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ADF Main Spindle Motors

Project Planning Manual

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Indramat

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The purpose of this document This document
- serves to introduce ADF main spindle motors
- offers technial explanations of the structural features of main spindle motors
- assists in selecting the correct main spindle motor for a specific application
- outlines the technical data of main spindle motors

Change sequence

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1. Introducing Main Spindle Motors

Applications

Main spindle motors of the ADF series are used as liquid-cooled main spindle drives and as servo drives in such applications as, for example, tool machines. ADF motors have been tried and proven in printing, textile and plastics injection moulding machines.

Power range

In conjunction with drive controllers, these motors feature:

- broad speed ranges and
- broad field weakening range of 1:6.

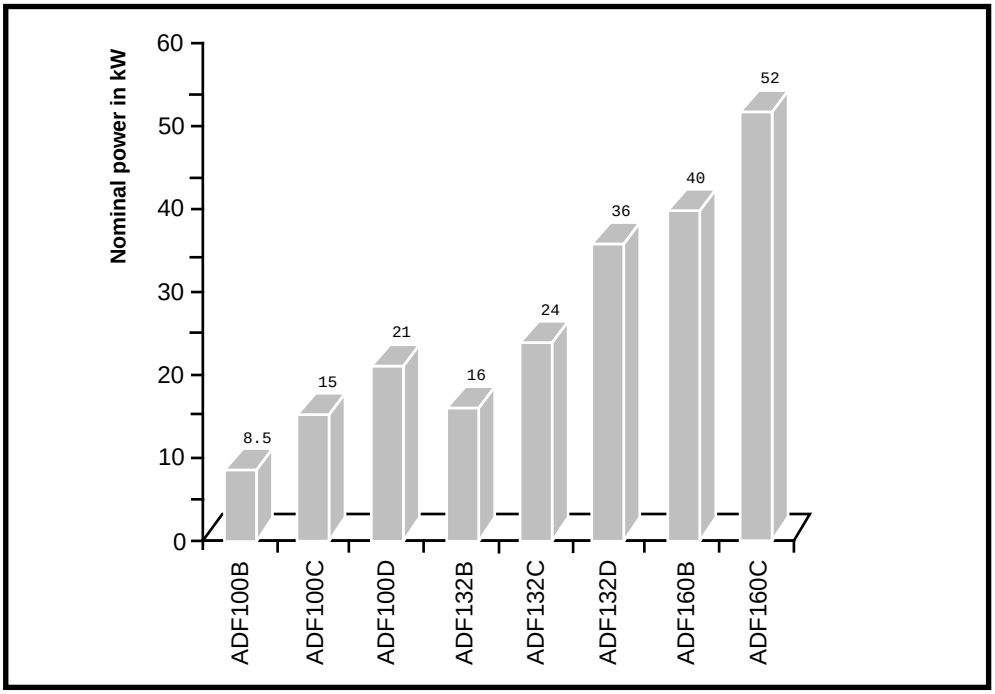


Fig 1.1: Nominal power ratings of AC main spindle drives

Motor feedback

The motor feedback measures rotor position and signals it to the drive, therewith regulating speed and rotor position. It functions with a resolution of 1/ 2 000 000th revolution.

holding brake

Using the holding brake, it is possible to clamp the output shaft into position at standstill. This means that the main spindle is safely held in place within the machine tool. Versions with either electrically-actuated clamp or release capabilities are availabe.

Side B shaft end

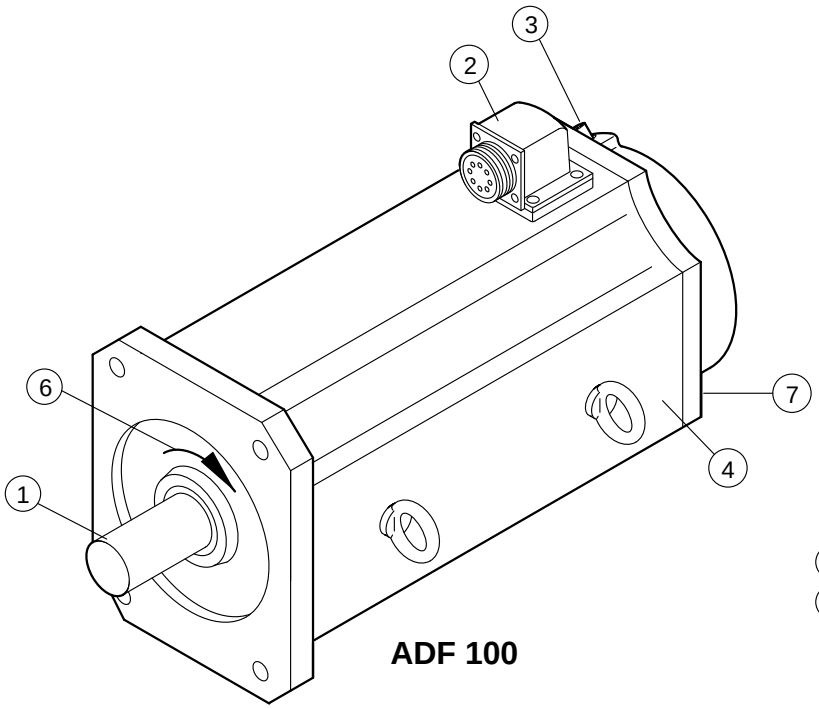
A shaft extension makes it possible to attach an additional position encoder to the B side of the motor.

Design

The motors of the ADF series are designed for flange mounting.

No maintenance

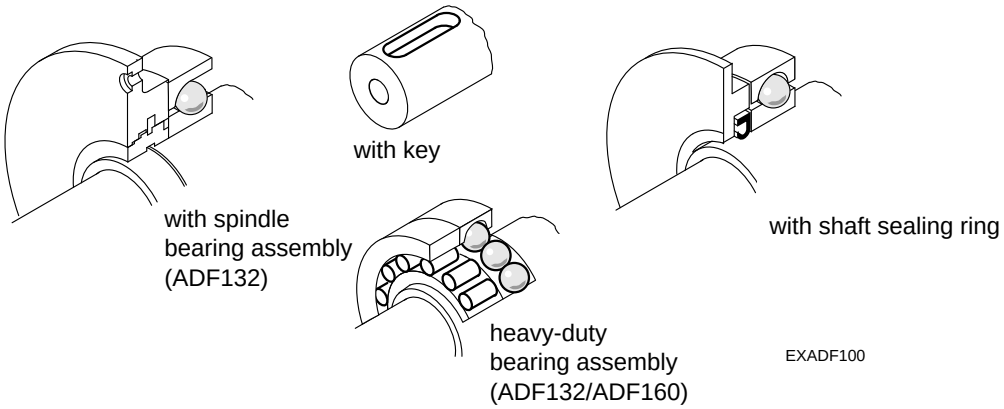
As the main spindle motor works in accordance with the induction principle, it is maintenance-free.



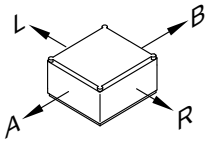
ADF 100

1. Output shaft
2. Power connector with integral connection for
   - motor NTC thermistor
   - blocking brake
3. Motor feedback connection
4. Integral blocking brake
5. Side B shaft end
6. Clockwise rotational direction
7. Coolant inlet and outlet

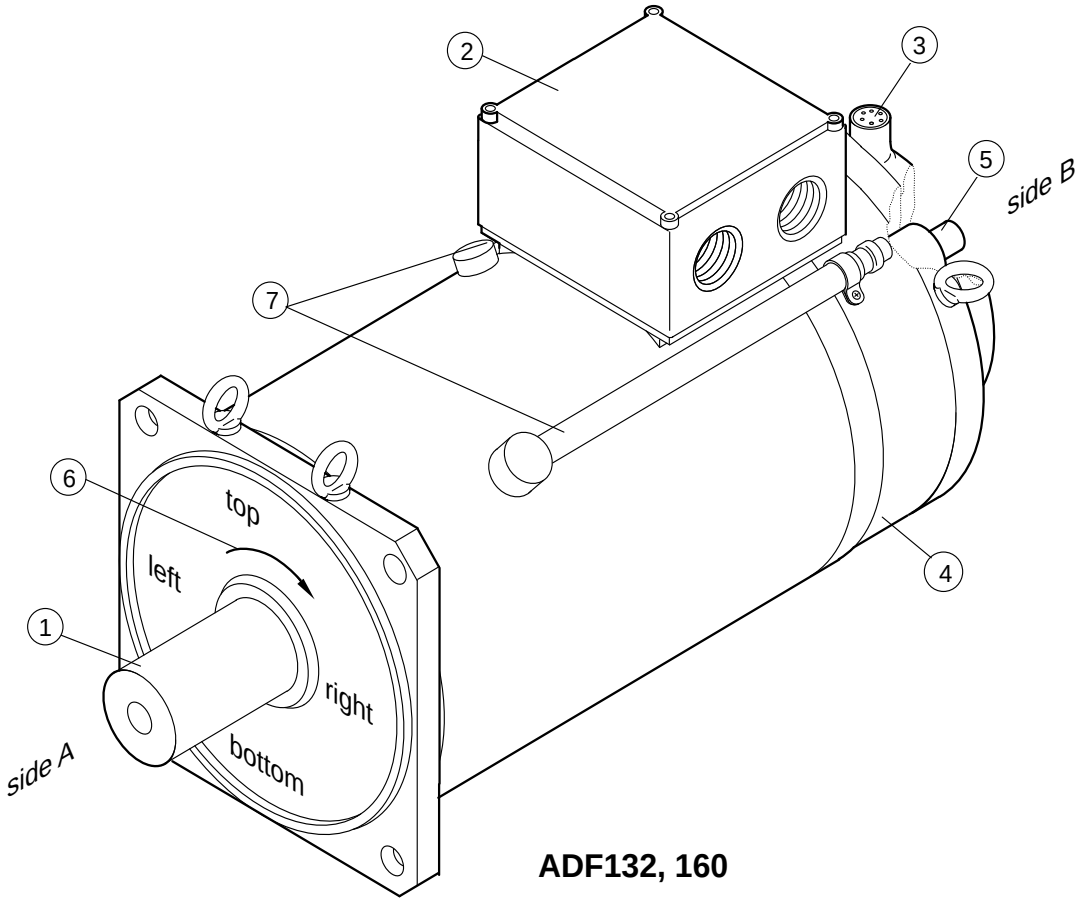
Output shaft



Power connection

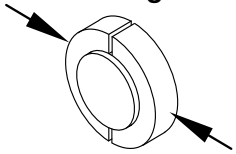


Output direction
can be selected

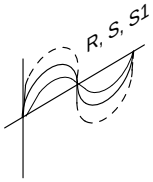


ADF132, 160

Holding brake



Balance classes



EXADF132

Fig 1.2: Main spindle motors - explanations of definitions

2. Technical Explanations

2.1. Ambient Conditions

Installaton elevation, ambient temperature

ADF main spindle motors can be operated at any elevation because they are liquid cooled. The values listed in the document “AC Main Spindle Drives with Regulated Main Spindle Motors 2AD and ADF; Selection Data” (doc. no. 209-0042-4133 EN) are only dependent on maintaining the cooling parameters of the coolant.

The ambient temperature range of 0° to 45° C must be maintained to guarantee a safe operation of the motor feedback.

Protection category

The ADF motors are, as per DIN 40050, protected by their housing and coverings against:

- contact with live or moving parts of the motor (contact guard),
- penetration by extrinsic objects
- or the seeping in of water.

The protection categories are indicated by the abbreviation **IP** (**I**nternational **P**rotection) and two digits for the protection grade, as, for example, IP 65.

The first digit denotes the protection grade for contact and penetration by extrinsic objects (see Figure 2.1).

The second digit denotes the protection grade for water (see Figure 2.2).

Figure 2.3 lists the range of protection categories for main spindle motors.

1st digit	Protection category (protection against contact and extrinsic object)
0	Little or not protection.
1	Protection against penetration by solid objects with a diameter greater than 50 mm. No protection against deliberate penetration, e.g., hands, but will keep larger body surfaces out.
2	Protection against penetration by solid objects with a diameter greater than 12 mm. Keeps out fingers and similar objects.
3	Protection against penetration by solid objects with a diameter greater than 2.5 mm. Keeps out tools, wires and similar objects with a thickness greater than 2.5 mm.
4	Protection against penetration by solid objects with a diameter greater than 1 mm. Keeps out tools, wires and similar objects with a thickness greater than 1 mm.
5	Protection against dust deposits. Penetration by dust is not completely prevented. Does not permit dust to penetrate to the extent that it can influence the operation of the quipment (protection against dust). Total protection against penetration.
6	Protection against dust (dust-proof). Total protection.

Fig 2.1: Categories of protection against contact and penetration by foreign objects as per DIN 40 050 , sec. 2 (edition dated 6/72)

2nd digit	Protection grade (protection against water)
0	Little or not protection.
1	Protection against vertically dripping water. Does not permit any damaging affects (dripping water).
2	Protection against vertically dripping water. Does not permit any damaging affects to equipment with housing tilted up to 15° in comparison to its normal position, i.e., water dripping at an angle.
3	Protection against water vertically falling at angle of up to 60° to the housing (spray water). Does not permit any damaging affects.
4	Protection against water sprayed at the equipment (housing) from all directions. Does not permit any damaging affects (splashwater).
5	Protection against a jet of water sprayed from a nozzle onto the equipment (housing) and coming from all directions. Does not permit any damaging affects (jet of water).

Fig 2.2: Categories of protection against water as per DIN 40 050, section2 (ed. dated 6/72)

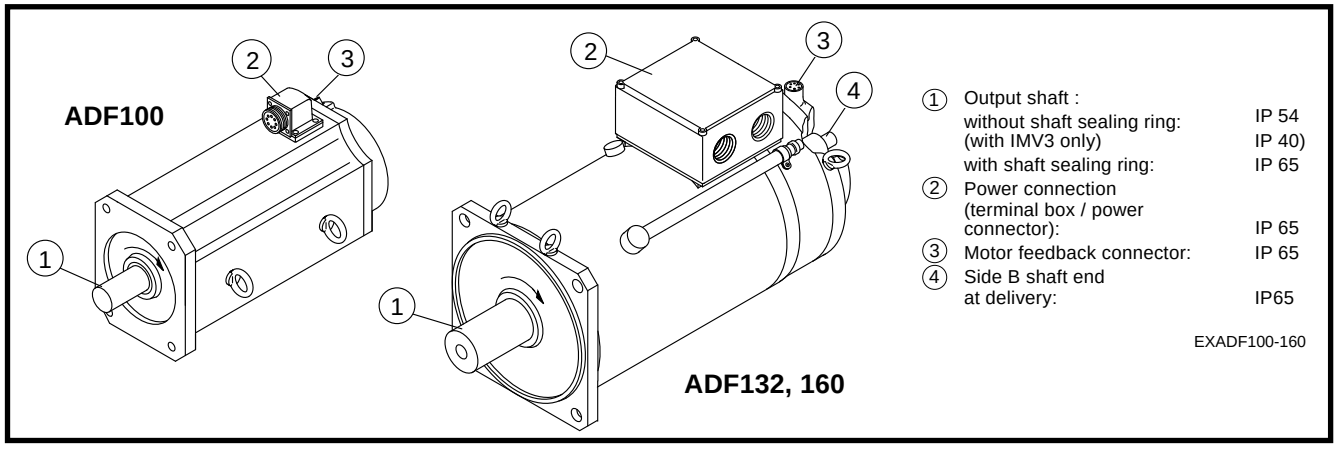


Fig 2.3: Protection categories as applied to ADF main spindle motors

Mechanical ambient conditions

ADF main spindle motors can be operated under the following conditions, as per IEC 721-3-3, 1987 edition, or EN 60721-3-3, edition of 6/1994, if stationary and given weather-proofed conditions:

- in terms of the longitudinal axis of the motor as per class 3M1 and
- in terms of the lateral axis of the motor as per class 3M6.

Thus, the maximum values listed in Figure 2.4 apply to storage, transport and operation of the ADFs.

Ambient variables		**Unit**	**Maximum values for the longitudinal axis**	**Maximum value for the lateral axis**
sinusoidal oscillations	Amplitude of the excursion	mm	0.3	7.0
	Frequency range	Hz	2 to 9	2 to 9
	Amplitude of the acceleration	m/s^2	1	20
	Frequency range	Hz	9 to 200	9 to 200
Impact	Total shock response spectrum	-	type L per IEC 721-1 ed. 1990 table 1 sect. 6	type II per IEC 721-1 ed. 1990 table 1 sect. 6
	Reference accel (in IEC 721-1 peak acceleration)	m/s^2	40	250
	Duration	ms	22	6

Fig 2.4: Maximum values of ambient variables

Housing paint

A primary black coat is applied to the motor housing. This prime coat can be covered with an additional layer of paint. It cannot be thicker than 40 µm, however.

The prime coat is resistant to:

- weathering, yellowing and chalky build ups and
- diluted acid and alkaline solutions.

If frequently cleaned with a steam cleaner, the coat can, however, peel.

2.2. Mechanical Features

Type of construction, Installation position

The mounting flange in all motor types is designed in such a way that mounting as per Design B5 (mounting flange with leadthrough drill hole) is possible.

The motors can be mounted to the machine as per DIN 42950, section 1 (edition dated 8/77). This is depicted in Figure 2.5.

Design	Permissible mounting orientations as per DIN IEC 34-7		
B05	 IM B5	 IM V1	 IM V3

Fig 2.5: Permissible mounting orientations

When mounting the motor in orientation IM V3, liquids must be prevented from collecting at the output shaft over longer periods of time. Even if a shaft sealing ring is used, it will not prevent liquids from penetrating into the motor housing along the output shaft.

Output shaft

Plain Output Shaft
For friction-locked shaft-hub connections.

The higher run quality and the backlash-free connection between shaft and hub are a significant advantage of this preferred and recommended design.

Output Shaft with Key
For a form-fitting shaft-hub connection.

This connection is suited to take up torques of a constant direction. The hub must be axially secured in this case. A threaded center hole is on the overhang.

Balanced with full key:
The rotor is balanced with the key used in the shaft-hub assembly. The rotor is balanced with the full key. A balanced, interconnecting part (toothed wheel, etc.) must be used. The keyway in the hub is not dependent upon the length of the key.

Balancing with half a key:
There is half a key in the keyway in the shaft. The mass ratios occurring at the keyway are comparable to those of a plain shaft. If a full key is inserted, then the projecting section of the key creates a state of imbalance. The rotor with the rull key is not balanced.

The interconnecting part must equalize this state of imbalance of the rotor. The keyway in the hub must correspond to the length of the key. Use a stepped key for shorter keyways.

Output shaft with seal

The motor is equipped with a radial sealing ring, per DIN 3760 type A, at the output shaft if it is attached to a drive which has an oil bath or circulating oil lubrication. This is not the case with an ADF 132 with spindle bearing, however.

The shaft seal is a rubbing seal. Wear and frictional heat occur at the lip of this seal. Make sure that the points of contact are sufficiently lubricated at all times. This ensures the least wear. The points of contact must never run dry!

The lubricant is simultaneously a coolant. It dissipates the frictional heat occurring at the point of contact.

When mounting vertically, please see Fig. 2.5 for guidelines on mounting orientations.

Permissible shaft load

Radial Shaft Load:
The permissible radial force at the output shaft is dependent upon bearing assembly and average speed. The diagrams in the "Technical Data" section outline the values for:

- standard assembly,
- heavy-duty assembly and
- spindle assembly.

The heavy-duty assembly can take greater radial loads. The cylindrical roller bearing on side A of the assembly absorbs the radial forces. This assembly should only be used in exceptional cases, as it doubles the rate of lubricant service life.

Motors with heavy duty bearing assemblies may only be operated with radial loads. Sliding friction could otherwise damage the bearings. See the "Technical Data" section for minimum radial load values.

Bearing service life

Axial Shaft Load:
Only very low axial loads are acceptable (see "Technical Data"). Thus, the motors are not suited for helical toothed output pinions.

Mechanical Service Life:
Indramat main spindle motors are equipped with lifetime lubricated deep-groove ball and cylindrical roller bearings.

The mechanical service life of the bearings equals 20,000 working hours (bearing calculations as per DIN 662, section 1), if the radial loads and average speeds listed in section "Technical Data" are maintained. Lubricant consumption also has a significant affect on bearing service life.

The duration of lubricant consumption is longer than the mechanical service life if the bearings have a normal load. Normal loads are:

- Radial loads corresponding to the "Permissible radial loads" diagrams in the "Technical Data" section.
- Average speeds as outlined in the "lubricant consumption" diagram in the "Technical Data" section, whereby $n_m < n_{m(tf= 20\ 000\ h)}$
- Operating the motor within the permissible ambient temperature range of 0° to +45° C.

Lubrication Consumption Duration:
Non-conforming loads cause the lubricant to be consumed in less than 20,000 working hours (compare with "Normal Load" data). This has an adverse affect on bearing service life.

Lubricant consumption is outlined in the "Lubricant Consumption Diagram" in the "Technical Data" section.

If higher average speeds occur with a heavy-duty bearing assembly, then the lubrication can be consumed more quickly. Thus, the working life of the motor is limited to that period in which the lubricant is available.

A longer working life for the motor can be anticipated if a standard bearing assembly is used, as the time over which lubricant is available is doubled if the load remains the same as above. A higher than specified load on the standard bearing assembly reduces the mechanical service life to under 20,000 working hours.

If the working life of the motor is limited by increased lubricant consumption, then it is possible to increase the working life of the motor, in some cases, by using a standard bearing assembly instead of the heavy-duty one.

In this case, Indramat must re-calculate bearing service life. Please contact our Sales Office and inform them of your application requirements (load cycle, speeds, bearing loads, etc.).

The following flow chart in Figure 2.6, "Sequence for Determining the Bearing Assembly", offers assistance in selecting a bearing assembly.

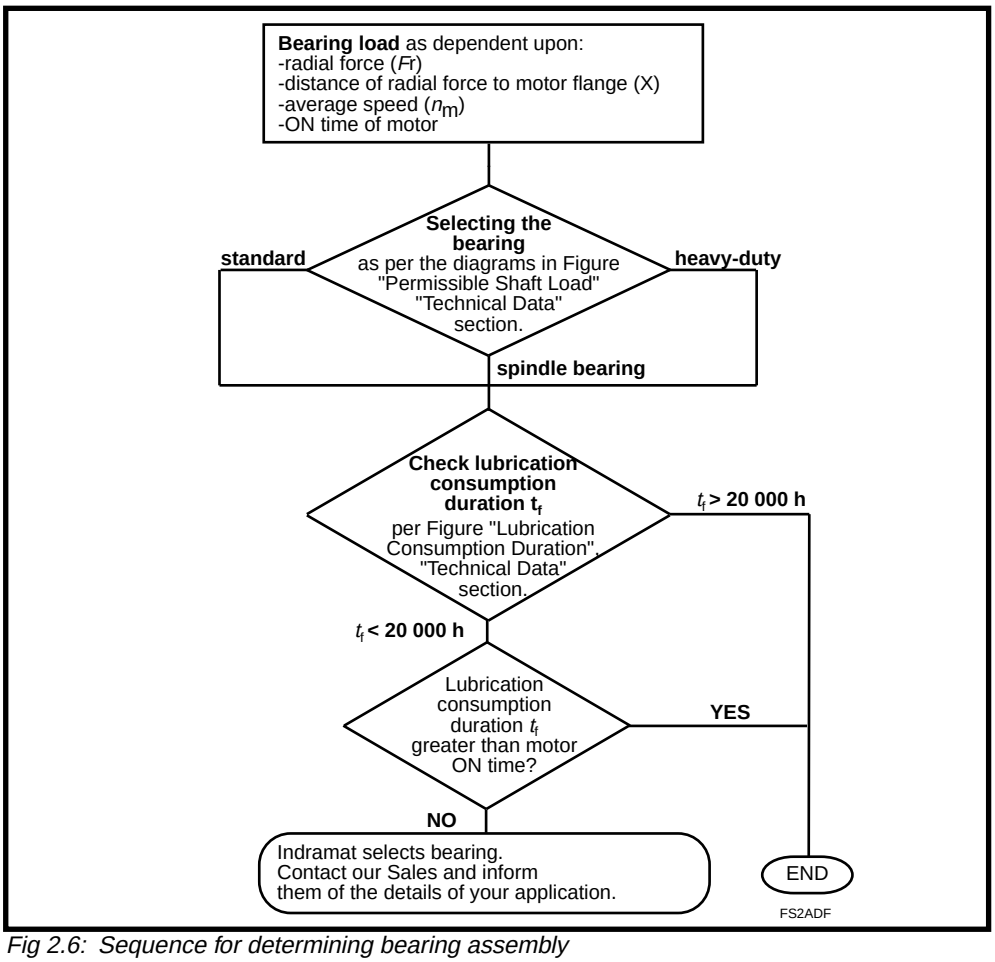


Fig 2.6: Sequence for determining bearing assembly

holding brake

The ADF motor series is available with integral holding brakes which can be ordered with **electrically-engaged clamp** or **electrically-engaged release**.

Main spindle applications of ADF motors:
The **electrically-engaged holding brake** is a locking element of the main spindle when it is standing still or when the drive enable is switched off, for example, when exchanging tools without a closed position control loop.

There can be no clamping until the drive has signalled that the motor is at a standstill.

See document, "Main spindle drives with regulated asynchronous motors or frameless spindle motors; Applications", doc. no. 209-0041-4109.

Do not use an electrically-released holding brake in main spindle applications. If the brake is unintentionally applied at high speeds, in this case for example as a result of a power failure or wire breakage, then the brake could be destroyed.

Servo applications of ADF motors:
The **electrically-released holding brake** holds linear axes when at standstill and when the drive enable signal is not applied. With vertical axes, in particular, the drive enable should not be switched off until the brake has clamped the mechanical system once it is at standstill! The occasional closing of the brake, because of a power failure or in an E-stop situation, is acceptable within the range of the braking energy permitted for the respective type of brake.

A heavy-duty electrically-released holding brake is also available.

The elecrically-clamped holding brake should not be used in servo applications. There is no clamping of the axis when there is no power!

The holding brake is not a working brake. It wears down after 20,000 motor revolutions when braking the axis.

If the motor has been stored for an extended period of time, then please note the following prior to commissioning it.

If the motor is stored for more than two years, then it is necessary to grind-in the holding brake prior to use.

Procedure:

1. **Let the motor turn at a speed of 100 min^{-1}.**
2. **Apply 24 V to the holding brake.**
3. **Permit the brake to open and close cyclically in a 1 second tact for approximately 60 seconds.**

Shaft extension

If absolute actual positions are to be derived from the position of the motor shaft, then a shaft extension is needed. This means that an absolute encoder must be mounted to side B.

The main spindle motor is available, upon request, with a mounted absolute encoder. (See "AC Main Spindle Drives with Regulated 2AD Main Spindle Motors", doc. no. 9-567-013-4"). A notation on the order next to the absolute encoder is all that is required.

The shaft extension is a plain shaft. The protection category at delivery is IP 65 for the main spindle motor with a shaft extension without mounted encoder. Encoders must also have protection category IP 65 because there is no seal at the feedthrough of the shaft extension.

Actual incremental position values can be picked off of the motor feedback signals of the main spindle drives via the option "incremental encoder output". No shaft extension with incremental encoder is needed, in this case.

Balance class

The main spindle motor is dynamically balanced as per balance class R (reduced) as per DIN ISO 2373.

Balance classes S (special) and S1 are also available, if special demands need to be made of the mechanical run quality. The table in Figure 2.7 outlines the root-mean square values of these vibrational speeds.

Vibrations V_{eff} in mm/s								
Balance class	**Motor size**							
	100 … 132				**160**			
	speed in min^{-1}				**speed in min^{-1}**			
	600 - 1800	**1800 - 3600**	**3600 - 6000**	**6000 - 8000**	**600 - 1800**	**1800 - 3600**	**3600 - 6000**	**6000 - 8000**
R	0.71	1.12	1.8	2.8	1.8		2.8	4.5
S	0.45	0.71	1.12	1.8	0.71	1.12	1.8	2.8
S1	0.28	0.45	0.71	1.12	0.45	0.71	1.12	1.8

Fig 2.7: Root-mean-square vibrational speeds

Cooling method

An ADF main spindle motor is always liquid-cooled. The technical data on this cooling method are outlined in the documentation of the relevant motor in the section entitled "Technical Data". For further information on liquid cooling please see the document “Liquid Cooling INDRAMAT Drive Components; Dimensioning and Selecting”, doc. no. 209-0042-4131.

2.3. Electrical Features

Terminal diagram

Figure 2.8 is a schematic diagram. It is the checklist for all the electrical connections needed to operate the ADF main spindle motor.

The electrical connections of Indramat main spindle drives are standardized. This focuses the available variety. The electrical connections required for each application are outlined in section 6.

The following electrical connections are on the main spindle motor:

- power connection with the motor's NTC thermistor connection and holding brake connection
- motor feedback connection

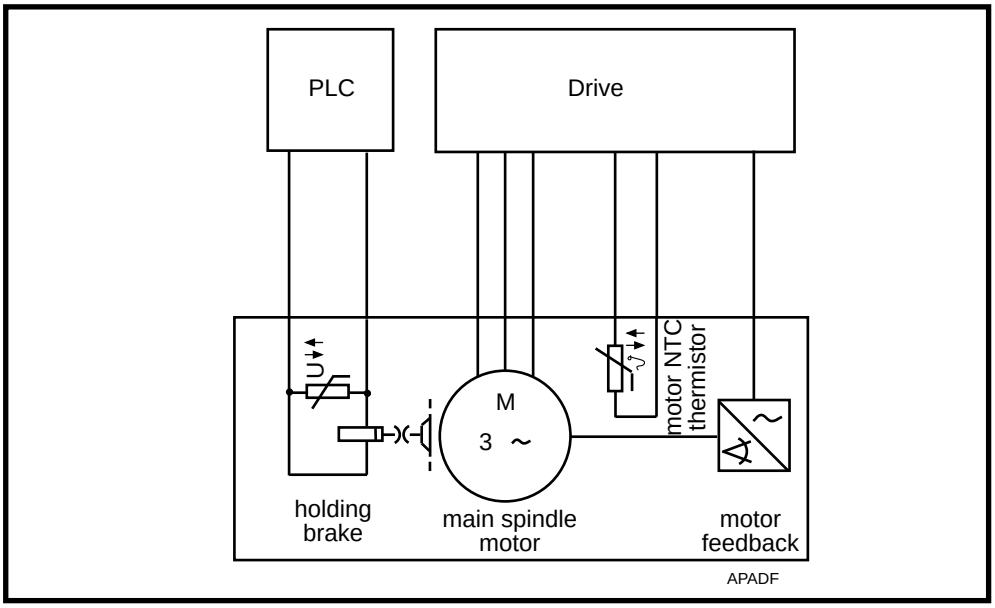


Fig 2.8: Schematic terminal diagram of an ADF main spindle motor

Power terminal

The power terminal in main spindle motors can be either

- a terminal box or
- a power connector.

The position of the power terminal can be specified when the order is placed and cannot be changed after delivery. The cable output direction out of the terminal box or power connector can be turned in increments of 90°. It can, however, be changed after the motor is delivered.

The technical power cable data is outlined in document "Electrical Connections of Main Spindle Drives, Project Planning", doc. no. 209-0042-4111.

Integrated into the power terminals are connections for:

- motor NTC thermistor and
- holding brake.

Motor NTC thermistor The motor NTC thermistor is built into the motor windings. The monitoring of the NTC thermistor in the drive protects the motor against overheating. The drive sends out an appropriate error message if the motor is shutdown for thermal reasons. (For details see document: "AC Main Spindle Drives with Regulated Asynchronous Motors or Frameless Spindle Motors, Applications", doc. no. 0041.4109).

holding brake The holding brake connection is integrated into the power terminal. The holding brake is triggered by the unit's control circuits.

Motor feedback The motor feedback connection is on the same side of the motor as the power terminal. It is a nine-pin socket. The position of the motor feedback connection cannot be changed once the motor is delivered.

3. ADF 100

3.1. Technical Data

Designation	Symbol	Unit	ADF 100			
Motor size			**B**	**C**	**D**	**D**
Windings call letter			BS		AS	CS
Nominal output 1)	P_n	kW	(8.5)	15	16	(21)
Nominal torque 1)	M_n	Nm	(40)	72	102	(100)
Nominal speed 1)	n_n	min^{-1}	2000		1500	2000
Nominal voltage 2)	U_{neff}	V	220			380
Nominal current	I_n	A	(45)	72	65	(59)
Minimum core diameter für Indramat cables	A	mm^2	(10)	25	16	(16)
Maximum speed with standard bearing	n_{max}	min^{-1}	9000			
Rotor moment of inertia	J_m	kgm^2	0.016	0.023	0.030	
Weight	m	kg	(64)	70	88	
Permissible ambient temperature		°C	5…45			
Insulation class			F			
Protection category			see section 2.1 “Ambient Conditions”			
Technical Data Liquid Cooling:						
Nominal heat dissipation	P_{Vn}	kW	(1.4)	2.4	3.2	(3.2)
Coolant temperature - at coolant entrance - increase with P_{Vn} 3)	 ϑ_{ein} $\Delta\vartheta_n$	 °C K	 10…40 10			
min. coolant flow required with $\Delta\vartheta_n$ 3)	Q_n	l/min	(2.0)	3.4	4.6	(4.6)
Pressure drop with Q_n 3)	Δp	bar	(0.2)	0.4	0.7	(0.7)
Maximum system pressure	p_{max}	bar	3			

Parenthetical values are preliminary.

1) Data refer to S1operating mode of motor on a KDA, TDA or DDS drive (U_{neff} = 220 V) or RAC/DKR (U_{neff} = 380 V). With other motor/drive combinations, check relevant operating curves for S1 data.

2) The motors are not suited for direct mains connections!

3) Data refer to water as coolant. If a different coolant is used, e.g., oil, then recalculate data or check flow diagrams!

Fig 3.1: Main spindle motor ADF 100 - nominal data

Permissible shaft load

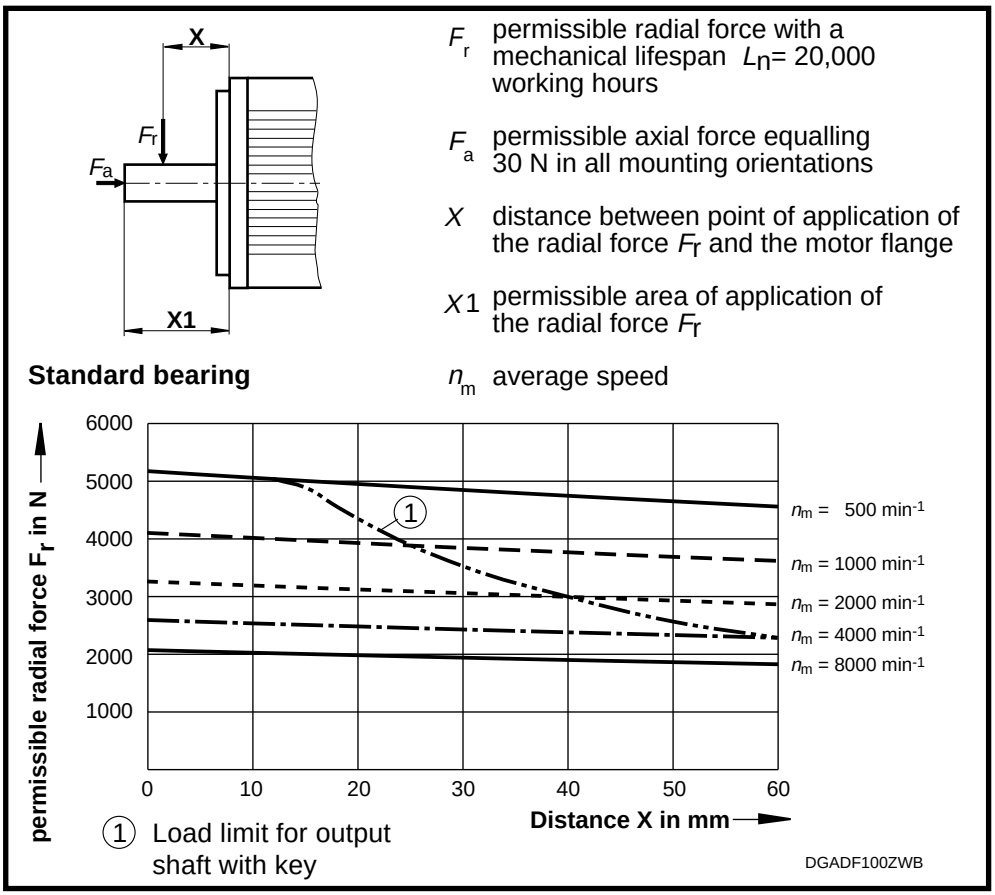


Fig 3.2: Main spindle motor ADF 100 - permissible shaft load

Lubricant consumption duration

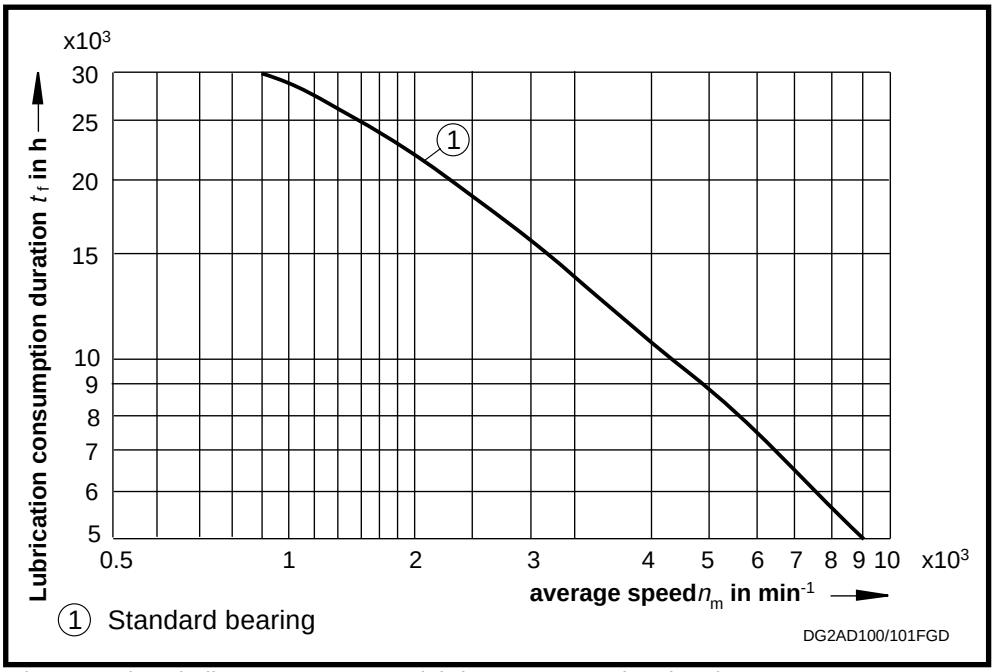
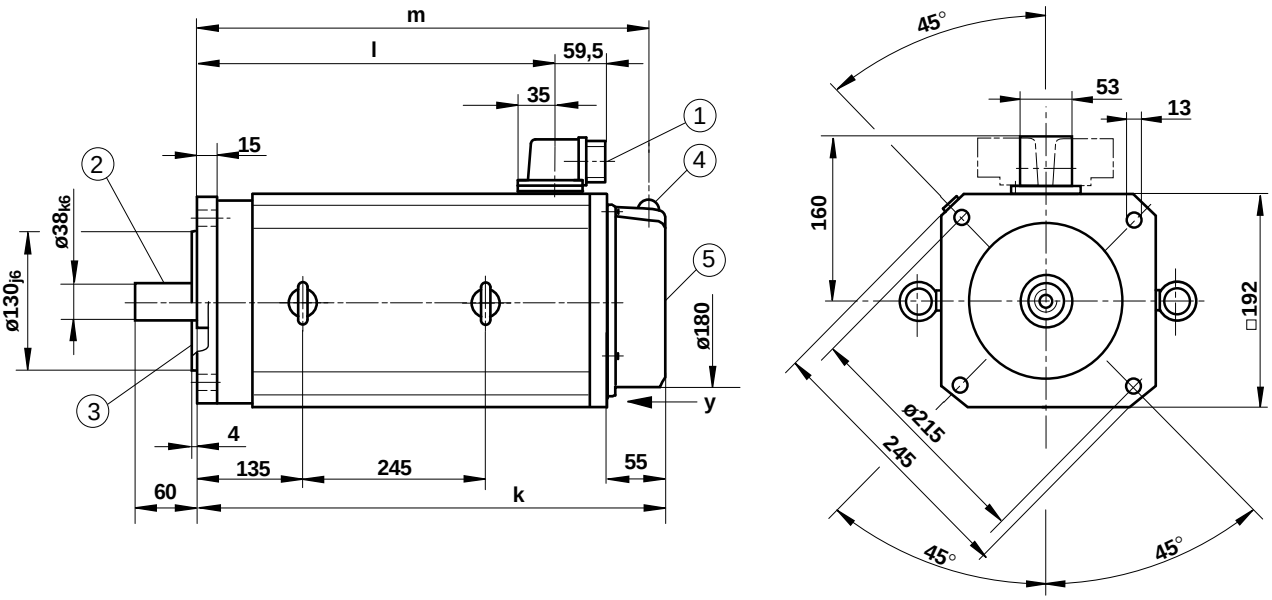


Fig 3.3: Main spindle motor ADF 100 - lubricant consumption duration

3.2. Dimensional Data - ADF 100

Main spindle motor, design B05



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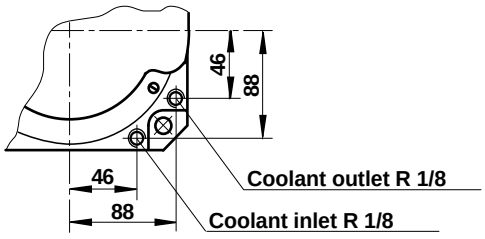


Dim.:	ADF 100 B	ADF 100 C	ADF 100 D
k	405	480	555
l	291	366	441
m	386	461	536

(1) Power connection, output direction, can be selected prior to delivery
- to side A
- to side B
- to the right (looking from front towards motor shaft)
- to the left

(2) Output shaft, as selected
- plain shaft, tolerance as per DIN 42955-R with center hole DS M8x19 as per DIN 332, sh. 2
- with key (see dimensions given in options)

(3) Flange dimensions as per DIN 42948

(4) Motor feedback connection

(5) Side B shaft end (see dimensions given in options)

MB ADF100-1

Fig 3.4: Main spindle motor ADF 100 - dimensional data

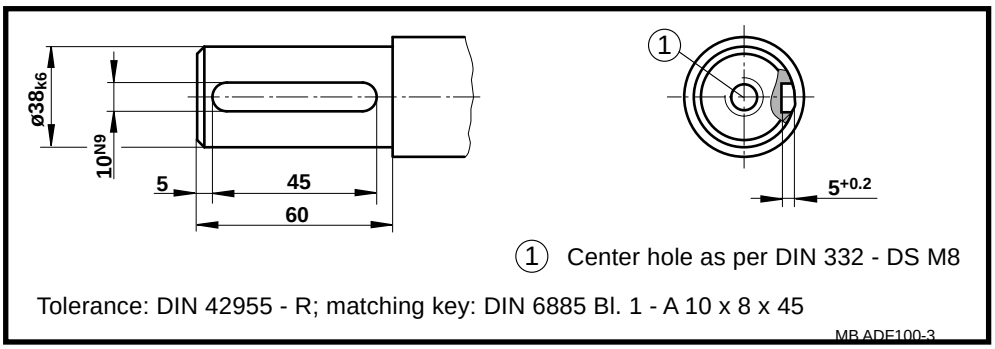


Fig 3.5: Main spindle motor ADF 100 - output shaft with key

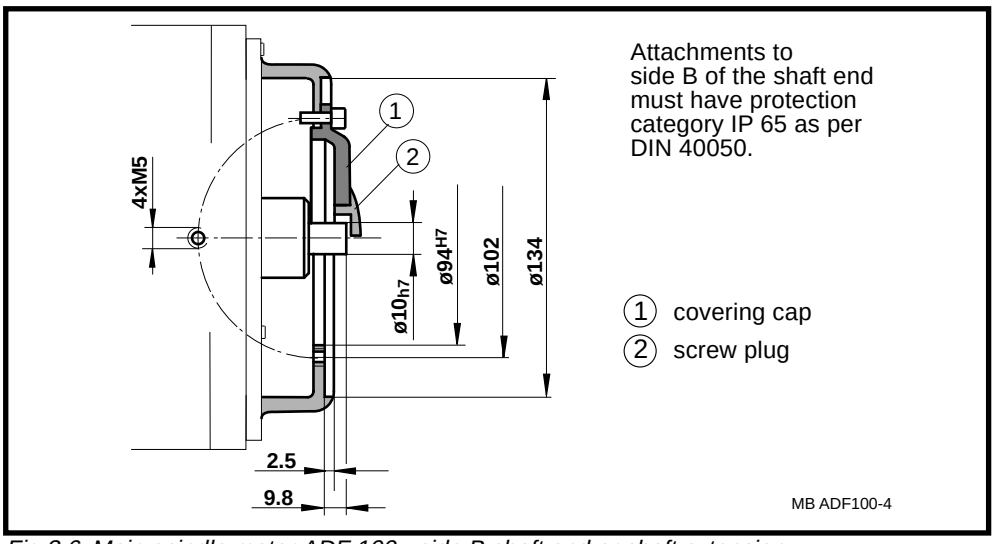


Fig 3.6: Main spindle motor ADF 100 - side B shaft end or shaft extension

3.3. Type Codes

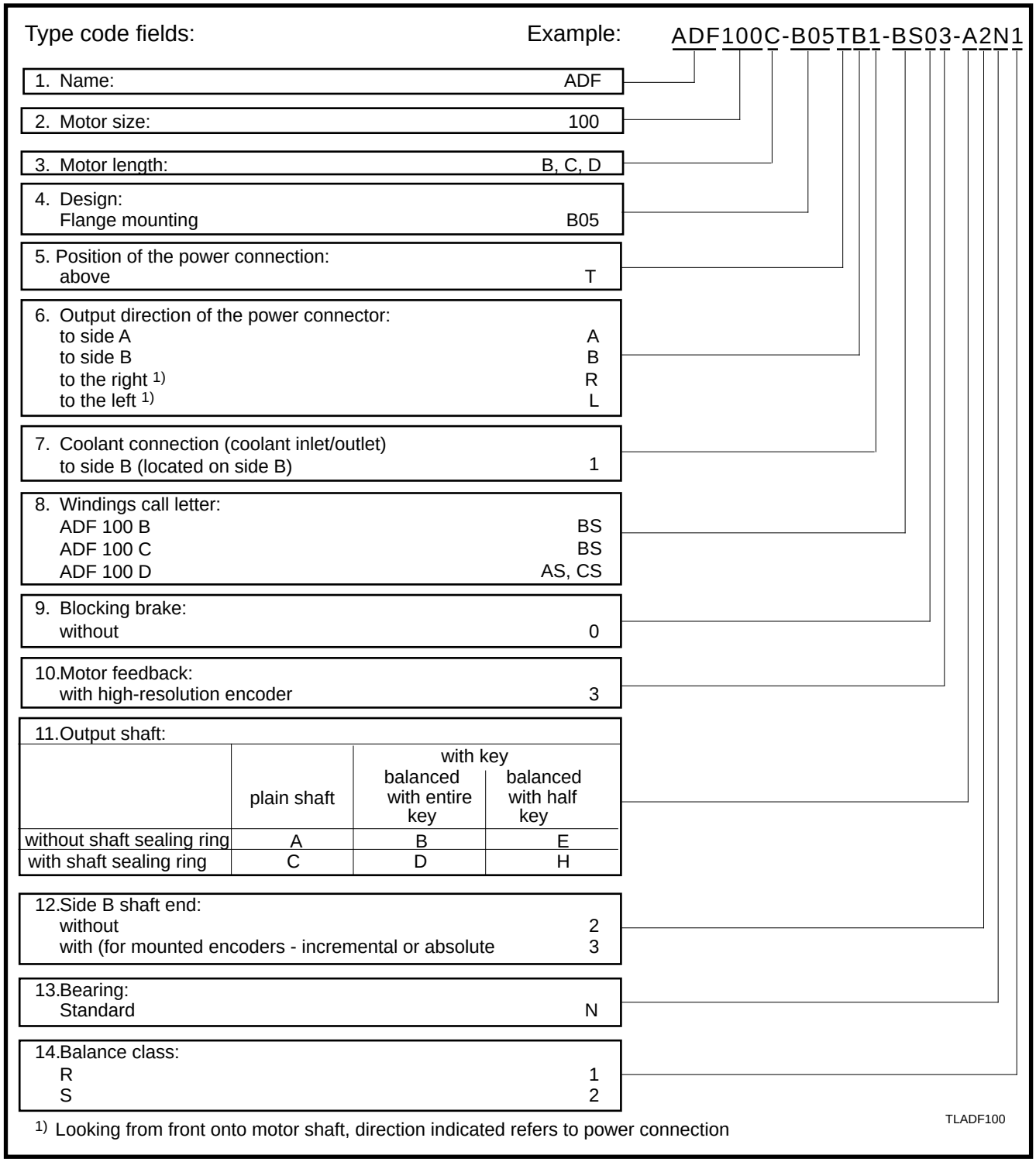


Fig 3.7: Main spindle motor ADF 100 - type codes

4. ADF 132

4.1. Technical Data

Designation	Symbol	Unit	ADF 132				
Motor size			**B**	**B**	**C**	**C**	**D**
Windings call letter			DS	BS	ES	BS	AS
Nominal output 1)	P_n	kW	16	(20)	24	33	36
Nominal torque 1)	M_n	Nm	102	(96)	153	125	229
Nominal speed 1)	n_n	min^{-1}	1500	2000	1500	2500	1500
Nominal voltage 2)	U_{neff}	V	380				
Nominal current	I_n	A	46	(68)	80	89	85
Minimum core diameter für Indramat cables	A	mm^2	10	(16)	25		
Maximum speed with - standard bearing - Spindellagerung	n_{max}	min^{-1}	7500 12000	7500 12000	7500 12000	7500 12000	7500 10000
Rotor moment of inertia	J_m	kgm^2	0.054		0.076		0.118
Weight	m	kg	94		(110)		(140)
Permissible ambient temperature		°C	5…45				
Insulation class			F				
Protection category			see section 2.1 “Ambient Conditions”				
Technical Data Liquid Cooling:							
Nominal heat dissipation	P_{Vn}	kW	2.2	(2.2)	3.0	3.0	4.0
Coolant temperature - at coolant entrance - increase with P_{Vn} 3)	ϑ_{ein} $\Delta\vartheta_n$	°C K	10…40 10				
min. coolant flow required with $\Delta\vartheta_n$ 3)	Q_n	l/min	3.2	(3.2)	4.3	4.3	5.7
Pressure drop with Q_n 3)	Δp	bar	0.1	(0.1)	0.2	0.2	0.3
Maximum system pressure	p_{max}	bar	3				

Parenthetical values are preliminary.

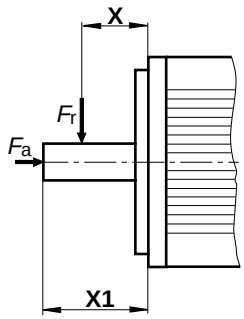
1) Data refer to S1operating mode of motor on a KDA, TDA or DDS drive (U_{neff} = 220 V) or RAC/DKR (U_{neff} = 380 V). With other motor/drive combinations, check relevant operating curves for S1 data

2) The motors are not suited for direct mains connections!

3) Data refer to water as coolant. If a different coolant is used, e.g., oil, then recalculate data or check flow diagrams!

Fig 4.1: Main spindle motor ADF 132 - nominal data

Permissible shat load



F_r permissible radial force with a mechanical lifespan L_h= 20,000 operating hours

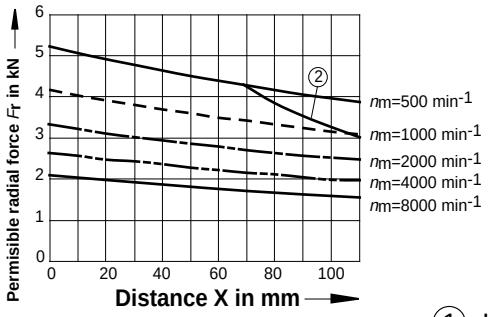
F_a permissible axial force equalling 50 N in all mounting orientations

X distance between point of application of the radial force F_r and the motor flange

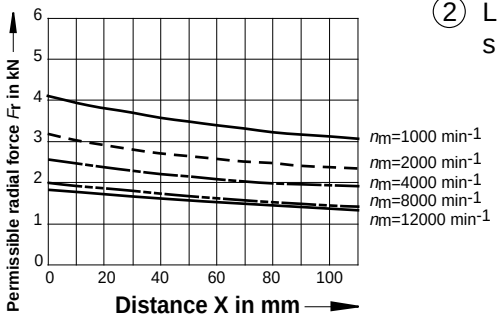
$X1$ permissible area of application of the radial force F_r

n_m average speed

Standard bearing



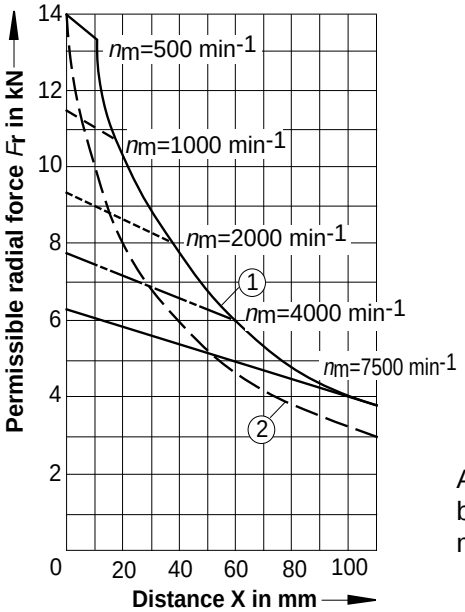
Spindle bearing



① Load limit for output shaft with plain shaft end

② Load limit for output shaft with key

Heavy-duty bearing



A main spindle motor with heavy-duty bearing may only be operated with a minimum radial force of 1 kN.

DGADF132ZWB

Fig 4.2: Main spindle motor ADF 132 - permissible shaft load

Lubricant consumption duration

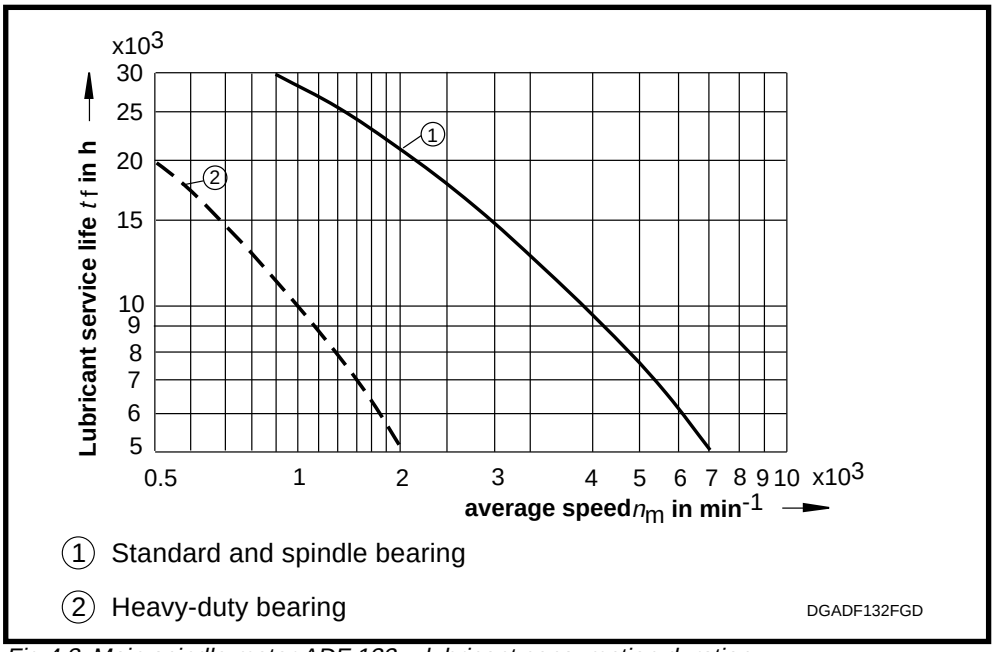


Fig 4.3: Main spindle motor ADF 132 - lubricant consumption duration

4.2. Holding Brake

Designation / Principle of action	Symbol	Unit	Type: electrical clamp	Type: electrical release
Holding torque	M_h	Nm	100	30
Nominal connect. voltage[1)]	U_n	V	24 ± 10 %	
Nominal current	I_n	A	1.5	1.3
Moment of inertia	J_B	kgm²	0.002	0.0018
Maximum braking energy	W_{max}	Ws	30000	
Peak speed [1)]	n_{max}	min⁻¹	7500	
Release delay	t_l	ms	140	120
Clamp delay	t_k	ms	110	65
Mass	m	kg	4	

[1)] In holding brakes with electrical release, the peak speed is fixed by the maximum braking energy W_{max} of the holding brake. It is calculated as follows:

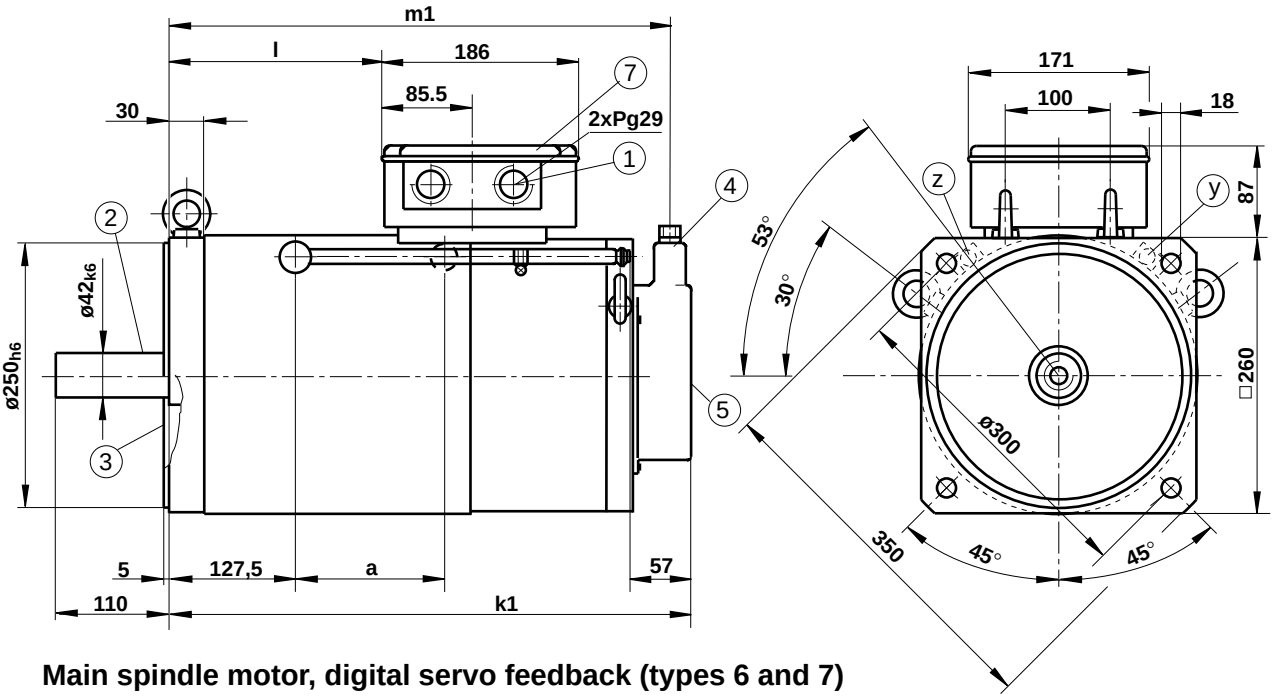
$$n_{max} = \sqrt{\frac{2 W_{max}}{J_M + J_B + J_C}} \bullet \frac{30}{3.14}$$

J_M Rotor moment of inertia
J_B holding brake moment of inertia
J_L Load moment of inertia (attachments to output shaft)

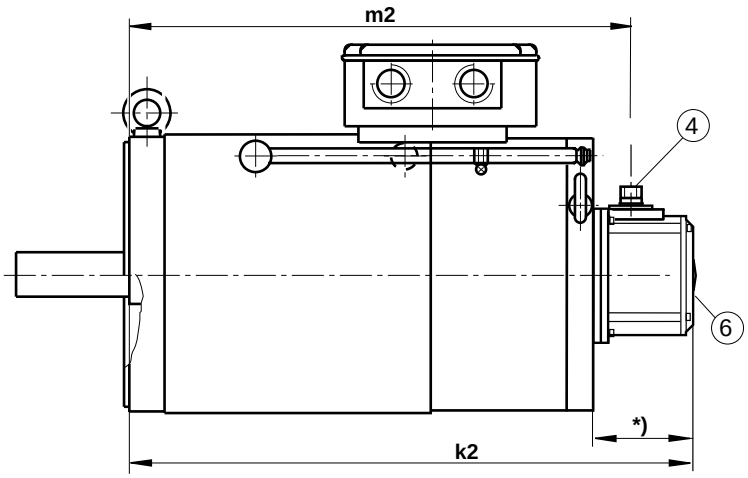
Fig 4.4: Main spindle motor ADF 132 - technical data - holding brake

4.3. Dimensional Data - ADF 132

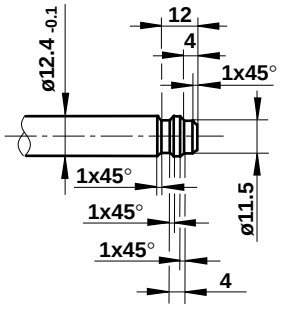
Main spindle motor, high-resolution motor feedback (type 3)



Main spindle motor, digital servo feedback (types 6 and 7)



Details y, z



(1) Power connection, output direction, selected prior to delivery
- to side A
- to side B
- to the right (looking from front onto motor shaft)
- to the left

(2) Output shaft, as selected
- plain shaft, tolerance DIN 42955-R with center hole DS M16x36 as per DIN 332 sh. 2
- with key (see dimensions under options)

(3) Flange dimensions as per DIN 42948

(4) Motor feedback connection

(5) Side B shaft end (see dimensions under options)

(6) Side B shaft end not possible

(7) Note asymetry when turning terminal box

Dim.:		ADF 132 B	ADF 132 C	ADF 132 D
a		103	173	303
k1	w/o holding brake	403.5	473.5	603.5
	with holding brake	465.5	535.5	665.5
k2	w/o holding brake	*)	*)	*)
	with holding brake	*)	*)	*)
l		168.5	238.5	268.5
m1	w/o holding brake	384.5	454.5	584.5
	with holding brake	446.5	516.5	646.5
m2	w/o holding brake	*)	*)	*)
	with holding brake	*)	*)	*)

*) in preparation

MB ADF132-1

Fig 4.5: Main spindle motor ADF 132 - dimensional data

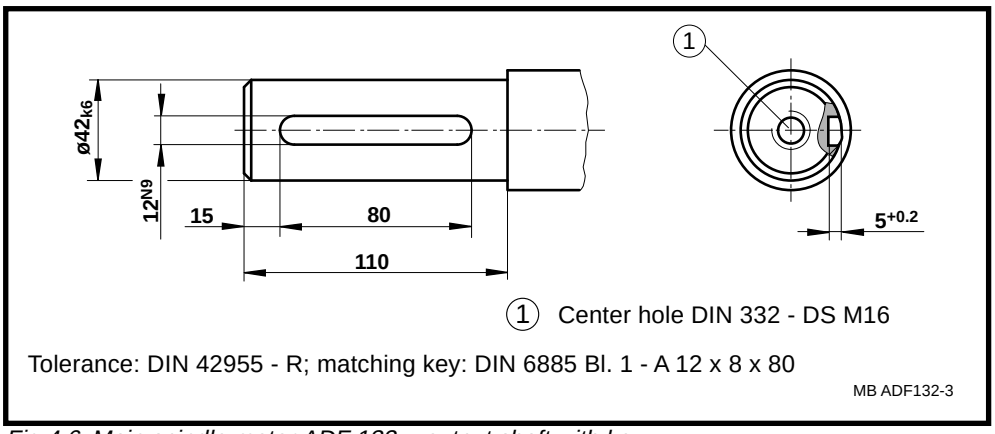


Fig 4.6: Main spindle motor ADF 132 - output shaft with key

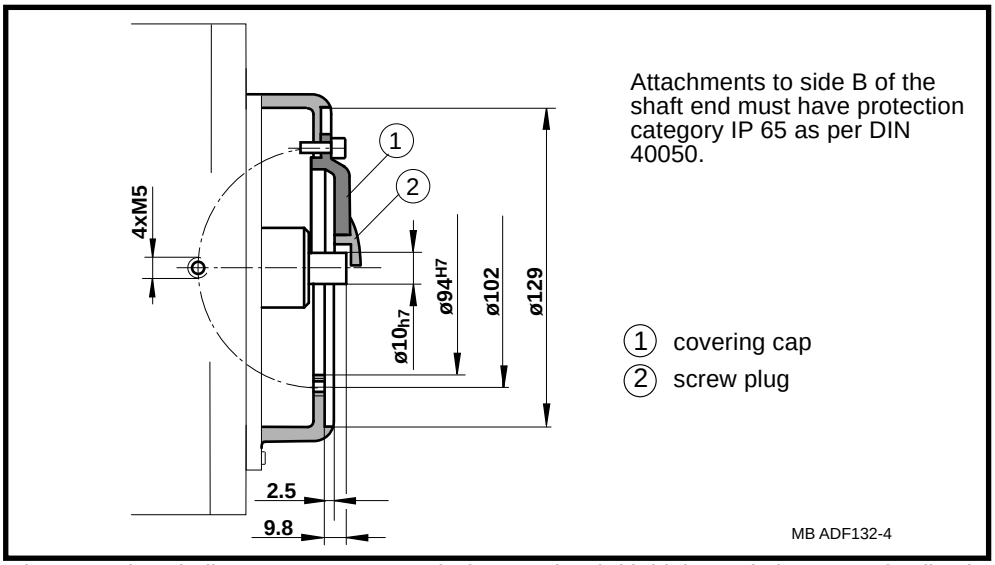


Fig 4.7: Main spindle motor ADF 132 - shaft extension (with high-resolution motor feedback, type 3 only)

4.4. Type Codes

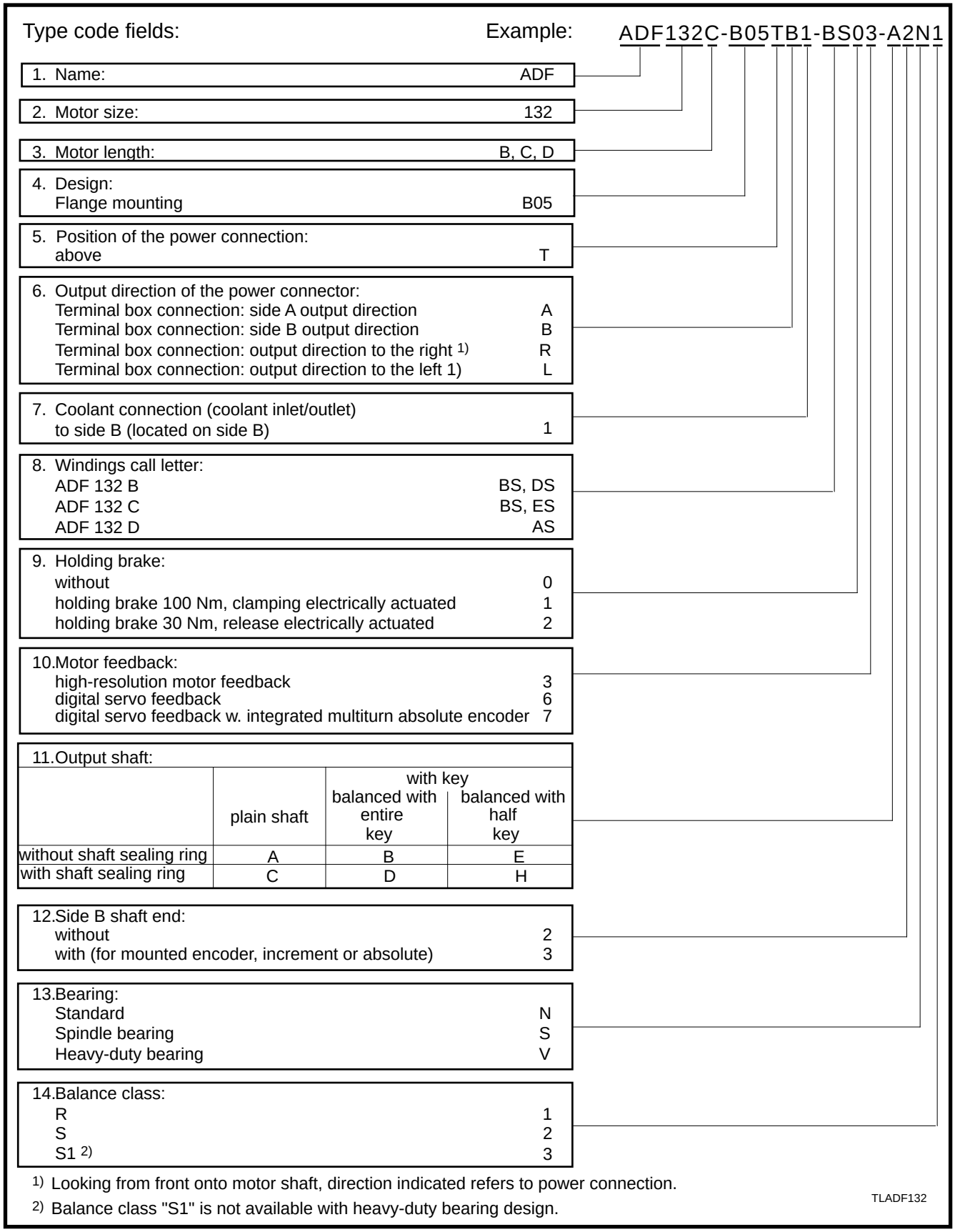


Fig 4.8: Main spindle motor ADF 132 - type codes

5. ADF 160

5.1. Technical Data

Designation	Symbol	Unit	ADF 160		
Motor size			**B**	**B**	**C**
Windings call letter			BS	CS	BS
Nominal output 1)	P_n	kW	40	55	(52)
Nominal torque 1)	M_n	Nm	255	250	(331)
Nominal speed 1)	n_n	min^{-1}	1500	2100	1500
Nominal voltage 2)	U_{neff}	V	380		
Nominal current	I_n	A	102	111	(134)
Minimum core diameter for INDRAMAT cable	A	mm^2	35		(2x16)
Maximum speed with standard bearing	n_{max}	min^{-1}	6000		
Rotor moment of inertia	J_m	kgm^2	0.174		0229
Weight	m	kg	206		(240)
Permissible ambient temperature		°C	5…45		
Insulation class			F		
Protection category			see section 2.1 “Ambient Conditions”		
Technical Data Liquid Cooling					
Nominal heat dissipation	P_{Vn}	kW	5.4	5.4	(6.9)
Coolant temperature - at coolant entrance - increase with P_{Vn} 3)	 ϑ_{ein} $\Delta\vartheta_n$	 °C K	 10…40 10		
min. coolant flow required with $\Delta\vartheta_n$ 3)	Q_n	l/min	7.7	7.7	(9.9)
Pressure drop with Q_n 3)	Δp	bar			
Maximum system pressure	p_{max}	bar	3		

Parenthetical values are preliminary.

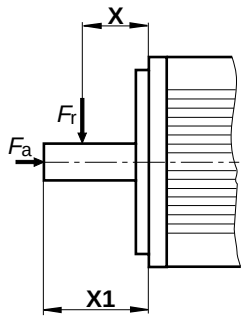
1) Data refer to S1operating mode of motor on a KDA, TDA or DDS drive (U_{neff} = 220 V) or RAC/DKR (U_{neff} = 380 V). With other motor/drive combinations, check relevant operating curves for S1 data

2) The motors are not suited for direct mains connections!

3) Data refer to water as coolant. If a different coolant is used, e.g., oil, then recalculate data or check flow diagrams!

Fig 5.1: Main spindle motor ADF 160 - nominal data

Permissible shaft loads



F_r permissible radial force with a mechanical lifespan L_h= 20,000 operating hours

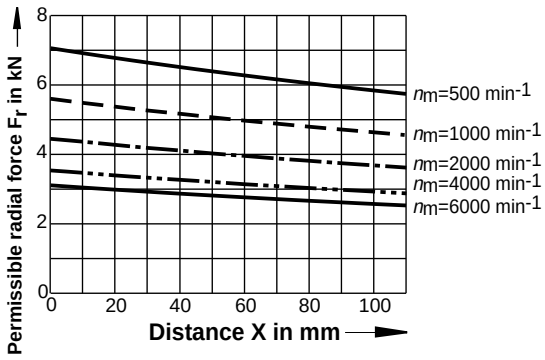
F_a permissible axial force equalling 30 N in all mounting orientations

X distance between point of application of the radial force F_r and the motor flange

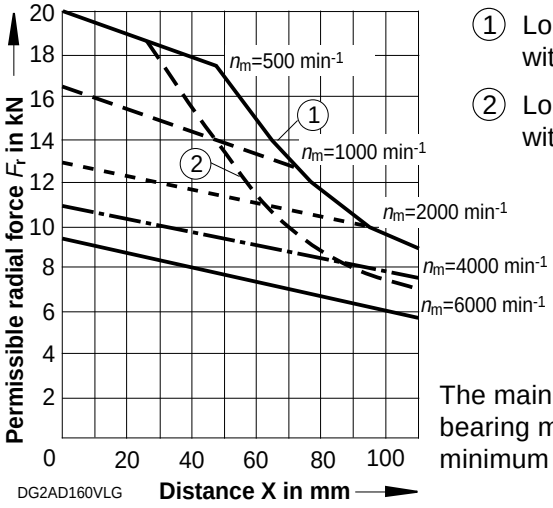
$X1$ permissible area of application of the radial force F_r

n_m average speed

Standard Bearing



Heavy-duty bearing



① Load limit for output shaft with plain shaft end

② Load limit for output shaft with key

The main spindle motor with heavy-duty bearing may only be operated with a minimum radial force of 1.5kN.

DGADF160ZWB

Fig 5.2: Main spindle motor ADF 160 - permissible shaft load

Lubricant consumption duration

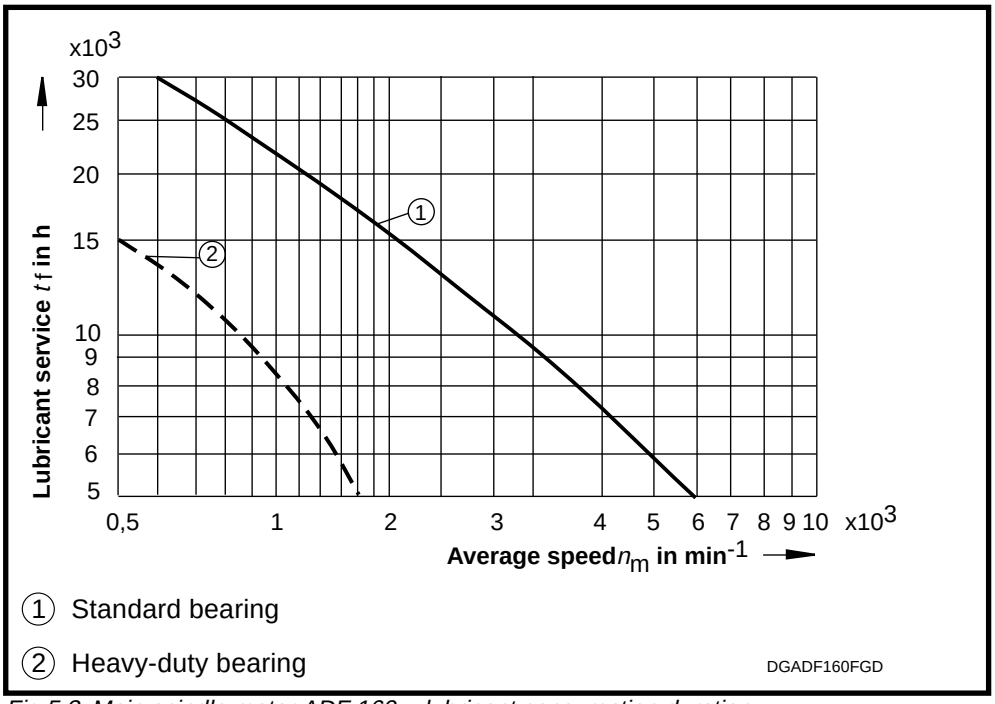


Fig 5.3: Main spindle motor ADF 160 - lubricant consumption duration

5.2. Holding brake

Designation / Principle of action	Symbol	Unit	Type: electrical clamp	Type: electrical release
Holding torque	M_h	Nm	100	70
Nominal connect. voltage[1)]	U_n	V	24 ± 10 %	
Nominal current	I_n	A	1.8	2.0
Moment of inertia	J_B	kgm²	0.0065	
Maximum braking energy	W_{max}	Ws	40000	
Peak speed [1)]	n_{max}	min⁻¹	6000	
Release delay	t_l	ms	120	130
Clamp delay	t_k	ms	90	85
Mass	m	kg	5	

[1)] In holding brakes with electrical release, the peak speed is fixed by the maximum braking energy W_{max} of the holding brake. It is calculated as follows:

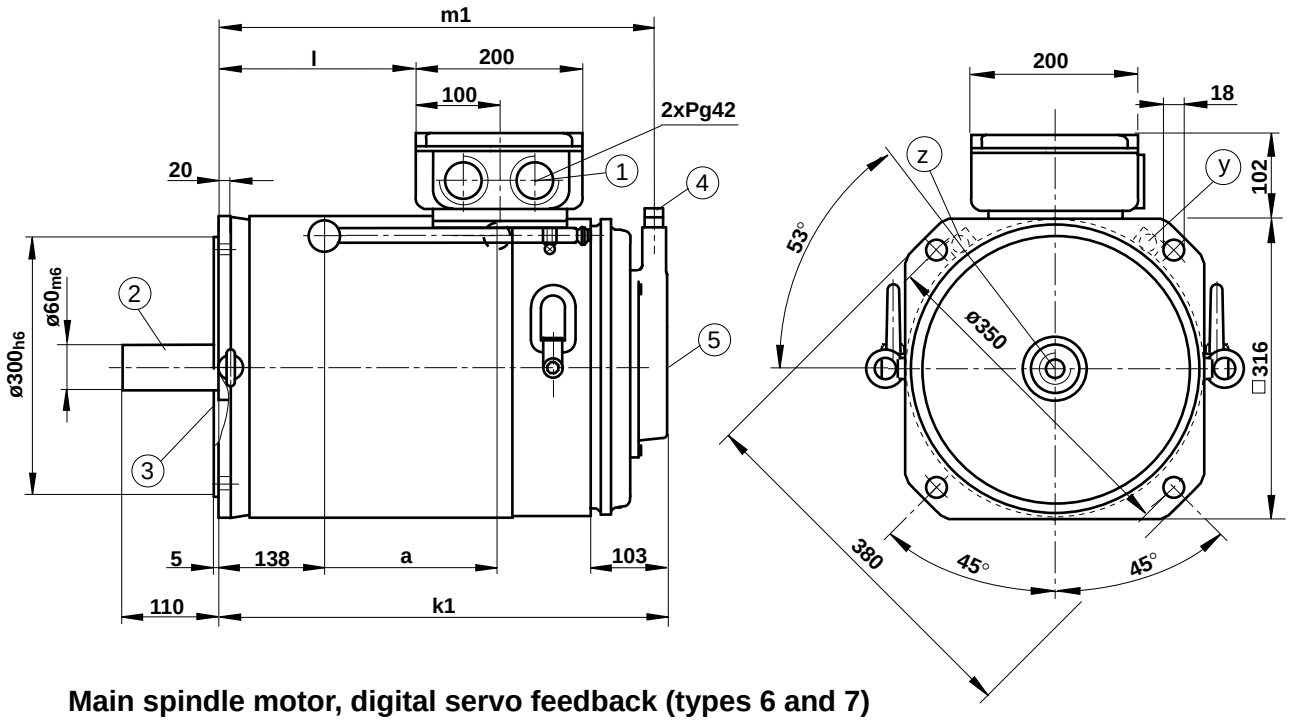
$$n_{max} = \sqrt{\frac{2 W_{max}}{J_M + J_B + J_C}} \bullet \frac{30}{3.14}$$

J_M Rotor moment of inertia
J_B holding brake moment of inertia
J_L Load moment of inertia (attachments to output shaft)

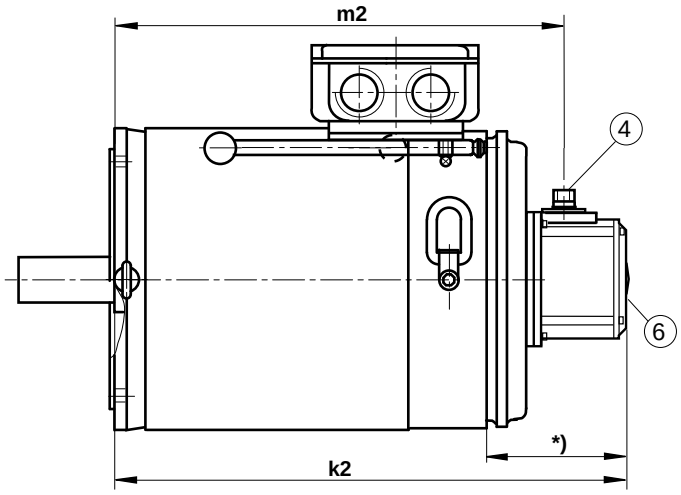
Fig 5.4: Main spindle motor ADF 160 - technical data - holding brake

5.3. Dimensional Data - ADF 160

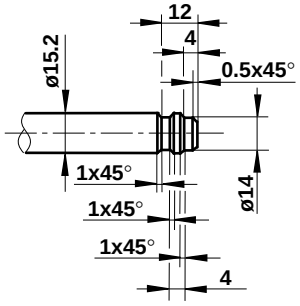
Main spindle motor, high-resolution motor feedback (type 3)



Main spindle motor, digital servo feedback (types 6 and 7)



Detail y, z



(1) Power connection, output direction, selected prior to delivery
- to side A
- to side B
- to the right (looking from front onto motor shaft)
- to the left

(2) Output shaft, as selected
- plain shaft, tolerance DIN 42955-R with center hole DS M16x36 as per DIN 332 sh. 2
- with key (see dimensions under options)

(3) Flange dimensions as per DIN 42948

(4) Motor feedback connection

(5) Side B shaft end (see dimensions under options)

(6) Side B shaft end not possible

Dim.:		ADF 160 B	ADF 160 C
a		269	359
k1	w/o holding brake	600	690
	with holding brake	662	752
k2	w/o holding brake	*)	*)
	with holding brake	*)	*)
l		310	400
m1	w/o holding brake	582	672
	with holding brake	644	734
m2	w/o holding brake	*)	*)
	with holding brake	*)	*)

*) in preparation

MB ADF160-1

Fig 5.5: Main spindle motor ADF 160 - dimensional data

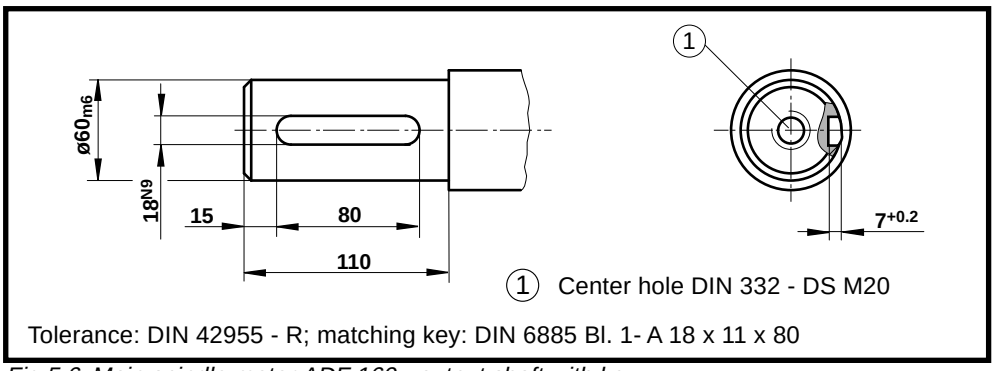


Fig 5.6: Main spindle motor ADF 160 - output shaft with key

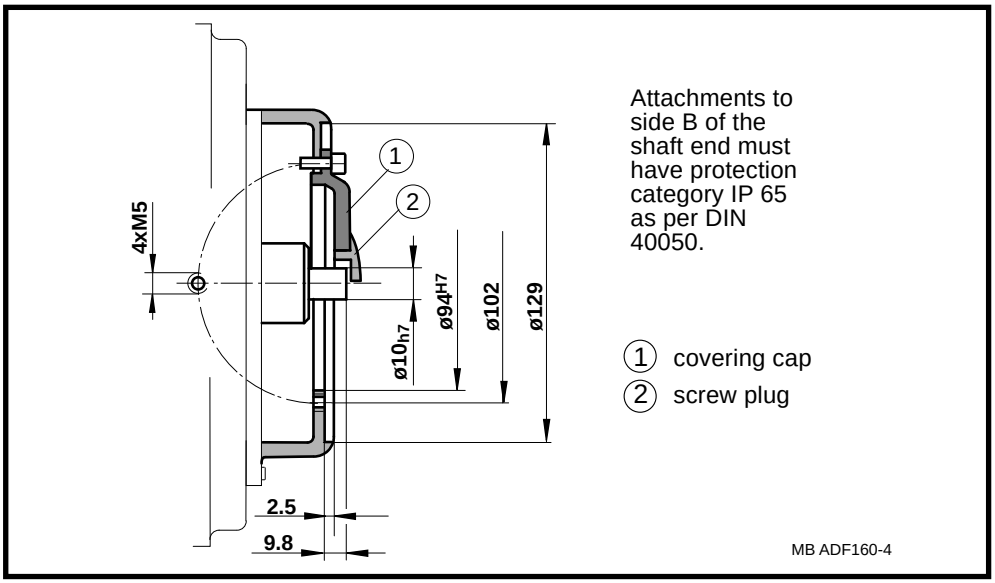


Fig 5.7: Main spindle motor ADF 160 - side B shaft end or shaft extension (with high-resolution motor feedback type 3 only)

5.4. Type Codes

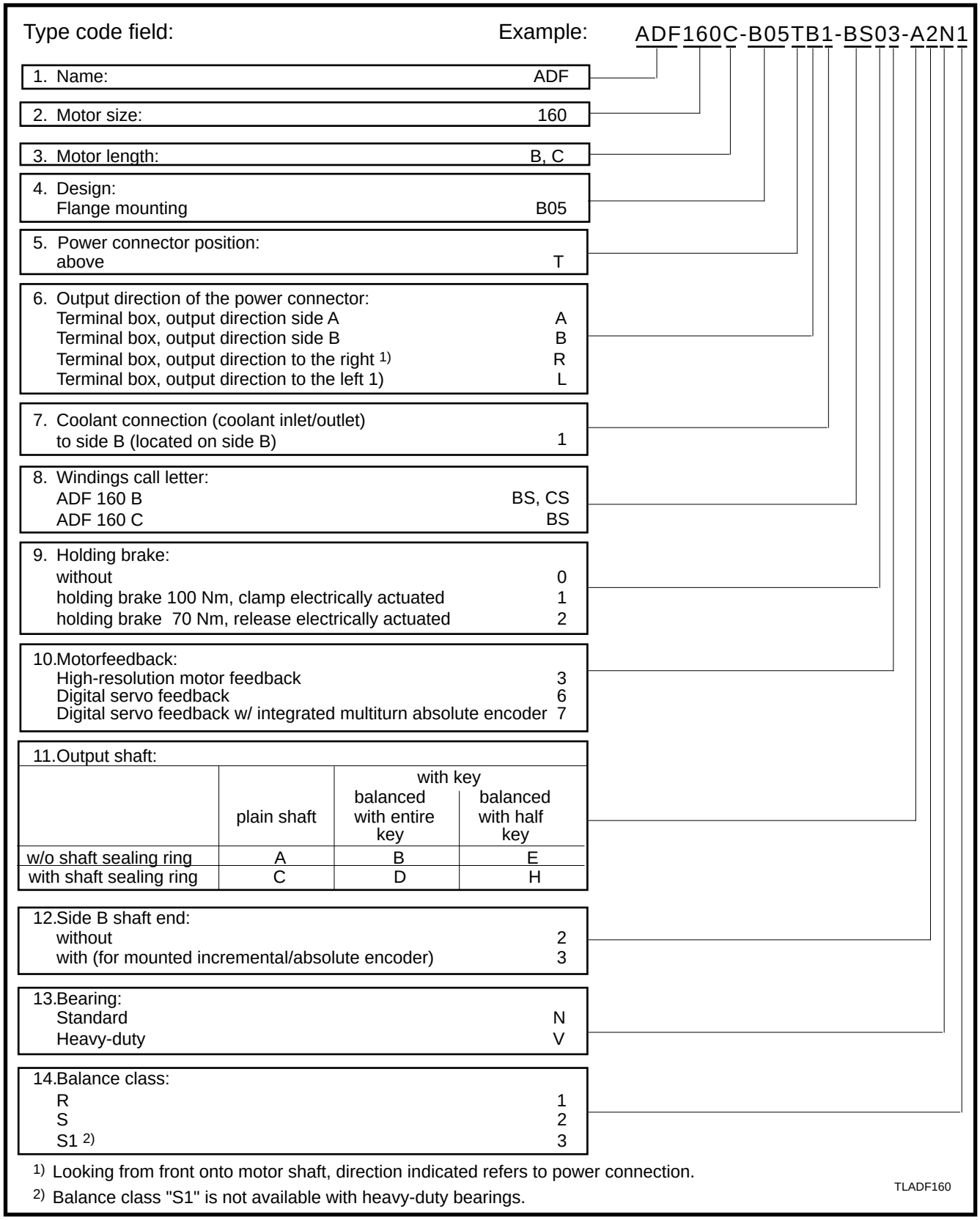


Fig 5.8: Main spindle motor ADF 160 - type codes

6. Electrical Connections

6.1. Terminal Diagram - ADF 100

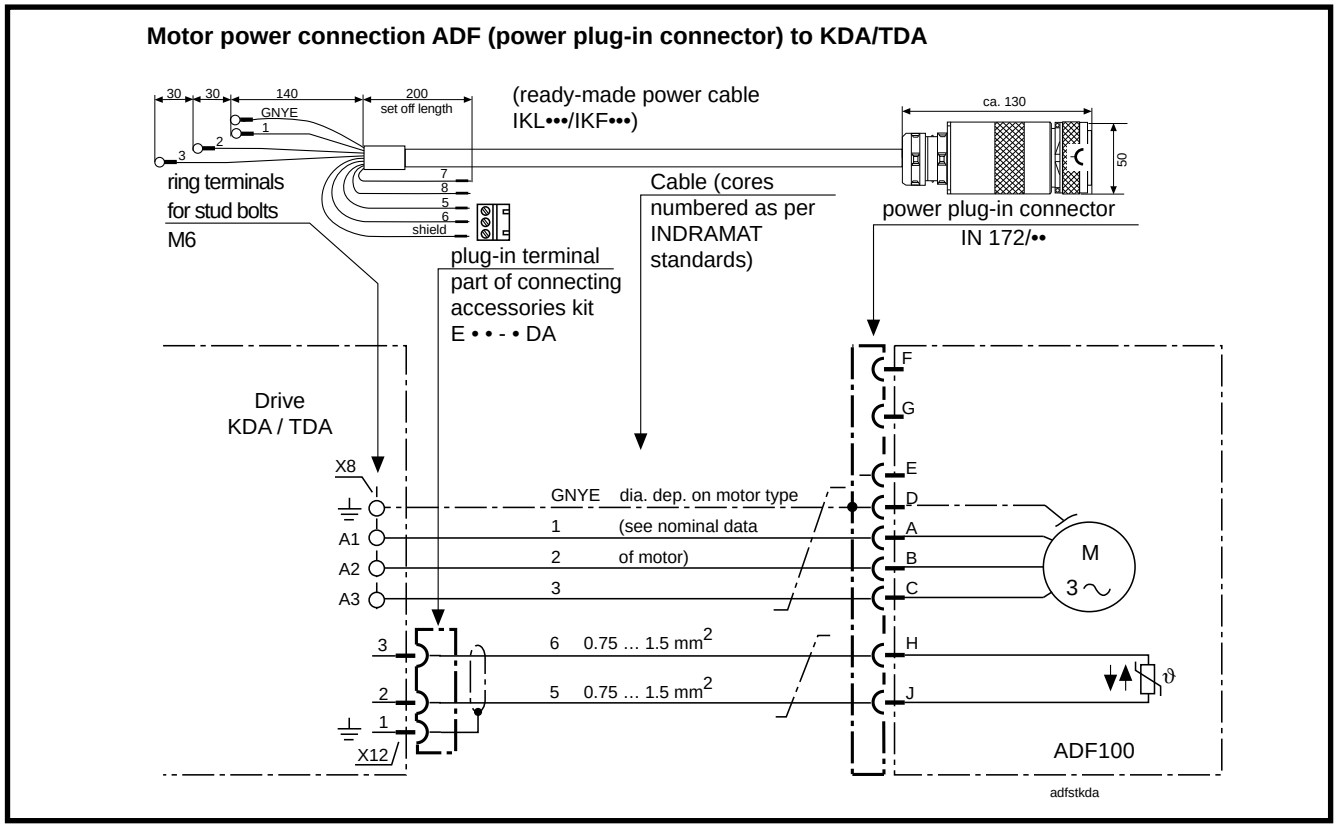


Fig 6.1: Terminal diagram - ADF 100 on KDA/TDA

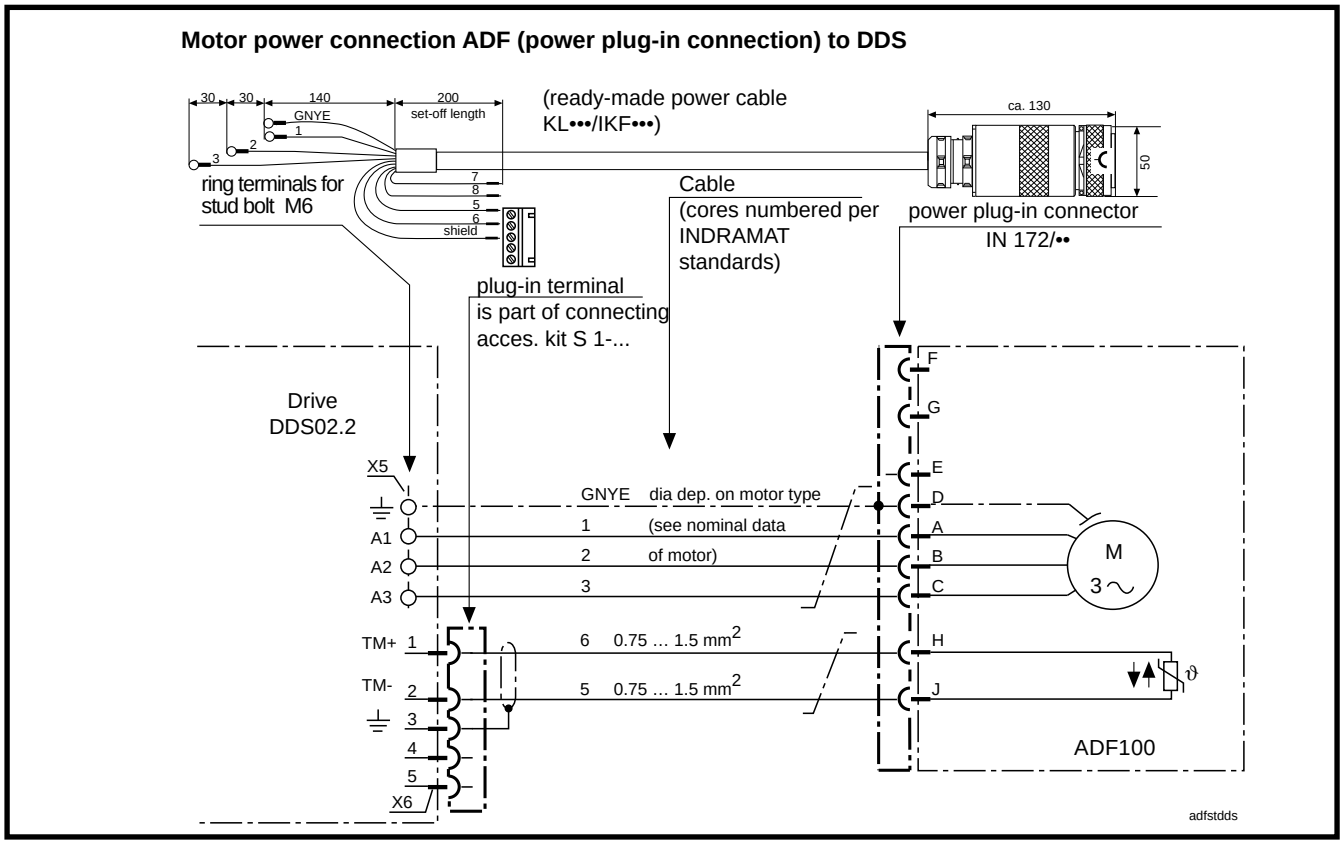


Fig 6.2: Terminal diagram - ADF 100 on DDS02.2

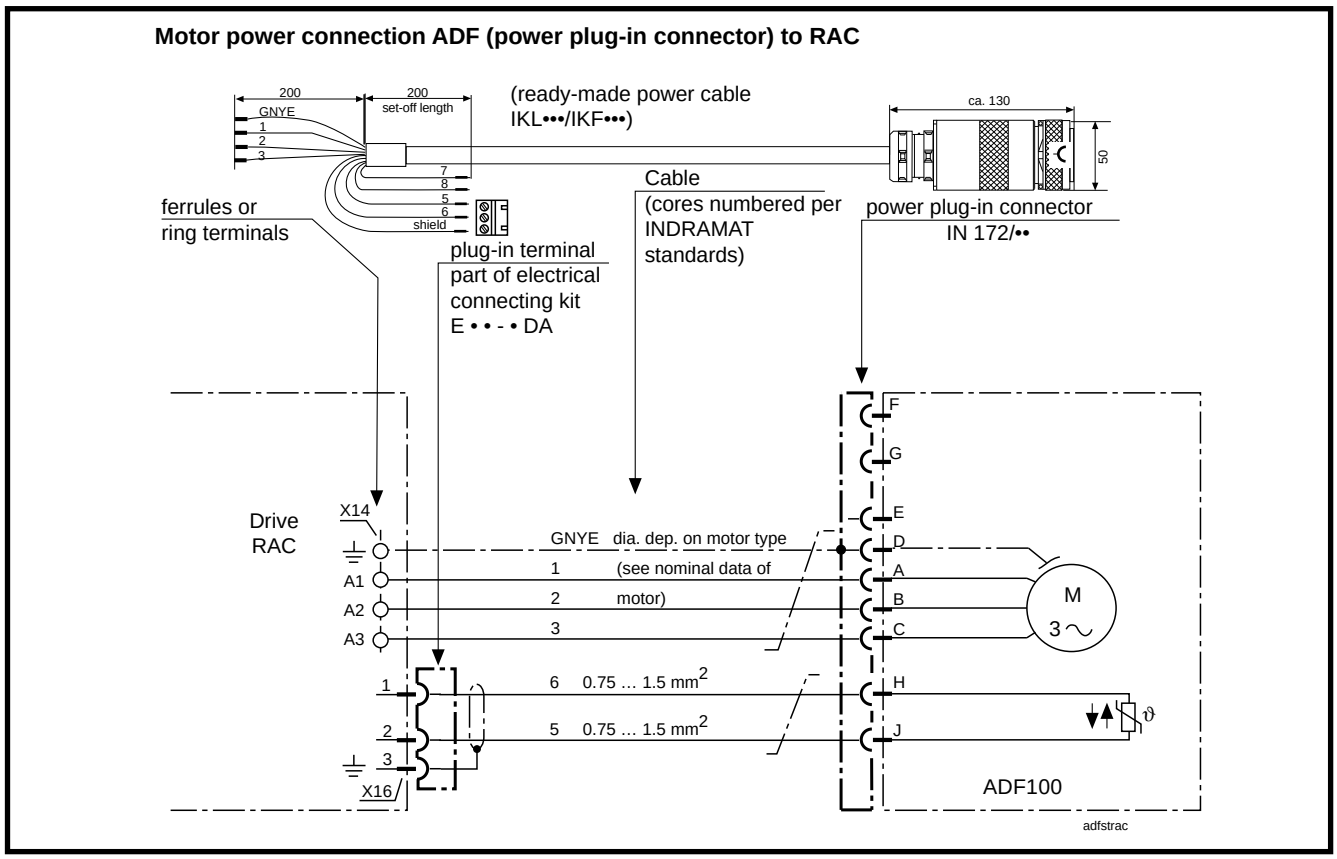


Fig 6.3: Terminal diagram - ADF 100 on RAC

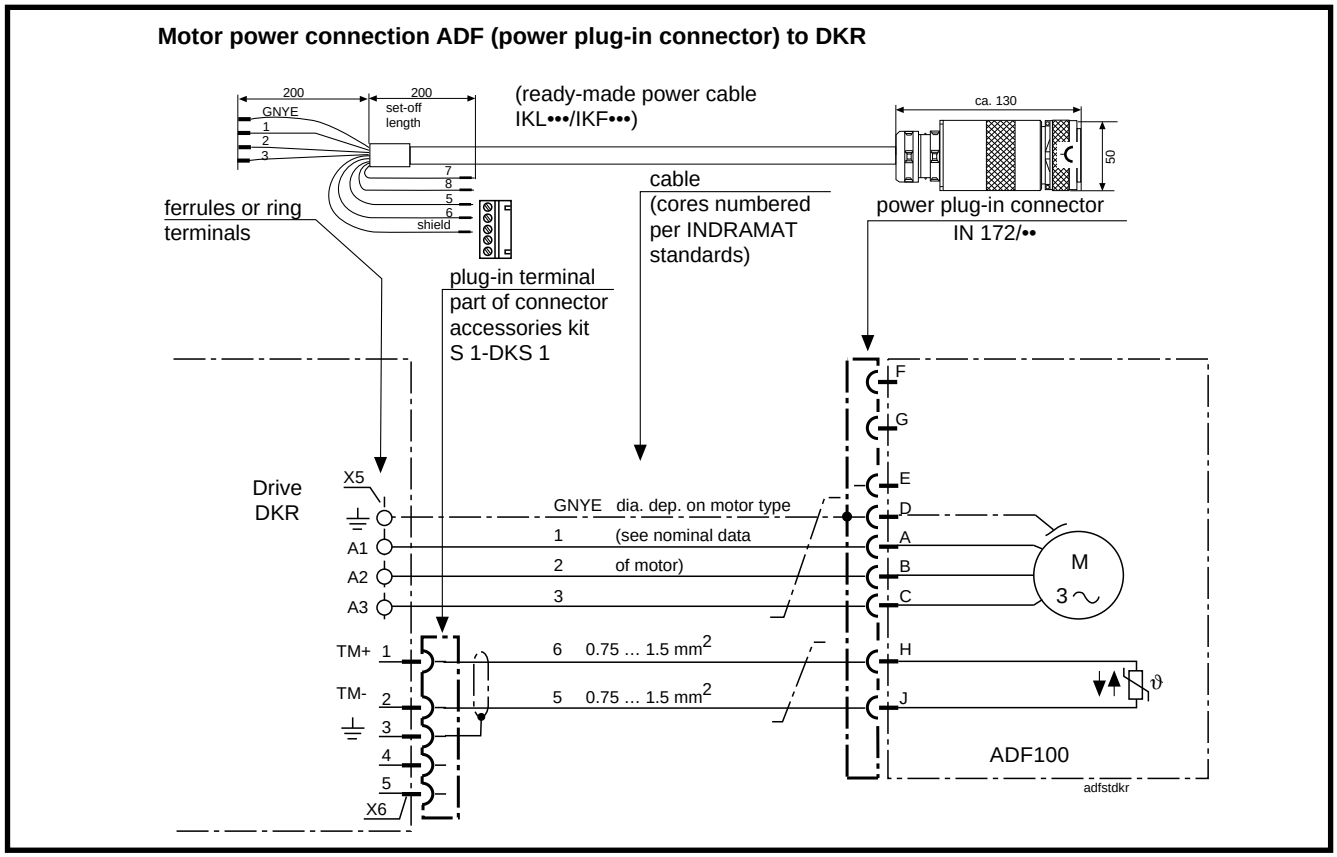


Fig 6.4: Terminal diagram - ADF 100 on DKR

6.2. Terminal Diagram - ADF 132 and ADF 160

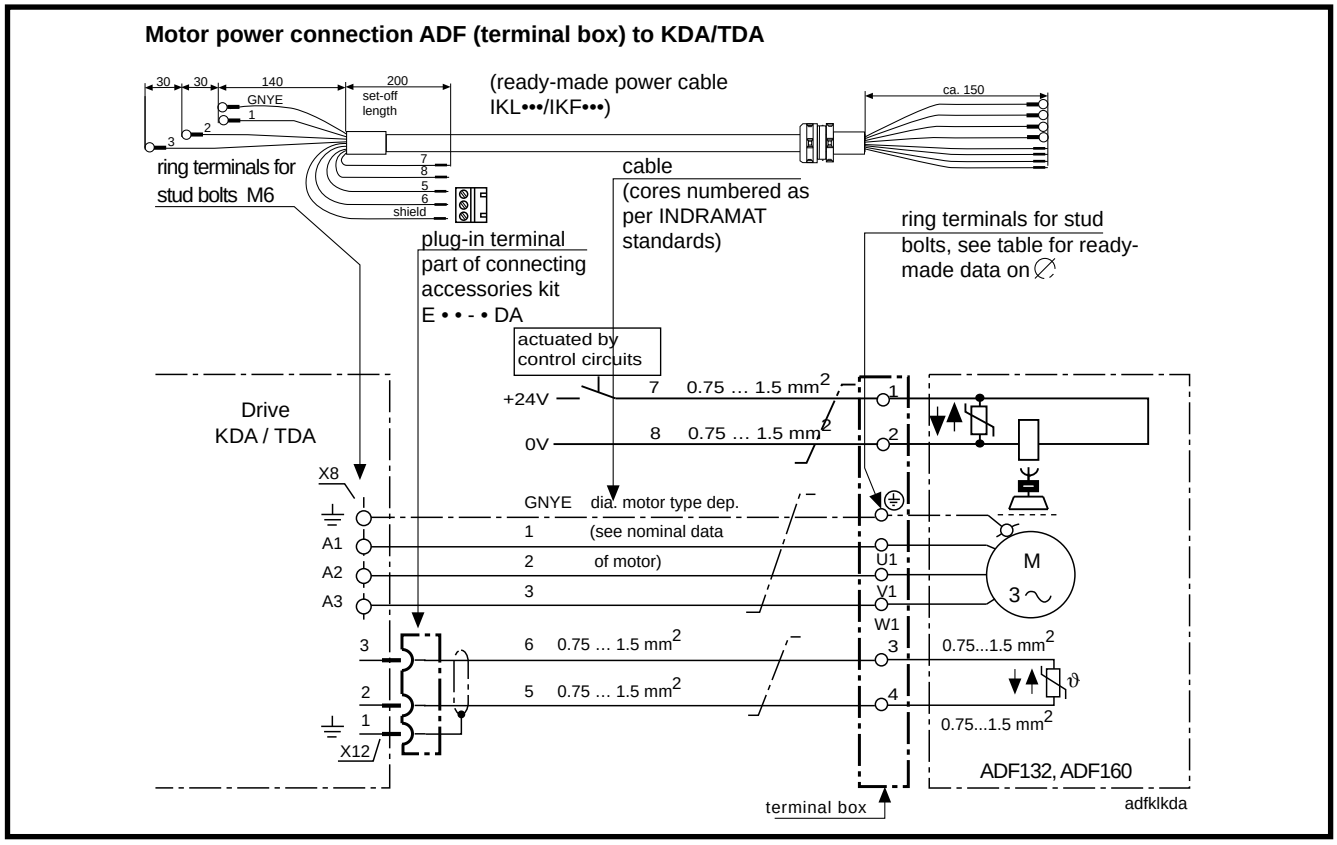


Fig 6.5: Terminal diagram - ADF 132 on KDA/TDA

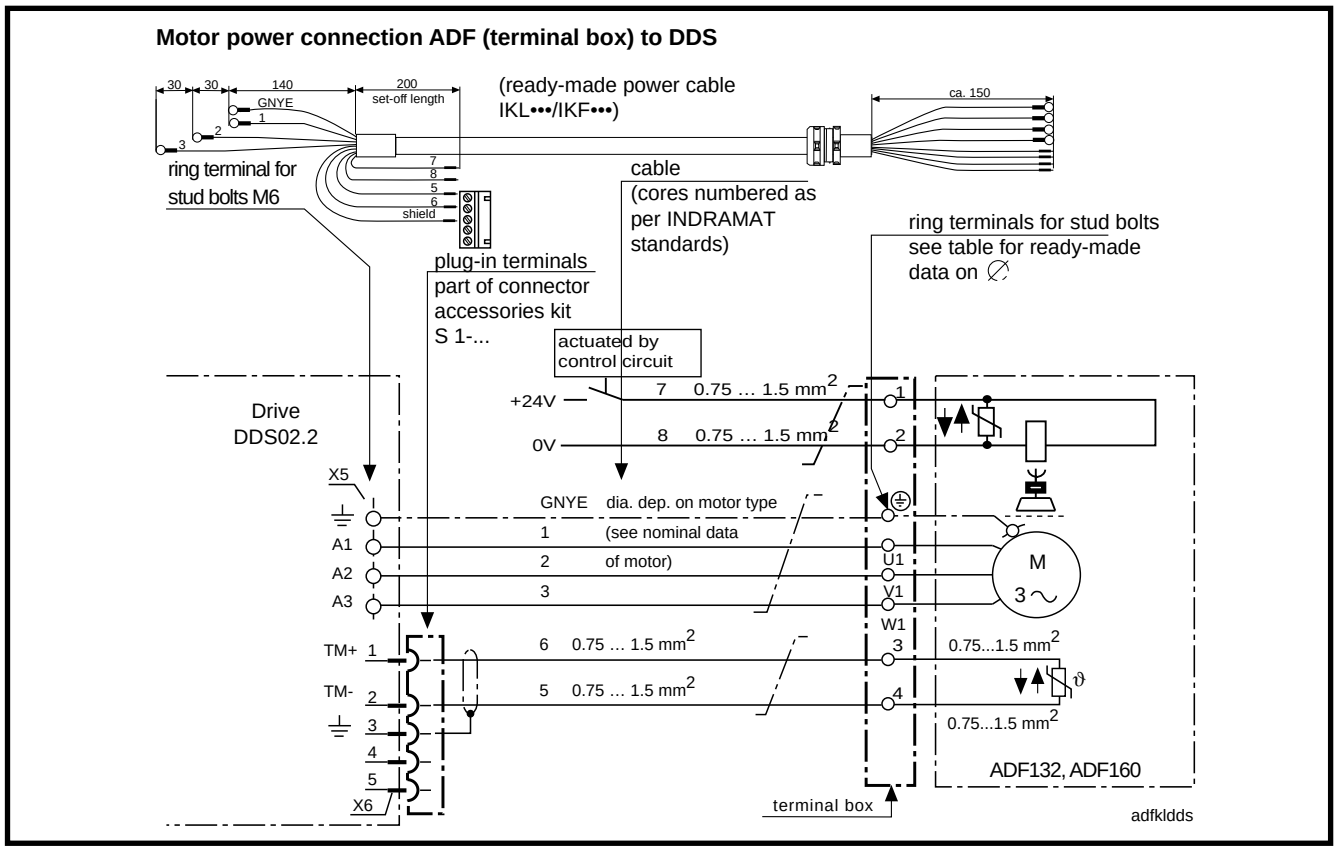


Fig 6.6: Terminal diagram - ADF 132 on DDS02.2

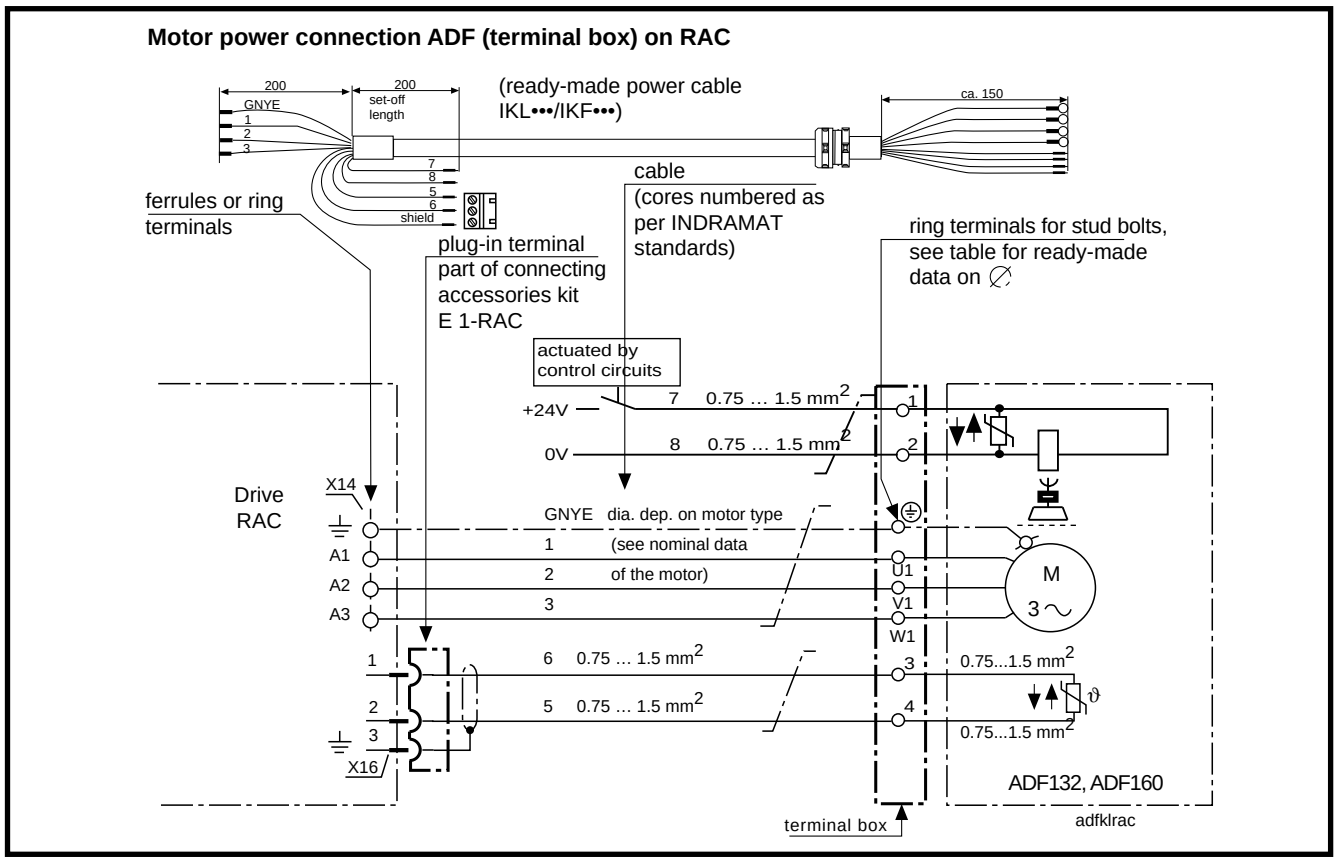


Fig 6.7: Terminal diagram - ADF 132 and ADF 160 on RAC

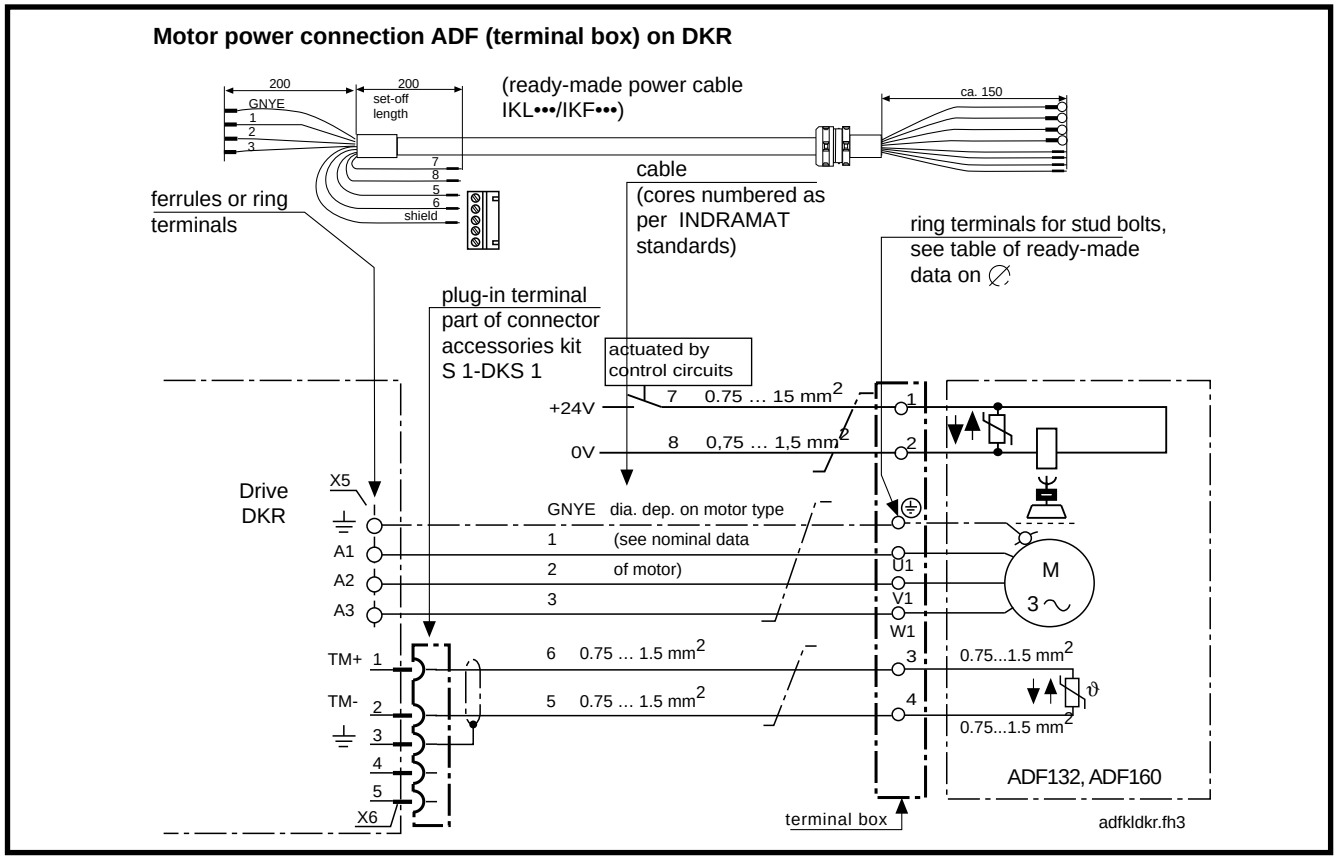
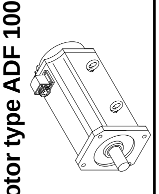


Fig 6.8: Terminal diagram - ADF 132 and ADF 160 on DKR

6.3. Table - Motor power cable

The cable diameters are dependent on the motor type. These are indicated in the relevant Technical Data section.



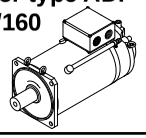
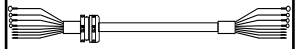
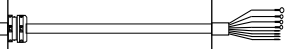
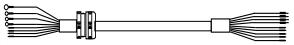
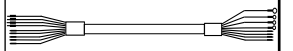
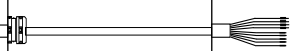
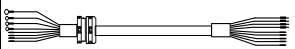
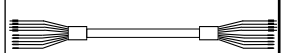
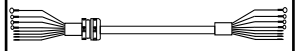
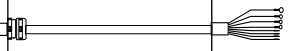
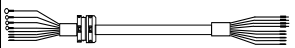
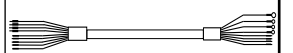
Motor type ADF 100	Connec. on drive	cable dia. A [mm²]	Ready-made cable for direct connections flex./ext. flex.	Components of the ready-made cable for direct connections: on the motor	cable flex./hochflex.	on the drive	Ready-made cables for intermediate clamping to terminal strip: on the motor flex./ext. flex.	on the drive flex./ext. flex.
	KDA TDA DDS					For...		
ADF100B-.-BS		10	IKL130/IKF130	INS172/10	INK205/INK405	...stud bolt M6 (KDA/TDA/DDS)	IKL134/IKF134	not available
ADF100D-.-AS ADF100D-.-CS		16	IKL159/IKF159	INS172/16	INK206/INK406	....stud bolt M6 (KDA/TDA/DDS)	IKL150/IKF150	not available
ADF100C-.-BS		25	IKL170/IKF170	INS172/25	INK207/INK407	....stud bolt M6 (KDA/TDA/DDS)	IKL179/IKF179	not available
	RAC2 RAC3 DKR02 DKR03					For...		
		6	IKL115/IKF115	INS172/06	INK204/INK404	...terminal block (RAC2/3, DKR2/3)	see left	not available
ADF100B-.-BS		10	IKL134/IKF134	INS172/10	INK205/INK405	...terminal block (RAC2/3, DKR2/3)	see left	not available
ADF100D-.-AS ADF100D-.-CS		16	IKL150/IKF150	INS172/16	INK206/INK406	...terminal block (RAC2/3, DKR2/3)	see left	not available
ADF100C-.-BS		25	IKL179/IKF179	INS172/25	INK207/INK407	...terminal block (RAC2/3, DKR2/3)	see left	not available

Symbols: plug-in power - connector; conduit threaded joint; ferrules; ring terminals

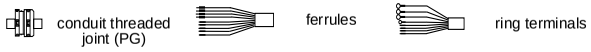
ADFKAB01

Fig 6.9: Ready-made motor power cable ADF 100

The cable diameters are dependent on the motor type. These are indicated in the relevant Technical Data section.

Motor type ADF 132/160 	Connec. to drive	Cable dia-meter A [mm²]	Ready-made cable for direct connections flex./ext. flex.	Components of the ready-made cable for direct connections: on the motor	Components of the ready-made cable for direct connections: cable flex./ext. flex.	Components of the ready-made cable for direct connections: on drive	Ready-made cables for intermediate clamping to terminal strip: on the mot. flex./ext. flex.	Ready-made cables for intermediate clamping to terminal strip: on the drive flex./ext. flex.
	KDA TDA DDS			Für... 		For...		
ADF132B-.-DS		10	IKL135/IKF135 (PG 29)	..stud M6 ⏚ M8	INK205/INK405	..stud M6 (KDA/TDA/DDS)	IKL136/IKF136	not avail.
ADF132B-.-BS		16	IKL157/IKF157 (PG 29)	..stud. M6 ⏚ M8	INK206/INK406	..stud M6 (KDA/TDA/DDS)	IKL151/IKF151	not avail.
ADF132C-.-ES ADF132C-.-BS ADF132D-.-AS		25	IKL174/IKF174 (PG 29)	.stud M8 ⏚ M8	INK207/INK407	..stud M6 (KDA/TDA/DDS)	IKL172/IKF172	not avail.
	RAC2 RAC3 DKR02 DKR03			For... 		For...		
ADF132B-.-DS		10	IKL136/IKF136 (PG 29)	..stud M6 ⏚ M8	INK205/INK405	...terminal block (RAC2/3, DKR2/3)	see left	not avail.
ADF132B-.-BS		16	IKL151/IKF151 (PG 29)	..stud M8 ⏚ M8	INK206/INK406	....terminal block (RAC2/3, DKR2/3)	see left	nnot avail.
ADF160C-.-BS		2x16	*)	..stud M10 ⏚ M10	INK206/INK406	....terminal block (RAC2/3, DKR2/3)	see left	not avail.
ADF132C-.-ES ADF132C-.-BS ADF132D-.-AS		25	IKL172/IKF172 (PG 36)	..stud M8 ⏚ M8	INK207/INK407	....terminal block (RAC2/3, DKR2/3)	see left	not avail.
ADF160B-.-BS ADF160B-.-CS		35	IKL182/ *) (PG 42)	..stud M10 ⏚ M10	INK267	....terminal block (RAC2/3, DKR2/3)	see left	not avail.
	RAC4 DKR04			For... 		For...		
		25	IKL 175/ IKF 175 (PG 48)	.. stud M12 ⏚ M12	INK207/INK407	...screw M12 (RAC4, DKR4)	*)	not avail.
		35	IKL 183/ *) (PG 48)	..stud M12 ⏚ M12	INK267/*)	...screw M12 (RAC4, DKR4)	*)	not avail.
		50	IKL 191/ *) (PG 42)	..stud M10 ⏚ M10	INK268/ *)	...screw M12 (RAC4, DKR4)	*)	not avail.

Symbols:



*) Available, request type code from INDRAMAT, Dept. ENT

ADFKAB02.FH3

Fig 6.10: Ready-made motor power cables ADF 132 and ADF 160

6.4. Terminal Diagram - Motor Feedback

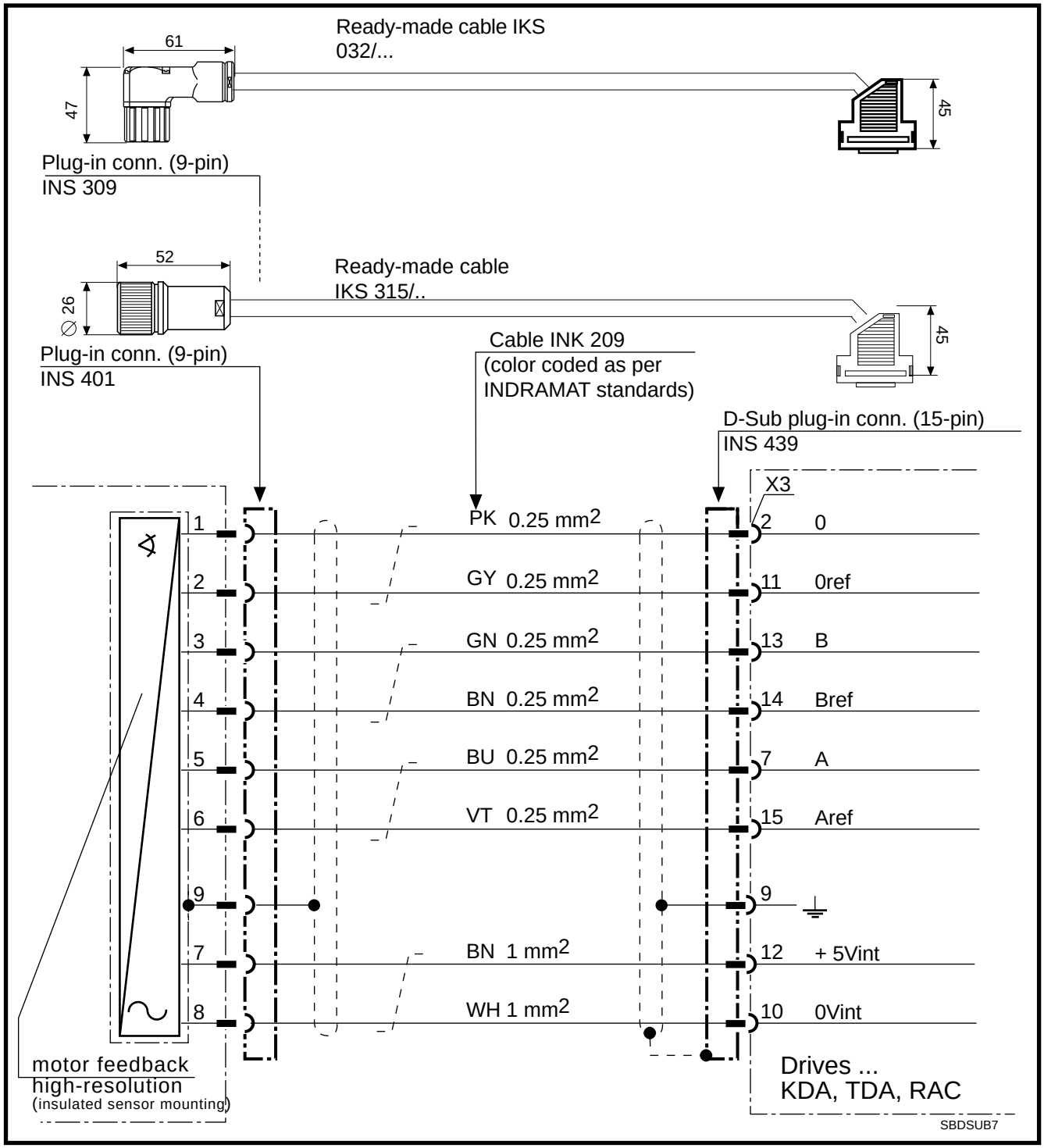


Fig 6.11: Terminal diagram - high-resolution motor feedback on KDA, TDA, RAC

Do not conduct the cable to the high-resolution motor feedback over a terminal strip as it is highly susceptible to interference!

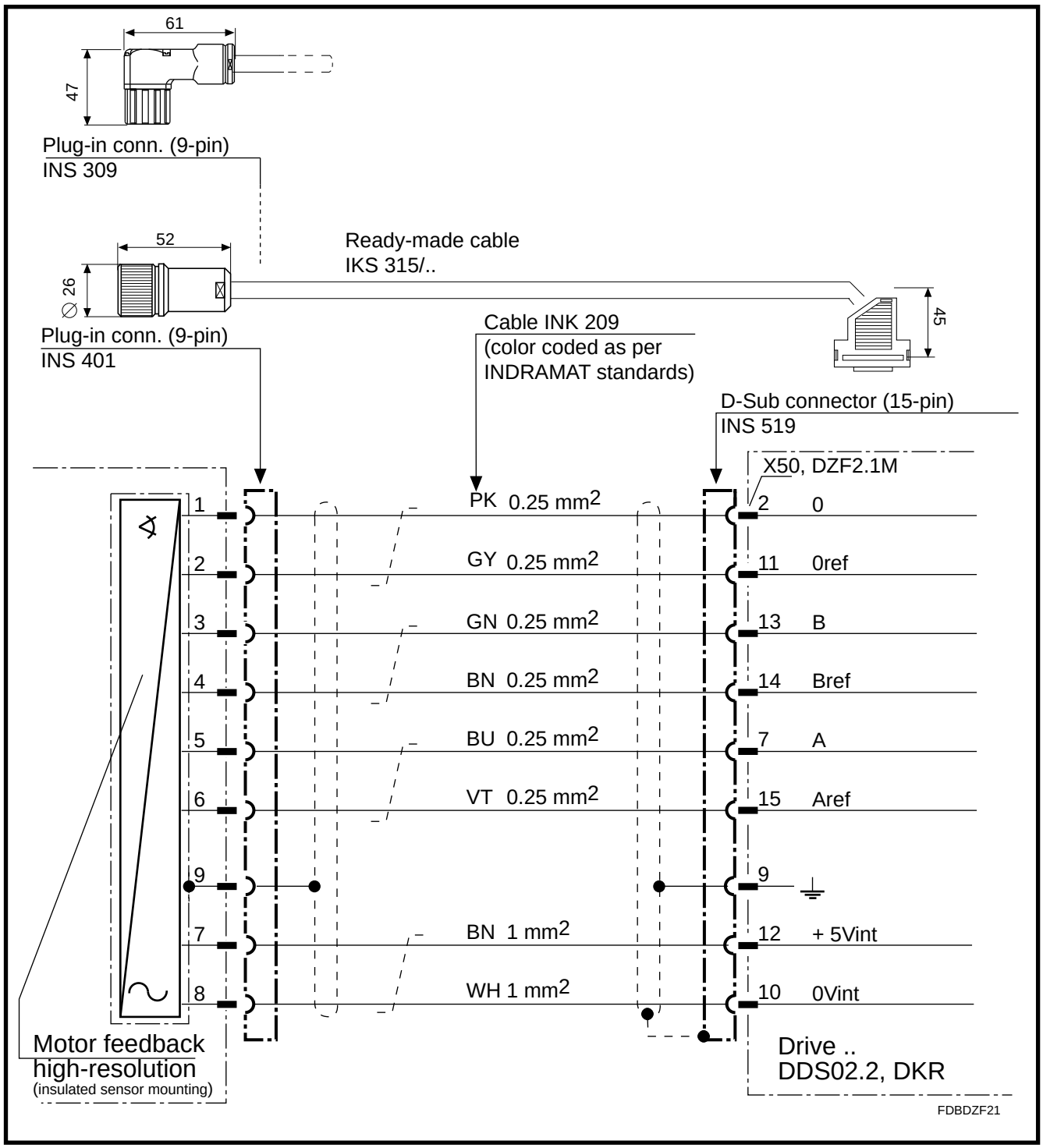


Fig 6.12: Terminal diagram - high resolution motor feedback on DDS02.2, DKR

Do not conduct the cable to the high-resolution motor feedback over a terminal strip as it is highly susceptible to interference!

6.5. Type Designations

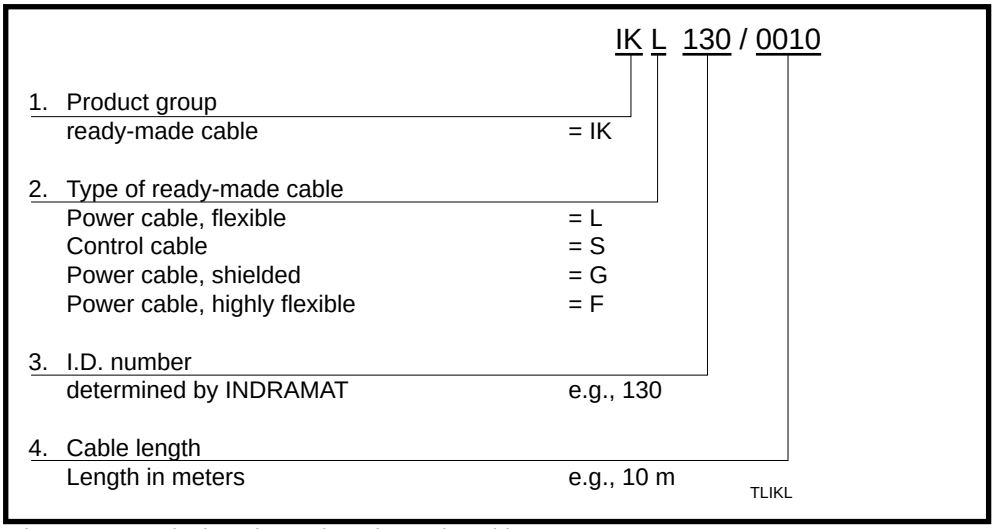


Fig 6.13: Type designations of ready-made cables

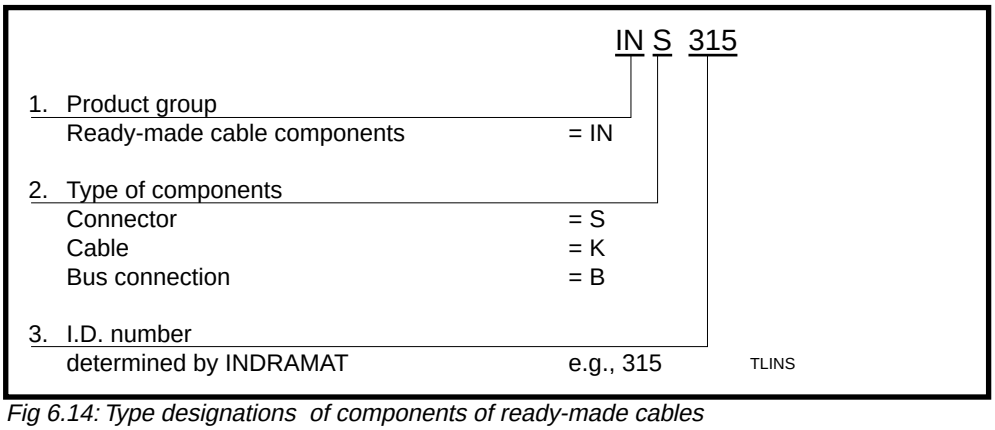


Fig 6.14: Type designations of components of ready-made cables

7. Condition at Delivery

The motor is packed onto a pallet or in cartons (depending on the number of or the size of the motors).

If a single motor is packed on a pallet, then it is secured by heavy-duty square timbered corners to prevent shifting and lashed with taut metal bands onto the pallet. If several motors are delivered at the same time, then up to three motors can be lashed onto one pallet. Styroform or cartons prevent them from colliding or impacting.

A carton is pulled over the items and fixed firmly into place with taut bands to protect them against inclement weather.

The items can be unpacked without damaging them by simply cutting through the bands.


Warning

Caution! There is considerable tension in the taut band!

There is the danger of injury from the uncontrolled movements of the taut bands when these are cut through!

Maintain a sufficient safety distance! Remove taut bands carefully!

There is an envelope with delivery slip attached to the carton. There is also a barcode sticker on the packaging.

8. Identifying the Merchandise

There is generally only one delivery slip supplied with each delivery. The delivery slip will list the merchandise, indicating the name of each item and the order number and designation. If the items listed are contained in several cartons (transport containers), then this will be noted on the delivery slip or freight slip.

Barcode Sticker

There is a barcode sticker on the packaging of the motor. If several motors are in one carton, then there is a sticker for each motor.

The barcode sticker helps identify the contents of the package and is required for consigment processing.

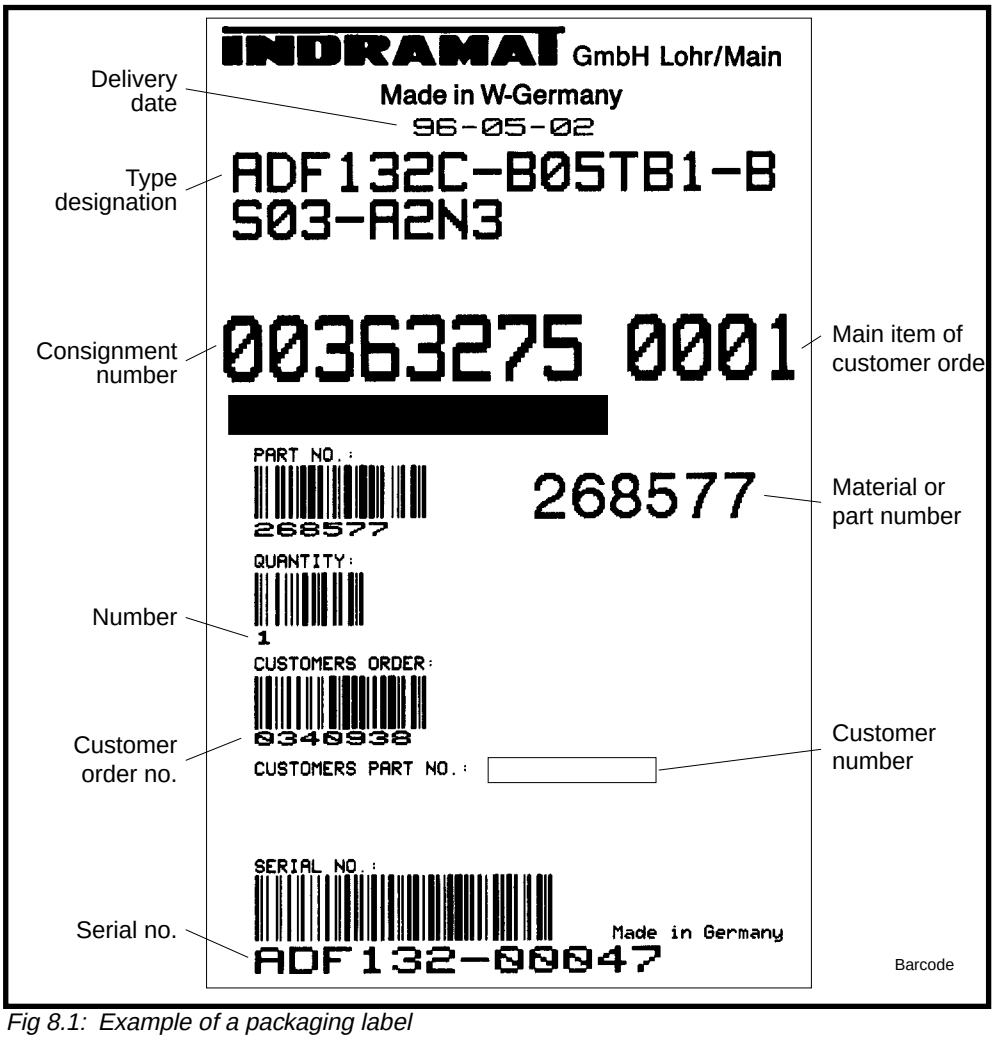


Fig 8.1: Example of a packaging label

Rating plate

There is a rating plate on the motor at the time of delivery. It is affixed to the motor housing.

If an additional rating plate is ordered, then it will be attached over the other one with double-sided tape.

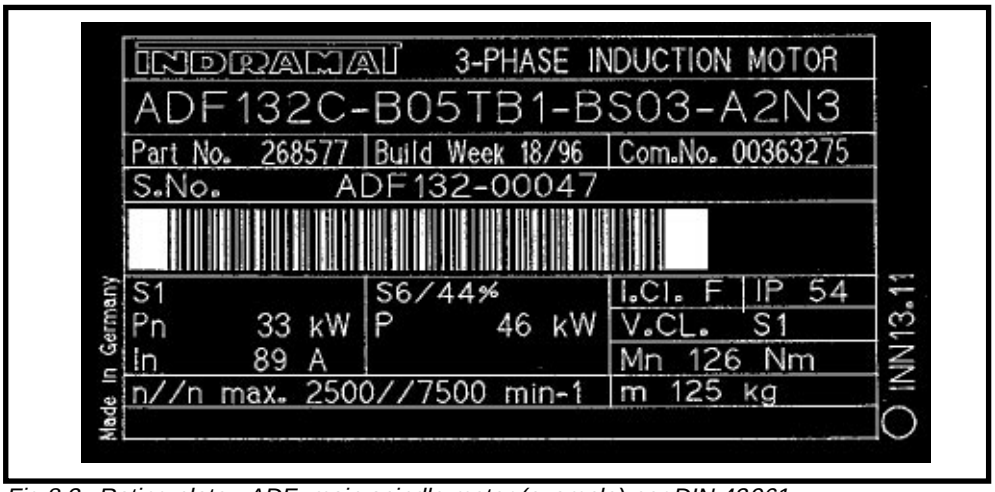


Fig 8.2: Rating plate - ADF main spindle motor (example) per DIN 42961

9. Storage, Transportation and Handling

There are guidelines on the storage and transport of the items printed on the packaging. These must be followed.

Achtung

Hochwertige Elektronik

Attention

Fragile Electronics

Vor Nässe schützen	**Nicht werfen**
nicht belasten	**Nicht kanten**
Do not apply load	**Do not tip**
Do not drop	**Keep dry**

Fig 9.1: Notes on storage and transport

Storing the Motors

The motors must be stored in a dust-free environment, protected against the hazard of impact. The permissible ambient temperature range is -25° to +85° C.

Plastic protective sleeves are placed over connector housing and output shaft. They serve to protect against moisture and mechanical damage. Do not remove these protective sleeves until the time of installation into the machine.

Transport and Handling

Avoid impacts to the output shaft and heavy loads on the shaft as these could damage the bearings in the motor.

When selecting the transportation and lifting devices, note the different weights and sizes of the individual motor types.

Pick the motor up only at the mounted eye bolts. If it is not picked up at these points, then the coolant inlet and outlet pipes can be damaged or destroyed!

Figure 9.2 depicts how the heavy motors should be lifted with the help of a crane and chains.

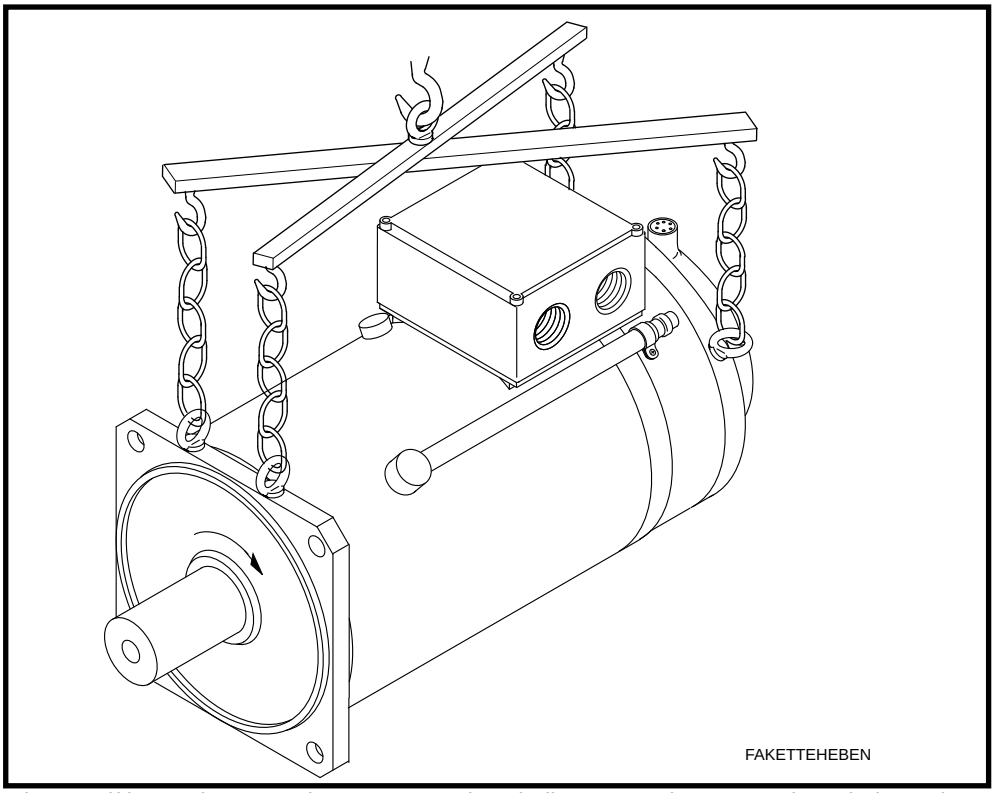


Fig 9.2: Lifting and transporting an ADF main spindle motor using appropriate chain equipment

10. Mounting and Installation Guidelines

The following guidelines should be complied with to avoid damaging the motor during commissioning and mounting.

- The larger and thus heavier motors may only be lifted and transported with the use of appropriate tools and devices as per section 11.
- Avoid shocks or impacts to the output shaft or impact stress to the shaft, as these may damage the bearing assembly of the motor.
- The motors may only be assembled and installed by properly trained personnel.
- The screwed caps on the connectors (motor power connector and feedback connector) must be screwed tightly into place when mounting.
- Ground the motor to the drive.
- Follow manufacturer's circuit diagrams when wiring the motor!
- The motor and the machine/facility may only be commissioned by trained personnel and under the supervision of an electrician.

11. Commissioning

The commissioning process is the same for all main spindle motors. It is described in Indramat’s main spindle motor documentation entitled, "AC Main Spindle Drives with Regulated Asynchronous Motors or Frameless Spindle Motors, Applications", doc. no. 209-0041-4109!

12. Service Guidelines

12.1. Contacting Customer Service

INDRAMAT customer service can be reached at the following hotline phone numbers at the times indicated.

Service-Hotline Phone no. 0172-6600406 or 0171-3338826

Monday - Friday 7.00 a.m. to 11.00 p.m.
Saturday 8.00 a.m. to 8 p.m.
Sundays and holidays 9.00 a.m. to 7 p.m.

Please note the following information prior to contact Indramat Customer Service.

- Type data of the drive and motor
- the faulty
- any and all fault or diagnostics displays.

This will help to rapidly and carefully locate the problem and eliminate it.

If a motor is returned, then please copy the repair card on the following page and return this, after it has been carefully filled out, with the motor. This will assist in locating the fault caused by this particular application.

12.2. Repair Report Card

Repair Report Card
for INDRAMAT equipment and components

Name:	Co./Loc.:		Date:
Part no. (by replacement of parts)		SN:	Del. cons. no.:
		SN:	Deliv. date:
Mach. manuf./co.:	Type:	Mach. no.:	Commissionig date (if applic.):
A x i s :	☐ horizontal ☐ vertical ☐	Op. time:	Date failed:

Fault status:

Fault _____

_____

☐ always present
☐ occurs sporadically
☐ occurs after ca. ___ hrs.
☐ occurs with vibrations
☐ temperature dependent
☐ other

_____
_____
_____

Additional notes:
(e.g., LED diagnostics,
error message in display)

_____
_____
_____
_____
_____
_____
_____
_____

Failure cause:

☐ unknown
☐ connection error
☐ ext. short
☐ mech. damage
☐ loose cable conn,
☐ other

_____
_____
_____

Supplementary Notes

General info:

☐ no functioning
☐ runs erratically
☐ uncontrolled drive movements
☐ fault in only one direction
☐ supply fuse tripped
☐ other

Concomitant phenomenon:

☐ Problems in mech. sys.
☐ Power section failed
☐ Control failed
☐ Motor failed
☐ Cable break
☐ other

Drive, Supply Unit, Drive, Power Section:

☐ Control voltage faulty
☐ Power sec. fuse F ___ failed
☐ Defective blower
☐ Defective bleeder resistor
☐ Faulty power voltage
☐ Conn. bolt torn off
☐ Other

Control:

☐ no functioning
☐ no display
☐ so setpoint output
☐ Diagnosis
☐ dim. offset in ___ direction
☐ interrupt in E-stop loop
☐ position control loop won't
☐ close
☐ error in program sequency
int. aux. function fault
☐ (outputs)
acknowledements not
☐ accepted (inputs)
other

_____
_____

Motor:

☐ Thermoelement defect
☐ Brake defect
☐ Blower defect
☐ Feedback defect
☐ Tachosignal faulty
☐ BLC signal faulty
☐ Short to ground
☐ Thermal overload
☐ other

_____
_____
_____
_____

Comments:

_____
_____
_____
_____
_____
_____
_____

PlRepBegl

Fig 12.1: Repair report card

13. Index