sealing ring
4) Bearing “A” is only available with Holding brake “0” and Vibration severity “1”
   Bearing “H” is not available with Encoder “S6” or “M6” and only with Shaft “H” and Holding brake “0”
5) Vibration severity “4” is only availbale with Length “B” or “C” and Bearing “N” or “H”

Fig. 6-5: Type code MAD130 (2/2)

6.4 Type code MAD160

Type short description	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	A	D	1	6	0	B	-	0	0	5	0	-	S	A	-	C	0	-	A	H	0	-	0	5	-	N	1												

01 Product
MAD.................. = MAD

02 SIze
160................................ = 160

03 Lentgh
Length................................ = B, C

04 Winding
MAD160B .... = 0050,0100,0150,0200
MAD160C .... = 0050,0100,0150,0200

05 Cooling mode
Axial fan, blowing.. = SA
Fan top with fan cowl...................................... = SL

06 Encoder 1)
Singleturn absolute encoder, EnDat2.1, 2048 increments ....= S2
Singleturn absolute encoder, EnDat2.1, 2048 increments, for Ex areas......................................= S6
Multiturn absolute encoder, EnDat2.1, 2048 increments ....= M2
Multiturn absolute encoder, EnDat2.1, 2048 increments, for Ex areas......................................= M6
Incremental encoder, 2048 increments ....= C0
Without motor encoder ....= N0

07 Electrical connection see picture 2)

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	G

08 Shaft 3)

	plain shaft	With key: balanced with entire key	With key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

DCCS-40001-160_TCO_N_EN_2015-12-03_1v2

Fig. 6-6: Type code MAD160 (1/2)

Type short description	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	A	D	1	6	0	B	-	0	0	5	0	-	S	A	-	C	0	-	A	H	0	-	0	5	-	N	1												

09 Holding brake

Without holding brake........................= 0
Electrically-released, 100 Nm........................= 1
Electrically-released, 240 Nm........................= 3
Electrically-clamped, 100 Nm........................= 5

10 Mounting style

Flange mounting........................ = 05
Flange and foot mounting........................ = 35

11 Bearing 4)

Fixed bearing A-Side........................ = A
High speed .... = H
Standard........................ = N
Reinforced bearing .... = V

12 Vibration severtity

A, according to DIN EN 60034-14........................= 1
B, according to DIN EN 60034-14........................= 3
C, spezification according to IndraDyn A - documentation ....= 4 5)

DCCS-40001-160_TCO_N_EN_2015-12-03_2v2

Note:

1) Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff Encoder “M6” or “S6” are only available with Cooling mode “SL”, not with Electrical connection “A”, “B”, “R” and “L” and only with Shaft “G”, “P” or “K” and Bearing “A”, “N” or “V”
2) According to DIN IEC 60204-1 and DIN IEC 60364-5-52
3) Shaft “F”, “M” and “R” are only available with shaft sealing ring
4) Bearing “A” is only available with Holding brake “0” and Vibration severity “1”
Bearing “H” is not available with Encoder “S6” or “M6” and only with Shaft “H” and Holding brake “0”
5) Vibration severity “4” is only availbale with Bearing “N” or “H”

Fig. 6-7: Type code MAD160 (2/2)

6.5 Type code MAD180

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	D	1	8	0	C	-	0	0	5	0	-	S	A	-	C	0	-	K	H	0	-	3	5	-	N	1												

Product
MAD . . . . = MAD

Size
180 . . . . = 180

Length
Lengths. . . . . = C, D

Winding
MAD180C . . = 0050, 0100, 0150, 0200
MAD180D . . . = 0050, 0100, 0150, 0200

Cooling
Axial fan, blowing . . . . = SA
Fan top with fan cowl . . . . = SL

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments . . = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments . . . . = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments. . . . . = C0
without motor encoder. . . . . = N0

ZN-40001-180_NOR_N_EN_2010-07-30_1v2

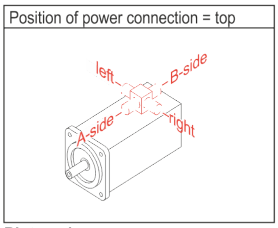
Fig. 6-8: Type code MAD180 (1/2)

Type codes IndraDyn A

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	A	D	1	8	0	C	-	0	0	5	0	-	S	A	-	C	0	-	K	H	0	-	3	5	-	N	1												

Electrical connection see picture 1 (2)

	Terminal box, turnable
A-Side	E
B-Side	H
Right	D
Left	G



Picture 1

Shaft (3)

	plain shaft	with key balanced with entire key	with key balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake
Without holding brake . . . . = 0
Electrically-released, 240 Nm . . . . = 2
Electrically-damped, 300 Nm . . . . = 5

Mounting style
Flange and foot mounting. . . . .= 35

Bearing (4)
Fixed bearing A-side . . . . = A
Standard . . . . = N
Reinforced bearing . . . . = V

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - dokumentation . . . .= 4 (5)

Note:
(1) Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6" are only available with cooling "SL" shaft "G", "P" and "K" and bearings "A", "N" and "V"
(2) According to DIN IEC 60204-1 and DIN IEC 60364-5-52
(3) Shaft "F", "M" and "R" always available with shaft sealing ring
(4) Bearing "A" is only available with holding brake "0" and vibration severity "1"
(5) Vibration severity "4" is only available with length "C" and bearing "N"

ZN-40001-180_NOR_N_EN_2010-07-30_2v2

Fig. 6-9: Type code MAD180 (2/2)

6.6 Type code MAD225

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	A	D	2	2	5	C	-	0	1	5	0	-	S	A	-	S	2	-	F	H	0	-	3	5	-	N	1												

Product
MAD . . . . = MAD

Size
225 . . . . = 225

Length
Lengths . . . . = C

Winding
MAD225C . . . . = 0050, 0100, 0150

Cooling
Axial fan, blowing . . . . = SA
Fan top with fan cowl . . . . = SL

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . .= C0
without motor encoder . . . .= N0

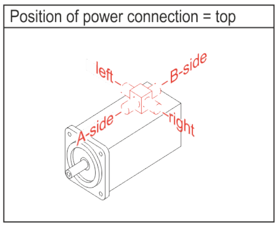
ZN-40001-225_NOR_N_EN_2010-07-30_1v2

Fig. 6-10: Type code MAD225 (1/2)

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	A	D	2	2	5	C	-	0	1	5	0	-	S	A	-	S	2	-	F	H	0	-	3	5	-	N	1												

Electrical connection see picture 1 ②

	Terminal box, turnable
A-Side	E
B-Side	H
Right	D
Left	G



Picture 1

Shaft ③

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake
Without holding brake . . . . = 0

Mounting style
Flange mounting . . . . = 05
Flange and foot mounting. . . . .= 35

Bearing
Standard . . . . = N
Reinforced bearing . . . . = V

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1

Note:
① Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6" are only available with cooling mode "SL" and only with shaft "G", "P" and "K"
② According to DIN IEC 60204-1 and DIN IEC 60364-5-52
③ Shaft "F", "M" and "R" always available with shaft sealing ring

ZN-40001-225_NOR_N_EN_2010-07-30_2v2

Fig. 6-11: Type code MAD225 (2/2)

Type codes IndraDyn A

6.7 Type code MAF100

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	A	F	1	0	0	C	-	0	1	5	0	-	F	Q	-	S	0	-	A	P	0	-	0	5	-	N	1												

Product
MAF . . . . = MAF

Size
100 . . . . = 100

Length
Lengths . . . . = B, C, D

Winding
MAF100B = 0050, 0100, 0150, 0200, 0250
MAF100C = 0050, 0100, 0150, 0200, 0250
MAF100D = 0050, 0100, 0150, 0200, 0250

Cooling
Liquid cooling with connection thread 1/4" = FQ
Liquid cooling with
Enclosed rapid action coupling 1/4" . . . . = FR

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . . = C0
without motor encoder . . . . = N0

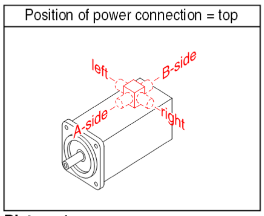
ZN-40002-100_NOR_N_EN_2010-07-30.fh11

Fig. 6-12: Type code MAF100 (1/2)

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	1	0	0	C	-	0	1	5	0	-	F	Q	-	S	0	-	A	P	0	-	0	5	-	N	1												

Electrical connection see picture 1 ②

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	G



Picture 1

Shaft ③

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake
Without holding brake . . . . = 0
Electrically-released, 24 Nm . . . . = 1
Electrically-clamped, 30 Nm . . . . = 5

Mounting style
Flange mounting . . . . = 05
Flange and foot mounting . . . . = 35

Bearing ④
Fixed bearing A-side . . . . = A
Standard . . . . = N
High Speed . . . . = H

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - documentation . . . . = 4 ⑤

Note:
① Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6" are not available with electrical connection "A", "B", "R" and "L" and only with shaft "G", "P" and "K" and bearings "A" and "N"
② According to DIN IEC 60204-1 and DIN IEC 60364-5-52
③ Shaft "F", "M" and "R" always available with shaft sealing ring
④ Bearing "A" is only available with holding brake "0" and vibration severity "1"
Bearing "H" is not available with encoder "S6" and "M6" and only with shaft "H" and holding brake "0"
⑤ Vibration severity "4" is only available with length "B" and "C" and bearing "N" and "H"

Standard reference

Standard	Edition	Title
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN IEC 60204-1	2002-09	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

Fig. 6-13: Type code MAF100 (2/2)

Type codes IndraDyn A

6.8 Type code MAF130

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	1	3	0	B	-	0	1	5	0	-	F	Q	-	M	0	-	L	H	0	-	0	5	-	N	1												

Product
MAF . . . . = MAF

Size
130 . . . . = 130

Length
Lengths . . . . = B, C, D

Winding (1)
MAF130B = 0050, 0100, 0150, 0200, 0250
MAF130C = 0050, 0100, 0150, 0200, 0250
MAF130D = 0050, 0100, 0150, 0200, 0250

Cooling
Liquid cooling with connection thread 1/4" = FQ
Liquid cooling with
enclosed rapid action coupling 1/4" . . . . = FR

Encoder (2)
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . . = C0
without motor encoder . . . . = N0

ZN-40002-130_NOR_N_EN_2010-07-30.fh11

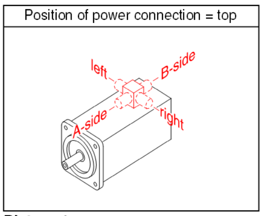
Fig. 6-14: Type code MAF130 (1/2)

Type codes IndraDyn A

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	A	F	1	3	0	B	-	0	1	5	0	-	F	Q	-	M	0	-	L	H	0	-	0	5	-	N	1												

Electrical connection see picture 1 3

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	G



Picture 1

Shaft 4

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake

Without holding brake . . . . = 0
Electrically-released, 80 Nm . . . . = 1
Electrically-clamped, 100 Nm . . . . = 5

Mounting style

Flange mounting . . . . = 05
Flange and foot mounting . . . . = 35

Bearing 5

Fixed bearing A-side . . . . = A
Standard . . . . = N
High Speed . . . . = H
Reinforced bearings . . . . = V

Vibration severity

A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - documentation . . . . = 4 6

Note:

1 Winding "0250" with length "D" is not available with electrical connection "A", "B", "R" and "L"
2 Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6" are not available with el. connection "A", "B", "R" and "L" and only with shaft "G", "P" and "K" and bearings "A", "N" and "V"
3 According to DIN IEC 60204-1 and DIN IEC 60364-5-52
Electrical connection "D" and "G" is not availble with length "B"
Electrical connection "E" is only available with length "D"
4 Shaft "F", "M" and "R" always available with shaft sealing ring
5 Bearing "A" is only available with holding brake "0" and vibration severity "1"
Bearing "H" is not available with encoder "S6" and "M6" and only with shaft "H" and holding brake "0"
6 Vibration severity "4" is only available with length "B" and "C" and bearings "N" and "H"

Standard reference

Standard	Edition	Title
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN IEC 60204-1	2002-09	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

Fig. 6-15: Type code MAF130 (2/2)

6.9 Type code MAF160

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	1	6	0	B	-	0	2	0	0	-	F	Q	-	M	0	-	K	G	0	-	0	5	-	N	1												

Product
MAF . . . . = MAF

Size
160 . . . . = 160

Length
Lengths . . . . = B, C

Winding 1
MAF160B . . . = 0050, 0100, 0150, 0200
MAF160C . . . = 0050, 0100, 0150, 0200

Cooling
Liquid cooling with connection thread 1/2" = FQ
Liquid cooling with
enclosed rapid action coupling 1/2" . . . . = FR

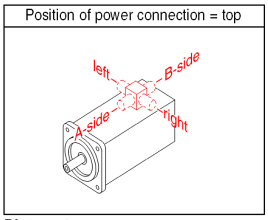
Encoder 2
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . . = C0
without motor encoder . . . . = N0

Fig. 6-16: Type code MAF160 (1/2)

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	1	6	0	B	-	0	2	0	0	-	F	Q	-	M	0	-	K	G	0	-	0	5	-	N	1												

Electrical connection see picture 1 (3)

	Connector	Terminal box, turnable
A-Side	A	E
B-Side	B	H
Right	R	D
Left	L	T



Picture 1

Shaft (4)

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake

Without holding brake . . . . = 0
Electrically-released, 100 Nm . . . . = 1
Electrically-clamped, 100 Nm . . . . = 5

Mounting style

Flange mounting . . . . = 05
Flange and foot mounting . . . . = 35

Bearings (5)

Fixed bearing A-side . . . . = A
High Speed . . . . = H
Standard . . . . = N
Reinforced bearings . . . . = V

Vibration severity

A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - documentation . . . . = 4 (6)

Note:

(1) Winding MAF160B-"0200", MAF160C-"0150" and MAF160C-"0200" are not available with electrical connection "A", "B", "R" and "L"
(2) Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6" are not available with el. connection "A", "B", "R" and "L" and only with shaft "G", "P" and "K" and bearings "A", "N" und "V"
(3) According to DIN IEC 60204-1 and DIN IEC 60364-5-52
(4) Shaft "F", "M" and "R" always available with shaft sealing ring
(5) Bearing "A" is only available with holding brake "0" and vibration severity "1"
Bearing "H" is not available with encoder "S6" and "M6" and only with shaft "H" and holding brake "0"
(6) Vibration severity "4" is only available with bearings "N"

Standard reference

Standard	Edition	Title
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN EN 60204-1	2007-06	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

Fig. 6-17: Type code MAF160 (2/2)

6.10 Type code MAF180

Abbrev. Column →									1										2										3										4
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	M	A	F	1	8	0	C	-	0	0	5	0	-	F	Q	-	C	0	-	C	H	0	-	3	5	-	N	1												

Product
MAF . . . . = MAF

Size
180 . . . . = 180

Length
Lengths . . . . = C, D

Winding
MAF180B . . . = 0050, 0100, 0150, 0200
MAF180C . . . = 0050, 0100, 0150, 0200

Cooling
Liquid cooling with connection thread 1/2" = FQ
Liquid cooling with
enclosed rapid action coupling 1/2" . . . . = FR

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas . . . . = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas . . . . = M6
Incremental encoder, 2048 increments . . . . = C0
without motor encoder . . . . = N0

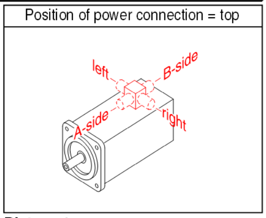
ZN-40002-180_NOR_N_EN_2010-07-30.fh11

Fig. 6-18: Type code MAF180 (1/2)

Abbrev. Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	1	8	0	C	-	0	0	5	0	-	F	Q	-	C	0	-	C	H	0	-	3	5	-	N	1												

Electrical connection see picture 1 ②

	Terminal box, turnable
A-Side	E
B-Side	H
Right	D
Left	G



Picture 1

Shaft ③

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth seal	F	R	M

Holding brake
Without holding brake . . . . = 0
Electrically-released, 240 Nm . . . . = 2
Electrically-clamped, 300 Nm . . . . = 5

Mounting style
Flange and foot mounting . . . . = 35

Bearings ④
Fixed bearing A-side . . . . = A
Standard . . . . = N
Reinforced bearings . . . . = V

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1
B, according to DIN EN 60034-14 . . . . = 3
C, specification according to IndraDyn A - documentation . . . . = 4 ⑤

Note:
① Ex type for cluster II 2G Ex pd IIB T3 according to DIN EN 60079 ff. Encoder "M6" and "S6"
② are only available with shaft "G", "P" and "K" and bearings "A", "N" and "V"
③ According to DIN IEC 60204-1 and DIN IEC 60364-5-52
④ Shaft "F", "M" and "R" always available with shaft sealing ring
Bearing "A" is only available with holding brake "0" and vibration severity "1"
⑤ Vibration severity "4" is only available with length "C" and bearing "N"

Standard reference

Standard	Edition	Title
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN IEC 60204-1	2002-09	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

Fig. 6-19: Type code MAF180 (2/2)

Type codes IndraDyn A

6.11 Type code MAF225

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	A	F	2	2	5	C	-	0	1	5	0	-	F	Q	-	S	2	-	F	K	0	-	3	5	-	N	1												

Product
MAF .... = MAF

Size
225 .... = 225

Length
Lengths .... = C

Winding
MAF225C .... = 0050, 0100, 0150

Cooling
Liquid cooling with connection thread 1/2" = FQ
Liquid cooling with
enclosed rapid action coupling 1/2" .... = FR

Encoder 1
Singleturn absolute encoder, EnDat2.1, 2048 increments = S2
Singleturn absolute encoder, EnDat2.1,
2048 increments, for Ex areas .... = S6
Multiturn absolute encoder, EndDat2.1, 2048 increments = M2
Multiturn absolute encoder, EndDat2.1,
2048 increments, for Ex areas .... = M6
Incremental encoder, 2048 increments .... = C0
without motor encoder .... = N0

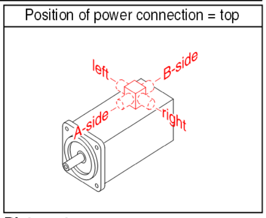
ZN-40002-225_NOR_N_EN_2010-07-30.fh11

Fig. 6-20: Type code MAF225 (1/2)

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	M	A	F	2	2	5	C	-	0	1	5	0	-	F	Q	-	S	2	-	F	K	0	-	3	5	-	N	1												

Electrical connection see picture 1 ②

	Terminal box, turnable
A-Side	E
B-Side	H
Right	D
Left	G



Picture 1

Shaft ③

	plain shaft	with key: balanced with entire key	with key: balanced with half key
Without shaft sealing ring	H	Q	L
With shaft sealing ring	G	P	K
With labyrinth sealing	F	R	M

Holding brake
without holding brake . . . . = 0

Mounting style
Flange mounting . . . . = 05
Flange and foot mounting . . . . = 35

Bearings
Standard . . . . = N
Reinforced bearings . . . . = V

Vibration severity
A, according to DIN EN 60034-14 . . . . = 1

Note:
① Ex type for cluster II 2G EEx pd IIB T3 according to DIN EN 60079 ff.
Encoder "M6" and "S6" are only available with shaft "G", "P" and "K"
② According to DIN IEC 60204-1 and DIN IEC 60364-5-52
③ Shaft "F", "M" and "R" are allways available with shaft sealing ring

Standard reference

Standard	**Edition**	**Title**
DIN EN 60034-14	2008-03	Rotating electrical machines - Part 14
DIN EN 60079 ff	-	Electrical apparatus for explosive gas atmospheres (ATEX)
DIN IEC 60204-1	2002-09	Safety of machinery - Electrical equipment of machines - Part 1
DIN IEC 60364-5-52	2004-07	Erection of low voltage installation - Part 5

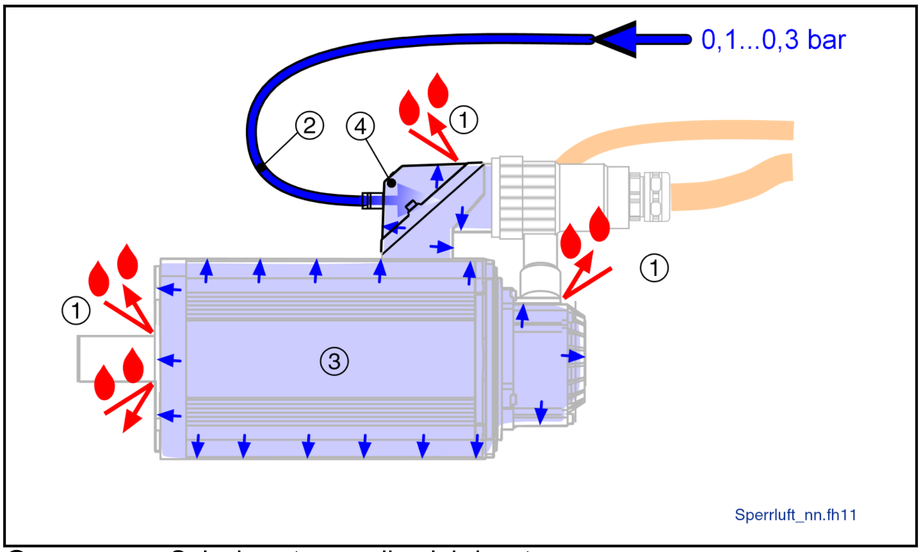
Fig. 6-21: Type code MAF225 (2/2)

7 Accessories

7.1 Sealing air connection

When the motor is used under adverse conditions, a higher degree of protection than the standard one (IP 65 with radial shaft sealing ring) may be required. This is especially the case when the motors are used in areas where the tightness of the motor seals must meet highest requirements because oily cooling lubricants are used. In these areas of application, we recommend that you use sealing air in addition to the radial shaft sealing ring.

A defined overpressure which is introduced into the interior of the motor reliably prevents, e.g., creep oils and cooling lubricants from ingressing.



① Splash water, cooling lubricant
② Compressed air line
③ Overpressure inside the motor
④ Lid for sealing air (with connection piece for compressed air line)

Fig. 7-1: Motor with sealing air connection

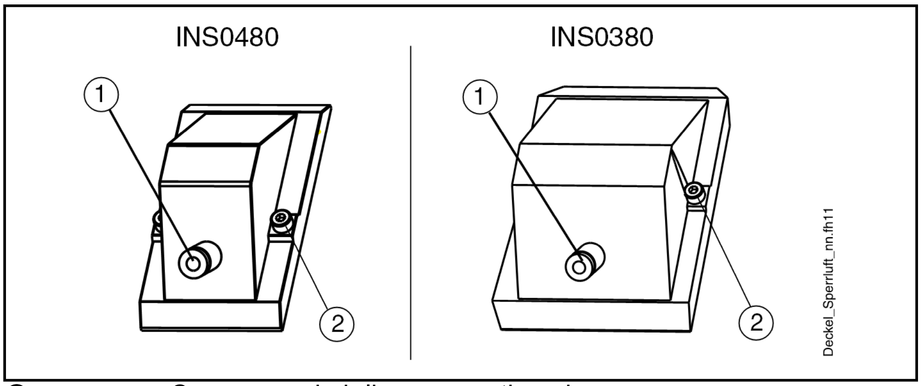
Sealing air connections are available as accessory parts for IndraDyn A motors of frame sizes 100 to 160, which are equipped with connector socket for power connection.

Order designations of accessory kits

Motor frame size MAD / MAF	Motor flange socket (type)	Designation
100	INS0480	SUP-M01-MHD (MNR R911283006)
130 ... 160	INS0380	SUP-M02-MHD (MNR R911283007)

Tab. 7-1: Accessories for sealing air connection

The sealing air connection can be retrofitted by simply replacing the existing lid with the lid in the accessory kit. This lid then features the connection piece for the compressed air line.



① Compressed air line connection piece
② Mounting screws (2x)

Fig. 7-2: Lid for sealing air connection

☞ When mounting the lid, ensure that the O-ring is properly positioned in the lid. The degree of protection required for the motor is only ensured by a properly seated O-ring.

- Tightening torque of the two mounting screws: 3 Nm.
- Mounting instructions are enclosed with the accessory kit selected.

Technical data

The motor may only be operated with sealing air under the following conditions:

- Motor shaft with shaft sealing ring
- System pressure applied to the motor
  - 0.1 ... 0.2 bar
- Compressed air composition
  - Free from dust and oil to the highest possible extent (select an appropriate filter)
  - Relative air humidity 20 ... 30 %

Additional components

To operate the motor with sealing air under the above-mentioned conditions, other devices or components are required, e.g.,

- compressor,
- pressure regulating valve,
- compressed air filter and, if necessary, compressed air dryer,
- compressed air line (e.g., plastic tube PA 4 x 0.75).

These devices and components must be procured and installed by the user as required.

For information on the selection and dimensioning of suitable Rexroth accessories, please contact your sales partner, or directly address

Supplier of additional components

Bosch Rexroth AG

Pneumatics

Ulmer Str. 4

30880 Laatzen, Germany

Phone: +49 (511) 21 36-0

Fax: +49 (511) 2 13 62-69

7.2 Gearboxes

Under certain conditions, IndraDyn A motors are suitable for the attachment of control and planetary gearboxes.

In this case, Bosch Rexroth recommends gearboxes of the Rexroth GTM series which are compatible with IndraDyn A motors.

Type	Gearbox type	Motor requirements	Supplier
GTM	Planetary gearboxes	Plain motor shaft	Bosch Rexroth

Tab. 7-2: Gearboxes for IndraDyn A motors

When selecting the gearbox, please note the information in the type code of the GTM gearbox.

The compatibility and availability of gearboxes from other manufacturers or other gearbox types must be clarified with the particular gearbox manufacturer. Please also observe the information provided in chapter 9.14.2 "Gears" on page 250.

☞ Only low axial shaft loads are allowed for IndraDyn A motors (see chapter 9.13 "Bearing variants and shaft load" on page 240). For this reason, IndraDyn A motors are not suitable for machine elements which generate axial motor loads (e.g., helical driving pinions) or are so suitable to a limited extent only.

7.3 Order designations for thread reducing fittings on the terminal box

All IndraDyn A motors which are connected to power via a terminal box are delivered with the reducing adapters required for the cable connecting threads ex works.

☞ The thread reducing fittings are provided in the terminal box and are part of the motor delivery.

To order additional reducing fittings, please use the following order numbers:

Reducing fitting	Order number
From M32x1.5 to M25x1.5	R911311878
From M40x1.5 to M25x1.5	R911310332
From M40x1.5 to M32x1.5	R911310197
From M50x1.5 to M25x1.5	R911311279
From M50x1.5 to M32x1.5	R911311876
From M50x1.5 to M40x1.5	R911311880

Tab. 7-3: Thread reducing fittings for terminal boxes

8 Connection technique

8.1 Notes

NOTICE **Motor destruction by direct connection on the 50/60 Hz - mains power supply (three phase or single phase net)!**

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

☞ Supplementary descriptions and important additional information on how to connect motors in ex-pxd type design are provided in the operating instructions of the ex-type motors. The order designation of these operating instructions is DOK-MOTOR*-IDYN*A*EXPD-IBxx-EN-P, MNR R911323996 (DE) and R911323997 (EN).

System functionality and operational reliability are only ensured when Rexroth components are used. Rexroth offers a wide range of ready-made cables and connectors which are optimally adapted to match the products and meet a variety of requirements.

The power wire cross-section was rated for cables by current carrying capacity according to VDE 0298-4 and laying type B2 according to EN 60204-1 at an ambient temperature of 40 °C.

Significant advantages of ready-made cables of Rexroth are:

- Ready-for-connection without any additional finishing
- Designed for continuous alternating bending stress
- Resistant against mineral oil, grease and bio-oil, silicone- and halogen-free, low-adhesion
- Use of cables approved according to UL and CSA
- Burning behavior fulfills requirements of VDE0472-804
- Compliance with the EMC directives
- Protection class up to IP67

Power cables and connectors are not in the scope of delivery of the motors. They must be ordered separately.

Further information ...

- on how to select **power and encoder cables** can be found in "Rexroth Connection Cables IndraDrive and IndraDyn", MNR R911322948 (DE) and MNR R911322949 (EN);
- on how to connect IndraDyn A motors in **ex-px d type design** can be found in the operating instructions of the ex-type motors with order designation DOK-MOTOR*-IDYN*A*EXPD-IBxx-EN-P, MNR R911323996 (DE) and R911323997 (EN);
- can be found in the documentation "Electromagnetic Compatibility (EMC) ...” MNR R911259740.

8.2 Power connection

8.2.1 General

IndraDyn A motors are connected to power on their upper side, either via

- Connector socket or
- Terminal box

depending on the motor type.

Please also observe the information in the type code of the particular motor.

8.2.2 Additional ground conductor on motors

Source: Rotating electrical machines - DIN EN 60034-1

Pursuant to EN 60034-1:2004 (11.1 Grounding of machines), motors of frame size MAF225C-0150 must be grounded with an additional ground conductor having a wire cross-section of at least 25 mm².

To achieve this, the motor flange is provided with a connection screw with an M12 thread. Use this connection screw to attach the additional ground conductor to the motor by means of a ring terminal for M12 threads and connect the cable to the ground bus in the control cabinet.

8.3 Power connection with connector socket

8.3.1 Motors with connector socket

MAD/MAF ...	Flange socket	Coupling	Terminal range [mm²]	Current carrying capacity
100	INS480	INS048x	1.5 ... 10	max. 41 A
130 ... 160	INS380	INS038x	6 ... 35	max. 100 A
180 ... 225	Not available	-/-	-/-	-/-

Tab. 8-1: Overview of motors with connector socket

Ready-made Rexroth power cables with coupling for connection of IndraDyn A motors feature a bayonet lock.

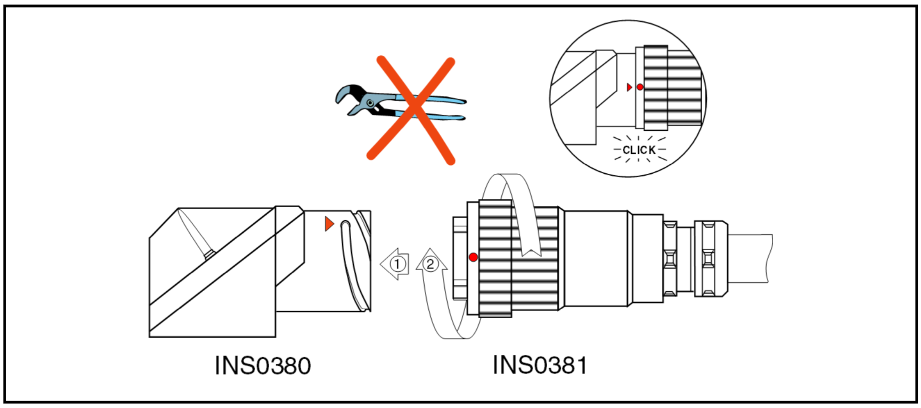
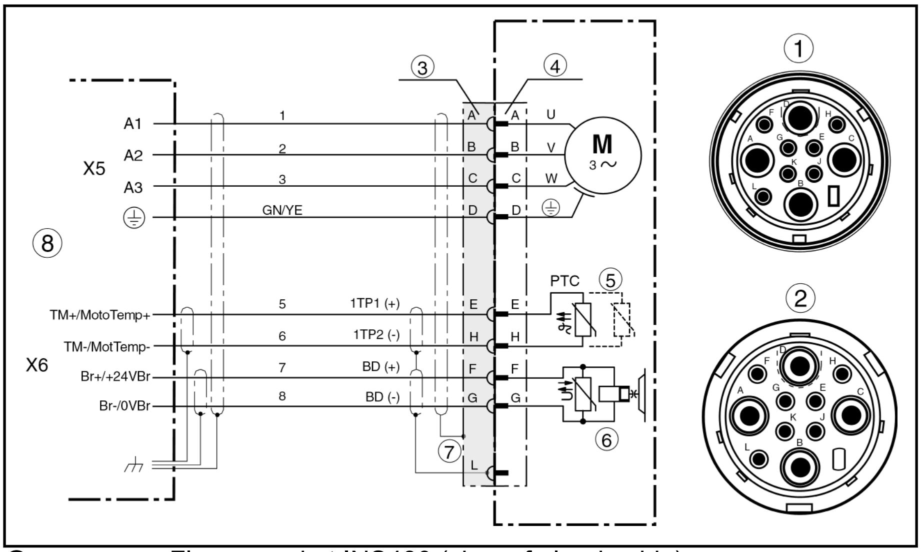


Fig. 8-1: Plug-in power connection

Proceed as follows to connect motors with connector socket:

1. Push the coupling into the connector socket and observe the coding.
2. Manually tighten the union nut until it you can hear it click into place.
3. The marker points on the coupling and the connector socket must be opposite to each other with the bayonet lock clicked into place.

8.3.2 Connection diagram



① Flange socket INS480 (view of plug-in side)
② Connector socket INS380 (view of plug-in side)
③ Coupling
④ Flange socket
⑤ Only one PTC sensor is applied (spare sensor lines are in the socket housing)
⑥ Holding brake (option)
⑦ Overall shield connection by clamping the cables of the strain relief in the connector
⑧ Connection designations on the Rexroth drive controller

Fig. 8-2: Power connection via connector socket, connection diagram

8.4 Power connection with terminal box

8.4.1 Overview of motors with terminal box

Motor frame size MAD/MAF ...	Terminal box (option D, E, G, H)				
	Designation	U-V-W	Terminal range [mm²]	∅ PE	Connection thread Cable gland
100	RLK1200	WEF[1)]	1.5 ... 16	RTE[2)] for M8 thread	See information in tab. 8-3 "Connection thread of cable gland at terminal box" on page 202
130	RLK1300	WEF	1.5 ... 35	RTE for M8 thread	
160	RLK1300	WEF	1.5 ... 35	RTE for M8 thread	
180	RLK1400	RTE for M12 thread	1.5 ... 50	RTE for M12 thread	
225	RLK1500	RTE for M12 thread	1.5 ... 70	RTE for M12 thread	

1) WEF = wire end ferrule

2) RTE = ring terminal end

Tab. 8-2: Overview of motors with terminal box

8.4.2 Cable connecting thread on terminal box

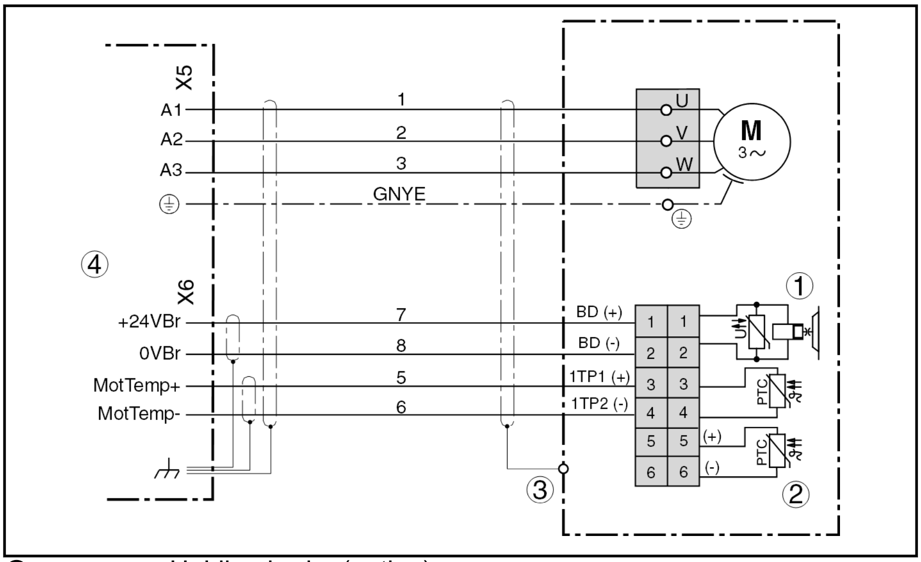
☞ Cables are screwed to the terminal box via adapter plates and, if necessary, thread reducing fittings. These components are included in the motor delivery. If necessary, however, they can also be reordered separately.

Connection technique

Motor	Terminal box	Cable gland connection thread	Adapter plate material number
MAD/MAF100x-...	RLK1200	1 x M32x1.5	R911324549
MAD130x-... MAF130B-... MAF130C-... MAF130D-0050/0100/0150-...	RLK1300	1 x M32x1.5 1 x M40x1.5	R911324551 R911324552
MAF130D-0200/0250-...		2 x M40x1.5	R911324552
MAD160B-... MAD160C-0050/0100/0150-... MAF160B-0050/0100-... MAF160C-0050-...		1 x M32x1.5 1 x M40x1.5	R911324551 R911324552
MAD160C-0200-... MAF160B-0150/0200-... MAF160C-0100/0150/0200-...		2 x M40x1.5	R911324552
MAD180C-0050-... MAF180C-0050-...	RLK1400	1 x M32x1.5 1 x M40x1.5	R911324551 R911324552
MAD180C-0100/0150/0200-... MAF180C-0100/0150/0200-...		2 x M40x1.5	R911324552
MAD180D-0050-... MAF180D-0050-...		1 x M32x1.5 1 x M40x1.5	R911324551 R911324552
MAD180D-0100/0150/0200-... MAF180D-0100/0150-...		2 x M40x1.5	R911324552
MAF180D-0200-...		2 x M50x1.5	R911324553
MAD/MAF225C-...	RLK1500	2 x M50x1.5	R911324554

Tab. 8-3: Connection thread of cable gland at terminal box

8.4.3 Connection diagram



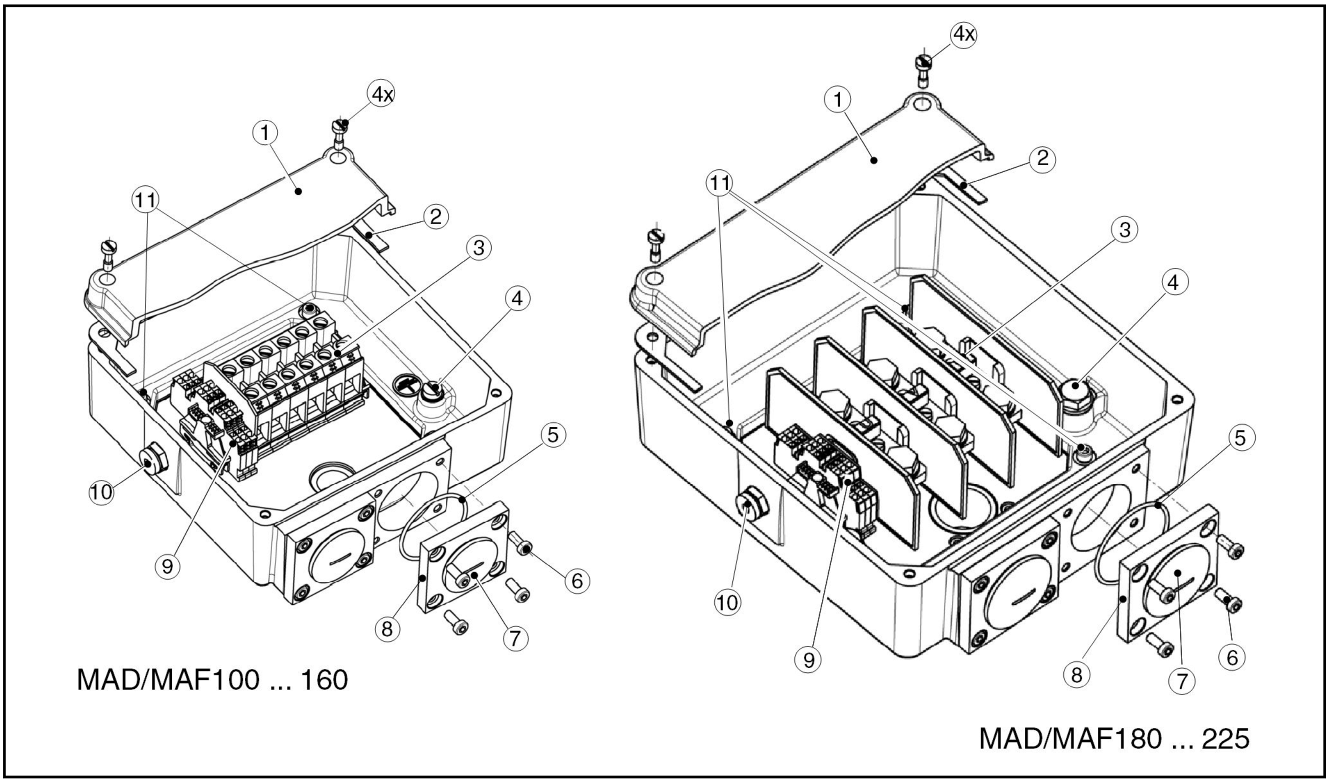
①	Holding brake (option)
②	Spare temperature sensor (connect spare sensor lines only if necessary)
③	Shield connection by clamping the cables of the strain relief in the cable gland
④	Connection designations on the Rexroth drive controller

Fig. 8-3: Terminal box connection diagram

☞

- Brake connections 1-2 are only assigned if the motor is manufactured with the optional brake.
- Only one contact pair of PTC thermistor connections 3-4 and 5-6 is connected to the motor cable.
- The seal which is glued into the lid at the factory may not detached or damaged.
- Observe the size of the cable gland and connection thread for the cable inlet into the terminal box.
- Make particularly sure that the connecting cables are placed orderly and without strain in the terminal box to prevent rubbing or pressure marks on the cables.
- The connections of the motor windings in the terminal box may not be removed.

8.4.4 Terminal box details



①	Cover
②	Seal
③	Terminal block U-V-W
④	PE connection
⑤	O-ring
⑥	Adapter plate mounting screws
⑦	Safety cover of the cable gland connection thread (for connection thread size, see tab. 8-3 "Connection thread of cable gland at terminal box" on page 202)
⑧	Adapter plate for cable gland
⑨	Terminal strip (brake, temperature sensor)
⑩	Purging gas connection (only applicable to Ex-type motors)
⑪	Clamping screws for setting the outgoing cable direction (4 pcs.)

Fig. 8-4: Terminal box details

8.4.5 Power connection

Power cable connection on terminal box

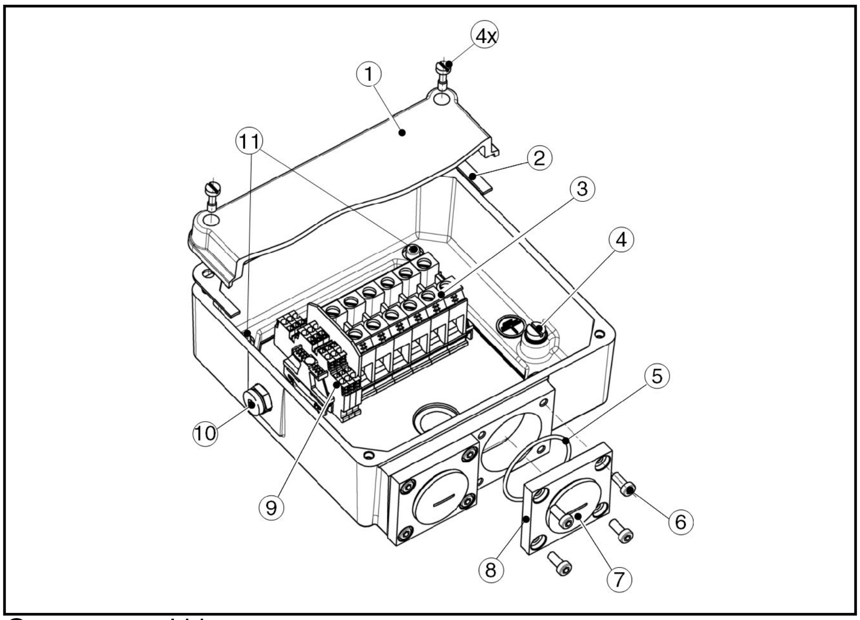
The outgoing direction required for the power cable is selected in the type code of the motor. The terminal box is mounted to the motor at the factory, based on the outgoing direction defined by the user.

☞ When selecting the "rotating terminal box" connection option, the user can adjust the outgoing cable direction to new or changed connection conditions directly at the place of use and at any time, simply by "rotating" the terminal box.

Proceed as follows to connect the power cable to the terminal box:

1. Open the terminal box lid ①.

Unscrew and remove the mounting screws (4 pcs.).



①	Lid
②	Seal
③	Terminal block U-V-W
④	PE connection
⑤	O-ring
⑥	Adapter plate mounting screws
⑦	Safety cover of the connection thread of the cable gland
⑧	Adapter plate for cable gland
⑨	Terminal strip (brake, temperature sensor)
⑩	Purging gas connection (only applicable to Ex-type motors)
⑪	Clamping screws for setting the outgoing cable direction (4 pcs.)

Fig. 8-5: Rotating terminal box (option D, E, G, H)

2. Check the outgoing cable direction and rotate the terminal box if necessary.
   - Detach the terminal box.

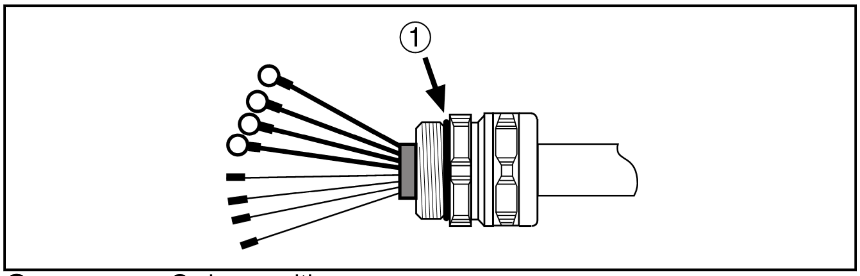
     Unscrew the mounting screws ⑪ and rotate the terminal box by 90 to max. 180 degrees to the desired outgoing direction.
   - Attach the terminal box.

   Screw in the mounting screws ⑪ and tighten them.

   Tightening torque of the screws ⑪: 6.5 Nm (±10%)

   WARNING! Improperly inserted or missing seals may lead to loss of the motor protection and to explosion hazard of Ex-type motors.

   ⇒ There is a seal between the terminal box and the motor housing. After having rotated or retightened the terminal box, check it to verify that the seal is in a proper state and in its correct position.
3. Turn out the safety cover of the cable gland ⑦.
4. Detach the adapter plate ⑧ from the terminal box.
5. Firmly secure the adapter plate to the metric cable gland on the power cable.



① O-ring position

Fig. 8-6: O-ring on cable gland

WARNING! Improperly inserted or missing O-rings may lead to loss of the motor protection and to explosion hazard of Ex-type motors.

⇒ Before attaching the adapter plate to the power cable, visually check the O-ring on the cable gland of the power cable to verify its proper state and correct position. Do not use the power cable if the O-ring is missing. In this case, please contact your local Rexroth sales or service partner.

6. Run the power cable to the adapter plate through the opening into the terminal box and reattach the adapter plate to the terminal box.

   Tightening torque of the screws ⑥: 9 Nm (±10%)

   WARNING! Improperly inserted or missing O-rings may lead to loss of the motor protection and to explosion hazard of Ex-type motors.

   ⇒ Before attaching the adapter plate ⑥ to the terminal box, check the O-ring ⑤ inserted into the adapter plate to verify its proper state and correct position.

7. Connect the wires according to the standard or double cabling connection diagram.

   Please observe the following tightening torques:

   Screw tightening torques in Nm (±10%) for MAD/MAF power connection to terminal boxes of "D, E, G, H" design

Terminal box to	U-V-W		PE	
	M6	M12	M8	M12
MAD/MAF100 ... 160	2.5	- / -	3.5	- / -
MAD/MAF180 ... 225	- / -	14	- / -	20

Tab. 8-4: Screw tightening torques in Nm in "D, E, G, H" terminal box

8. Close and attach the terminal box lid.

   Apply Loctite 243 (liquid screwlock) to the thread of the mounting screws for the lid ① and then attach the lid with all of the mounting screws.

   Tightening torque of the screws: 6.5 Nm (±10%)

   WARNING! Improperly inserted or missing seals may lead to loss of the motor protection and to explosion hazard of Ex-type motors.

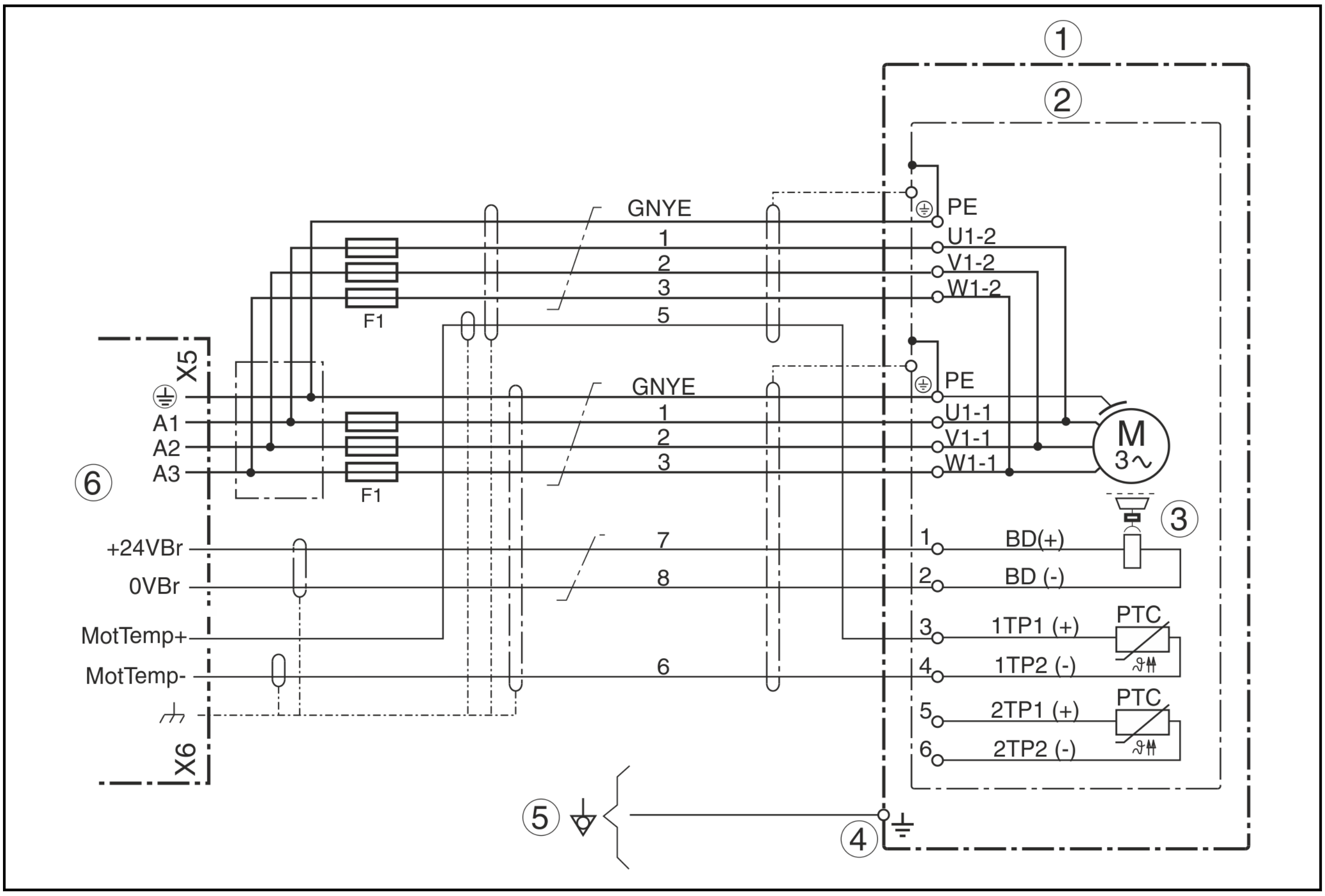
   ⇒ Before attaching the lid to the terminal box, check the glued-in seal ② on the terminal box lid to verify its proper state and correct position.

8.5 Double cabling

Motor connection requires two power cables if an appropriate single cable cannot be used because of the large bending radius or because of its dimensions.

The following connection diagram shows a possible connection. When planning the double cabling, please note the applicable installation regulations at the installation site of the machine.

Double cabling connection diagram



①	Motor housing
②	Terminal boxes
③	Holding brake (option)
④	Potential equalization connection at the motor (only available on MAF225C-0150 and Ex-type motors)
⑤	Potential equalization connection at the machine (required for MAF225C-0150 and Ex-type motors)
⑥	Rexroth drive controller

Fig. 8-7: Double cabling connection diagram

☞

- The terminal box can only be used for double cabling where power connection is concerned.
- If a motor equipped for double cabling is only connected with one power cable by the customer, the cores of this power cable are to be attached to the terminals on which the cores for the motor winding are attached.
- Fuses F1 (NH...) protecting the wires against overload in case of a cable break must be dimensioned according to the current carrying capacity of the particular line cross-section.
- The fuses should be installed in the control cabinet such that they are as close as possible to the power output of the controller.
- The shield of the motor power cable must be connected to the control cabinet on the motor side of the fuses such that it is conducting over a large area.
- Power cables are not available to establish the double cabling. To install the fuses, standard Rexroth power cables must be opened and cut to the appropriate length on site.

8.6 Encoder connection

Depending on the encoder type, the encoder connection of IndraDyn A motors is designed as 10-pin, 12-pin or 17-pin connector socket on the motor housing.

Motor	Frame size	Connector socket (X3) for encoder connection		
		M2 / S2	C0	M6 / S6
MAD	100	RGS1003	INS0629	RGS1002
	130 ... 225	RGS1004 *)	INS0719	
MAF	100 ... 225	RGS1003	INS0629	RGS1002
*) Connector socket RGS1004 cannot be ordered as a single component. It is an integral part of the encoder connecting cable for connecting encoder option M2/S2.				

Tab. 8-5: Encoder connector socket designations

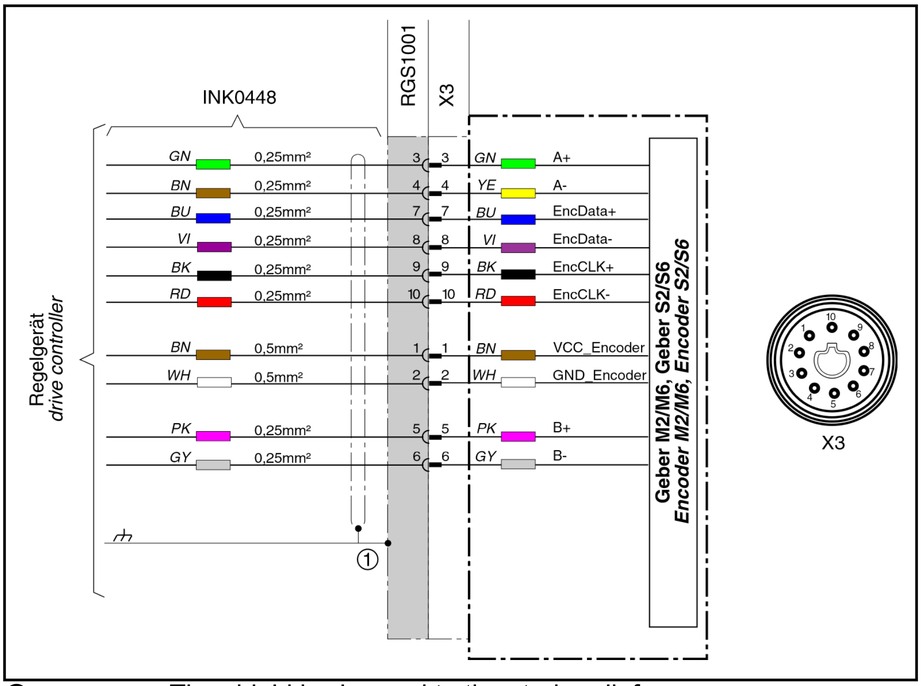
The following couplings can be used on the connecting cable in connection with the connector sockets specified:

Connector socket (X3)	Coupling
INS0629	INS0379
INS0719	INS0379
RGS1002	RGS1001
RGS1003	RGS1001
RGS1004 *)	RGS1001
*) Connector socket RGS1004 cannot be ordered as a single component. It is an integral part of the encoder connecting cable for connecting encoder option M2/S2.	

Tab. 8-6: Couplings for encoder connector sockets

The following table shows the pin assignments.

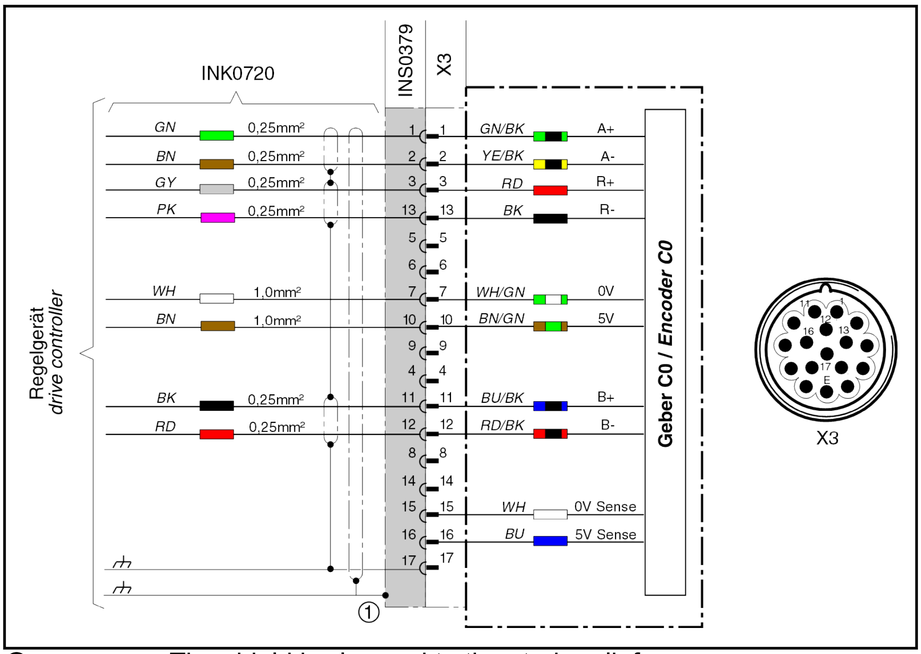
Pin assignment for encoder options M2/S2 and M6/S6



① The shield is clamped to the strain relief.

Fig. 8-8: Connecting encoder types M2/S2 and M6/S6

Pin assignment for encoder option C0



① The shield is clamped to the strain relief.

Fig. 8-9: Connecting encoder type C0

The cable connecting the motor encoder to the controller must be provided with a compatible coupling on the motor side.

The motor-sided connector socket and the cable-sided coupling must be fitted onto each other and screwed to each other manually. Their structure is therefore mirror-inverted, i.e., they have a different "pole image".

Observe the mechanical coding.

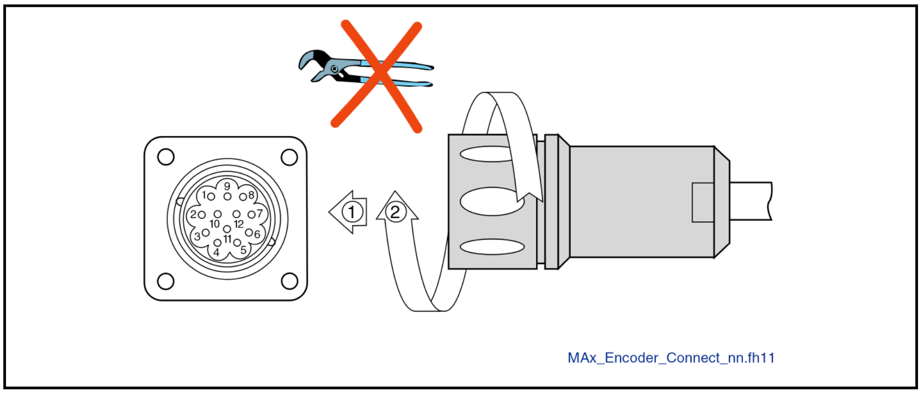


Fig. 8-10: Example encoder plug connection

1. Push the coupling into the connector socket and observe the coding.
2. Manually tighten the union nut.

8.7 Temperature sensor

IndraDyn A motors feature two PTC temperature sensors KTY84-130 which are permanently installed in the motor winding. For additional information on the temperature sensor, please refer to chapter 9.9 "Motor temperature monitoring" on page 230.

☞

- Before reconnecting the sensor, take measures regarding ESD protection.
- If the sensor is to be used externally for temperature measurement, proper polarity must be ensured when it is connected.
- For connection diagrams, see fig. 8-2 "Power connection via connector socket, connection diagram" on page 201 and fig. 8-3 "Terminal box connection diagram" on page 203 at the beginning of this chapter.

8.8 Holding brake

The motor holding brake is activated either directly by the controller or externally.

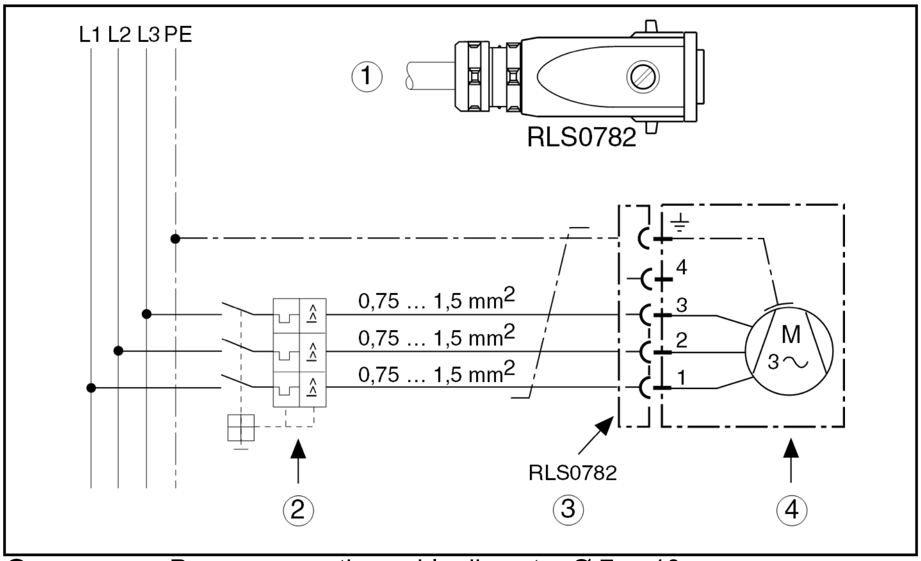
☞

- For connection diagrams, see fig. 8-2 "Power connection via connector socket, connection diagram" on page 201 and fig. 8-3 "Terminal box connection diagram" on page 203 at the beginning of this chapter.
- The control voltage is +24 V_{DC} (+/-10%).
- Please note that there are functional differences between electrically clamping and electrically releasing brakes (see chapter 9.10.3 "Selecting holding brakes" on page 233).

8.9 Motor cooling

8.9.1 Fan connection

The motor fan is connected to the supply network via a cable and a motor protective switch and is operated independently of the controller.



① Power connection cable diameter Ø 7 ... 10 mm
② Protective switch
③ Plug connector
④ Fan

Fig. 8-11: Fan connection

- To connect the motor fan, the fan connector must be opened and closed.
- Electric connection may only be established by specialized staff. Observe the safety instructions.
- The tightness of the connector housing may not be reduced.
- Motor protective switch and electric fusing are selected by the machine manufacturer. Follow the regulations applicable in the country where the machine is set up.
- The connector for connecting the motor fan is included in the scope of delivery and is located on the motor fan.

8.9.2 Coolant connection

The following coolant ports can be selected for motors with liquid cooling:

- Coolant port via the connection thread on the motor
- Coolant port via quick couplings

The inlet (IN) and outlet (OUT) can be arbitrarily assigned. The assignment does not have any effect on the performance data of the motor.

Coolant connection thread

Motor MAF ...	Connection via ...		Remark
	Thread	Quick coupling [Ø d_i tube]	
100 ... 130	G1/4"	9 mm	Select connection according to type code
160 ... 225	G1/2"	13 mm	

Tab. 8-7: Overview of coolant ports

The connection threads at the motor are covered with factory-provided protective plugs. These protective plugs may only be removed immediately before screwing in the coolant ducts or the quick coupling to prevent dirt from entering the cooling system.

The following table gives an overview of the loads allowed for the motor-side connection threads.

Frame size MAF ...	Connection thread	Max. allowed screw-in depth [mm]	Max. allowed tightening range [Nm]
100 ... 130	G1/4"	14	18 ... 20
160 ... 225	G1/2"	18	27 ... 30

Tab. 8-8: Coolant connection thread, allowed tightening torques and screw-in depths

NOTICE **The coolant port threads on the motor may be destroyed by incorrect tightening torques!**

The allowed motor connection tightening torque may not be exceeded! If the tightening torque or screw-in depth is exceeded, the motor may be damaged irreversibly.

The coolant connections on the motor side are provided for coolant connection threads with axial sealing.

Bosch Rexroth recommends to use threaded connections which contain an O-ring for axial sealing of the screw connections.

For example, seals consisting of hemp, teflon tape or cone-shaped screw connections are not considered to be suitable, since this type of seal may stress the connection thread at the motor to an unreasonably high extent and/or damage it permanently.

☞ The machine manufacturer is responsible for ensuring that the coolant connection is tight and for verifying and accepting the tightness after the motor has been installed.

Additionally, record regular monitoring of the proper state of the cooling connection in the maintenance plan of the machine.

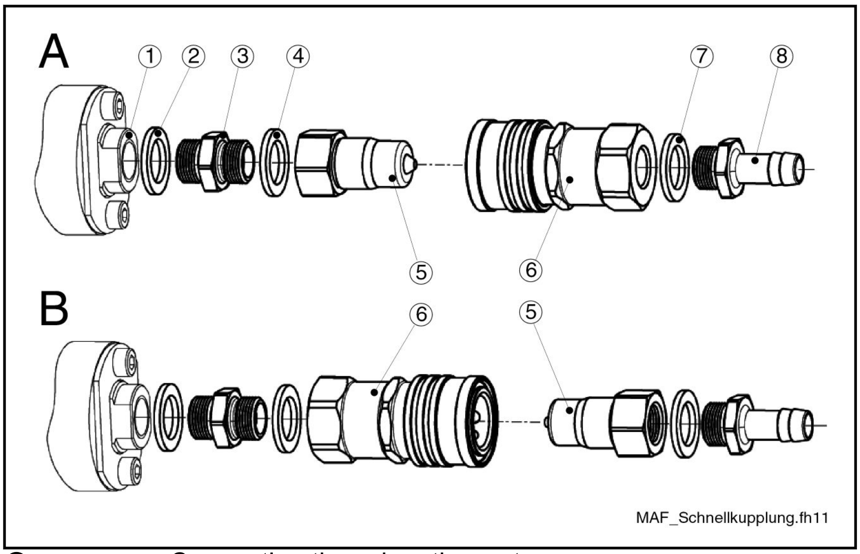
Quick coupling

It is also possible to use a quick coupling for the coolant port. The quick coupling features leak protection on either side and can be released even under full pressure.

If a motor with this type of coolant port is ordered, all quick coupling parts are included in the motor delivery. Based on the ambient conditions of the motor, the user can select from two quick coupling mounting methods.

1. **Method A**: Lock nipple mounted on the motor side

2. **Method B**: Coupling mounted on the motor side



①	Connection thread on the motor
②④⑦	Seal
③	Double nipple
⑤	Lock nipple
⑥	Coupling
⑧	Threaded adapter for tube

Fig. 8-12: Quick coupling mounting methods

☞ Connect the double nipple to the coupling or the lock nipple. Then screw the double nipple into the connection thread on the motor. This procedure prevents the connection thread in the motor from being stressed repeatedly.

When mounting the quick coupling, ensure

- that the seals are correctly positioned,
- that the following tightening torques between the individual coupling components are kept,

Quick coupling thread size	Allowed tightening range [Nm] between the components of the quick coupling
1/8" ... 1/4"	23 ... 25
1/2"	28 ... 30

Tab. 8-9: Allowed tightening torque of the quick coupling

- that the allowed screw-in depths and tightening torques at the motor are kept.

Frame size MAF ...	Connection thread	max. allowed screw-in depth [mm]	Allowed tightening range [Nm]
100	G1/8"	14	14 ... 15
130	G1/4"	14	18 ... 20
160 ... 225	G1/2"	18	27 ... 30

Tab. 8-10: Coolant connection thread, allowed tightening torques and screw-in depths

When selecting the coolant hose, ensure you use the required inside hose diameter d_i according to tab. 8-7 " Overview of coolant ports" on page 212.

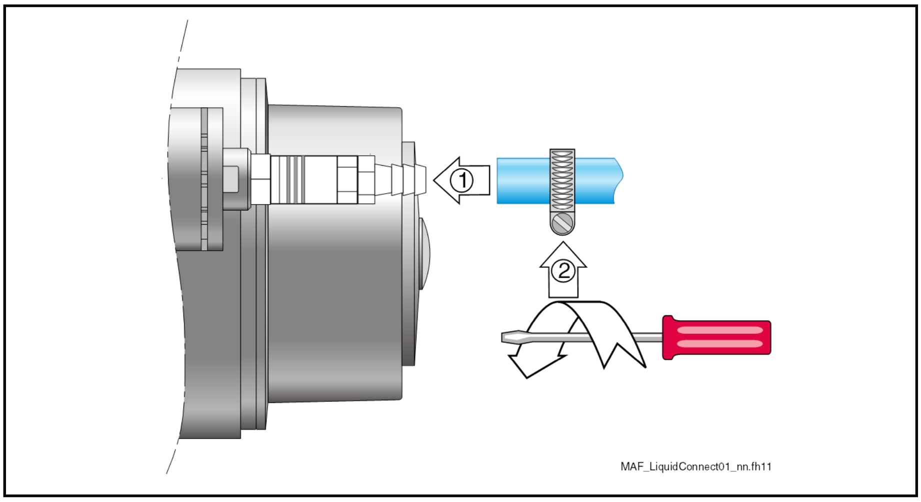


Fig. 8-13: Connecting the coolant hose (example)

When mounting the coolant hose, proceed as follows:

1. Remove the protective caps from the coolant port threads on the motor and screw in the pre-assembled quick coupling.
2. Push the tube onto the connection piece (threaded adapter). Do not bend or damage the motor-sided screw connection.
3. Screw the tube end with the mounting clamp tightly above the connection piece.
    - In service cases, the quick coupling can be disconnected from the lock nipple by means of the coupling. It is not necessary to disconnect the tube connection.

If a different connection method is used on the tube side, other mounting steps may be required. Mounting instructions can be obtained from the manufacturer.

☞ To supply MAF motors with coolant, other installation materials are also required, for example, tubes and mounting clamps (these are not included in the scope of delivery).

8.9.3 Coolant input pressure

The maximum coolant input pressure for all MAF motors which were manufactured prior to 2008-07-01 is **6 bar**, in relation to the pressure which is effectively present directly at the coolant port of the motor.

Please observe that additional screw connections or junctions in the cooling circuit can have a negative influence on the flow and supply pressure of the cooling medium.

9 Application notes

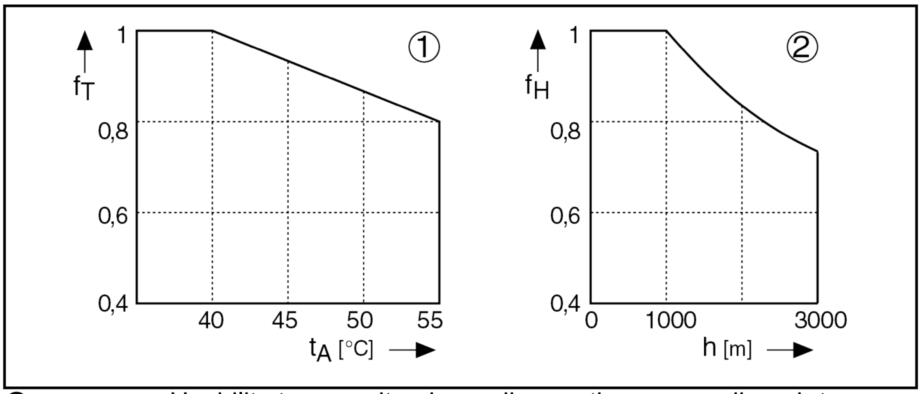
9.1 Operating conditions

9.1.1 Setup elevation and ambient temperature

The motor performance data specified are applicable for

- Ambient temperatures ranging from 0 °C to +40 °C,
- Installation altitudes from 0 m to 1000 m above MSL

The performance data of motors used outside of the above ranges is reduced according to the following figure.



①	Usability to capacity, depending on the surrounding air temperature
②	Usability to capacity, depending on the installation altitude
f_T	Temperature utilization factor
t_A	Ambient temperature in degrees Celsius
f_H	Height utilization factor
h	Installation altitude in meters

Fig. 9-1: Utilization factors

If **either** the ambient temperature **or** the installation altitude is above the nominal data:

1. Multiply the motor data specified in the selection data by the determined utilization factor.
2. Ensure that your application does not exceed the reduced motor data.

If **both** the ambient temperature **and** the installation altitude are above the nominal data:

1. Multiply the determined utilization factors f_T and f_H.
2. Multiply the resulting value by the motor data specified in the selection data.
3. Ensure that your application does not exceed the reduced motor data.

9.2 Humidity

Climatic environmental conditions are defined according to different classes as specified in DIN EN 60721-3-3, Table 1. They are based on long-term experiences and take all influencing variables into account, e.g., air temperature and air humidity.

IndraDyn A motors may be continuously operated within the limit ranges of class 3K4. The following table provides extracts from this class.

Environmental factor	Unit	Class 3K4
Low air temperature	°C	+5 [1])
High air temperature	°C	+40
Low rel. air humidity	%	5
High rel. air humidity	%	95
Low absolute air humidity	g/m³	1
High absolute air humidity	g/m³	29
Temperature change rate	°C/min	0.5

1) The lowest air temperature allowed by Rexroth is 0°C.

Tab. 9-1: Classification of climatic ambient conditions according to DIN EN 60721-3-3, Table 1

9.3 Vibration and shock

9.3.1 Vibration

Vibrations are sinusoidal oscillations in stationary use, which vary in their effect on the resistance of the motors depending on their intensity. The resistance 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 are allowed for Rexroth IndraDyn A motors:

Direction	Maximum allowed vibration load 10 – 2000 Hz
Axial	10 m/s²
Radial	30 m/s² (10 m/s² in connection with M2/M6 and S2/S6 encoders)

Tab. 9-2: Maximum values for sinusoidal vibrations

The construction and effectiveness of vibration-absorbing or vibration-decoupling attachments depends on the application and must be tested using measurements. This is not the motor manufacturer's responsibility. Modifications of the motor design result in loss of the warranty.

9.3.2 Shock

The shock load of the motors is defined by the maximum allowed acceleration in non-stationary use, e.g., during transport.

Function-impairing effects are avoided as long as the limits specified are kept. Based on DIN EN 60721-3-3, the following values are applicable for IndraDyn A motors:

Motor frame size	Maximum allowed shock load (duration 6 ms)	
	Axial	Radial
100 ... 225	10 m/s²	150 m/s²

Tab. 9-3: Shock load

☞ Please also observe the information provided in chapter 10 "Handling and transport" on page 263.

9.4 Compatibility test

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

As it is not possible to follow the continuing development of all materials (e. g. lubricants in machine tools) which may interact with our controls and drives, it cannot be completely ruled out that any reactions with the materials used by Bosch Rexroth might occur.

For this reason, before using the respective material a compatibility test has to be carried out for new materials (e. g. lubricants and cleaning agents) and our housing or our housing materials.

9.5 Degree of protection

The protection classes according to IEC 60529 apply to IndraDyn A motors. All installation positions of the motor have to provide for the motors not being exposed to ambient conditions outside of the applicable degree of protection.

The degree of protection is defined by the IP (International Protection) abbreviation and two reference numbers specifying the degree of protection. The first reference number stands for the degree of protection against contact and ingress of foreign bodies, the second one stands for the degree of protection against ingress of water.

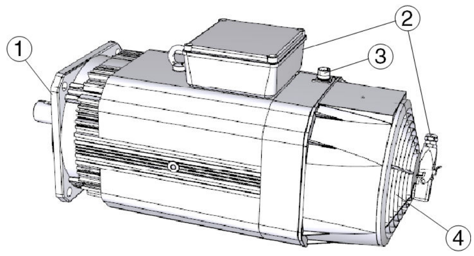


Fig. 9-2:

Component subject to protection		Degree of protection	Remark
①	Output shaft without shaft sealing ring	IP 54	IP 40 with vertical installation position (see chapter 9.6.3 "Vertical installation positions" on page 221)
	Output shaft with shaft sealing ring	IP 65	Optional (see chapter 9.12.3 "Output shaft with shaft sealing ring" on page 237)
	Output shaft with labyrinth seal	IP 65	Optional (see chapter 9.12.4 "Output shaft with labyrinth seal" on page 238)
②	Power connection Fan connection	IP 65	Terminal box or plug
③	Motor encoder connection	IP 65	
④	Motor fan	IP 65	Fan motor IP 65 Fan grille IP 24

Tab. 9-4: Defining the motor components subject to protection

Products and components with low degree of protection are not suitable for cleaning procedures using high pressures, vapor or water jet.

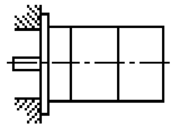
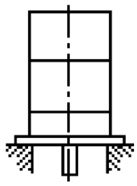
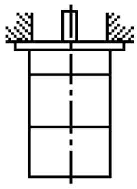
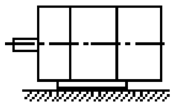
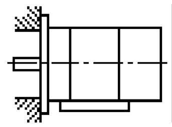
NOTICE **Ingressing fluid may damage the motor!**

Fluids (e.g., cooling lubricants, gear oil, etc.) may not be present at the output shaft. If, e.g., gears are attached, only gears with a closed (oil-tight) lubrication system may be used.

9.6 Frame shape and Installation position

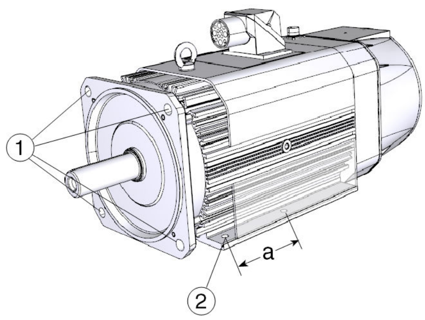
9.6.1 General

IndraDyn A motors are available in frame shapes B05 and B35. The installation types allowed according to EN 60034-7 are shown in the following table.

Motor	Allowed installation types		
Frame size	Designation	Drawing	Installation
B05	IM B5		Flange attachment on the drive side of the flange
	IM V1		Flange attachment on the drive side of the flange, drive side facing down
	IM V3		Flange attachment on the drive side of the flange, drive side facing up
B35	IM B3		Foot assembly, feet at the bottom
	IM B5		Flange attachment on the drive side of the flange

Tab. 9-5: Mounting position

IndraDyn A motors of frame shape B35 can be attached either via foot assembly or flange assembly.

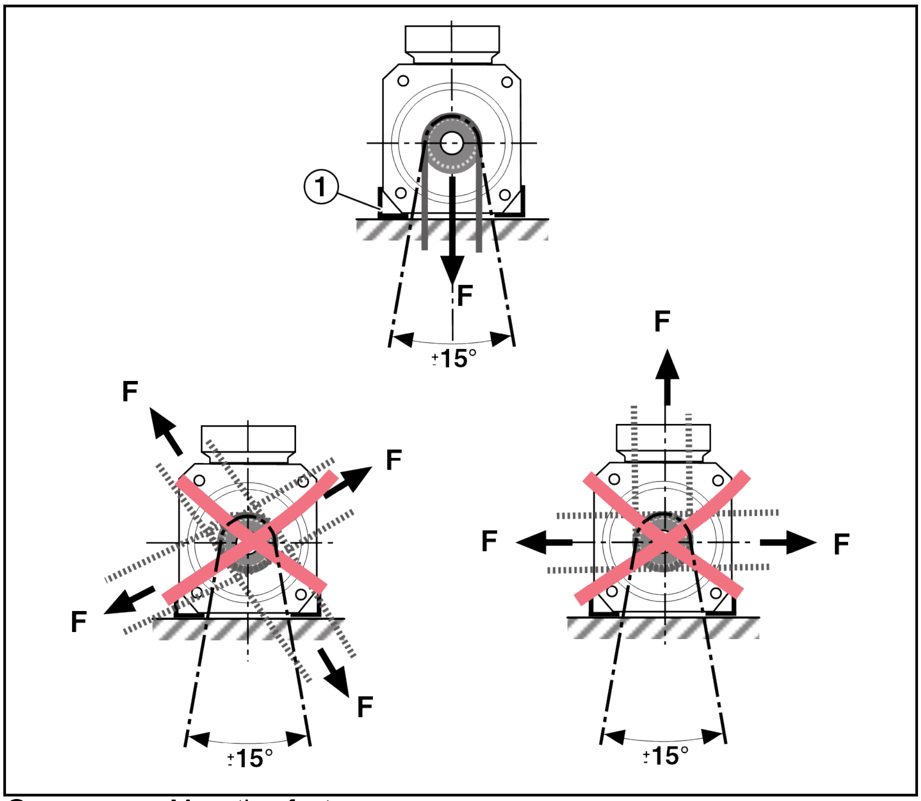


① Flange for foot assembly
② Mounting foot (on either side)
a Hole clearance, see motor dimension drawing

Fig. 9-3: IndraDyn A motor attachment types

9.6.2 Foot assembly

In contrast to flange assembly, radial forces may only be effective in a direction perpendicular to the mounting surface (± 15°) if foot assembly is selected. The transmission of forces in other effective directions is not allowed.



① Mounting feet

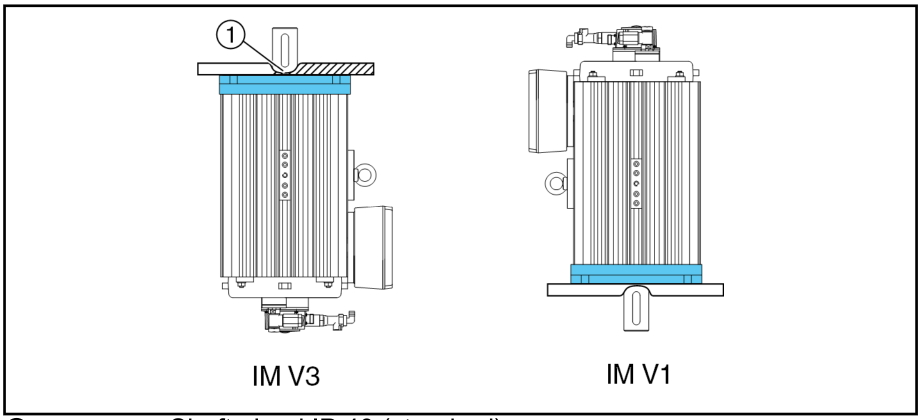
Fig. 9-4: Example: MAF foot assembly

Please note the following in case of foot assembly ...

- Forces which are transmitted by a gear and have an effect on the motor feet are not allowed.

  Forces taking effect via the gear shaft must be supported against the gear.
- Incorrect installation situations give rise to forces which may cause short-term damage to the motors.
- See also the instructions on foot assembly in chapter 11 "Installation" on page 269. If necessary, consider "flange assembly" as an alternative.

9.6.3 Vertical installation positions



① Shaft gland IP 40 (standard)
Shaft gland with radial shaft sealing ring IP 65 (optional)

Fig. 9-5: Example: vertical MAF installation position

- **Side A:** The degree of protection on the flange side of motors with a shaft sealing ring is IP 65. However, tightness is ensured only against incoming splash fluids. Fluid levels present on the output side require a higher degree of protection.
- **Side B:** The degree of protection for the fan screens in axial fans is IP 24. Shavings or large dirt particles can also penetrate the fan screen.
- **Degree of protection:** The factory-set degree of protection of IndraDyn A motors may not be reduced by modifying the motors or retrofitting accessories.

Output shaft at top

If motors are installed vertically with the output shaft positioned at the top (chapter 9.6.3 "Vertical installation positions" on page 221), dirt and fluids can easily enter into the interior of the motor and lead to malfunctions or failures.

Also note that, in this installation position, the axial bearing load (side B) of motors of frame size 225 is so high (due to the heavy rotor weight and the bearing pretension force) that the service life of the bearing must be expected to be clearly reduced to ~30 % of the service life that was determined originally.

If installed vertically with the output shaft positioned at the top, the service life of motors of frame size 225 must be expected to be reduced to **approx. 30%**.

Output shaft at bottom

If motors of frame size 225 are operated in vertical installation position with the output shaft positioned at the bottom and in connection with a coupling, the coupling must be selected such that

- the axial pretension force of the coupling is not higher than **max. 400 N** in the pretensioned state.

9.7 Motor paint

Color

Black (RAL9005)

Resistance

Resistant against

- Diluted acids/lyes
- Water, seawater, sewage
- Current mineral oils

Resistant to a limited degree against

- Organic solvents
- Hydraulic oil

Not resistant against

- Concentrated acids/lyes

Additional paint

Allowed for:

Standard products.

The housing may be painted with a coating thickness of no more than 40 µm. Before painting the housing, check the adhesiveness and resistance of the new paint.

NOT allowed for:

Products for potentially explosive atmospheres.

Ex-type motors may not be repainted to ensure that there will be no negative effects on surface properties (e.g., insulation resistance, electrostatic charging).

If motors are repainted, all safety labels, name plates and open plug connectors must be covered to be protected against painting.

9.8 Motor cooling

9.8.1 Fan

MAD motors may only be operated with a fan. These motors are cooled via air currents which are guided across the surface of the motor by air baffles.

The fan is designed such that it uses clean air from its environment to cool the motor. If the motors are used in heavily soiled or hazardous areas, special precautions must be taken. Please also observe the guidelines in chapter 9.8.2 "Radial ventilation in heavily soiled or potentially explosive atmospheres" on page 224 in this context.

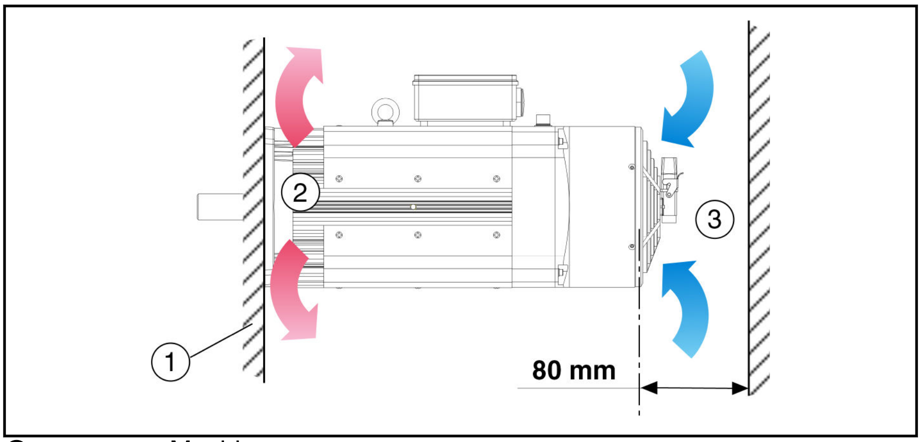
It is explicitly prohibited to use the fan under the following conditions:

- Delivery of air which contains abrasive particles
- Delivery of air which has a strongly corroding effect, e.g., salt mist
- Delivery of air which contains a high dust load, e.g., extraction of saw dust
- Delivery of combustible gases/particles
- Use of the ventilator as a technical safety component or as a component assuming safety-relevant functions

Axial fan

The fan used is an axial fan. The fan is only available as "blowing" fan. Please observe the data in the type code.

To ensure that the axial fan can move the required air volume, a minimum distance for letting the air in and out must be kept between the fan grille and the machine. This distance is based on the motor construction.



① Machine
② Air outlet space
③ Air inlet space

Fig. 9-6: MAD ventilation

- Provide for the minimum distance of the air supply ③ when designing the machine.
- All fans are "blowing" fans.

Dirt and contaminants can reduce the flow rate of the fans and result in a thermal overload of the motors.

When the motors are operated in a dirty environment, the availability of the system is increased by cleaning the fans and motor cooling fins at regular intervals.

When designing the machine, provide for accessibility of the motor and fan for maintenance purposes.

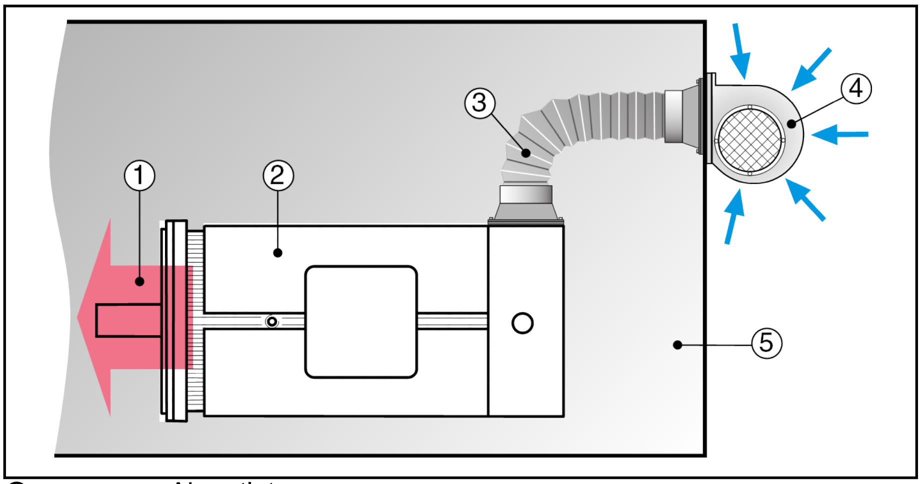
For special instructions on maintenance and troubleshooting of motor fans, please refer to chapter 12.5.3 "Motor fan" on page 279.

9.8.2 Radial ventilation in heavily soiled or potentially explosive atmospheres

If IndraDyn A motors in ex-type design are operated in an potentially explosive or heavily soiled atmosphere, clean air for cooling the motor must be supplied from outside via a tube or an air duct.

- In this case, motors with fan cowl and fan shroud (type code option "SL") must be selected to allow connection of an air tube.

Example application



① Air outlet
② Motor
③ Air duct (not included in delivery)
④ Air inlet (radial fan not included in delivery)
⑤ Working area

Fig. 9-7: Example radial ventilation via fan shroud

The machine manufacturer has to select a suitable radial fan while taking the machine specification into account.

In general, radial fans for IndraDyn A motors are not included in the Rexroth scope of delivery.

Fan shroud on MAD...	Diameter for air tube connection (for further details, see motor dimension drawing)
100	Ø 80 mm
130	Ø 100 mm
160 ... 225	Ø 150 mm

Tab. 9-6: Connection diameter of fan shroud

☞ After the ventilation system has been installed, a specific air volume flow must be available at the motor (see data on the mean air volume flow in the motor data sheet in chapter 4).

For this reason, the installed tube or air duct length and the type of air supply (straight or bent) must be taken into account when selecting the radial fan or when using central ventilation.

- The machine manufacturer has to calculate the required air flow rate based on the plant specification.
- The air duct and the fan tubes are not included in the Rexroth scope of delivery.

Bosch Rexroth recommends the following manufacturers of powerful radial fans and connection material, such as air tubes, tube clamps, etc.:

Source of supply for radial fans	
Elektror airsystems GmbH	Richard-Hirschmann-Strasse 12 73728 Esslingen am Neckar, Germany Phone +49(0)711 319 73- 0 Fax +49(0)711 319 73- 5000 Email: info@elektror.de Internet: www.elektror.de
Source of supply for air tubes and connection accessories	
NORRES Schlauchtechnik GmbH & Co. KG	Freiligrathstrasse 38 45881 Gelsenkirchen, Germany Phone +49(0)209 800 00-0 Fax +49(0)209 800 00-71/-72 Email: info@norres.de Internet: www.norres.de

Tab. 9-7: Sources of supply for radial fans and connection accessories

Elektror's radial fan names (preferred types) for tube ventilation

Motor frame size MAD...	Fan*	
	Air tube length 10 m	Air tube length 15 m
100	D064M	RD16
130	RD64	RD72
160	RD5	RD6
180	RD62	RD64
225	RD7	RD7
*) for 400 V/50 Hz		

Tab. 9-8: Preferred radial fan types

For more detailed information about the radial fans, e.g., technical data, dimension drawings or radial fans for different supply voltages, please contact Elektror.

9.8.3 Coolants

MAF motors may only be operated via an externally connected cooling system. The motor power loss P_V transformed to heat is dissipated via the coolant. For this reason, MAF motors may only be operated as long as coolant supply is ensured. The machine manufacturer must size the cooling system in such a way that all requirements regarding flow, pressure, cleanliness, temperature gradient, etc. are complied with in every operating state.

NOTICE **Impairment or failure of motor, machine or cooling system!**

- Observe the manufacturer's instructions when designing and operating cooling systems.
- Do not use any cooling lubricants or cutting materials from machining processes.

All details and technical data are based on water as coolant. If other coolants are used, these data are not applicable any longer and must be redetermined.

Cooling with running water from the public supply network is not allowed. Hard water may cause precipitations or corrosion and damage both motor and cooling system. Water which is to be used as cooling water must comply with certain criteria and treated accordingly if necessary. For detailed information, please contact your manufacturer of coolant additives.

To ensure corrosion protection and chemical stabilization, an additive which is suitable for mixed installations with materials according to chapter 9.8.5 "Materials used" on page 229 must be admixed to the cooling water.

If the coolants, additives or cooling lubricants used are too aggressive, the motors may be damaged to an irreparable degree.

☞ ⇒Use systems with a closed circuit and a fine filter ≤ 100 µm.

⇒ Observe the environmental protection and waste disposal instructions at the place of installation when selecting the coolant.

Aqueous solution

Aqueous solutions ensure reliable corrosion protection without significant changes to the physical properties of the water. The recommended additives do not contain any substances hazardous to water.

Emulsion with corrosion protection

Corrosion protection oils for coolant circuits 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 ducts against corrosion and cavitation. An oil content of 0.5 to 2 vol.% has proven its worth.

If, in addition to its function of corrosion protection, the corrosion protection oil also assumes the function of lubricating the coolant pump, the oil content must be approx. 5 vol.%.

- Observe the pump manufacturers' instructions!

Cleaning the coolant circuit

Inspect and clean (purge) the cooling system at regular intervals as specified in the machine and cooling system manufacturer's maintenance schedule.

Note that the utilization of unsuitable cleaning agents may cause irreversible damage to the motor cooling system. This type of damages does not lie within the responsibility of Bosch Rexroth.

NOTICE **Risk of damage to the motor cooling system by unsuitable cleaning agents! Loss of warranty!**

⇒ The only liquids or materials allowed to be used for cleaning and motor cooling are those which do not corrode the motor cooling system and do not react aggressively to the materials used in our motors.

⇒ Observe the instructions of the manufacturers of the cleaning agent and the cooling system.

9.8.4 Coolant additives

Recommended manufacturers of coolant additives

The proper chemical treatment of the closed water systems is precondition to prevent corrosion, to maintain thermal transmission, and to minimize the growth of bacteria in all parts of the system.

Bosch Rexroth recommends using coolant additives of NALCO Deutschland GmbH.

Depending on the size of the cooling system, the user may use different additives in form of “ready-to-use cooling water” and “water treatment kits”.

☞

- Use of the following chemicals is designed for closed cooling systems and the following metallurgy: Stainless steel, aluminum, copper and non-ferrous metal.
- The container size and its ingredients of a water treatment kit are adjusted for the specified system volume and can be poured into the coolant tank without regard to other mixture ratios.

Ready-to-use cooling water (Company NALCO)

System volume in liters	Order code	Additives NALCO...
0.5 ... 50	Nalco CCL100.11R	CCL100

Tab. 9-9: Ready-to-use cooling water (Company NALCO)

Cooling water NALCO CCL100

Nalco CCL100 is a ready-to-use, preserved cooling water for the use in closed cooling water systems. It is supplied directly to the closed systems and contains all reagents in the proper treatment concentration.

Nalco CCL100 contains a corrosion inhibitor protecting ferrous metal, copper, copper alloys and aluminum against corrosion. Nalco CCL100 is free of nitrite and minimizes the micro-biological growth.

Water treatment kits (Fa. NALCO)

System volume in liters	Order code	Additives NALCO...
50 ... 99	480-BR100-100.88	TRAC100 7330 73199
100 ... 199	480-BR100-200.88	
200 ... 349	480-BR100-350.88	
350 ... 500	480-BR100-500.88	

Tab. 9-10: Water treatment kits (company NALCO)

Coolant additive NALCO TRAC100

Nalco TRAC100 is a liquid corrosion and film inhibitor for the use in closed cooling systems. Optionally with TRASAR technology: it monitors, shows and dosages the product automatically to its target concentration and continuously protects the system. Nalco TRAC100 is a complete inhibitor protecting ferrous metal, copper alloys and aluminum against corrosion. Nalco TRAC100 is free of nitrite and minimizes the requirements for micro-biological control.

Coolant additive NALCO 7330

Nalco 7330 is a non-oxidizing broad band biocide and suitable for application in closed cooling circuit systems.

Coolant additive NALCO 73199

Nalco 73199 is an organic corrosion inhibitor supporting a fast own protection layer and covering protection layer for non-ferrous metals.

The above additives are part of the preventive water treatment program by Nalco. It comprises not only the chemicals but also test methods, service and equipment. All these are made available to the user of the products.

Water quality of additional water

Conductivity	< 20 µS/cm (e.g. purified water, osmosis water, a.s.o.)
Total hardness	< 0.5 °dH bzw. < 10 mg/l $CaCO_3$
Microbiology	< 100 KBE/ml (CFU/ml)
Iron / copper	< 0.1 mg/l
Turbidity	free from turbidity substances

Tab. 9-11: Water quality of additional water

The water treatment program is a specification for the user and describes the necessary minimum.

Additional equipment, tests and service must be coordinated with Nalco to reach optimum performance and system protection for the cooling system.

For further information or ordering please contact

NALCO Deutschland GmbH

www.nalco.com

☞ Bosch Rexroth gives no general statements or investigations regarding suitability of device-specific cooling media, additives or operating conditions.

The suitability test for the used cooling media and the designing of the liquid cooling system lies in the responsibility of the machine manufacturer.

9.8.5 Materials used

When used in MAF motors, the coolant comes into contact with the following materials:

Motor, housing	Screw connections	Quick coupling
CU, CuZn39Pb2	Chrome-plated brass	Chrome-plated brass

Tab. 9-12: Materials in the cooling circuit

For the sizing and operation of the cooling system, the machine manufacturer has to exclude all chemical or electro-chemical interactions with subsequent corrosion or disintegration of motor parts.

9.8.6 Coolant inlet temperature

According to DIN EN 60034-1, IndraDyn A motors are designed for operation at a coolant temperature of +10...+40 °C. This temperature range must be strictly observed. Higher coolant temperatures cause higher reduction of the available torque. Due to high temperature gradients, lower coolant temperatures may result in the destruction of the motor.

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

Setting the inlet temperature

The coolant supply temperature must be adjusted such that the specified temperature range is kept and the present surrounding air temperature is taken into account.

The lower limit of the recommended coolant inlet temperature can be limited in relation to the existing ambient temperature.

☞ The coolant inlet temperature must be set in a temperature range of +10 ... +40°C and may only amount to a maximum of 5°C below the existing ambient temperature to avoid .

Example 1:

Ambient temperature: +20 °C

Coolant inlet temperature to be set: +15 ... +40 °C

Example 2:

Ambient temperature: +30 °C

Coolant inlet temperature to be set: +25 ... +40 °C

9.9 Motor temperature monitoring

In their standard configuration, IndraDyn A motors are equipped with integrated temperature sensors for motor protection.

Temperature measurement sensors

Designation	KTY84-130
Resistance at 25 °C	577 ohm
Resistance at 100 °C	1000 ohm
Continuous current at 100 °C	2 mA

Tab. 9-13: Temperature measurement sensor

The response temperatures of the sensors are as follows:

⇒**110 °C** Prewarning temperature

⇒**120 °C** Shut-off temperature

Exception:

- Frame size MAD225 ⇒ **120°C** pre-warning temperature
- Frame size MAD225 ⇒ **130°C** switch-off temperature

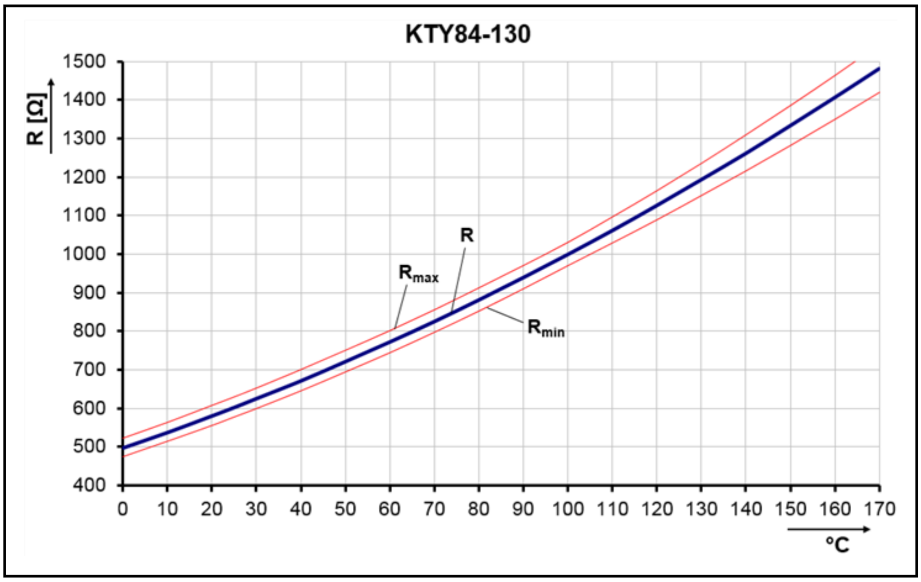


Fig. 9-8: Characteristic of temperature measurement sensor KTY84-130 (PTC)

For more information on the connection of temperature sensors, please refer to chapter 8.7 "Temperature sensor " on page 210.

9.10 Holding brake (option)

9.10.1 General

The holding brake serves to hold axes which have come to a standstill. It may only be used while the motor is at standstill or to carry out the brake test integrated in the drive.

☞ Do not use the holding brake as an operating brake for moving axes. If the holding brake is repeatedly activated with the drive rotating or the allowed braking energy is exceeded, premature wear and tear may occur. It must be expected that the holding brake is completely worn after approx. 20000 revolutions against the applied brake.

Brake activation

The voltage supply of the holding brake is to be designed such that the voltage available at the motor (**24 volts +/- 5%**) for releasing/applying the holding brake is sufficient even in the most unfavorable case during installation and operation (see also Rexroth IndraDrive Drive Systems DOK-INDRV*-SYSTEM*****-PRxx-EN-P, Chapter "Specification of control voltage").

☞ The switching voltage incoming at the motor is subject to the line length and the cable properties, e.g., conductor resistance.

- A minimum voltage of 22.8 V (24 V - 5 %) is recommended at the drive controller for ready-made Bosch Rexroth power cables up to 50 m in length.
- A minimum voltage of 24.7 V (26 V - 5 %) is recommended at the drive controller for ready-made Bosch Rexroth power cables more than 50 m in length.

In order to detect a fault during operation early enough, a monitoring device must be provided to monitor the voltage supply for the brakes for undervoltage.

Functional test

Prior to commissioning and on request during operation, the brake must be tested for proper functioning via the brake check using the brake monitoring command. A low torque is applied to the motor to check whether the brake has been completely released. For additional information and data on the availability, please refer to the functional firmware descriptions of Rexroth controllers.

Observe the commissioning-related guidelines for holding brakes in chapter chapter 12 "Operating of IndraDyn A Motors" on page 275.

9.10.2 Holding brakes - notes regarding safety

Observe the safety requirements for the system planning and development.

⚠ DANGER **Personal injury through hazardous movements caused by falling or descending axes!**

Secure vertical axes against falling or descending after disconnection:

- lock the vertical axes mechanically,
- provide an external braking / collecting / clamping device, or
- Ensure sufficient weight compensation of the axes.

The serially delivered holding brakes which are driven by the control device are **not** suited for personal safety!

Personal protection must be realized by superordinate fail-safe measures, such as e.g. the locking off of the danger zone by means of a protective fence or grill.

Beside the specified details and notes about holding brakes, heed the additional standards and directives when planning the system.

For Europian countries:

- EN 954 and ISO 13849-1 and ISO 13849-2 Safety-related components of controls
- Information sheet no. 005 "Gravity-loaded axes (vertical axes)" published by: Fachausschuss Maschinenbau, Fertigungssysteme, Stahlbau

For the USA:

- See National Electric Code (NEC), National Electrical Manufacturers Association (NEMA) as well as local building regulations.

Comply with all applicable national regulations!

The permanent magnetic brake is no safety brake. This means, a torque reduction by non-influenceable disturbance factors can occur (see EN 954 and ISO 13849-1 and ISO 13849-2 or the information leaflet No. 005 about "Gravity-loaded axes (vertical axes)").

Please pay particular attention to the following:

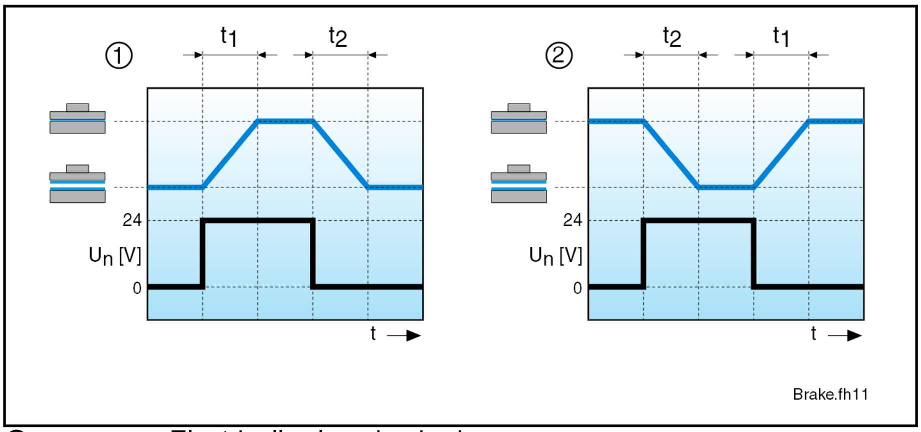
- Corrosion on friction surfaces, as well as dust, perspiration and sediments reduce the braking effect.
- Grease must not hit the friction surface.
- Overvoltage and too high temperatures can durably weaken the permanent magnets and thus the brake.

The functionality of the holding brake is no longer ensured, if the air gap between armature and pole is increasing due to wear.

9.10.3 Selecting holding brakes

General

Brakes are either electrically clamping or electrically releasing. Since there are functional differences between main spindle and servo axes, different brakes should be used for these axes.



① Electrically clamping brake
② Electrically releasing brake
t_1 Holding brake connection time, clamping delay
T_2 Holding brake disconnection time, release delay

Fig. 9-9: Holding brake wiring diagram

Main spindle applications

Electrically clamping holding brake

The **electrically clamping** holding brake serves as a locking element for the main spindle at standstill and deactivated drive enable, e.g., when the tool is changed without closed position control loop.

☞ Clamp the holding brake only while the motor is at standstill, i.e., after the drive has signaled that the motor has come to a standstill.

The **electrically releasing** holding brake should not be used for main spindle applications because the brake may not only be under extreme wear and tear but may also be destroyed if the holding brake is applied unintentionally at high speeds (e.g., voltage failure or wire break).

Servo applications

Electrically releasing holding brake

The **electrically releasing** holding brake serves to hold axes at standstill and with deactivated drive enable. If the supply voltage fails and drive enable is deactivated, the **electrically releasing** holding brake is applied automatically.

- Do not use the holding brake as an operating brake for moving axes.

If the brake is repeatedly activated with the drive rotating or the allowed braking energy is exceeded, premature wear and tear may occur.

The **electrically clamping** holding brake is inappropriate for servo applications because there will be no clamping of axes in the de-energized state.

9.10.4 Layout of holding brakes

Holding brakes on motors are basically not designed for service braking. The effective braking torques are physically conditionally different in static and dynamic operation.

Normal operation and EMERGENCY STOP	event of faults
In **normal operation**, using the holding brake for clamping of a standstill axes, the ”statistic holding torque” (M4), applies as indicated in the data sheets. For **EMERGENCY STOP** to deactivate an axis ($n < 10\ min^{-1}$), a "dynamic braking moment" acts (M_{dyn}) - sliding friction.	For **fault conditions** to deactivate a moving axis ($n \geq 10\ min^{-1}$), a "dynamic braking moment" acts (M_{dyn}) - sliding friction.
$M4 > M_{dyn}$ Therefore, note the following description of dynamic sizing.	

Tab. 9-14: Dynamic sizing

Dynamic sizing

The load torque must be smaller than the minimum dynamic moment M_{dyn} which the holding brake can provide. Otherwise the dynamic holding brake torque is not sufficient to stop the axes.

If a mass is to be decelerated in a defined time or in a defined route, the additional mass moment of inertia of the whole system must be taken into account.

Project planning recommendation

To ensure construction safety, reduce the required holding torque to 60% of the static holding torque (M4) of the holding brake.

9.11 Motor encoder

9.11.1 Options

"**S2**": Single-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1 V_{pp} with 2048 lines per revolution and absolute period assignment within one revolution. The encoder features a data memory which contains all relevant motor parameters required for commissioning the motor.

”**M2**”: Multi-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1V_{pp} with 2048 lines per revolution and absolute period assignment within 4096 revolutions. The axis position remains stored in the event of a voltage failure. The encoder features a data memory which contains all relevant motor parameters required for commissioning the motor.

"**S6**": Optional encoder for potentially explosive atmospheres in pressure-resistant encapsulation with 15m long connecting cable. Technical properties same as for "**S2**".

"**M6**": Optional encoder for potentially explosive atmospheres in pressure-resistant encapsulation with 15m long connecting cable. Technical properties same as for "**M2**".

"**C0**": Incremental encoder. Sine/cosine signals 1 Vss with 2048 periods per revolution.

"**N0**": The motor is delivered without any factory-mounted encoder unit. The motor is closed with a cover on its rear.

☞ For more information on the supply voltage required for the motor encoders, please refer to tab. 6-1 " IndraDyn A motor encoders" on page 171.

9.11.2 Compatibility

Due to different encoder technologies, the motor encoders can be connected to certain drive controllers and interfaces only. The encoder data must be parameterized in the controller. The following table gives an overview of the compatibility:

Encoder option	IndraDrive					
	ADVANCED	BASIC OPENLOOP	BASIC SERCOS	BASIC PROFIBUS	BASIC ANALOG	BASIC UNIVERSAL
C0	+	-	-	-	-	+
M2, M6 S2, S6	+	+	+	+	+	+
+ ⇒ compatible - ⇒ incompatible						

Tab. 9-15: Encoder compatibility

9.11.3 Precision

The accuracy of rotary encoders is divided into "absolute accuracy" and "relative accuracy".

Absolute

The absolute accuracy of rotary encoders is primarily determined by the quality and precision of the encoder construction and the mechanical attachment to the motor. The following values are applicable for IndraDyn A motors:

Encoder option	Technical data	Absolute accuracy
S2, S6	Single-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1 Vss with 2048 periods.	± 0.0056° (± 20")
M2, M6	Multi-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1 Vss with 2048 periods.	± 0.0056° (± 20")
C0	Incremental encoder, sine/cosine signals 1 Vss with 2048 periods.	± 0.0056° (± 20")

Tab. 9-16: Absolute encoder accuracy

Relative

The relative accuracy of encoder systems is also referred to as "repeat accuracy". It is mainly determined by the interpolation discrepancies occurring when the measurement signals are further processed in the built-in and the external interpolation and digitization electronics. The following reference values are applicable for IndraDyn A motors which are operated with Rexroth controllers (as of the publishing date of this documentation):

Encoder option	Technical data	Relative accuracy
S2, S6	Single-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1 Vss with 2048 periods.	± 0.001'
M2, M6	Multi-turn absolute encoder with EnDat2.1 interface. Sine/cosine signals 1 Vss with 2048 periods.	± 0.005'
C0	Incremental encoder Sine/cosine signals 1 Vss with 2048 periods.	± 0.01'

Tab. 9-17: Relative encoder accuracy

Since both hardware and firmware of the controllers are under continuous further development, actual values may be different from the values specified above. Therefore, the data in the current documentation of the controllers must always be observed.

The accuracy of encoder systems is only a subordinate factor for the precision of machining and positioning process of a plant. Factors that are decisive for the accuracy that can be reached are, among others, the functionality of the plant and the quality of the mechanical construction.

9.11.4 Encoder connection

The position of the encoder connection cannot be changed. For more detailed information, please refer to the motor dimension sheet and to chapter 8.6 "Encoder connection " on page 208.

For detailed information on the controller-side encoder connection and on the parameterization, please refer to the documentation of the controllers.

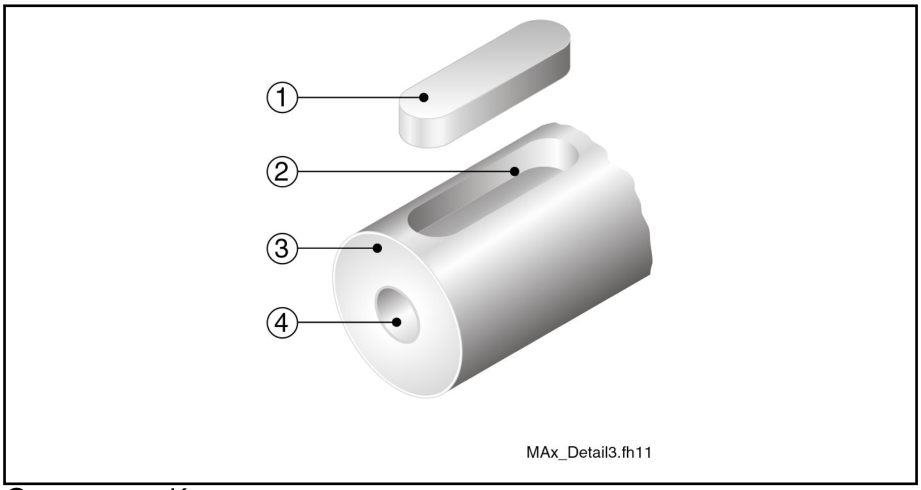
9.12 Output shaft

9.12.1 Plain shaft

The recommended standard configuration of all IndraDyn A motors features a non-positive, non-floating shaft-hub connection with a high degree of smooth running. Use clamping sets, pressure sleeves or clamping elements for coupling the machine elements to be driven.

9.12.2 Output shaft with key

The optional key according to DIN 6885, Sheet 1, Edition 08-1968, allows form-locking transmission of torques with constant direction and low requirements for the shaft-hub connection.



① Key
② Keyway
③ Motor shaft
④ Centering hole

Fig. 9-10: Output shaft with keyway

In addition, the machine elements to be driven must be secured in axial direction via the centering hole on the end face.

☞ ⇒ Avoid strong reversing operation.

⇒ Deformations in the area of the keyway can lead to breakage of the shaft.

⇒ The key is included in the scope of delivery of the motor.

Balancing with a half key

The motor is balanced with a half key. Mass ratios are comparable to those of a plain shaft. If a complete key is inserted, there will be an imbalance which must be compensated at the machine element to be driven.

The hub of a machine element to be driven (pinion, pulley, etc.) should correspond to the length of the key.

☞ If the hub is shorter, use a graduated key.

Balancing with complete key

The motor is balanced with the supplied key. That means that the machine element to be driven must be balanced without key. The keyway length in the hub is independent of the length of the keyway.

Modifications to the keys can only be made by the users themselves and within their own responsibility. Bosch Rexroth does not give any warranty for modified keys or motor shafts.

9.12.3 Output shaft with shaft sealing ring

If equipped with the optional radial shaft sealing ring according to DIN 3760 - design A, IndraDyn A motors are, e.g., suitable for attachment in a dusty environment and in moist rooms or for attachment of gears with closed oil bath or oil circulation lubrication.

If the motor is used in strong atomized spray or at speeds over 4000 min^{-1}, we recommend that you order the motor with additional labyrinth seal (see chapter 9.12.4 "Output shaft with labyrinth seal" on page 238).

Fluids (e.g., cooling lubricants, gear oil, etc.) may not be present at the output shaft. If, e.g., gears are attached, only gears with a closed (oil-tight) lubrication system may be used.

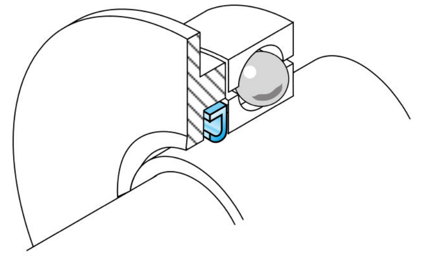


Fig. 9-11: Shaft sealing ring

Wear

Radial shaft sealing rings are friction seals. They are therefore subject to wear and generate frictional heat. Wear symptoms of the rubbing seal can be reduced if the sealing point is adequately clean. The service life of the sealing lip at the radial shaft sealing ring depends on the cleanliness and the motor speed.

Resistance

The materials used for radial shaft sealing rings are highly resistant against oils and chemicals. The suitability test for the particular operating conditions lies, however, within the machine manufacturer responsibility.

The following material assignment has been applicable as of the publishing date of this document:

Motor MAD/MAF ...	Sealing material	Short name
100 ... 225	Polytetrafluoroethylene	PTFE

Tab. 9-18: Material shaft sealing ring

The complex interactions between sealing ring, shaft and fluid to be sealed on the one hand and the particular conditions of use (frictional heat, soiling, etc.) on the other hand do not allow any accurate calculation of the service life of the shaft sealing ring.

However, with a circumferential speed of 5 m/s and under favorable conditions (e.g., adequate cleanliness), a useful life of 5000 ... 10000 h can be reached.

Vertical installation positions IM V3 / IM V6

The degree of protection on the flange side of motors with a shaft sealing ring is IP 65. Therefore, tightness is ensured only against incoming splash fluids. Here, it must be noted that continuously incoming splash fluids accumulate between motor shaft and shaft sealing ring due to the adhesive forces at the sealing point, so that they act as present fluids. Continuously incoming splash fluids require a higher degree of protection than, e.g., a labyrinth seal.

If the motor is installed in a vertical position, please additionally observe the guidelines in chapter 9.6.3 "Vertical installation positions" on page 221.

9.12.4 Output shaft with labyrinth seal

To be protected against incoming splash fluids at the motor output shaft, IndraDyn A motors can also be directly ordered with a labyrinth seal. Please also observe the correct order designation of the motors in the motor type code in this context.

Proper functioning of the labyrinth seal is only ensured when

- the motor is installed horizontally,
- the drain hole is positioned below the output shaft,
- the fluid level present at the motor is at least 5 mm below the drain hole,
- the motor speed is at least 200 min^{-1}.

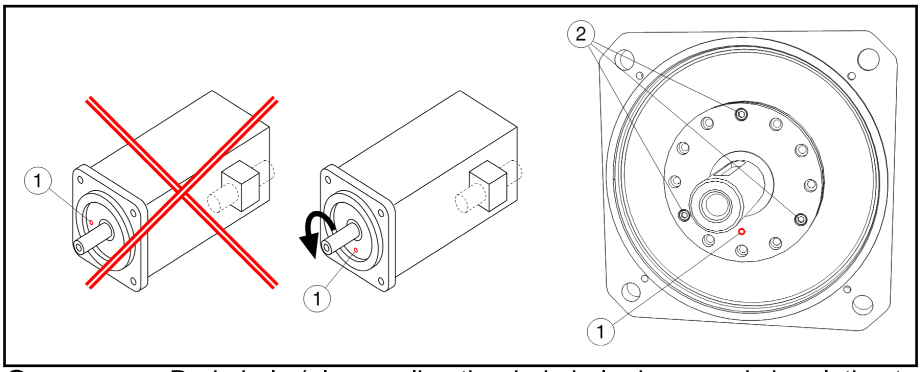
On delivery of the motor, the labyrinth seal is mounted such that, as seen from side A of the motors, the terminal box and the power plug are positioned at the top and the drain hole of the labyrinth seal is positioned at the bottom (below the output shaft).

☞ There are certain installation situations where the motor must be installed with the power connection being positioned laterally or facing down. In these cases, the flange of the labyrinth seal must be turned before installation of the motor such that the drain hole is again positioned below the output shaft.

Modifying the position of the drain hole of the labyrinth seal

If the motor is not mounted as delivered (power connection at the top), the position of the drain hole of the labyrinth seal must be adjusted.

To achieve this, the flange of the labyrinth seal can be rotated in 30° increments. In this manner, the drain hole can be quickly adjusted to the conditions of the machine, i.e., aligned downwards.



① Drain hole (always align the drain hole downwards in relation to the motor installation position)

② Mounting screws M6 DIN912 (4 pcs. for MAx225)

Fig. 9-12: Allowed position of the drain hole of the labyrinth seal (example MAD130)

To put the drain hole into the correct position, the following working steps must be carried out before the motor is mounted:

1. Unscrew the mounting screws ①.

   ⇒ To facilitate unscrewing the screws, heat them up to approx. 70 °C since they are locked with Loctite 243 screwlock.

2. Observe the required installation position of the motor and turn the flange into the position in which the drain hole ② is again positioned below the output shaft.
3. Apply Loctite 243 to the mounting screws and screw them into the corresponding threaded holes through the holes in the flange.

   ⇒ Observe the 30° increments!

⇒ Tightening torque of the mounting screws: 9 Nm.

9.13 Bearing variants and shaft load

9.13.1 Bearing variants

The following bearing variants are available depending on the frame size of the IndraDyn A motors:

- Standard bearing "N" = deep-groove ball bearing
- A-side fixed bearing "A" = deep-groove ball bearing
- High-speed bearing "H" = deep-groove ball bearing, light construction
- Reinforced bearing "V" = deep-groove ball bearing + cylindrical roller bearing

Standard bearing

Universal bearing type **(type code option "N")** suitable for absorbing low to medium radial and axial forces.

Advantages:

- High availability and long service life.
- Suitable for high speeds.
- Low-noise running.

Limitation:

- Only suitable for low to medium radial and axial loads.

A-side fixed bearing

Universal bearing type **(type code option "A")** suitable for absorbing high circumferential radial forces.

Advantages:

- Increased availability and longer service life under the effect of circumferential radial forces.
- Allows absorption of increased circumferential radial forces, such as they can occur when the motor is operated in connection with a coupling.
- Low-noise running.
- Thermally induced shaft expansion does not affect the machine accuracy.

Limitation:

- Motors with A-bearing are not available with brake.

High-speed bearing

The high-speed bearing **(type code option "H")** features a deep-groove ball bearing of appropriately light construction and therefore allows very high speeds.

Advantage:

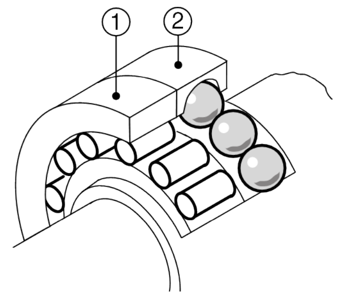
- Very high speeds are possible.

Limitation:

- Can only be used with low radial load.
- Can only be used when the motor is installed horizontally.
- Cannot be used in combination with a shaft sealing ring.

Reinforced bearing

The reinforced bearing **(type code option "V")** features an additional cylindrical roller bearing on the output side.



① Cylindrical roller bearing
② Deep-groove ball bearing

Fig. 9-13: Reinforced bearing

Advantage:

- Can absorb increased radial forces.

Limitation:

- The grease service life of the reinforced bearing is reduced to half the default value.
- In some motors, the allowed maximum speed is reduced.
- Motors with reinforced bearing may only be operated with a continuous radial load. Developing kinetic friction might damage the bearings.

Motors with a reinforced bearing must be operated at a minimum with the following radial loads:

Frame size	130	160	180	225
Minimum radial load [kN]	1	1.5	2	

Tab. 9-19: Minimum radial load with reinforced bearing

9.13.2 Selection tips

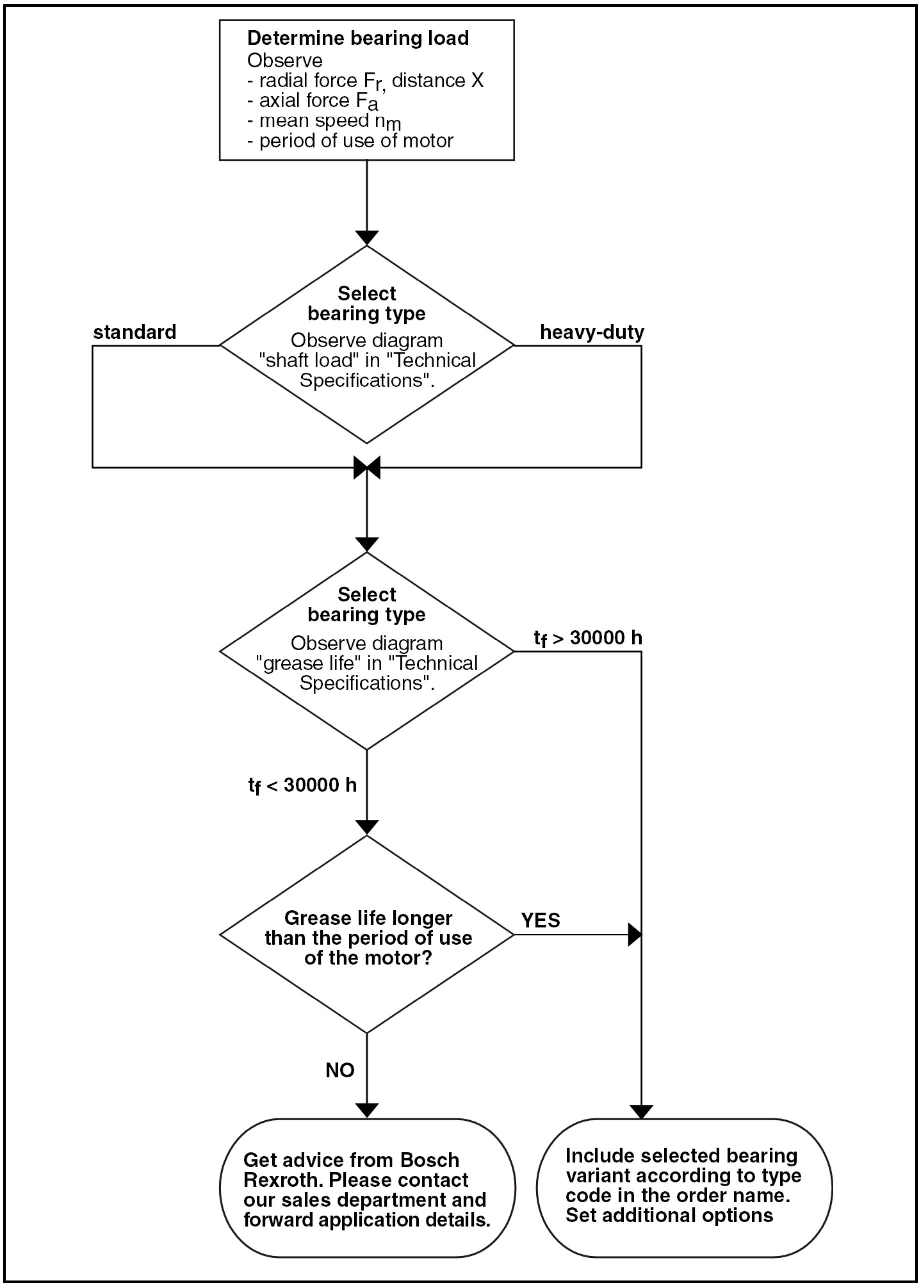


Fig. 9-14: Bearing selection flow diagram

9.13.3 Radial load, axial load

During operation, both radial and axial act on the motor shaft and therefore on the bearings as well. The machine construction and the motor type must be carefully coordinated to ensure that the specified load limits will not be exceeded.

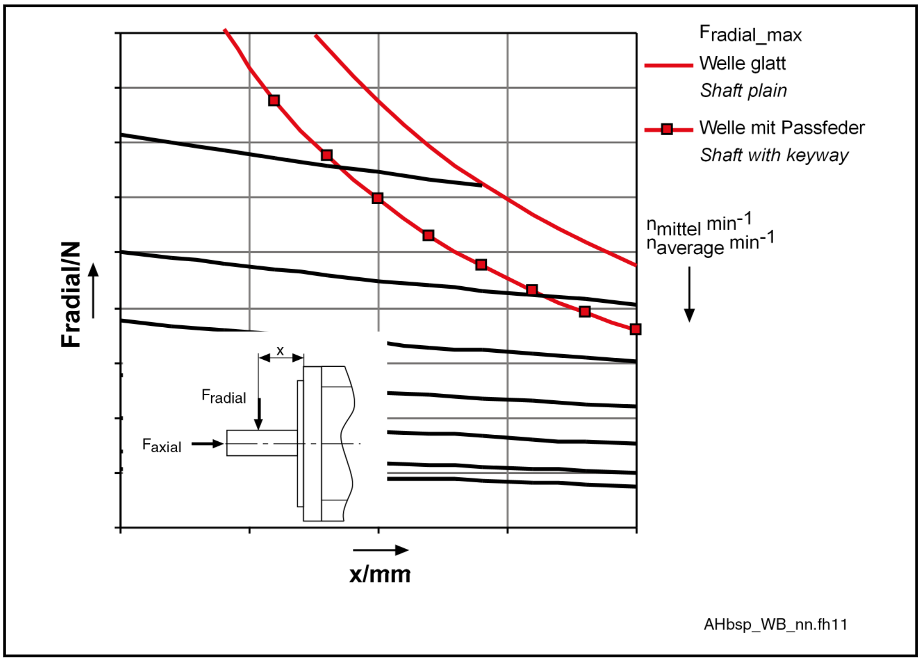


Fig. 9-15: Example shaft load diagram

Maximum allowed radial force

The maximum allowed radial force F_{radial_max} depends on the following factors:

- Force action point x
- Shaft design (smooth or with keyway)

Allowed radial force

The allowed radial force F_{radial} depends on the following factors:

- Arithmetically averaged speed (n_{mean})
- Force action point x
- Bearing service life

Allowed axial force

Only low axial shaft loads are allowed for IndraDyn A motors.

MAD/MAF...	100	130 ... 180	225
Allowed axial load F_{axial}[N]	30	50	100

Tab. 9-20: Axial load

The admissible axial load is applicable to all installation positions. For this reason, IndraDyn A motors are **not** suitable for machine elements which generate axial motor loads (e.g., helical driving pinions).

NOTICE

Motor damage due to strikes onto the motor shaft

▶ Do not strike the shaft end and do not exceed the allowed axial and radial forces of the motor.

When installing the motor vertically, also observe the guidelines in chapter 9.6.3 "Vertical installation positions" on page 221.

Mean speed

The run-up and braking times can be ignored in the calculation, if the time in which the drive is operated at a constant speed is significantly greater than the acceleration and braking time. If the mean speed is calculated according to the following equation, the acceleration and deceleration times are taken into account.

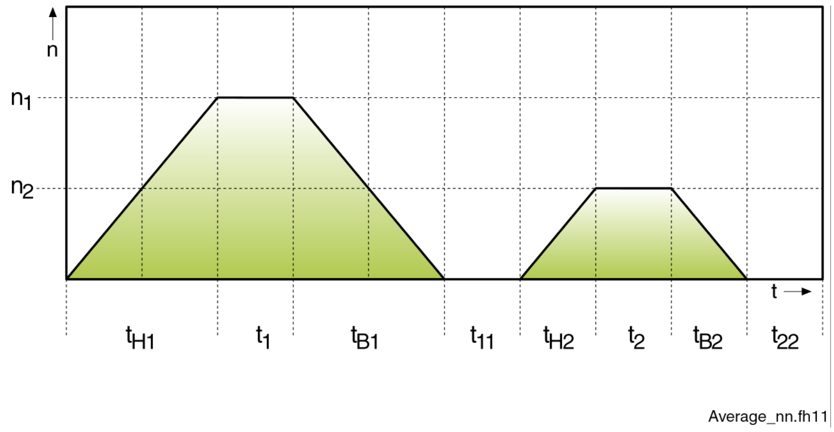


Fig. 9-16: Mean speed (graphical diagram)

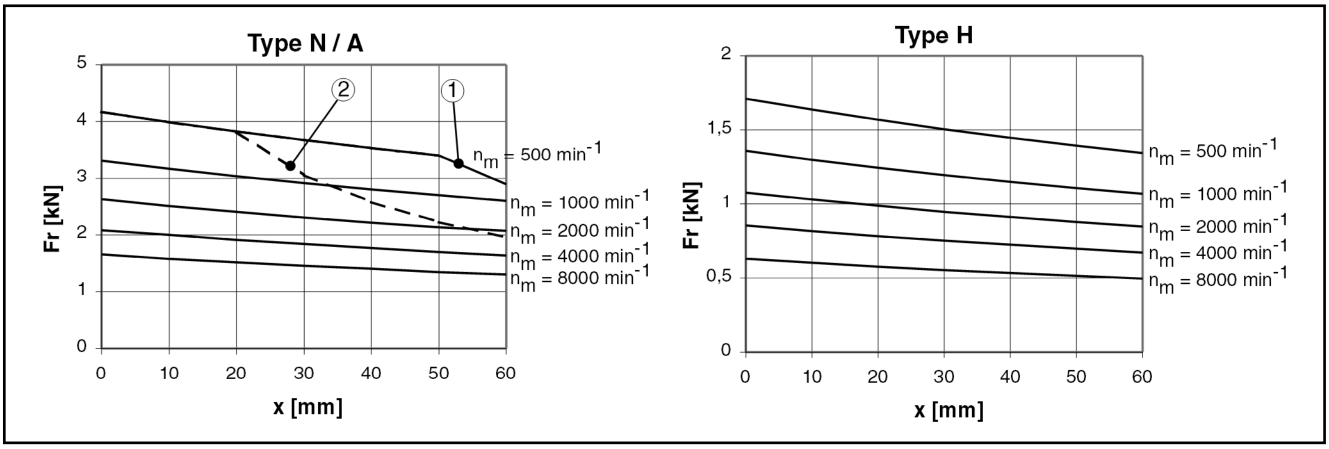
$$n_{1m} = \frac{\frac{n_1}{2} \cdot t_{H1} + n_1 \cdot t_1 + \frac{n_1}{2} \cdot t_{B1}}{t_{H1} + t_1 + t_{B1} + t_{11}}$$

n_{1m}	Mean speed in section 1
n_1	Machining speed
t_{H1}	Acceleration time
t_1	Machining time
t_{B1}	Deceleration time
t_{11}	Standstill time
n_{2m}	Mean speed in section 2
n_2	Machining speed
t_{H2}	Acceleration time
T_2	Machining time
t_{B2}	Deceleration time
t_{22}	Standstill time

Fig. 9-17: Mean speed (calculation formula)

A complete machining cycle can consist of several sections with different speeds. In this case, the average must be calculated from all sections.

Shaft load with frame size 100

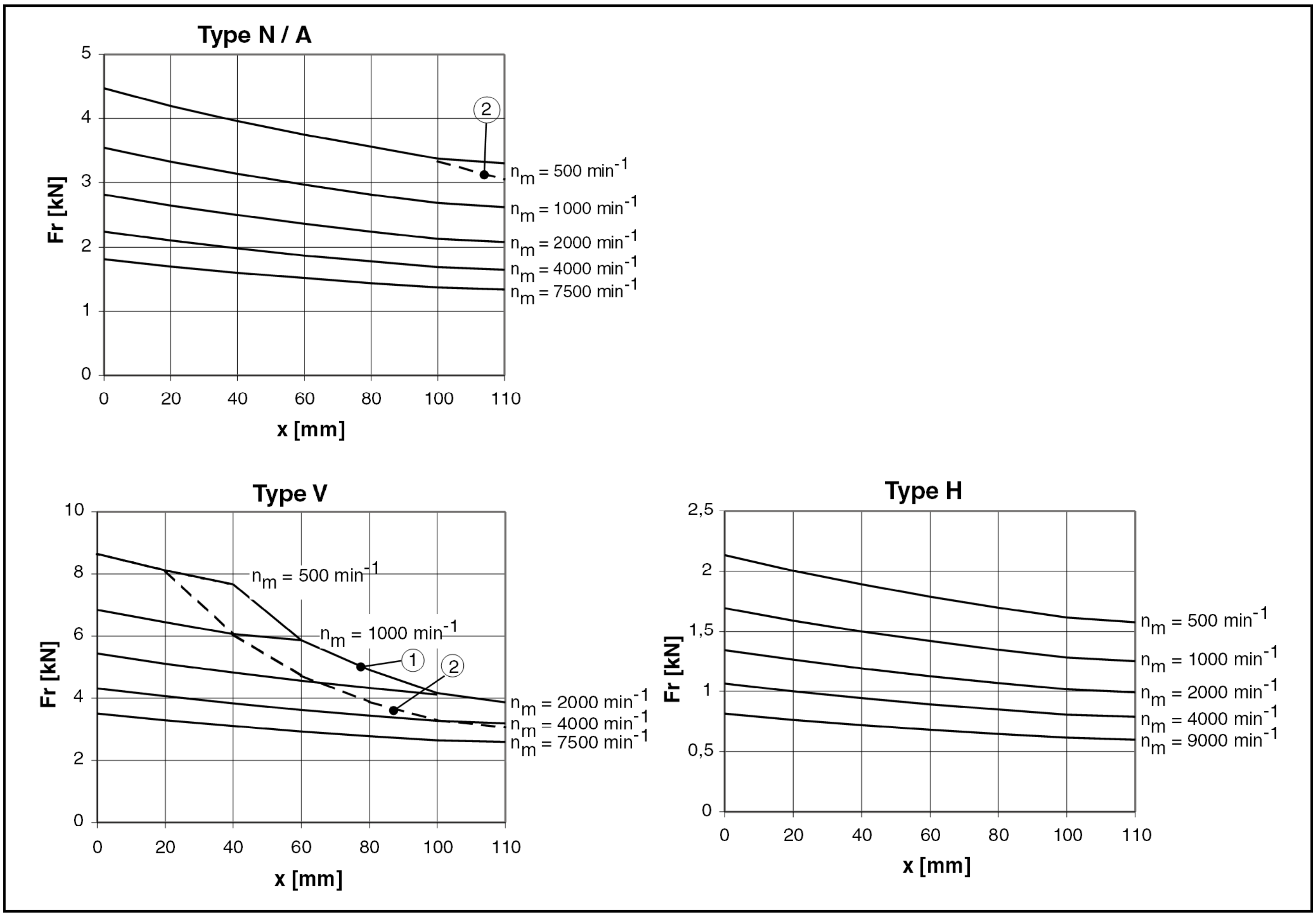


N	Standard bearing
A	A-side fixed bearing
H	High-speed bearing
①	Load limit for output shaft without key
②	Load limit for output shaft with key
n_m	Mean speed

Fig. 9-18: Shaft load with frame size 100 (Lh = 30000 operating hours)

Shaft load with frame size 130

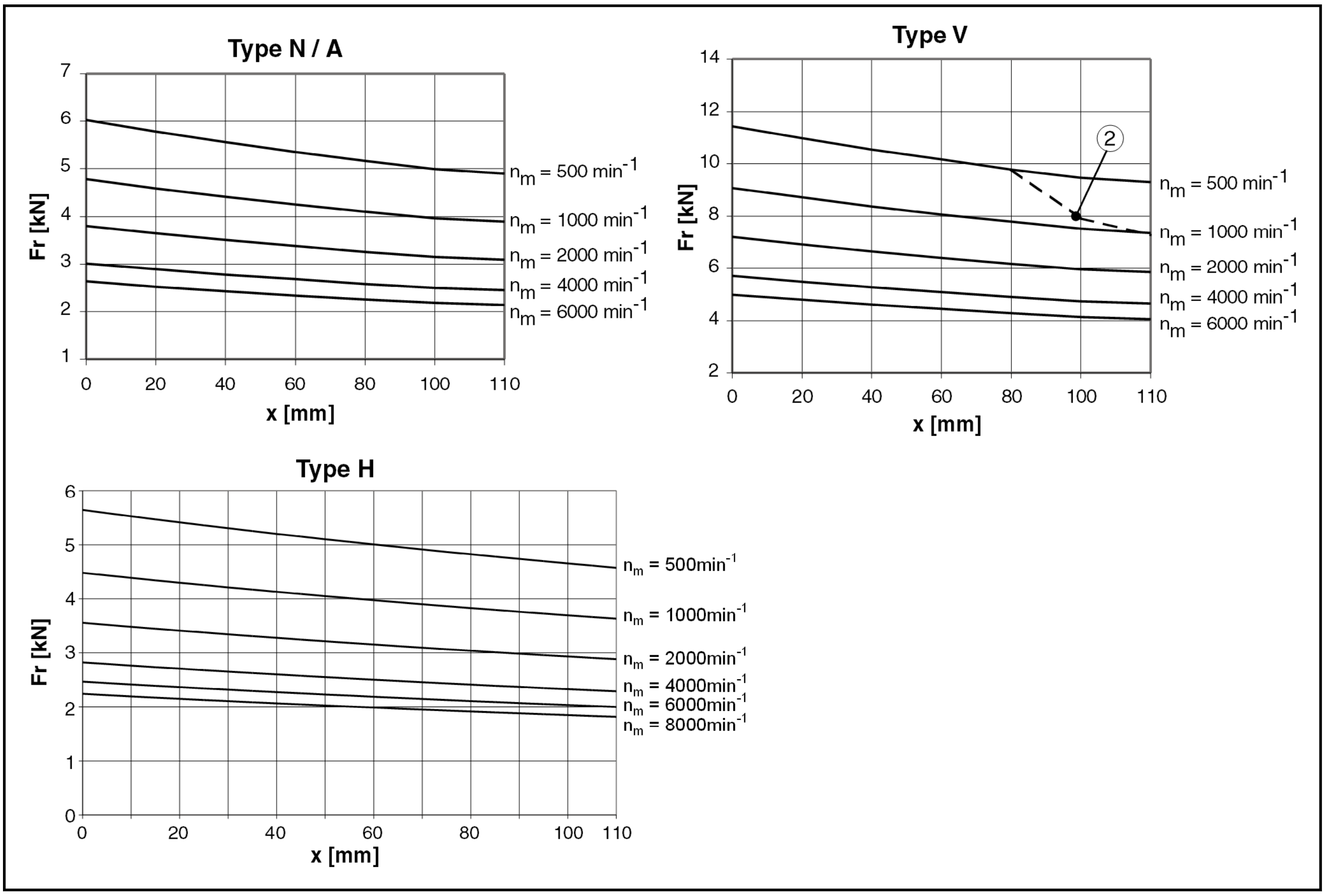
Application notes



N	Standard bearing
A	A-side fixed bearing
V	Reinforced bearing
H	High-speed bearing
①	Load limit for output shaft without key
②	Load limit for output shaft with key
n_m	Mean speed

Fig. 9-19: Shaft load with frame size 130 (Lh = 30000 operating hours)

Shaft load with frame size 160

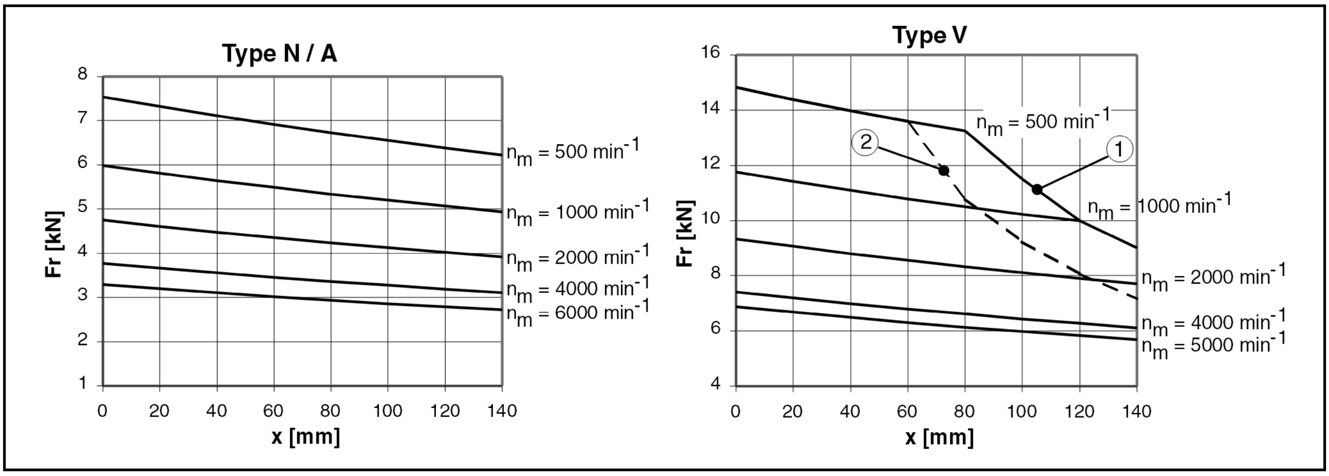


N	Standard bearing
A	A-side fixed bearing
V	Reinforced bearing
H	High-speed bearing
①	Load limit for output shaft without key
②	Load limit for output shaft with key
n_m	Mean speed

Fig. 9-20: Shaft load with frame size 160 (Lh = 30000 operating hours)

Shaft load with frame size 180

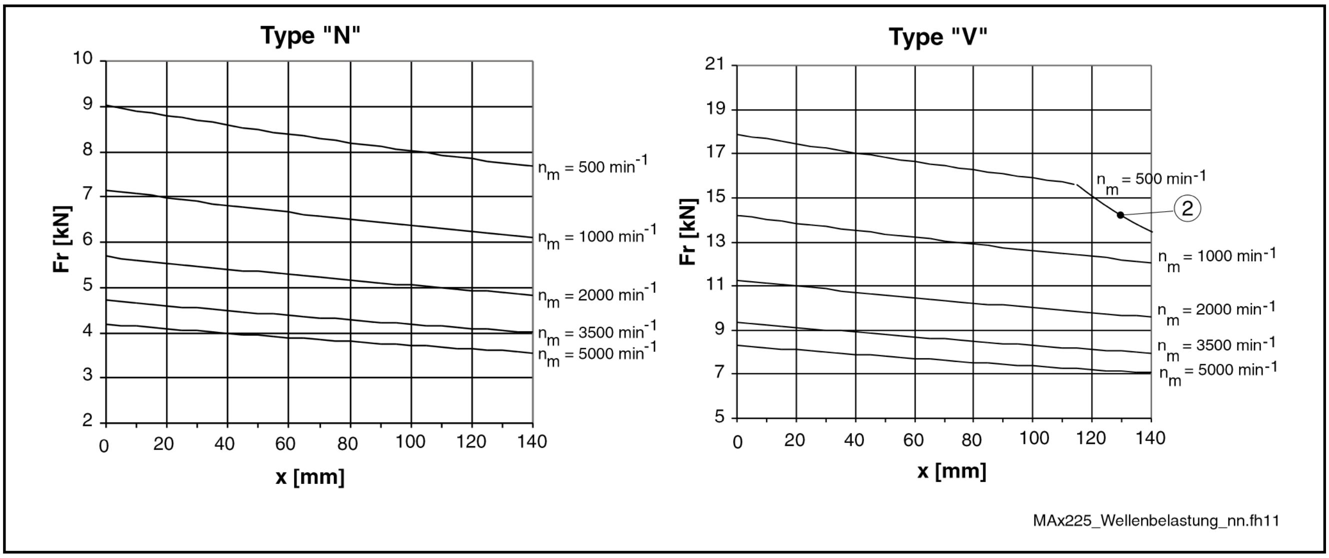
Application notes



N	Standard bearing
A	A-side fixed bearing
V	Reinforced bearing
①	Load limit for output shaft without key
②	Load limit for output shaft with key
n_m	Mean speed

Fig. 9-21: Shaft load with frame size 180 (Lh = 30000 operating hours)

Shaft load with frame size 225



N	Standard bearing
V	Reinforced bearing
②	Load limit for output shaft with key
n_m	Mean speed

Fig. 9-22: Shaft load with frame size 225 (Lh = 30000 operating hours)

9.14 Attaching drive elements

9.14.1 General

Whenever attaching drive elements to the output shaft, such as

- Gears
- Couplings
- Pulley
- Pinions

it is absolutely necessary that the following guidelines be followed.

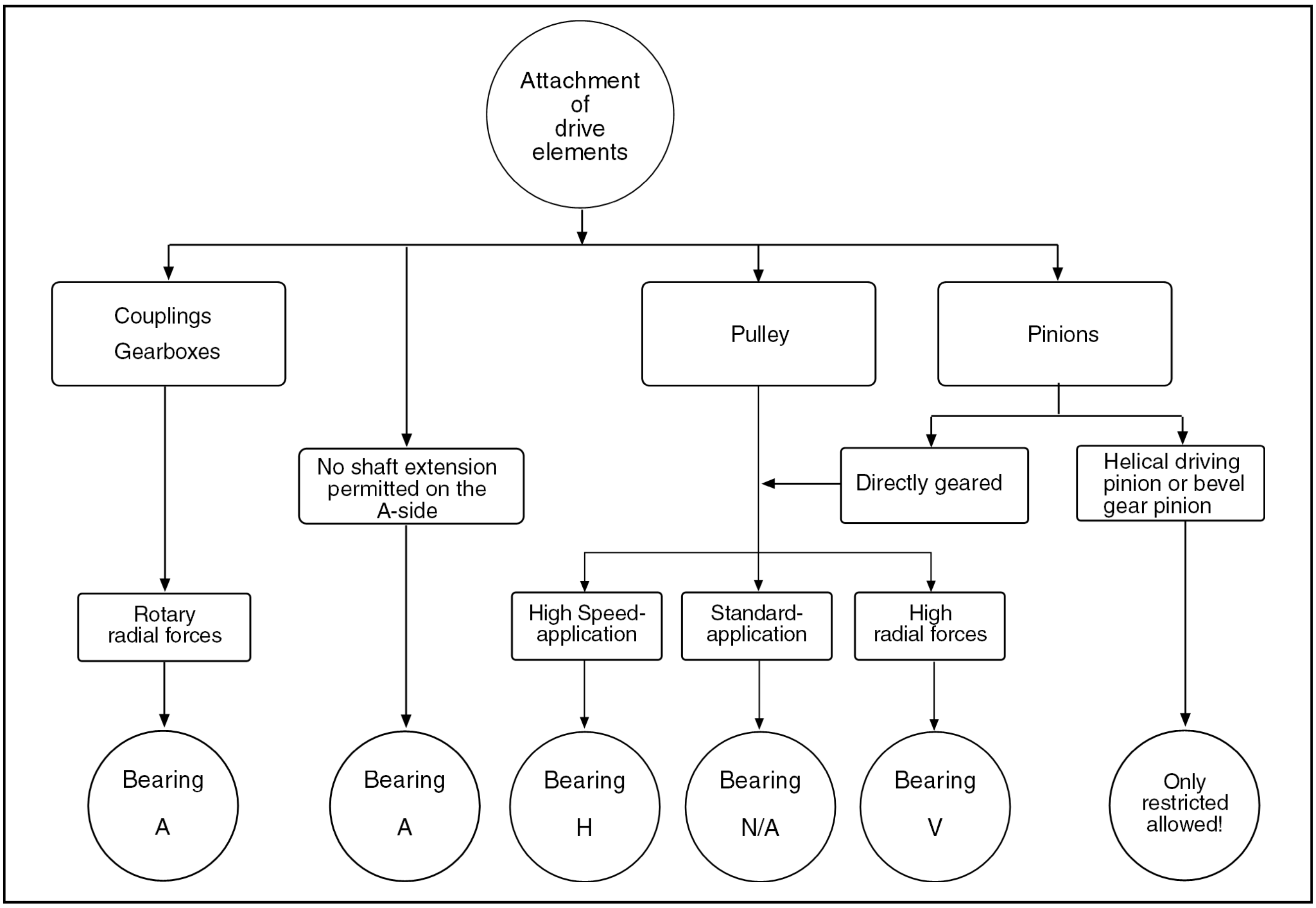


Fig. 9-23: Attaching drive elements

Overdefined bearing

In general, it is absolutely necessary that overdefined bearings when attaching drive elements. The tolerances inevitably present in such cases will lead to additional forces acting on the bearing of the motor shaft and, where applicable, to a considerably reduced service life of the bearing and/or to fatigue transverse rupture/vibration rupture of the motor shaft.

☞ If overdefined attachment cannot be avoided, it is absolutely necessary that Bosch Rexroth be consulted.

9.14.2 Gears

NOTICE **Ingressing fluid may damage the motor!**

Fluids (e.g., cooling lubricants, gear oil, etc.) may not be present at the output shaft. When gears are attached, only gears with a closed (oil-tight) lubrication system may be used.

9.14.3 Couplings

Couplings are attached to transmit torques of two separate shaft ends. Usually, shaft offset, phase-angle errors or axial distances must be compensated. If the couplings attached are too stiff, a circumferential radial load (= constantly changing the angular position) can therefore be generated on the output side. This circumferential radial load may result in an inadmissible high load of the bearing seat and therefore to a significantly reduced service life of the bearing.

☞ Rexroth offers bearing variant "A" for attaching couplings to IndraDyn A motors.

By selecting bearing "A", increased circumferential radial forces can be absorbed without limiting the speed of the motor. In addition, there is no significant thermally induced change in length in the vicinity of the connection of the motor output shaft.

Motor frame size MAD/MAF...	Allowed circumferential radial forces F_{radial_max} in N	
	Bearing A	Bearing N / H / V
100B	1000	25
100C	1000	25
100D	1000	30
130B	1200	40
130C	1200	50
130D	1200	55
160B	1500	65
160C	1500	65
180C	1800	95
180D	1800	100
225C	Not available	120

Tab. 9-21: Allowed circumferential radial forces

Recommended couplings

In connection with bearing A, Rexroth recommends axially compensating couplings, such as

- Spring disk couplings with two sets of springs (double gimbal),
- Metal bellows couplings.

These coupling variants are free from play and have a high torsional strength with low radial spring stiffness.

☞ If the recommended coupling types cannot be used, it is absolutely necessary that consult Bosch Rexroth be consulted.

For example, recommended manufacturers of the aforementioned couplings are:

- **KTR Kupplungstechnik GmbH**
  Postfach 1763
  D-48407 Rheine
  Phone +49 (0)5971 79 80
  Fax +49 (0)5971 79 86 98
  Internet: www.ktr.com/de/

- **A. Friedrich Flender GmbH**
  Alfred Flender Strasse 77
  46395 Bocholt, Germany
  Phone +49 (0)2871 920
  Fax +49 (0)2871 922 596
  Internet: www.flender.com

- **JAKOB GmbH&CoKG**
  Daimler Ring 42
  63839 Kleinwallstadt, Germany
  Phone +49 (0)6022 2208 0
  Fax +49 (0)6022 2208 22
  Internet: www.jakobantriebstechnik.de

- **R+W Antriebselemente GmbH**
  Alexander-Wiegand-Strasse 8
  63911 Klingenberg, Germany
  Tel. +49 (0)9372 9864 0
  Fax +49 (0)9372 9864 20
  Internet: www.rw-kupplungen.de

9.14.4 Skew bevel driving pinions

By attaching skew bevel driving pinions directly to the drive shaft, the motor bearings are exposed to inadmissible operation conditions in the vicinity of the force reversal point (reversal point between acceleration and deceleration or vice versa). What is more, the flange-side end of the output shaft may be displaced in relation to the motor housing due to thermal effects, thus exceeding the allowed axial forces of the motor bearings.

☞ It is not allowed to **directly attach** skew bevel driving pinions to the drive shaft of the motor. If skew bevel driving pinions must be used nevertheless, no other drive elements may be used than self-bearing drive elements which are connected to the motor shaft via axially compensating couplings.

9.14.5 Bevel gear pinions

Depending on the motor bearings selected, the flange-side end of the output shaft may be displaced in relation to the motor housing due to thermal effects, thus exceeding the allowed axial forces of the motor bearings.

When bevel gear pinions directly attached to the output shaft are used, this change in length results in a thermally induced axial force if the drive pinions are located axially on the machine side. There is the risk of exceeding the maximum allowed axial force or of increasing the play within the gears to an unallowed high degree.

☞ For this reason, bevel gear pinions may only be directly attached to the motor shaft if the motor is equipped with an A bearing. If bevel gear pinions must nevertheless be used in connection with a different bearing variant, no other drive elements may be used than self-bearing drive elements which are connected to the motor shaft via axially compensating couplings.

9.15 Bearing service life

The bearing lifetime is an important criterion for the availability of motors. The bearing service life is divided into the "mechanical service life" of bearing components and material on the one hand and "grease service life" of the bearing lubricant on the other hand.

If IndraDyn A motors are operated within the limits specified for radial and axial loads, the mechanical service life of the bearings is

L_{10h} = 30000 operating hours

(calculated according to ISO 281, version 1993.01)

This is applicable to all IndraDyn A motors provided the following requirements are met:

- The allowed motor load specified in chapter chapter 9.13 "Bearing variants and shaft load" on page 240 is never exceeded.
- The motor is operated under the allowed conditions of use and within the allowed surrounding air temperature range of 0 °C to +40 °C.
- The "mean speed" used over the entire machining cycle complies with the following characteristic curves for the grease service life, where

$$n_m < n_{m(t_r = 30000\ h)}$$

n_m	Mean speed
$n_{m(t_r)}$	Mean speed at which a grease service life of 30000 h can be expected

Fig. 9-24: Mean speed (grease service life)

Different loads may have the following effects:

- Early failure of the bearings due to increased wear or mechanical damage.
- Reduction of the grease lifetime leads to premature failure of the bearing.
- Avoid exceeding the load limits.

Mechanical bearing service life with increased radial force

Otherwise, the service life of the bearing is reduced to:

$$L_{10h} = \left(\frac{F_{radial}}{F_{radial\_act}} \right)^3 \cdot 30{,}000$$

L_{10h} Bearing service life (according to ISO 281, Version 12/1990)
F_{radial} Determined allowed radial force in N (Newton)
F_{radial_act} Actually acting radial force in N (Newton)

Fig. 9-25: Calculating the bearing service life L10h if the allowed radial force Fradial is exceeded

☞ The actually acting radial force F_{radial_act} may never be higher than the maximum allowed radial force F_{radial_max}.

9.16 Grease service life

The grease service life (t_f) is defined as the time from the point when the bearing is started until it fails as a result of lubrication failure. Unfavorable operating and ambient conditions reduce the grease service life. When the grease service life to be expected (t_{fq}) is determined, it is therefore absolutely necessary that certain reduction factors for unfavorable operating and ambient conditions be taken into account for each single case of application. The following table specifies the reduction factors, which refer to publication no. WL 81 115/4 DA by FAG Kugelfischer AG.

Reduction factors

<table>
<tr><th>Designation</th><th>Designation</th><th>Influence</th><th>Factor</th><th>Remark</th></tr>
<tr><td rowspan="3">Influence of dust and moisture on the functional surfaces of the bearing</td><td rowspan="3">f_1</td><td>Moderate</td><td>0.9 ... 0.7</td><td rowspan="3">Rexroth offers the "radial shaft sealing ring" as an option for this environment.
If this option is used
⇨ $f_1 = 1$</td></tr>
<tr><td>Strong</td><td>0.7 ... 0.4</td></tr>
<tr><td>Very strong</td><td>0.4 ... 0.1</td></tr>
<tr><td rowspan="3">Influence of abrupt loads, vibrations and oscillations</td><td rowspan="3">f_2</td><td>Moderate</td><td>0.9 ... 0.7</td><td>e.g., with machine tools and printing presses</td></tr>
<tr><td>Strong</td><td>0.7 ... 0.4</td><td>e.g., with materials handling equipment (portals)</td></tr>
<tr><td>Very strong</td><td>0.4 ... 0.1</td><td>e.g., with punches, presses</td></tr>
<tr><td rowspan="3">Influence of an increased bearing temperature</td><td rowspan="3">f_3</td><td>Moderate (up to 75 °C)</td><td>0.9 ... 0.6</td><td rowspan="3">The bearing temperature depends on the degree of capacity utilization of the motor.
If a special high-temperature grease is used: Capacity utilization 0 ... 70%
⇨ $f_3 = 1$
Capacity utilization 71 ... 100% ⇨ f_3 = 0.99 ... 0.7</td></tr>
<tr><td>Strong (75 ... 85 °C)</td><td>0.6 ... 0.3</td></tr>
<tr><td>Very strong (85 ... 120 °C)</td><td>0.3 ... 0.1</td></tr>
<tr><td rowspan="3">Influence of a high load</td><td rowspan="3">f_4</td><td>P/C = 0.1 ... 0.15</td><td>1.0 ... 0.7</td><td rowspan="3">If the shaft/bearing is appropriately loaded according to the particular shaft load diagram, the following results for IndraDyn A motors: Load 0 ... 70% ⇨ $f_4 = 1$
Load 71 ... 100% ⇨ f_4 = 0.99 ... 0.7</td></tr>
<tr><td>P/C=0.15 ... 0.25</td><td>0.7 ... 0.4</td></tr>
<tr><td>P/C=0.25 ... 0.35</td><td>0.4 ... 0.1</td></tr>
</table>

Application notes

Designation	Designa-tion	Influence	Factor	Remark
Influence of air currents caused by the bearing	f_5	Minor currents	0.7 ... 0.5	There is no influencing air current in the motor if it is operated properly ⇨ $f_5 = 1$
		Strong air cur-rents	0.5 ... 0.1	
If there is a centrifugal effect or if the shaft is vertical depending on the sealing	f_6	Vertical	0.7 ... 0.5	If the motor is installed horizontally ⇨ $f_6 = 1$

Tab. 9-22: Grease service life reduction factors

Calculation

$$t_{fg} = t_f \times f_1 \times f_2 \times f_3 \times f_4 \times f_5 \times f_6$$

Fig. 9-26: Reduction factors for calculating the grease service life to be expected

Ensure that the allowed loads mentioned in chapter 9.13 "Bearing variants and shaft load" on page 240 are not exceeded.

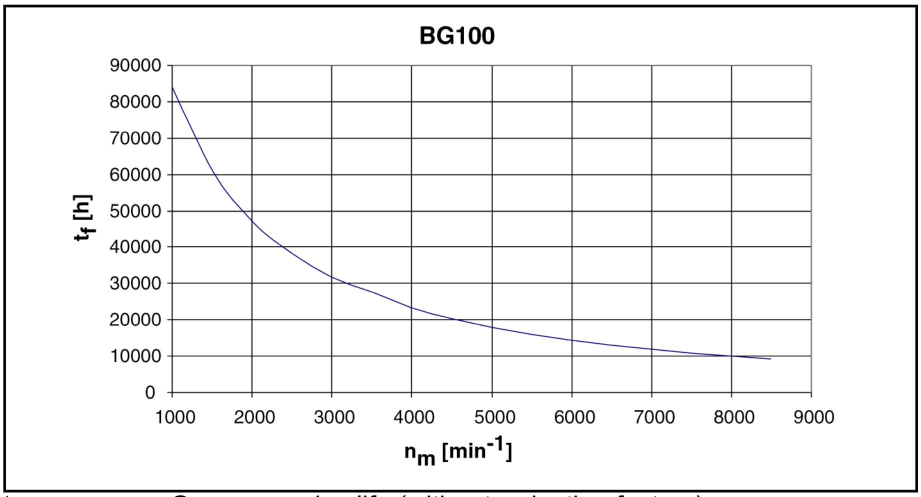
If the grease service life limits the time of use of the motor, the time of use can be prolonged in edge cases by using the standard bearing instead of the reinforced bearing. However, the higher load of the standard bearing reduces the available mechanical service life to less than 30000 operating hours.

In this case, the bearing service life must be recalculated by Bosch Rexroth. Contact one of our branch offices and describe your application with all relevant application data (load cycle, axial and radial loads, speeds).

Calculation and sizing of the bearings is based on the standard DIN ISO 281.

The available grease service life of deep-groove ball bearings and cylindrical roller bearings in IndraDyn A motors is illustrated in the following diagrams. The diagrams contain varying characteristic curves, depending on the bearing type.

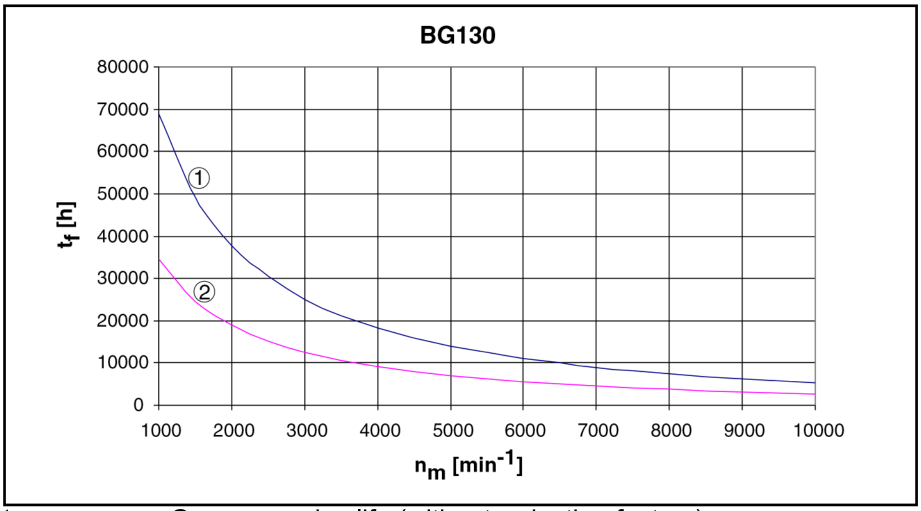
Grease service life with frame size 100



t_f Grease service life (without reduction factors)
n_m Mean speed

Fig. 9-27: Grease service life with frame size 100

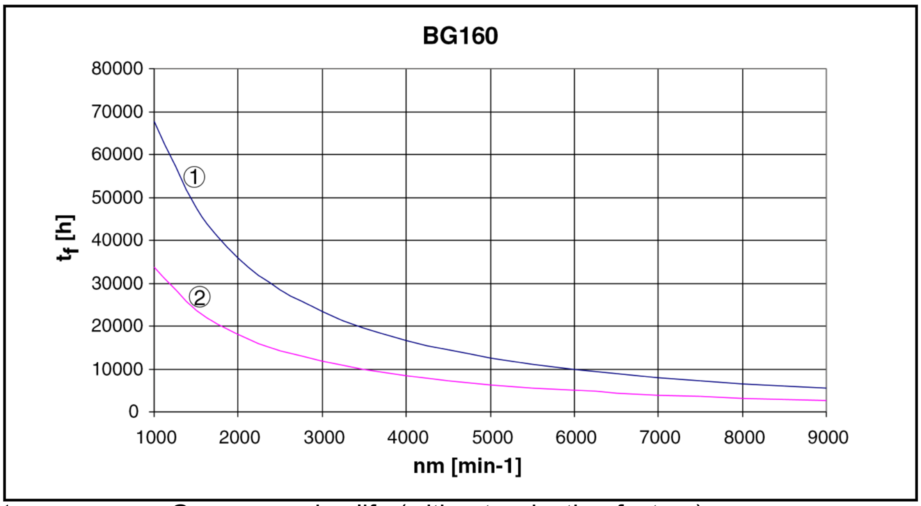
Grease service life with frame size 130



t_f	Grease service life (without reduction factors)
n_m	Mean speed
①	Characteristic curve of bearing N / A / H
②	Characteristic curve of bearing V

Fig. 9-28: Grease service life with frame size 130

Grease service life with frame size 160

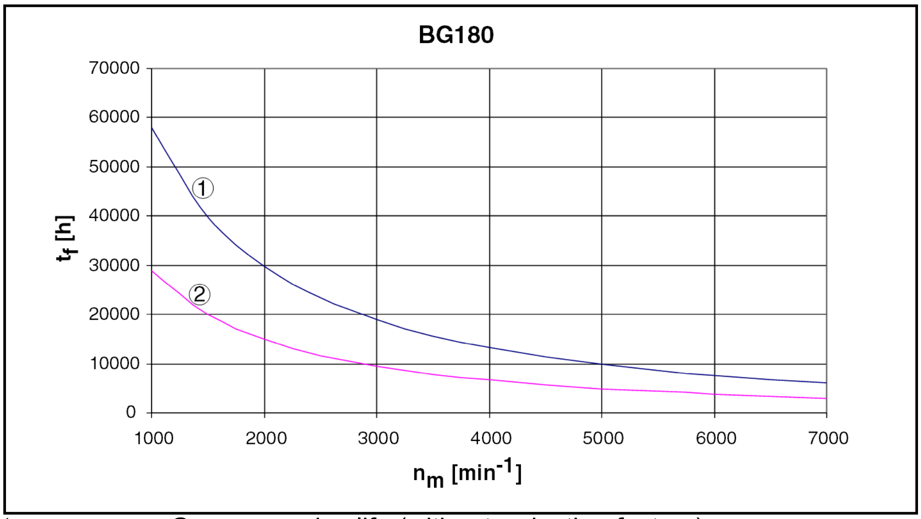


t_f	Grease service life (without reduction factors)
n_m	Mean speed
①	Characteristic curve of bearing N / A / H
②	Characteristic curve of bearing V

Fig. 9-29: Grease service life with frame size 160

Application notes

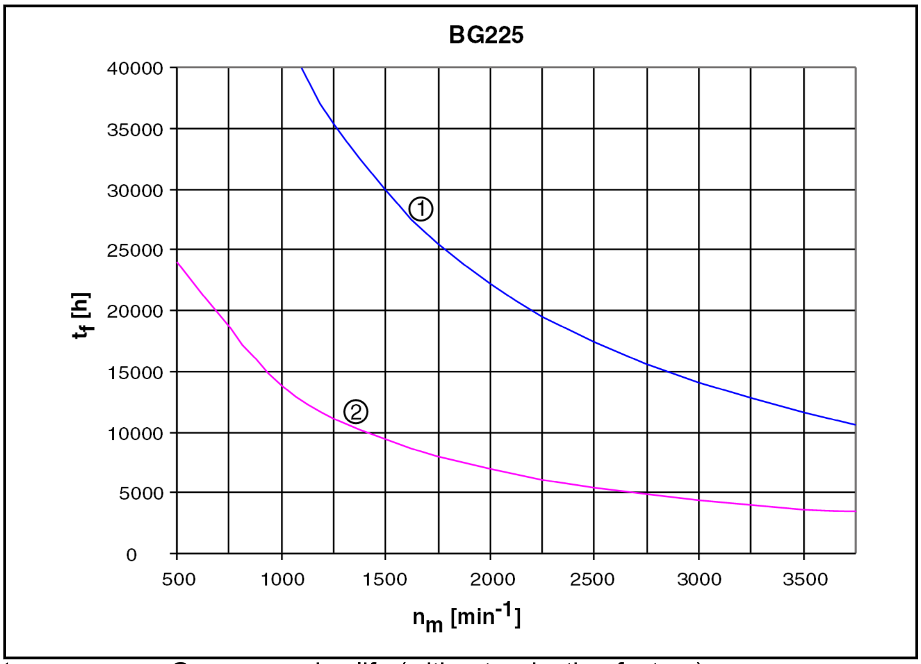
Grease service life with frame size 180



t_f	Grease service life (without reduction factors)
n_m	Mean speed
①	Characteristic curve of bearing N / A
②	Characteristic curve of bearing V

Fig. 9-30: Grease service life with frame size 180

Grease service life with frame size 225



t_f	Grease service life (without reduction factors)
n_m	Mean speed
①	Characteristic curve of bearing N
②	Characteristic curve of bearing V

Fig. 9-31: Grease service life with frame size 225

9.17 Oscillating quantity level

IndraDyn A motors are balanced dynamically and meet the limits of the bearing housing vibrations according to EN 60034-14:2004. The motors are measured in free suspension (see EN 60034-14:2004, chapter 6.2 Free suspension) and at a specific RPM value (vibration severity grade A) or in specified speed levels (vibration severity grades B and C).

The following tables give an overview of the position of the various oscillating quantity levels in connection with other oscillating quantity levels improved and defined by Bosch Rexroth.

Oscillating quantity level A (standard design)

In level A, Rexroth IndraDyn A motors basically achieve better values than the values required by EN 60034-14:2004. For vibration severity grade A, the measurement is only effective for the type-depending RPM value.

Admissible vibration speeds

Winding marks	Measurement speed [min-1]	Vibration speed [mm/s]	
		Frame size 100 ... 130	Frame size 160 ... 225
0050	500	0.71	1.2
0100	1000		
0150	1500		
0200	2000	1.12	1.8
0250	2500		
0300	3000		
0350	3500	1.8	2.8
0400	4000		

Tab. 9-23: Admissible vibration speeds from a type-depending speed

Application notes

Oscillating quantity level B and C

If the degree of mechanical smooth running must meet increased requirements, level B and level C (factory standard) are available for certain motors.

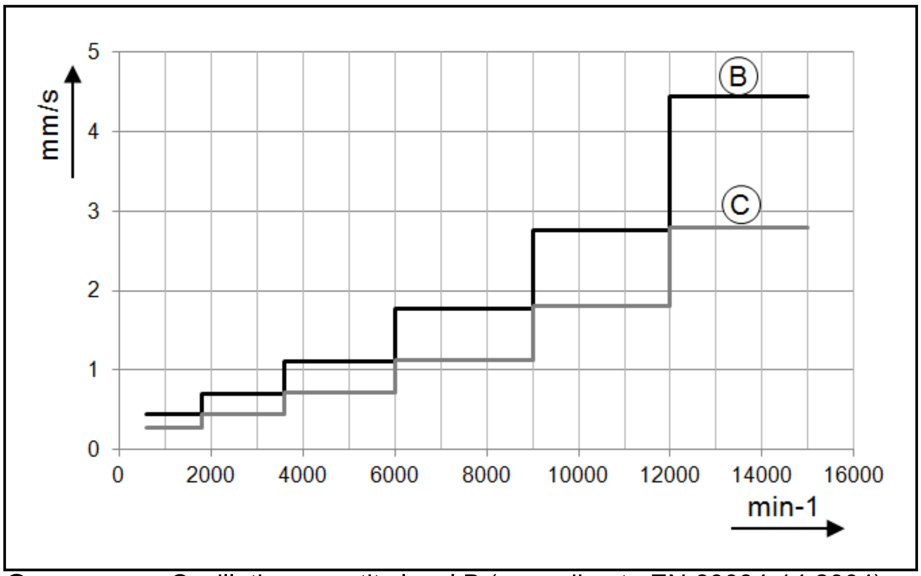
☞ Please also observe the information in the respective type code of the particular motor when selecting the oscillating quantity level.

Allowed oscillating velocities for frame sizes 100 ... 130

Speed	Vibration speed [mm/s]	
	Level B	Level C
600 ... 1800	0.44	0.28
1800 ... 3600	0.7	0.45
3600 ... 6000	1.1	0.71
6000 ... 9000	1.77	1.12
9000 ... 12000	2.76	1.8
12000 ... 15000	4.44	2.8

Tab. 9-24: Allowed oscillating velocities for frame sizes 100 ... 130

Vibration severity grade diagram for frame size 100 ... 130



Ⓑ Oscillating quantity level B (according to EN 60034-14:2004)
Ⓒ Oscillating quantity level C (corresponding to Bosch Rexroth factory standard)

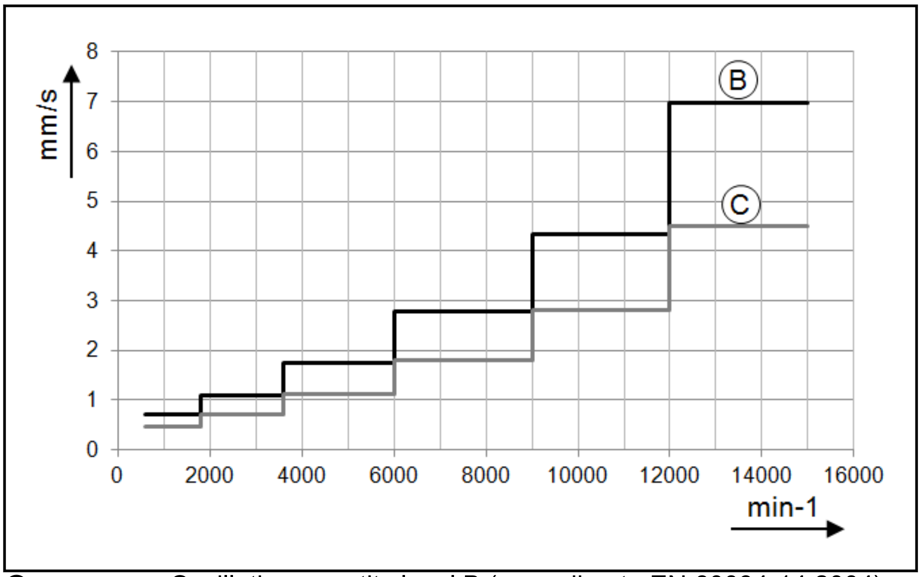
Fig. 9-32: Graphical diagram of the oscillating quantity levels B and C of frame sizes 100 ... 130

Allowed oscillating velocities for frame sizes 160 ... 225

Speed	Vibration speed [mm/s]	
	Level B	Level C
600 ... 1800	0.7	0.45
1800 ... 3600	1.1	0.71
3600 ... 6000	1.74	1.12
6000 ... 9000	2.79	1.8
9000 ... 12000	4.34	2.8
12000 ... 15000	6.97	4.5

Tab. 9-25: Allowed oscillating velocities for frame sizes 160 ... 225

Vibration severity grade diagram for frame size 160 ... 225



Ⓑ Oscillating quantity level B (according to EN 60034-14:2004)
Ⓒ Oscillating quantity level C (corresponding to Bosch Rexroth factory standard)

Fig. 9-33: Graphical diagram of the oscillating quantity levels B and C of frame sizes 160 ... 225

For more detailed information, e.g., on measuring variables, machine installation or measurement conditions, please refer to EN 60034-14.

☞ Please note that the vibration behavior of attached or driven machine elements can also generate reactions to the motor which lead to early wear or failure in unfavorable cases.

Due to the system-specific influences on the vibration behavior of the overall system, the machine manufacturer must determine the specific circumstances.

In certain cases, the machine elements to be driven may need to be balanced in such a manner that no resonance or repercussions occur.

☞ The vibration behavior of the motor and the machine elements should be taken into account as early as during the plant design phase.

9.18 Explosion protection

9.18.1 Motors in ex-px d design (type code option "M6" or "S6")

☞ Ex-type motors (Ex-px d) are certified as explosion-protected devices.

Motors having this degree of protection are devices of device group II, category 2G, Directive 94/9/EC, Appendix II, Chapter 2.2.1, and may only be used in environments in which

- **an explosive atmosphere results seldom or on a short-term basis** caused by gases, vapors or mists
- **an explosive atmosphere may result occasionally** caused by gases, vapors or mists.

The system and the components must be so designed and constructed by the user as to prevent ignition sources arising, even in the event of frequently occurring disturbances or equipment operating faults, which normally have to be taken into account.

☞ The motor that is approved for Ex-areas and is identified accordingly is merely a part of a drive concept. In these areas, the motors may only be commissioned with a control unit which is classified and approved according to the conditions of the potentially explosive atmosphere. Please be absolutely sure to also follow the information and instructions on the configuration of the control unit selected for purging the motor as early as during the project planning phase and prior to commissioning the plant.

Observe the required selection criteria in the type code of the particular motor as well as the additional data, e.g., on the selection, the protection principle and the labeling of the motors in chapter 13.5 "Selecting and labeling Ex-type motors " on page 293.

9.19 Acceptances and approvals

9.19.1 CE mark

Declarations of conformity confirming the design and compliance with the valid EN standards and directives are available for the IndraDyn A motors. If necessary, these declarations of conformity can be requested from the responsible sales office.

The CE mark is applied to the motor name plate of IndraDyn A motors.

CE_Zeichen.fh11

Fig. 9-34: CE mark

9.19.2 UR, cUR listing

IndraDyn A motors were presented to “Underwriters Laboratories Inc.®” and have been approved by this UL authority.

The appropriate identification of the motors is specified on the motor name plate.

CUR_Zeichen.fh11

Fig. 9-35: cUR mark

10 Handling and transport

10.1 Condition on delivery

10.1.1 General information

IndraDyn A motors are delivered in wooden crates or in cartons. Packing units on pallets are secured by retaining straps.

⚠ CAUTION **When being cut open, the retaining straps may make uncontrolled movements which may result in injuries.**

⇒ Stay away from the retaining straps and cut them open with particular care.

Motor shaft and plug connections are provided with protective sleeves at the factory. Remove these protective sleeves only immediately before starting assembly.

10.1.2 Factory test

All IndraDyn A motors are subjected to the following and other tests:

Electrical test

- High-voltage test according to EN 60034-1 (pursuant to VDE 0530-1)
- Insulation resistance according to EN 60204-1/1.92, Section 20.3
- Protective conductor connection according to EN 60204-1/1.92, Section 20.3

Mechanical test

- Concentricity and position tolerances of shaft end and mounting flange according to DIN 42955
- Vibration measurement according to DIN 2373

10.1.3 Test performed by the customer

Since all IndraDyn A motors are subjected to a standardized inspection procedure, the customer does not have to perform high-voltage tests. Repeated high-voltage tests may damage both motors and components.

NOTICE **Improperly conducted high-voltage tests may destroy motor components. This will invalidate the warranty!**

⇒ Avoid repeated tests.

⇒ Comply with the requirments of EN 60034-1 (pursuant to VDE 0530-1).

10.2 Identification

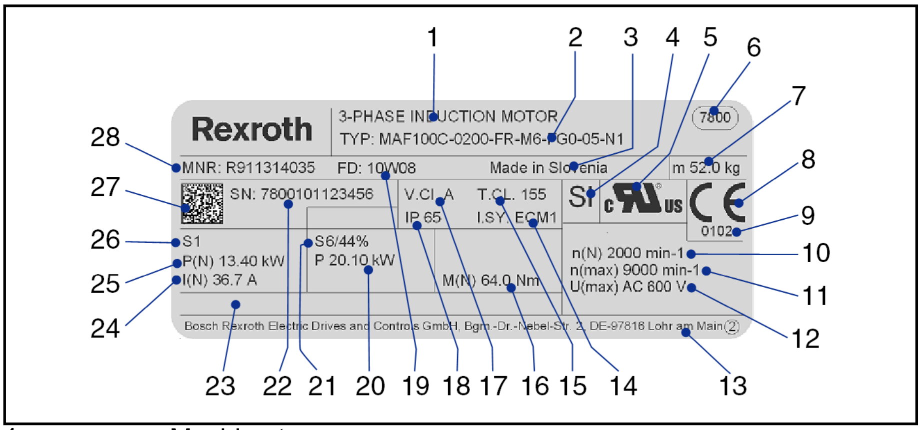
The total scope of a delivery is specified on the delivery or consignment note. However, the contents of a delivery may be distributed over several packages. Each individual package can be identified using the shipment label attached on the outside. In addition, each device has an individual name plate containing the device designation and technical data.

☞ After having received the goods, compare the supplied type with the ordered type. Immediately file complaints about non-compliances.

10.3 Labeling

The type designation of the complete product is composed based on the options selected. These codes are printed on the name plate along with other product data.

The code and the serial number allow unique identification of each Bosch Rexroth product.



1	Machine type
2	Type designation
3	Origin
4	Safety technology according to EN 61508-1
5	UL mark
6	Manufacturer's factory
7	Motor mass in kg
8	CE mark
9	Test body's ID code
10	Rated speed
11	Maximum speed
12	Maximum input voltage
13	Company address
14	Insulation system
15	Thermal temperature class
16	Rated torque
17	Vibration severity grade
18	Degree of protection through housing
19	Manufacturing date
20	Motor power in operation mode S6
21	Operation mode S6/44%
22	Serial number
23	Field for holding brake (optional) with holding torque, rated voltage, rated current
24	Rated current in delta connection in operation mode S1
25	Rated power in delta connection in operation mode S1
26	Operation mode S1
27	Rexroth bar code
28	Part number

Fig. 10-1: Example name plate MAF

IndraDyn A motors are each delivered with 2 name plates.

Attach the second name plate to the machine at a well visible place. This allows reading the motor data at any time without having to reach the motor at places which are difficult to access.

Before submitting inquiries to Bosch Rexroth, please always note down the complete type designation and serial number.

10.4 Transport and storage

10.4.1 General information

NOTICE **Improper handling may result in damage or injuries and invalidate the warranty.**

- Protect the products against moisture and corrosion.
- Avoid putting the products under mechanical load. Do not throw, tilt or drop the products.
- Only use lifting equipment suitable for the weight of the motor.
- Never lift the motor by the fan housing.
- Use suitable protective devices and wear protective clothing when transporting the device.

10.4.2 Transport-related guidelines

To protect the motor against dirt, dust, etc., Bosch Rexroth recommends to transport the motor in its original packaging

- until it has reached its intended installation site and
- until it is actually installed into the machine.

To lift the motor out of the transport crate or to install it into the machine, use the transport or lifting eye bolts provided at the motor.

The lifting eye bolts at least meet the requirements of DIN 580. Whenever intending to transport the motor, ensure that the lifting eye bolts are completely screwed down to the stop face and are not overloaded by the selected lifting equipment and lifting method.

☞ When transporting the motors by means of the attache lifting eye bolts, ensure to meet the requirements of DIN 580. Failure to comply with the requirements of this standard may overload the lifting eye bolts and result in personal injury and/or product damage.

Based on DIN EN 60721-3-2, the following table specifies the classifications and limit values to which our products may be exposed while they are transported by land, water or air. Also read the detailed description of the classifications to ensure that all factors which are specified in the respective class are taken into account.

Environmental condition classes allowed for transport according to DIN EN 60721-3-2

Classification type	Allowed class
Classification of climatic environmental conditions	2K2
Classification of biological environmental conditions	2B1
Classification of chemically active substances	2C2
Classification of mechanically active substances	2S2
Classification of mechanical environmental conditions	2M1

Tab. 10-1: Environmental condition classes allowed for transport

To provide a better overview, the table below gives some essential environmental factors of the aforementioned classifications. Unless otherwise stated, the values specified correspond to the values of the respective class. However, Bosch Rexroth reserves the right to adjust these values to future experiences or changed environmental conditions at any time.

Allowed transport conditions

Environmental factor	Symbol	Unit	Value
Temperature	T_T	°C	-20 ... +80 1)
Air humidity (relative humidity, not to be combined with rapid changes in temperature)	φ	%	75 (at +30 °C)
Occurrence of salt mist			Not allowed 1)

1) In contrast to DIN EN 60721-3-2

Tab. 10-2: Allowed transport conditions

☞ If necessary, liquid-cooled motors should be drained of coolant prior to transport in order to avoid frost damage.

Transport by air

If motor components with permanent magnets are shipped by air, the DGR (**D**angerous **G**oods **R**egulations) of the IATA (International Air Transport Association) for hazardous materials of class 9 which also include magnetized substances and objects must be observed. For example, these regulations are applicable for

- Secondary parts of synchronous linear motors
- Rotors of synchronous kit motors
- Rotors of synchronous housing motors (if shipped as motor components, i.e., separated from the stator or motor housing in case service work is required)

For information on the maximum allowed magnetic strenghts and methods of measuring such magnetic field strengths, please refer to the current IATA DGR (chapter 3.9.2.2).

10.4.3 Storage-related guidelines

Storage conditions

In principle, Bosch Rexroth recommends that all components be stored as follows until they are actually installed into the machine:

- In their original packaging
- At a dry and dustfree place
- At room temperature
- Free of vibration and oscillation
- Protected against light and direct solar radiation

Our motors may be equipped with protective sleeves and covers at the factory. These sleeves and covers must remain on the motor while the latter is transported. Remove these parts only immediately before starting assembly.

Based on DIN EN 60721-3-1, the following table specifies the classifications and limit values to which our products may be exposed as long as they are stored. Also read the detailed description of the classifications to ensure that all factors which are specified in the respective class are taken into account.

Environmental condition classes allowed for storage according to DIN EN 60721-3-1

Classification type	Class
Classification of climatic environmental conditions	1K2
Classification of biological environmental conditions	1B1
Classification of chemically active substances	1C2
Classification of mechanically active substances	1S1
Classification of mechanical environmental conditions	1M2

Tab. 10-3: Environmental condition classes allowed for storage

To provide a better overview, the table below gives some essential environmental factors of the aforementioned classifications. Unless otherwise stated, the values specified correspond to the values of the respective class. However, Bosch Rexroth reserves the right to adjust these values to future experiences or changed environmental conditions at any time.

Environmental condition classes allowed for storage according to DIN EN 60721-3-1

Environmental factor	Symbol	Unit	Value
Air temperature	T_L	°C	-20 ... +60 1)
Relative air humidity	φ	%	5 ... 95
Absolute air humidity	ρw	g/m³	1 ... 29
Moisture condensation	- -	- -	Not allowed
Formation of ice / icing	- -	- -	Not allowed
Direct solar radiation	- -	- -	Not allowed 1)
Occurrence of salt mist	- -	- -	Not allowed 1)

1) In contrast to DIN EN 60721-3-1

Tab. 10-4: Allowed storage conditions

☞ If necessary, liquid-cooled motors should be drained of coolant before they are put back in storage, in order to avoid frost damage.

Motor storage times

Irrespective of the storage time - which may also go beyond the warranty time for our products - their function remains preserved when additional measures are initiated and taken during commissioning. However, this does not include any additional warranty claim.

Storage time	Measures during commissioning
< 1 year	Resurface the holding brake
1 ... 5 years	1. Verify that electric contacts are free from corrosion 2. Let the motor run in without load for one hour at 800 ... 1000 rpm 3. Resurface the holding brake
> 5 years	1. Exchange bearings 2. Exchange encoders 3. Resurface the holding brake 4. Verify that electric contacts are free from corrosion

Tab. 10-5: Measures before commissioning motors in long-term storage

Cables and connectors

Storage time	Measures to be taken before commissioning
< 1 year	None
1 ... 5 years	⇒ Verify that electric contacts are free from corrosion
> 5 years	⇒ Exchange cables if you detect porous spots on the cables or cable jackets; otherwise, verify that electric contacts are free from corrosion

Tab. 10-6: Measures to be taken before commissioning cables and connectors in long-term storage

11 Installation

11.1 Safety

⚠ WARNING **Risk of injury due to live parts! Lifting of heavy loads!**

- Install the motors only when they are de-energized and not connected electrically.
- Use suitable lifting equipment and protective equipment and wear protective clothing during transport.
- Do not lift or move the motor by the fan unit.
- Please observe the safety-related guidelines in the preceding chapters and the transport-related guidelines in chapter chapter 10 "Handling and transport" on page 263.

Carry out all working steps with particular care This minimizes the risk of accidents and damage.

☞ Some of the IndraDyn A motors of frame size 130 and higher feature additional threaded holes on their longitudinal sides where eyelets can be inserted (for details, see dimension drawing). Additional eyelets can simplify the transport and handling of the motors.

11.2 Mechanical attachment

11.2.1 Motor attachment

Mounting screws

To attach the motors properly and safely to the machine, Bosch Rexroth recommends the following screws and washers for attachment.

- Motor frame size 100
  - Pan head screw DIN EN ISO 4762 - M12 x ... - 8.8

    and
  - Washer DIN EN ISO 28738
- Motor frame size 130 ... 225
  - Hexagon screws DIN EN ISO 4014 - M... x ... - 8.8

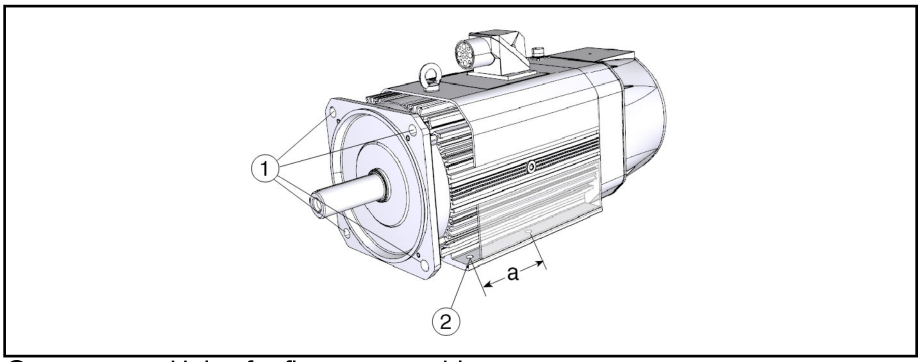
    or
  - Pan head screw DIN EN ISO 4762 - M... x ... - 8.8

    and
  - Washer DIN EN ISO 7090 - ... - 200 HV

☞ If screws and washers other than the recommended ones are used, the property class of the screws and the hardness class of the washers must be equivalent in order to ensure that the required tightening torques are transmitted (see tab. 11-1 " Mounting holes and screw tightening torques" on page 270).

Installation

Attachment types



① Holes for flange assembly
② Mounting feet for foot assembly
a For hole clearance "a", refer to the table of the particular motor dimension drawing

Fig. 11-1: Motor attachment types

At the factory, IndraDyn A motors are manufactured either for flange assembly (B05) or foot assembly (B35). The particular dimension drawing contains details on the position of the mounting holes. In general, the following assignment is applicable for attaching the motors:

MAD/MAF	B05 (flange assembly)			B35 (foot assembly)		
	Hole	Screw (8.8)		Hole	Screw (8.8)	
	Ø [mm]	Type	M_A [Nm] with μ_G 0.12	Ø [mm]	Type	M_A [Nm] with μ_G 0.12
100	14	M12	84	11	M10	48
130	18	M16	206	12	M10	48
160				14	M12	84
180				14.5		
225				22	M20	415

M_A Tightening torque in Newton meters
μ_G Coefficient of friction

Tab. 11-1: Mounting holes and screw tightening torques

Foot assembly

Before attaching the IndraDyn A motors according to the foot assembly method, observe the clearance from the center of the motor shaft to the bottom edge of the foot specified in the particular motor dimension drawing. Compare this clearance with the connection clearance actually present on the machine.

☞ The mounting holes and clearances correspond to the general tolerance according to ISO 2768-m.

Before attaching the motor to the machine, align the motor such that the center line of the motor shaft is flush with the center line of the connection shaft.

Also note the information on this mounting type provided in chapter 9.6.2 "Foot assembly" on page 220.

If attaching the motors according to the foot assembly method, proceed as follows:

1. MAD130 ... 225: Dismount the lower lateral air baffles to have free access to the mounting holes.
2. Align the motor such that the center line of the motor shaft is flush with the center line of the connection shaft of the machine. Support the motor on sheet steel strips when aligning it.
3. Firmly connect the motor to the machine (for tightening torques, see tab. 11-1 " Mounting holes and screw tightening torques" on page 270).
4. MAD130 ... 225: Reattach the air baffles to the motor.

Frame size	Motor attachment type	Number of mounting holes	Roughness height of the screwing surface to the machine
100	Mounting feet (4 pcs.)	4	Rz32
130	Foot plates (2 pcs.)		
160	Mounting feet (4 pcs.)		
180	Via stator profile		
225	Mounting feet (4 pcs.)		

Tab. 11-2: Foot assembly

11.2.2 Preparing assembly

Record all measures taken in the commissioning log.

Prepare motor assembly as follows:

1. Check the components for visible damage. Damaged components may not be mounted.
2. Ensure that the dimensions and tolerances of the plant are suitable for motor attachment (for details, see dimension drawing).
3. Ensure that the motor can be assembled in a clean, dry and dust-free environment.
4. Keep tools and auxiliary materials as well as measuring and testing equipment ready at hand.
5. Inspect all components, mounting surfaces and threads to ensure they are clean.
6. Ensure that the machine-sided receptacle for the motor flange has no burrs.
7. Remove the protective sleeve from the motor shaft. Keep the sleeve for later use.

11.2.3 Assembling the motor

Please note:

- In case of flange assembly: Avoid clamping or jamming the motor-sided centering collar.
- In case of flange assembly: Avoid damaging the plant-sides receptacle fit.
- In case of foot assembly: Align the center line of the motor shaft flush with the connection shaft of the machine. Also observe the guidelines regarding foot assembly in this chapter.
- Connect the motor to the machine (observe tightening torques).
- Check whether the connection is firm and accurate before carrying out any further steps.

After having assembled the motor mechanically, prepare it for electrical connection.

11.3 Mount transmission elements

Fit and pull off the transmission elements such as pulleys and couplings only with suitable equipment; heat them, if necessary.

▶ Avoid inadmissible belt tensions. Please consider the allowed radial and axial forces .

▶ The balancing state of transmission element must comply with the balancing mode of the motor.

NOTICE

Motor damage due to strikes onto the motor shaft

▶ Do not strike the shaft end and do not exceed the allowed axial and radial forces of the motor.

Fitting

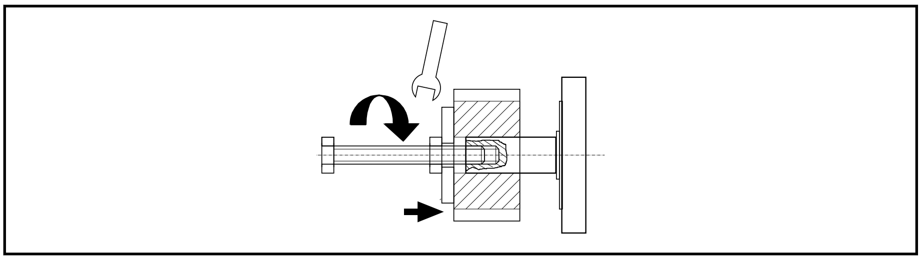


Fig. 11-2: Fitting the transmission element

▶ Use the centering hole for fitting transmission elements. For details on centering holes, please refer to the project planning manual 🕮 If applicable, heat up the Rexroth IndraDyn A. transmission element.

11.4 Electrical connection

11.4.1 General

Use ready-made cables by Bosch Rexroth. These cables have numerous benefits, e.g., extreme resilience and resistance as well as EMC-compliant design.

- Connect IndraDyn A motors electrically as described in chapter 8 "Connection Methods" and Ex-type motors as described in chapter 13 "Motors for Potentially Explosive Atmospheres".

☞ The connection diagrams of the product documentation serve to create system circuit diagrams. The drive components must be connected in the machine exclusively according to the machine manufacturer's system circuit diagrams.

11.4.2 Additional ground conductor on motors

When being connected, some of the motors must be equipped with an additional ground conductor. For more information about this additionally required ground conductor, please refer to chapter 8.2.2 "Additional ground conductor on motors" on page 200.

12 Operating of IndraDyn A Motors

12.1 Commissioning

12.1.1 General

NOTICE **Property damage caused by errors when controlling motors and moving parts! Unclear operating states and product data!**

- Do not commission the motors if connections, operating states or product data are unclear or faulty.
- Do not commission the motors if safety devices and monitoring units of the plant are damaged or not in operation.
- Damaged products may not be operated.
- Contact Bosch Rexroth for additional information or support during commissioning.

The following notes on commissioning refer to IndraDyn A motors as part of a drive system with drive and control devices.

12.1.2 Preparation

1. Have the documentation of all products used ready at hand.
2. Record all measures taken in the commissioning log.
3. Check the products for damage.
4. Check all mechanical and electrical connections.
5. Activate the safety and monitoring equipment of the system.

12.1.3 Procedure

Once all requirements are met, proceed as follows:

1. Activate the fan at the MAD motor or the external cooling system supplying the MAF motor and check them to verify that they are in a proper condition. Observe the manufacturer's instructions.
2. Commission the drive system according to the instructions of the corresponding product documentation. The corresponding information is provided in the functional description of the drive controllers.
3. Record all measures taken in the commissioning log.

☞ Sometimes, additional steps may be required for commissioning controllers and control units. Commissioning of the motor does not include checks for proper functioning and performance of the plant. These checks must be carried out while the machine is commissioned as a whole. Observe the machine manufacturer's specifications and instructions.

12.2 Operation on external controllers

Rate of rise of voltage

The isolation system of the motor underlies a higher dielectric load in converter operation than in a sinusoidal source voltage only. The voltage stress of the winding isolation in converter operation is mainly defined by the following factors:

- Crest value of voltage
- Rise time of impulse on the motor terminal
- Switching frequency of converter output
- Length of power cable to the motor

Main components are the switching times of converter output and the length of the power cable to the motor. The occured rates of rise of voltage on the motor may not exceed the specified limits from **DIN VDE 0530-25 (VDE 0530-25):2009-08 (picture 14, limit curve A)** of impulse voltage, measured on the motor terminals of two strands in depencence of the rise time.

☞ Outputs of IndraDrive converters keep this limits.

12.3 Shutdown

In the case of malfunctions, maintenance measures or to deactivate the motors, proceed as follows:

1. Observe the instructions in the machine documentation.
2. Use the machine-side control command to decelerate the drive to a controlled standstill.
3. Switch off the power and control voltage of the controller.
4. **Only applicable to MAD motors**: Switch off the motor protection switch for the motor fan.

   Only applicable to MAF motors: Switch off the external coolant supply.
5. Switch off the main switch of the machine.
6. Secure the machine against accidental movements and against unauthorized operation.
7. Wait until the discharge time of the electrical systems has elapsed and then disconnect all electrical connections.
8. Before dismounting the motor and, if applicable, the fan unit, secure them to ensure they cannot drop or move, and detach mechanical connections only thereafter.
9. Record all measures taken in the commissioning log.

12.4 Disassembly

⚠ WARNING **Fatal injury due to errors during the activation of motors or work on moving elements!**

- Work on machines is only allowed if they are secured and while they are not running.
- Before starting to eliminate the failure, switch off the controller and the machine and wait until the discharge time of the electrical systems has elapsed.
- Before starting disassembly, secure the machine against unforeseeable movements and against unauthorized operation.
- Before dismounting the motor and the supply lines, secure them against dropping or moving and disconnect the mechanical connections only thereafter.
- Do not disconnect coolant lines as long as they are still under pressure (not applicable if the optional "quick coupling" is used).

1. Observe the instructions in the machine documentation.
2. Observe the safety instructions and carry out all steps as described above in Section "Deactivation".
3. Before dismounting the motor and the supply lines, secure them against dropping or moving and disconnect the mechanical connections only thereafter. Discharge the coolant ducts at MAF motors.
4. Dismount the motor from the machine. Store the motor properly!
5. Document all executed measures in the commissioning report and the machine maintenance plan.

12.5 Maintenance

12.5.1 General

Asynchronous motors of the IndraDyn A series are maintenance-free as long as they operated under the operating conditions specified and during the given service life. However, operation under unfavorable conditions can lead to limitations in availability.

- Increase availability with regular preventive maintenance measures. Observe the machine manufacturer's instructions in the machine maintenance plan and the maintenance measures described below.
- Log all maintenance measures in the machine maintenance plan.

12.5.2 Measures

⚠ WARNING **Danger of injury due to moving elements! Danger of injury due to hot surfaces!**

- Do not carry out any maintenance measures while the machine is running.
- Before starting maintenance, switch off the controller and the machine and wait until the discharge time of the electrical systems has elapsed.
- While carrying out maintenance work, secure the machine such that it cannot restart or be used by unauthorized persons.
- Do not work on hot surfaces.

Bosch Rexroth recommends the following maintenance measures, based on the maintenance plan of the machine manufacturer:

Measure	Interval
Only applicable to MAF motors: Check the coolant system for proper functioning.	According to the specifications in the machine maintenance plan, but at least every 1000 operating hours.
Only applicable to MAD motors: Check the motor fan and the air circulation for proper functioning.	According to the specifications in the machine maintenance plan, but at least every 1000 operating hours.
Check the mechanical and electrical connections.	According to the specifications in the machine maintenance plan, but at least every 1000 operating hours.
Check the machine for smooth running, vibrations and bearing noise.	According to the specifications in the machine maintenance plan, but at least every 1000 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.

Tab. 12-1: Maintenance measures

12.5.3 Motor fan

General

There may be cases when the fan unit must be dismounted for maintenance measures or troubleshooting.

- This work may only be carried out by skilled personnel.
- When dismounting the fan unit, keep all strips, screws and nuts with which it is attached.

In parts, the housings of the fan units consist of several screwed elements. Only unscrew the screws that are marked as such.

⚠ CAUTION **Immediately after the motor has been operated, high temperatures must be expected on the fan housing! Risk of burns!**

- Ensure adequate contact protection and wait until the motor has cooled down.
- Ensure that there are no combustible and flammable materials in the environment of the hot fan.

⚠ CAUTION **While voltage is applied, the motor restarts automatically, e.g., after a power failure. Risk of injuries!**

- Do not stay within the danger zone of the device.
- When working on the device, switch off the line voltage and ensure that it cannot be reactivated.
- Wait until the device has come to a standstill.

⚠ WARNING **Rotating device!**

If coming into contact with rotor or impeller, body parts may be crushed! Risk of injuries!

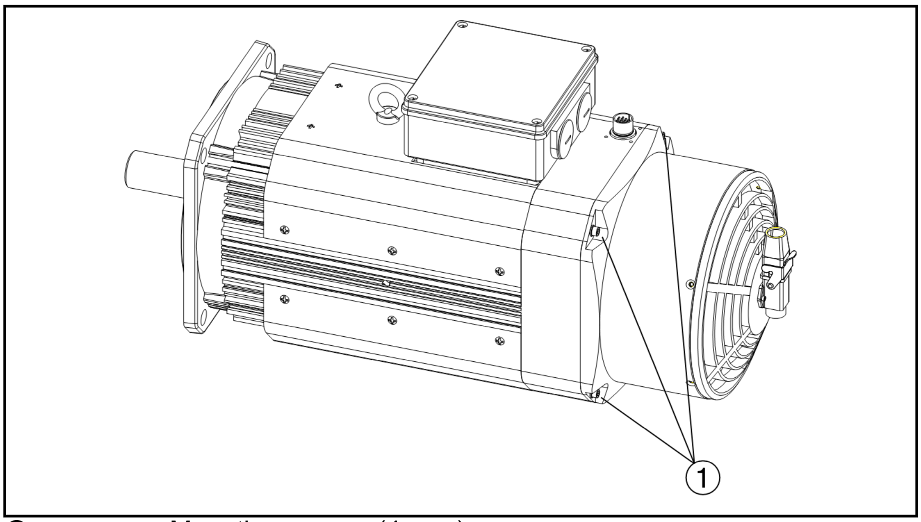
- Protect the device against contact. Before starting work on the plant/machine, wait until all parts have come to a standstill.
- Do not wear jewels or loose or dangling garments when working on moving parts.
- Wear a cap to protect long hair.

General fan maintenance steps:

1. Switch off the machine and disconnect the electrical fan connection.
2. Before unscrewing mounting screws, secure the fan unit such that it cannot drop and carefully remove the fan unit from the motor.
3. Reattach the fan unit after having cleaned or visually inspected the motor or after troubleshooting (see guidelines below). Protect all mounting screws with LOCTITE 243 (screwlock) and reestablish all connections.

   When attaching the power supply connector, particularly ensure the following:

   There is a seal between the connector and the plug on the fan. Ensure that the cable cannot put the plug under tensile load in order to avoid inadequate tightness of this plug connection. If necessary, attach the connecting cable in flush direction with the plug and provide strain relief at a close distance.
4. Check the motor fan and the air circulation for proper functioning.
5. Log all maintenance measures in the machine maintenance plan.



① Mounting screws (4 pcs.)

Fig. 12-1: MAD fan (illustrated example: MAD130)

Required visual inspections of the fan

Inspection	Interval
Line insulation	As specified in the machine maintenance schedule, however, at least every 6 months
Attachment of connecting lines	
Lining of contact protection	
Fan for damage	
Attachment of fan	

Tab. 12-2: Visual fan inspection

Notes on troubleshooting

Failure/fault	Possible cause	Possible action
Fan motor not running	Mechanical blockage	Switch off and de-energize the motor and remove the mechanical blockage.
	Wrong line voltage	Check the line voltage and reestablish voltage supply.
	Faulty connection	Correct the connection.
	Motor winding interrupted	Exchange the device
Impeller running untrue	Imbalance of rotating parts	Clean the device. If there is still an imbalance after cleaning, exchange the device.
Overtemperature of fan motor	Ambient temperature too high.	If possible, reduce the surrounding air temperature.
	Unallowed operating point	Check the operating point
	Inadequate cooling	Improve the cooling system
Please contact your Rexroth sales partner in case of other failures.		

Tab. 12-3: Notes on troubleshooting

12.5.4 Coolant supply

It may become necessary to dismantle the coolant supply for maintenance measure or troubleshooting.

- This work may only be carried out by skilled personnel.
- Do not carry out any maintenance measures while the machine is running. Observe the safety instructions.
- Protect open supply cables and connections against penetration of contaminants.

12.5.5 Servicing and commissioning holding brakes

Before installing the motor, check the holding brake to ensure it is functioning properly.

Before initial startup

Measure the holding torque of the brake and resurface the holding brake if necessary.

Procedure:

1. De-energize the motor and ensure it cannot be restarted.
2. Measure the transmittable holding torque of the holding brake using a torque wrench. The holding torque of the brakes is specified on the data sheets.
3. Once the holding torque specified on the data sheets is reached, the holding brake is ready for operation.

☞ If the holding torque specified on the data sheets is **not reached,** the holding brake must be resurfaced as described in step 4.

4. Resurfacing:

Recommended resurfacing	
Interval	1x
Resurfacing speed	100 min^{-1}/ duration 30 s
Program	Supplied with 500 ms clock pulses

Tab. 12-4: Recommended resurfacing of motor holding brakes

Once the holding torque specified on the data sheets is reached, the holding brake is ready for operation.

If the holding torque specified on the data sheets is **not reached,** the holding brake must be resurfaced as described in step 4.

If the specified holding torque is not reached after the holding brake has been resurfaced the second time, the holding brake is not operational. In this case, please contact Bosch Rexroth Service.

During operation

If holding brakes are required only sporadically in the operating phase (brake cycle > 48 h), film rust may form on the brake surfaces.

To prevent the holding torque from falling below the specified value, we recommend that you proceed as follows:

Recommended resurfacing	
Interval	1x in 48 h
Resurfacing speed	100 min^{-1}
Number of resurfacing revolutions	1

Tab. 12-5: Recommended resurfacing of motor holding brakes

- The brake does not have to be resurfaced during normal operation. It is sufficient to switch on the brake 2 times a day by removing the controller enable signal.
- Options of automatically implementing the resurfacing routine in the program run are described in the particular drive controller documentation.

12.6 Troubleshooting

12.6.1 General

⚠ WARNING **Danger of injury due to moving elements! Danger of injury due to hot surfaces!**

- Do not carry out any maintenance measures while the machine is running.
- Before starting to eliminate the failure, switch off the controller and the machine and wait until the discharge time of the electrical systems has elapsed.
- While carrying out maintenance work, secure the machine such that it cannot restart or be used by unauthorized persons.
- Do not work on hot surfaces.

Possible causes for failures of IndraDyn A motors can be restricted to the following areas:

- Motor cooling circuit or fan function and temperature behavior
- Internal temperature sensor
- Motor encoder or encoder connection
- Mechanical damage of the motor
- Mechanical connection to machine

The encoder connection and the temperature sensor are monitored by the controller or the control unit; corresponding diagnostic messages are displayed. Observe the instructions in the corresponding documentation.

The sections below describe examples of some fault states along with possible causes. This list is not exhaustive.

12.6.2 Excessive temperature of motor housing

State

The housing temperature of the motor rises to unusually high values.

NOTICE **Damage to motor or machine by restarting after excessive motor temperature!**

- Liquid-cooled motors may not restarted or supplied with cold coolant immediately after a failure of the cooling system or an increased motor temperature. Risk of damage!
- Before restarting the motor, wait until the motor temperature has dropped to approx. 40 °C.

Possible causes

1. Failure or fault in the fan or cooling system.
2. The original operating cycle has been changed.
3. The original motor parameters have been changed.
4. Motor bearings are worn or defective.

Measures

1. Check the fan of MAD motors for proper functioning. Clean as required. Contact Bosch Rexroth Service in case of a failure.

   Check the cooling system of MAF motors for proper functioning. Clean or rinse the cooling circuit as required. Contact the machine manufacturer in case of a failure of the coolant system.
2. Check the layout of the drive for changed requirements. Stop operation in case of overload. Risk of damage!
3. Restore the original parameters. Check the layout of the drive if requirements have been changed.
4. Contact the machine manufacturer.

12.6.3 High motor temperature values, but housing temperature is normal

State

The diagnostic system of the controller shows exceptionally high values of the winding temperature on its display or via the application software. However, the temperature of the motor housing is normal.

Possible causes

1. Wiring error or cable break in sensor cable.
2. Diagnostic system defective.
3. Check the wiring and connection of the temperature sensor according to the interconnection diagram.
4. Failure of the winding temperature sensor (PTC).

Measures

1. Check the diagnostic system at the controller or the control unit.
2. Check the resistance value of the temperature sensor using a multimeter.
   - Set the measuring device to resistance measurement mode.
   - Shut down the system and wait until the discharging time has elapsed. Disconnect the temperature sensor from the controller and connect the wire pair to the measuring device (this also checks the sensor line). Check the values according to fig. 9-8 "Characteristic of temperature measurement sensor KTY84-130 (PTC)" on page 230.

12.6.4 Motor or machine table generates vibrations

State Vibrations can be heard or felt on the motor.

Possible causes

1. Driven machine elements are insufficiently coupled or damaged.
2. Motor bearings are worn or defective.

   Available bearing lifetime or grease lifetime has elapsed.
3. Motor mount has come 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 the parameterization of the drive system (motor and encoder data). Observe the instructions in the controller documentation.

12.6.5 Specified position is not reached

State The positioning command of the control unit is executed either not precisely or not at all. No malfunction displayed by the controller or the control unit.

Possible causes

1. Wiring of encoder cable is incorrect or defective. Pin assignment (encoder signals) in cable or plug may be interchanged.
2. Insufficient shielding of encoder cable against interference signals.
3. Incorrect parameterization of encoder data in controller.
4. Motor-machine connection has come loose.
5. Encoder defective.

Countermeasures

1. Check wiring according to terminal diagram and check cables for damage.
2. Check shielding; if necessary, increase effective contact surfaces of shielding.
3. Correct the parameterization. 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.

12.7 Environmental protection and disposal

12.7.1 Environmental protection

Production processes The products are made with energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substances Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant components Basically, our products contain the following components:

Electronic devices	Motors
• steel • aluminum • copper	• steel • aluminum • copper

- synthetic materials
- electronic components and modules
- brass
- magnetic materials
- electronic components and modules

12.7.2 Disposal

Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send the products ”free domicile” to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Strasse 2
97816 Lohr am Main, Germany

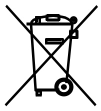
Packaging

The packaging materials consist of cardboard, wood and polystyrene. These materials can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.



The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual modules.

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the valid legal requirements.

13 Motors for potentially explosive atmospheres

13.1 General information on motors in Ex-px d design (Type code option "M6" / "S6")

13.1.1 Introduction

IndraDyn A motors of this Ex-type design are not certified as explosion-protected parts but are merely prepared to be accepted as a part of an overall plant. Additionally required safety devices, such as they are described in the following chapter and the operator manual of the motors, must be set up by the user.

On delivery ex factory, each Ex-type motor is accompanied by an operator manual. This operator manual is an integral part of the product and must be kept by the user of the motors for the entire useful and service life of the product. When the product is passed on or sold, this manual must be passed on to each new owner or user.

☞ In cases of doubt, the operator manual has priority over the information in this chapter. The user manual has the following order designation:

DOK-MOTOR*-IDYN*A*EXPD-IBxx-EN-P, MNR R911323996 (DE) or R911323997 (EN).

The operator manual of Ex-type motors contains detailed instructions on ...

- the mechanical attachment,
- the connection (electrical connection, coolant connection, purge gas connection)
- commissioning of the overall system,
- maintenance and disassembly.

☞ If you do not have any operator manual in your language at your disposal before installing the motor, please contact your Bosch Rexroth sales partner.

⚠ DANGER **Improper handling may result in mortal danger and severe property damage. Explosion hazard!**

Users may not install or commission Ex-type IndraDyn A motors without having read and understood the supplied operator manual and implemented the measures described therein.

13.1.2 Device group / device categories

According to Directive 94/9/EC, Rexroth IndraDyn A Ex-type motors are operating resources of

- device group II
  - device category 2G
  - device category 3G

and are suitable for use in the following potentially explosive atmospheres:

- zone 1
- zone 2

Device group II, device category 2G

Devices which are designed such that they can be operated in conformity with the parameters specified by the manufacturer while ensuring a high degree of safety. Devices of this category are intended for use in areas where it must be expected that an explosive atmosphere comprising dust-air mixtures occurs **occasionally**. The equipment-based explosion protection measures of this category ensure the required degree of safety, even in case of frequent device malfunctions or error conditions which must be usually expected.

Device group II, device category 3G

Devices which are designed such that they can be operated in conformity with the parameters specified by the manufacturer while ensuríng a normal degree of safety. Devices of this category are intended for use in areas where it is **unlikely** that dust whirling up generates an explosive atmosphere and, if such an atmosphere is indeed generated, that it occurs **only rarely and for a short period**. Devices of this category ensure the required degree of safety during normal operation.

13.1.3 Zones of potentially explosive atmospheres

> The following information is based on EN 60079-14:2008 and on BGBl. 1996, part 1, page 1914. For more detailed information, please refer to this document.

Potentially explosive atmospheres are classified into the following zones according to the probability of the occurrence of an explosive atmosphere:

Zone 0

... comprises areas with an explosive atmosphere consisting of a mixture of air and gases, vapors or mists or with such an atmosphere existing permanently, over a long period, or frequently.

Electrical operating resources may be used in zone 0 if they meet the requirements of EN 60079-11:2007 (intrinsic safety “i”).

Zone 1

... comprises areas where an explosive atmosphere consisting of gases, vapors or mists occurs occasionally.

Electrical operating resources may be used in zone 1 if the have been designed according to the requirements for zone 0 or according to one of the ignition protection types described in tab. 13-2 " Ignition protection types" on page 289.

Zone 2

... comprises areas where it is unlikely that an explosive atmosphere is induced by gases, vapors or mists and, if such an atmosphere is indeed occurring, that it occurs only rarely and for a short period.

Electrical operating resources may be used in zone 2 if they

- are designed according to the requirements for zone 0 or 1,
- are especially designed for zone 2,

- meet the requirements of a recognized standard for industrial electrical operating resources and have hot surfaces that are not ignitable during undisturbed operation.

13.1.4 Device groups, ignition protection types and temperature classes

Electrical operating resources for potentially explosive atmospheres are subdivided into:

Device groups

- **Group I:** Electrical operating resources for underground parts of mines liable to be endangered by firedamp.
- **Group II:** Electrical operating resources for all potentially explosive atmospheres, except for underground parts of mines liable to be endangered by firedamp.

The electrical operating resources of Group II can be further subdivided according to the properties of the explosive atmosphere for which they are intenden.

As regards the ignition protection types explosion-proof enclosure "d" and intrinsic safety "i", electrical operating resources of group II are subdivided into IIA, IIB and IIC (EN 60079-0:2009, chapter 4.2).

Classification of gases and vapors

Explosion subgroup	Gases and vapors			
IIA	Ammonia Methane Ethane Propane	Ethyl alcohol Cyclohexane n-butane	Benzines in general Kerosine n-hexane	Acetaldehyde
IIB	City gas Acrylonitrile	Ethylene Ethylene oxide	Ethylene glycol Hydrogen sulfide	Ethyl ether
IIC	Hydrogen	Ethine (acetylen)	Carbon disulfide	

Tab. 13-1: Explosion subgroup gases and vapors

All ignition protection types require that operating resources of Group II be labeled subject to their maximum surface temperature according to tab. 13-3 " Classification of the maximum surface temperatures of electrical operating resources of Group II" on page 290.

Ignition proteciton types

Based on the ignition protection type, electrical operating resources are classified by their construction. Requirements are defined in special standards.

Ignition protection type	Labeling	Standard
Explosion-proof enclosure	Ex d	EN 60079-1
Pressurized enclosure	Ex p	EN 60079-2
Powder filling	Ex q	EN 60079-5
Oil immersion	Ex o	EN 60079-6
Increased safety	Ex e	EN 60079-7
Intrinsic safety	Ex i	EN 60079-11

Ignition protection type	Labeling	Standard
Ignition protection type n	Ex n	EN 60079-15
Encapsulation	Ex m	EN 60079-18

Tab. 13-2: Ignition protection types

Electrical operating resources of these ignition protection types are certified by a neutral body based on a type test.

Temperature classes

Electrical operating resources of Group II must be labeled according to EN 60079-0:2009, chapter 5.3.2.2 and must

- (preferably) be assigned to a temperature class according to the following talbe, or
- be labeled with the particular maximum surface temperature, or
- if applicable, be limited to the exposure of a specific gas for which the operating resource is intended.

Temperature class	Maximum surface temperature [°C]
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Tab. 13-3: Classification of the maximum surface temperatures of electrical operating resources of Group II

13.2 Appropriate use

⚠ WARNING **Improper handling may result in mortal danger and severe property damage. Explosion hazard!**

- IndraDyn A motors of this Ex-type design are not certified as explosion-protected devices but are merely prepared to be accepted as a part of an overall plant. The user has to set up additional safety devices. Please also observe the information provided in chapter 13.6 "Additional components " on page 295.
- To ensure explosion protection, do not use any purging devices other than those having an Ex protection class corresponding to the motor or a higher class.
- The values specified on the name plate (fig. 13-1 " Ex-identification plate on Ex-type motors" on page 294) for purge volume, purge gas, upstream pressure, overpressure, etc. must be ensured and monitored by the purging device.

Range of application

The motors described here (components for device group II, category 2G, Directive 94/9/EC, Annex II, Chapter 2.2.1) may only be used in environments in which

- gases, vapors or mists are **not likely to generate an explosive atmosphere**,

- gases, vapors or mists can generate an explosive atmoshpere only **occasionally**.

For this reason, the user has to design and manufacture the plant and the components such that ignition sources are avoided even in the event of frequently occurring device malfunctions or faulty operating states which must usually be expected.

13.3 Conditions of use

13.3.1 General information

Connection conditions

The motors may only be operated with Bosch Rexroth drive controllers and IndraDrive connecting cables. Controllers or cables from other manufacturers are not allowed. Clamp-type terminals must be securely screwed into the terminal box. Because of the risk of sparking, plugs in potentially explosive atmospheres may only be disconnected or connected when they are de-energized.

Grounding

Speed-controlled drive systems contain unavoidable leakage current discharging via the earth. For this reason, motors must be grounded according to EN 60079-0:2009, chapter 15.3 via the motor cable and a second separate ground conductor with a cross-section of **at least 4 mm²** (MAF225C-0150 with at least 25 mm²). Prior to commissioning, the protective conductor must be checked for proper connection and tight seating.

☞ Incorporate regular checks of the protective conductor connectors into the machine maintenance schedule.

If the protective conductor in the motor cable and the second separate protective conductor on the motor housing are not connected or are interrupted by corrosion or other defects during their service life, the discharge current flows (as leakage current) over conducting housing parts. This must be prevented with the above-mentioned measures (Directive 94/9/EC, Annex II, chapters 1.2.3 and 1.3.3, 1.4).

Risk of corrosion

Corrosion of the motor housing by aggressive materials (such as certain coolants, lubricants, cutting oils or salt mists) must be prevented.

Emergency stop

Stored energies in the drive controller must be removed or isolated as quickly as possible when the **emergency stop device** is actuated to ensure that the risk or an effect into the danger zone is reduced in the event of a failure (Directive 94/9/EG, Annex II, chapter 1.6.2).

For example, this can be achieved as follows:

- Discharge of the energies via a DC bus short-circuit
- Isolation of the energies before they are transferred into the potentially explosive atmosphere by isolating the voltage of the lines and motors present in the potentially explosive atmosphere.

Other environmental factors

Observe the following with regard to risks caused by external disturbances:

- Operation only within the specified ambient conditions
- Maximum vibration and impact loads
- Protection of protective conductor connections against dirt, corrosion, moisture and/or aggressive materials, etc.

Surface of the motor housing

The housing paint of the motors consists of a black (RAL9005) 2K epoxy resin coating based on epoxy-polyamide resin in water.

Overcoating the motors in ATEX design is not admissible in order to not to effect the surface properties (such as insulation resistance, electrostatic charge) adversely.

13.3.2 Internal motor brake (Optional)

The brake incorporated in the motor may only be used during **normal operation** and only for the drive-internal brake test. In this case, only low temperatures of T < 100 °C occur and sparks are not generated because there is no critical surfacing of the brake pads.

Brake activation

The voltage supply of the holding brake is to be designed such that the voltage available at the motor for releasing/applying the holding brake is sufficient even in the most unfavorable case during installation and operation (see also Rexroth IndraDrive Drive Systems with HMV01/02, HMS01/02, HMD01, HCS0203, Chapter "Project Planning of Control Voltage").

☞ The switching voltage incoming at the motor is subject to the line length and the cable properties, e.g., conductor resistance.

- A minimum voltage of 22.8 V (24 V - 5 %) is recommended at the drive controller for ready-made Bosch Rexroth power cables up to 50 m in length.
- A minimum voltage of 24.7 V (26 V - 5 %) is recommended at the drive controller for ready-made Bosch Rexroth power cables more than 50 m in length.

If a fault occurs during operation, causing a voltage deviation, this fault must be detected and eliminated immediately. For example, the fault can be detected by a undervoltage monitoring unit.

Malfunction

While the motor is under speed, the brake may only be actuated in the event of a **malfunction**, i.e., in the event of a fault in the machine, for example, to impede or prevent dangerous dropping of vertical axes, as a support in addition to other measures. In this case, sparks may be generated in the brake and increased temperatures may occur within the motor. Any such fault must be immediately elimianted by the operator.

Functional test

Prior to commissioning and at periodical intervals during operation (for example, approx. every 8 hours), the brake must be tested for proper functioning in a suitable brake test. A defined torque is applied to the motor to check whether the brake has been completely released. Some drive controller types allow carrying out an integrated brake test by means of the Brake check command. For further information and data, please refer to the particular firmware functional descriptions relating to the drive controller.

13.4 Residual risks

Protective equipment failure

In the event of a failure of the purging device and, at the same time, the monitoring unit for maintaining the safety measures, explosion protection is no longer ensured in an explosive atmosphere, therefore posing the risk of an explosion.

Overload

If the motor is overloaded, including cases where errors in the mechanical or electrical equipment of the machine cause such overloading, high temperatures may occur that result in explosion hazards.

Grounding and leakage currents

Variable-speed drive systems cause unavoidable leakage currents. If the protective conductor in the motor cable and the second separate protective conductor on the motor housing are not connected or are interrupted by corrosion or other defects during their service life, the discharge current flows (as leakage current) over conducting housing parts. This is associated with the risk of sparking at transition points and with explosion hazard if explosive materials are present. For this reason, checks of the proper condition of the two protective conductor connections must be carried out at regular intervals.

Material ageing

The time of action and penetration of explosive materials depend on the application. It depends on the ageing degree of the seals, on the mechanical attachment of the motor, the properties of the explosive materials and the average temperature occurring during the operating time as a result of the load cycles.

13.5 Selecting and labeling Ex-type motors

Selecting the motors

Ex-type motors must be selected and ordered based on a predefined encoder type in the particular motor type code.

Ex-type motors are defined in the motor type code by selecting the encoder option

- M6
- S6

Ex-type motors are therefore labeled at the 18th digit of the type code. This label is applicable for the following motors:

- MAD□□□□-□□□□-□□-□6-□□□-□□-□□
- MAF□□□□-□□□□-□□-□6-□□□-□□-□□

Motor name plate

See fig. 10-1 "Example name plate MAF" on page 264.

Additional identification plate containing motor purging data

In addition to the motor name plate, Ex-type motors also bear an additional identification plate. This identification plate is located on the side of the motor housing next to the motor name plate and shows

- the classification of the motor according to ATEX,
- important details for adjusting the motor purging device.

Motors for potentially explosive atmospheres

Bosch Rexroth Electric Drives and Controls GmbH
Bgm.-Dr.-Nebel-Straße 2, 97816 Lohr am Main, Germany

⇒	**Ex II 2G Ex px d IIB T3 Gb**	**TPS 05 ATEX 57401-1-X**
①	Spülvolumen:	6 Liter
②	zu verwendendes Spülgas:	Instrumentenluft
③	Technik:	Ausgleich der Leckverluste
④	Minimaler Vordruck (Spülgas):	2 bar Überdruck
⑤	Mindestdurchfluss Vorspülung:	35 l/min
⑥	Minimale Vorspülzeit:	60 Sekunden pro Motor
⑦	Minimaler Überdruck:	1 mbar
⑧	Maximaler Überdruck:	23 mbar
⑨	Maximale Leckverluste:	10 l/min
⑩	Max. Umgebungstemperatur:	0°C <= Ta <= +40°C

⇒ II	Device group II, suitable for all potentially explosive atmospheres except for underground parts of mines liable to be endangered by firedamp
⇒ 2G	Device category 2, device only suitable for potentially explosive atmospheres cause by occasionally occurring gas
⇒ Ex	The European Standard for explosion protection has been applied
⇒ px	Ignition protection type px means that potentially explosive atmospheres are kept away from the ignition source (EN 60079-2) in compliance with special requirements in the type test certificate
⇒ d	Ignition protection type d means that any transmission of an explosion to the outside is excluded (EN 60079-1)
⇒ IIB	Explosion subgroup for certain gases and vapors
⇒ T3	The max. allowed surface temperature is 155 °C (within and without of the housing)
⇒ Gb	Device with a high safety level for use in potentially gas explosive atmospheres where there is no ignition risk during normal operation or in the event of foreseeable faults/malfunctions
⇒ TPS***-X	Motor registration number. X = Special requirements are applicable because Bosch Rexroth does not deliver the related safety device (control unit for pressurized enclosure). The instructions in the operator manuals of the Ex-type motors for adjusting the control unit (e.g., minimum purging time, minimum pre-purging flow, ...) are mandatory.
①	Purge volume: MAD/MAF100 = 4 L; MAD/MAF130 = 6 L; MAD/MAF160 = 10 L; MAD/MAF180 = 15 L; MAD/MAF225 = 19 L
②	Purge gas to be used: Instrument air
③	Method: Compensation of leak losses
④	Minimum upstream pressure (purge gas): 2 bar overpressure
⑤	Minimum pre-purging flow: MAD/MAF100 = 25 l/min; MAD/MAF130 = 35 l/min; MAD/MAF160 = 55 l/min; MAD/MAF180 = 80 l/min; MAD/MAF225 = 100 l/min
⑥	Minimum pre-purge time: 60 seconds per motor
⑦	Minimum overpressure: 1 mbar
⑧	Maximum overpressure: 23 mbar
⑨	Maximum leak losses: 10 l/min
⑩	Max. surrounding air temperature: 0 °C <= Ta <= +40 °C

Fig. 13-1: Ex-identification plate on Ex-type motors

☞ The minimum pre-purging flow volume is based on a required total tube length of 20 m. Longer tubes may require higher values. In this context, the details on the purge gas connection and the pre-purging time of the overall system given in the operator manual must be observed.

UR/cUR listing

The motors were presented to “Underwriters Laboratories Inc.®” and have been approved by this UL authority according to UL1004 and CSA22.2, No. 100. The corresponding mark is provided on the motor name plate.

Declaration of conformity

Declarations of conformity confirming the structure and the compliance with applicable EN standards and guidelines are available for the motors. For a copy of the Declaration of Conformity, please refer to the operator manual of the motors.

13.6 Additional components

13.6.1 General information

To allow operation of the motor as a part of an overall system in potentially explosive atmosphere, additional components are required. Components not available from Bosch Rexroth are referred to as additional components and must be provided by the manufacturer of the machine.

An overall system mainly consists of:

Bosch Rexroth components

- MAD or MAF motors in Ex-type design (type code encoder option S6 or M6)
- IndraDrive motor controller
- Connecting cable

Additional components to be provided by other manufacturers

- Purging device and monitoring unti with connection tubes, accepted as overall system and certified for the degree of protection required.
- For MAF motors: External cooling system (liquid cooling). Specifications can be found in the motor project planning manual.
- For MAD motors: External cooling system (fan). Specifications can be found in the motor project planning manual and in the following instructions.

13.6.2 Motor fan

MAD motors for potentially explosive atmospheres must be cooled by forced ventilation during operation. We recommend to use a radial fan which must be attached outside of the potentially explosive atmosphere. It is not allowed to attach a fan directly to the motor in potentially explosive atmospheres. When calculating and selecting a suitable motor fan, please observe the instructions in the project planning manual on motor cooling.

☞ The fan, air tube and necessary small connection parts (tube clamps, etc.) are not included in the Bosch Rexroth delivery.

13.6.3 Ex-p control unit for motor purging

Ex-type IndraDyn A motors are merely a part of a drive system which only ensure appropriate explosion protection in connection with an Ex-p control unit for motor purging.

⚠ WARNING **Improper handling may result in mortal danger and severe property damage. Explosion hazard!**

In potentially explosive atmospheres, the motor may only be commissioned as an overall system with a control unit for motor purging. The control unit must be classified and approved according to the same protection class as the motor or a higher one.

☞ The control unit required for operating the motor in a potentially explosive atmosphere is not included in the Bosch Rexroth delivery and must be provided by the user.

The approval of the motors was given based on ignition protection type

- **Ex-d** (encoder housing)
- **Ex-px** (motor housing)

according to EN 60079-1:2007 and EN 60079-2:2007 with a control unit of type **Typs 07-3711-2213/1002** from

- **BARTEC GmbH**
  Max-Eyth-Str. 16
  97980 Bad Mergentheim, Germany
  Phone +49 (0)7931 597-0
  Fax +49 (0)7931 597 -119
  E-mail: info@bartec.de
  Postfach 1166, D-97961 Bad Mergentheim

Alternatively, it is also possible to use control units from other manufacturers for motor purging, e.g.:

Gönnheimer Elektronic GmbH

Gewerbegebiet Nachtweide

Dr.-Julius-Leber-Strasse 2

67433 Neustadt, Germany

Postfach 100507, D-67405 Neustadt

Phone +49 (0)6321 49919-0, Fax +49 (0)6321 49919-41

☞ The manufacturer's instructions on selecting and commissioning the control unit should be observed as early as in the design phase of the drive system.

13.6.4 Connecting cables

☞ No other power cables than Bosch Rexroth power cables may be used to operate the motors in potentially explosive atmospheres.

Bosch Rexroth offers appropriately ready-made power cables for the motors. These cables are checked for conformity with directives and relevant DIN and EN standards. Use the following documentation for selecting the cables:

- Rexroth Connection Cables IndraDrive and IndraDyn
  DOK-CONNEC-CABLE-*INDRV-CAxx-xx-P
  Material number R911322948 (German)
  Material number R911322949 (English)

13.7 Installing, commissioning, servicing and dismounting Ex-type motors

Motors for potentially explosive atmospheres may only be installed and commissioned by appropriately trained and instructed staff. As a minimum requirement, the instructions should cover the various ignition protection types and installation methods as well as pertinent rules, regulations and general principles on zone classification.

Before installing the motor, check whether the required data on the name plate of the motor, e.g.,

- device group and device category,
- explosion subgroup,
- maximum allowed surface temperature,

comply with the locally allowed conditions of use in potentially explosive atmospheres.

Before installing the motor, ensure that the ambient conditions at the place of use, e.g., surrounding air temperature, humidity and vibration and/or shock load, do not exceed the values allowed.

Check the components for visible damage. Defective components may not be mounted.

☞ For more detailed information on

- the mechanical attachment,
- the connection (electrical connection, coolant connection, purge gas connection),
- commissioning,
- pre-purging time of the overall system,
- maintenance and disassembly

of the Ex-type motors, please refer to the following operator manual:

- DOK-MOTOR*-IDYN*A*EXPD-IBxx-xx-P
  Material number R911323996 (DE) and R911323997 (EN)

14 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	+49 9352 40 5060
Fax:	+49 9352 18 4941
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

Index

Index

Notes

Notes

The Drive & Control Company

Bosch Rexroth AG
Electric Drives and Controls
P.O. Box 13 57
97803 Lohr, Germany
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr, Germany
Phone +49 9352 18 0
Fax +49 9352 18 8400
www.boschrexroth.com/electrics

R911295781

DOK-MOTOR*-MAD/MAF****-PR10-EN-P