



INTORQ

setting the standard

INTORQ BFK470

Spring-applied brake with electromagnetic release

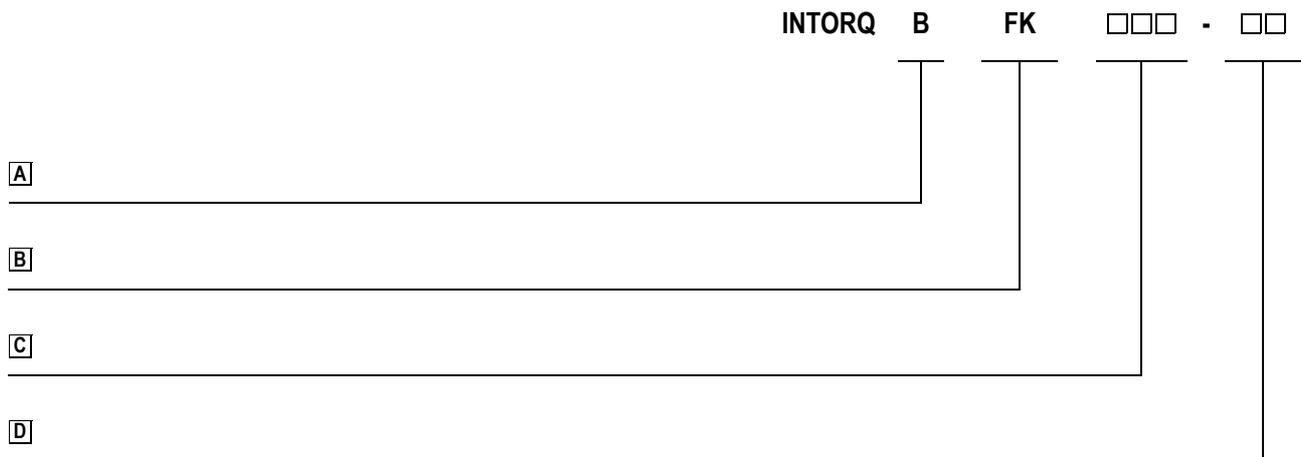
Translation of the Original Operating Instructions

www.intorq.com

This documentation applies to the:



Product key



Legend for the product key

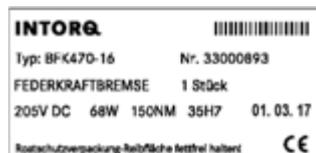
INTORQ BFK470

A	Product group	Brakes
B	Product type	Spring-applied brake
C	Type	470
D	Size	06, 08, 10, 12, 14, 16, 18

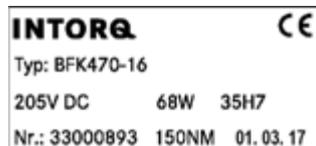
Not coded: Connection voltage, hub bore hole, options

Identification

Packaging label	Example
Manufacturer	Bar code
Type (see product key)	Type No.
Designation	Qty. per box
Rated voltage Rated power Rated torque Hub diameter	Packaging date
Addition	CE mark



Name plate	Example
Manufacturer	CE mark
Type (see product key)	
Designation	
Rated voltage Rated power Hub diameter	
Type No. Rated torque Date of manufacture	



Document history

Material number	Version			Description
33001439	1.0	01/2012	TD09	First edition
33001439	1.1	03/2012	TD09	Supplemented the technical data
33001439	1.2	10/2012	TD09	Added to the "Brake assembly" chapter Updated the "Abbreviations used" table Supplemented the characteristics, rated data and switching times
33001439	2.0	05/2013	TD09	Degree of protection changed Added note about the end shield characteristics Shaft characteristic defined, "Mechanical installation" chapter "Checking the brake" chapter (maintenance and repair) supplemented
33001439	3.0	05/2013	TD 09	Text with regard to the disengagement time updated
33001439	3.1	03/2014	SC	Restructured FM; note concerning brake sealing 23
33001439	4.0	01/2015	SC	Harmonized connection diagrams
33001439	5.0	07/2016	SC	Additional sizes: 06, 08, 10, 12
33001439	6.0	03/2017	SC	Corrosion protection class; change to table on page 18

Refer to www.intorq.de for the latest version of these operating instructions.

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1 Preface and general information

1.1 About these Operating Instructions

- These Operating Instructions will help you to work safely with the spring-applied brake with electromagnetic release. They contain safety instructions that must be followed.
- All persons working on or with electromagnetically released spring-applied brakes must have the Operating Instructions available and observe the information and notes relevant for them.
- The Operating Instructions must always be in a complete and perfectly readable condition.

1.2 Terminology used

Term	In the following text used for
Spring-applied brake	Spring-applied brake with electromagnetic release
Drive system	Drive systems with spring-applied brakes and other drive components

1.3 Conventions in use

This document uses the following styles to distinguish between different types of information:

Spelling of numbers	Decimal separator	Point	The decimal point is always used. For example: 1234.56
Symbols	Page reference		Reference to another page with additional information For example:  16 = refer to page 16
	Wildcard	<input type="checkbox"/>	Wildcard for options, selections For example: BFK458- <input type="checkbox"/> <input type="checkbox"/> = BFK458-10
	Note		Important notice about ensuring smooth operations or other key information.

1.4 Abbreviations used

Letter symbol	Unit	Designation
F_R	N	Rated frictional force
I	A	Current
I_H	A	Holding current, at 20 °C and holding voltage
I_L	A	Release current, at 20 °C and release voltage
I_N	A	Rated current, at 20 °C and rated voltage
M_A	Nm	Tightening torque of fastening screws
M_{dyn}	Nm	Braking torque at a constant speed of rotation
M_K	Nm	Rated torque of the brake, rated value at a relative speed of rotation of 100 rpm
n_{max}	rpm	Maximum occurring speed of rotation during the slipping time t_3
P_H	W	Coil power during holding, after voltage change-over and 20 °C
P_L	W	Coil power during release, before voltage change-over and 20 °C
P_N	W	Rated coil power, at rated voltage and 20 °C
Q	J	Quantity of heat/energy
Q_E	J	Max. permissible friction energy for one-time switching, thermal parameter of the brake
Q_R	J	Braking energy, friction energy
Q_{Smax}	J	Maximally permissible friction energy for cyclic switching, depending on the operating frequency
R_N	Ohms	Rated coil resistance at 20 °C
S_h	1/h	Switching frequency: the number of switching operations evenly spread over the time unit
S_{hue}	1/h	Transition operating frequency, thermal parameter of the brake
S_{hmax}	1/h	Maximum permissible operating frequency, depending on the friction energy per switching operation
S_L	mm	Air gap: the lift of the armature plate while the brake is switched
S_{LN}	mm	Rated air gap
S_{Lmin}	mm	Minimum air gap
S_{Lmax}	mm	Maximum air gap
t_1	ms	Engagement time, sum of the delay time and braking torque - rise time $t_1 = t_{11} + t_{12}$
t_2	ms	Disengagement time, time from switching the stator until reaching 0.1 M_{dyn}
t_3	ms	Slipping time, operation time of the brake (according to t_{11}) until standstill

Letter symbol	Unit	Designation
t_{11}	ms	Delay during engagement (time from switching off the supply voltage to the beginning of the torque rise)
t_{12}	ms	Rise time of the braking torque, time from the start of torque rise until reaching the braking torque
t_{ue}	s	Overexcitation period
U	V	Voltage
U_H	V DC	Holding voltage, after voltage change-over
U_L	V DC	Release voltage, before voltage change-over
U_N	V DC	Rated coil voltage; in the case of brakes requiring a voltage change-over, U_N equals U_L

1.5 Safety instructions and notices

The following icons and signal words are used in this document to indicate dangers and important safety information:

Safety instructions

Structure of safety instructions:

	 SIGNAL WORD
	Icon Indicates the type of danger
	Signal word Characterises the type and severity of danger
	Note Describes the danger
	Possible consequences ■ List of possible consequences if the safety instructions are disregarded.
	Protective measure ■ List of protective measures to avoid the danger.

Danger level

	<p> DANGER</p> <p>DANGER indicates a hazardous situation which, if not avoided, <i>will</i> result in death or serious injury.</p>
	<p> WARNING</p> <p>WARNING indicates a potentially hazardous situation which, if not avoided, <i>could</i> result in death or serious injury.</p>
	<p> CAUTION</p> <p>CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</p>
	<p>NOTICE</p> <p>Notice about a harmful situation with possible consequences: the product itself or surrounding objects could be damaged.</p>

1.6 Scope of delivery

After receipt of the delivery, check immediately whether the items delivered match the accompanying papers. INTORQ does not accept any liability for deficiencies claimed subsequently.

- Claim visible transport damage immediately to the deliverer.
- Claim visible deficiencies or incomplete deliveries immediately to INTORQ GmbH & Co. KG.

1.7 Disposal

The spring-applied brake consists of different types of material.

- Recycle metals and plastics.
- Ensure professional disposal of assembled PCBs according to the applicable environmental regulations.

1.8 Drive systems

Labelling

Drive systems and components are unambiguously designated by the indications on the name plate.

Manufacturer: INTORQ GmbH & Co. KG, Wülmser Weg 5, D-31855 Aerzen, Germany

1.9 Legal regulations

Liability

- The information, data and notes in these Operating Instructions are up to date at the time of printing. Claims referring to drive systems which have already been supplied cannot be derived from this information, illustrations and descriptions.
- We do not accept any liability for damage and operating interference caused by:
 - inappropriate use
 - unauthorised modifications to the product
 - improper work on or with the drive system
 - operating errors
 - disregarding the documentation

Warranty

- Terms of warranty: Refer to the terms of sale and delivery for INTORQ GmbH & Co. KG.
- Warranty claims must be made to INTORQ immediately after the defects or faults are detected.
- The warranty is void in all cases when liability claims cannot be made.

2 Safety instructions

2.1 General safety instructions

- INTORQ components ...
 - ... must only be used as directed.
 - ... must not be commissioned if they are noticeably damaged.
 - ... must not be technically modified.
 - ... must not be commissioned if they are incompletely mounted or connected.
 - ... must not be operated without the required covers.
 - ... may contain moving parts or parts with live voltage during operations, according to their degree of protection. Surfaces may be hot.
- For INTORQ components ...
 - ... the documentation must always be kept at the installation site.
 - ... only permitted accessories may be used.
 - ... only original spare parts from the manufacturer may be used.
- Follow all specifications and information found in the corresponding enclosed documentation. These must be followed to maintain safe, trouble-free operations and to achieve the specified product characteristics.
- Only qualified, skilled personnel are permitted to work on and with INTORQ components. According to IEC 60364 or CENELEC HD 384, qualified, skilled personnel are persons ...
 - ... who are familiar with the installation, mounting, commissioning, and operation of the product.
 - ... who have the qualifications necessary for their job.
 - ... who know and apply all regulations for the prevention of accidents, directives, and laws relevant on site.
- Risk of burns!
 - Surfaces may be hot during operation! Provide for protection against accidental contact.
- Risk of injury due to a rotating shaft!
 - Wait until the motor is at standstill before you start working on the motor.
- The friction lining and the friction surfaces must never contact oil or grease since even small amounts reduce the braking torque considerably.
- The brake is designed for operation under the environmental conditions that apply to IP66 protection. Because of the numerous possibilities of using the brake, it is still necessary to check the functionality of all mechanical components under the corresponding operating conditions.

2.2 Application as directed

- INTORQ components ...
 - ... are intended for use in machinery and systems.
 - ... must only be used for the purposes ordered and confirmed.
 - ... must only be operated under the ambient conditions prescribed in these Operating Instructions.
 - ... must not be operated beyond their corresponding power limits.

Any other use or excessive usage shall be deemed improper!

Possible applications of the INTORQ spring-applied brake

- No potentially explosive or aggressive atmosphere.
- Humidity: no restrictions
- Ambient temperature:
 - Standard design: -20 °C to +50 °C
 - Optional CCV design: -40 °C to +50 °C

3 Technical specifications

3.1 Product description

3.1.1 Structure and function

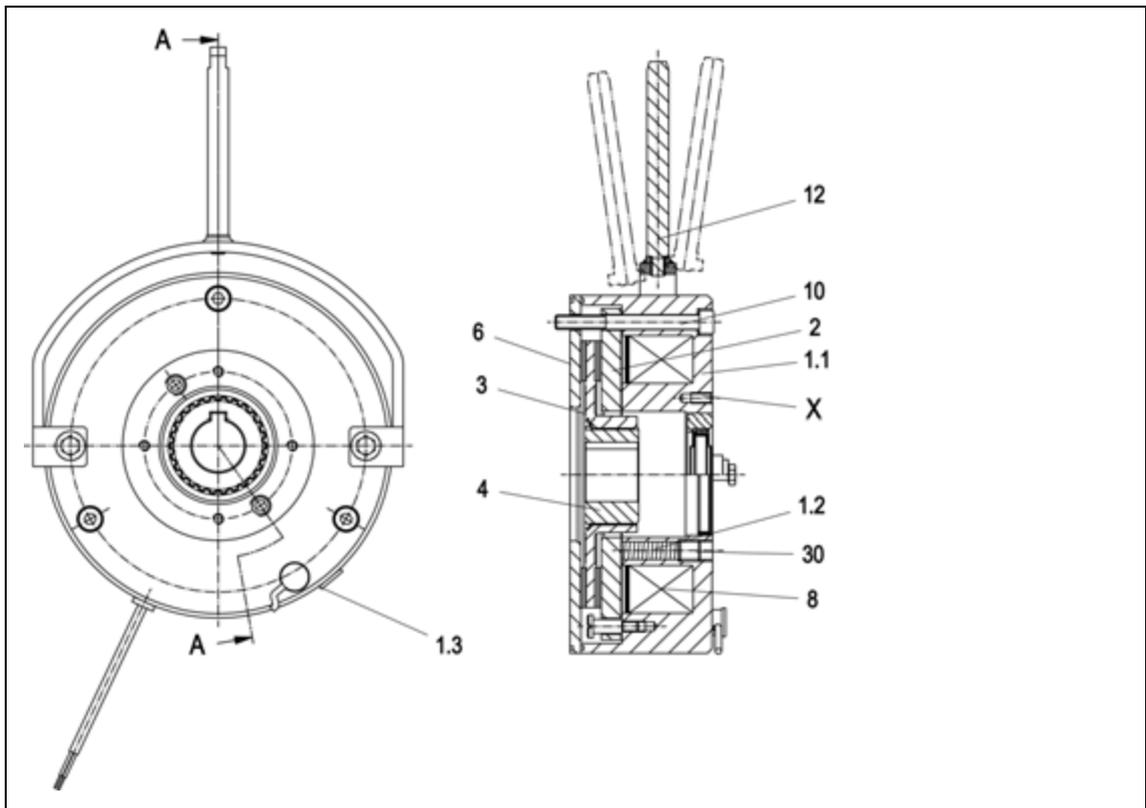


Abb.1 Design of a BFK470 spring-applied brake

1.1 Stator	3 Complete rotor	10 Socket head cap screw, DIN EN ISO 4762
1.2 Pressure springs	4 Hub	12 Complete hand-release (optional)
1.3 Plug (check for air gap)	6 Flange (optional)	30 Setting screw for the factory-set adjustment of the spring force (sealed), applies only to sizes 12-18
2 Armature plate	8 Coil	X Bore holes are optional

This brake is an electrically releasable spring-applied brake with a rotating brake disc (rotor) that is equipped on both sides with friction linings. In its de-energised state, the rotor is clamped with braking force applied by pressure springs between the armature plate and a counter friction surface. This corresponds to a fail-safe functionality.

The brake torque applied to the rotor is transferred to the input shaft via a hub that has axial gear teeth.

The brake can be used as a holding brake, as an operating brake, and as an emergency stop brake for high speeds.

The asbestos-free friction linings ensure a safe braking torque and low wear. In addition to the powerful standard friction linings, there are also special friction linings for a range of different applications, such as those with high wear resistance or an increased friction coefficient.

To release the brake, the armature plate is released electromagnetically from the rotor.

The rotor, shifted axially and balanced by the spring force, can rotate freely.



NOTICE

The BFK470 is a sealed brake (with IP66 protection) with an optional sealed hand-release.

Due to the structural design of the stator, the air gap cannot be installed downstream.

If the wear limit is reached, the rotor must be replaced.

Project planning notes

- When designing a brake for specific applications, torque tolerances, the limiting speeds of the rotors, the thermal resistance of the brake, and the effect of environmental influences must all be taken into account.
- The brakes are dimensioned in such a way that the specified rated torques are reached safely after a short run-in period.
- However, as the organic friction linings used do not all have identical properties and because environmental conditions can vary, deviations from the specified braking torques are possible. These must be taken into account in the form of appropriate dimensioning tolerances. Increased breakaway torque is common in particular after long downtimes in humid environments where temperatures vary.
- If the brake is used as a pure holding brake without any dynamic load, the friction lining must be reactivated regularly.

3.2 Rated data

Type	Max. speed of rotation ¹⁾ n _{max} [rpm]	Temperature class Stator	Duty cycle [%]	Moment of inertia Rotor [kgcm ²]	Mass of brake			
					without flange [kg]	with Flange [kg]	without flange + Hand-release [kg]	With flange + Hand-release [kg]
BFK470-06	6000	F (155°C)	100	0.15	1.3	1.5	1.4	1.6
BFK470-08	5000	F (155°C)	100	0.61	2.0	2.2	2.1	2.3
BFK470-10	4000	F (155°C)	100	2.0	3.5	3.9	3.7	4.0
BFK470-12	3600	F (155°C)	100	4.5	5.0	5.6	5.3	5.8
BFK470-14	3600	F (155°C)	100	6.3	7.7	8.5	8.1	8.9
BFK470-16	3600	F (155°C)	100	15.0	11.9	13.1	12.5	13.7
BFK470-18	3600	F (155°C)	100	29.0	17.6	19.1	18.6	20.0

Tab. 1: General brake characteristics

¹⁾ Maximum speed of rotation when installed horizontally (for higher speeds, contact the manufacturer)

Type	Air gap			Rotor thickness		
	s _{LN} [mm]	s _{L max}		Min.		New state [mm]
		Operating brake [mm]	Holding brake [mm]	Operating brake [mm]	Holding brake [mm]	
BFK470-06	0.2 ^{+0.08} _{-0.05}	0.5	0.3	5.73	5.93	6.0 _{-0.05}
BFK470-08	0.2 ^{+0.08} _{-0.05}	0.5	0.3	6.73	6.93	7.0 _{-0.05}
BFK470-10	0.2 ^{+0.13} _{-0.05}	0.5	0.35	8.73	8.88	9.0 _{-0.1}
BFK470-12	0.3 ^{+0.08} _{-0.10}	0.6	0.45	9.68	9.83	10.0 _{-0.1}
BFK470-14	0.3 ± 0.1	0.75	0.45	9.55	9.85	10.0 _{-0.1}
BFK470-16	0.3 ^{+0.15} _{-0.05}	0.80	0.50	11.05	11.35	11.5 _{-0.1}
BFK470-18	0.4 ^{+0.20} _{-0.10}	1.0	0.65	12.50	12.85	13.0 _{-0.1}

Tab. 2: Air gap / rotor thickness

Type	Outer diameter [mm]	Pitch hole circle		Fastening screws DIN EN ISO 4762		Minimum thread depth		Tightening torque M_a [Nm]
		\varnothing [mm]	Thread	without flange [mm]	with flange [mm]	without flange [mm]	with flange [mm]	
BFK470-06	89	72	M4	3 x M4x40	3 x M4x45	7.5	9.0	3.0
BFK470-08	106	90	M5	3 x M5x45	3 x M5x50	10.5	10.0	5.9
BFK470-10	130	112	M6	3 x M6x55	3 x M6x60	14.0	13.5	10.1
BFK470-12	148	132	M6	3 x M6x60	3 x M6x65	12.5	12.5	10.1
BFK470-14	168	145	M8	3 x M8x75	3 x M8x80	19.5	18.5	24.6
BFK470-16	200	170	M8	3 x M8x80	3 x M8x85	18.0	17.0	24.6
BFK470-18	226	196	M8	6 x M8x90	6 x M8x100	19.5	23.0	24.6

Tab. 3: Installation data

	 CAUTION
	<ul style="list-style-type: none"> ■ The minimum thread depth of the end shield must be maintained!  Tab. 3. ■ If the required thread depth is not maintained, the fastening screws may run onto the root. This has the effect that the required pre-load force is no longer established – the brake is no longer securely fastened! ■ The material of the end shield must have a tensile strength of $R_m \geq 250 \text{ N/mm}^2$.

3.3 Rated data (dimensioning data) electrical data

Type	Electrical power $P_{20}^{1)}$ [W]	Coil voltage U [V]	Coil resistance R_{20} $\pm 8\%$ [Ω]	Rated current I_N [A]
06	20	12	7.2	1.667
		20	20.0	1.000
		24	28.8	0.833
		32	51.2	0.625
		42	88.2	0.476
		70	245.0	0.286
		96	460.8	0.208
		103	530.5	0.194
	127	806.0	0.158	
	21	150	1071.0	0.140
	20	170	1445.0	0.118
		180	1620.0	0.111
		190	1805.0	0.105
		215	2311.0	0.093
205		2101.0	0.098	
225		2531.0	0.089	
23	250	2717.0	0.092	
08	25	12	5.76	2.083
	20	24	28.8	0.833
	25	20	16.0	1.250
		32	40.96	0.781
		42	70.56	0.595
		70	196.0	0.357
		96	368.6	0.260
	20	103	530.5	0.194
	27	127	597.4	0.213
	25	150	900.0	0.167
		170	1156.0	0.147
	20	180	1620.0	0.111
	25	190	1444.0	0.132
	20	205	2101.0	0.098
	25	215	1849.0	0.116
		225	2025.0	0.111
	27	250	2314.0	0.108

Tab. 4: Rated data for coil power

Type	Electrical power $P_{20}^{1)}$ [W]	Coil voltage U [V]	Coil resistance R_{20} $\pm 8\%$ [Ω]	Rated current I_N [A]
10	30	12	4.8	2.500
		20	13.33	1.500
		24	19.2	1.250
		32	34.1	0.938
		42	58.8	0.714
		70	163.3	0.429
	31	96	297.3	0.323
	32	103	331.5	0.311
	30	127	537.6	0.236
		150	750.0	0.200
		170	963.3	0.176
	32	180	1013.0	0.178
	30	190	1203.0	0.158
	33	205	1273.0	0.161
	30	215	1540.83	0.140
32	225	1582.0	0.142	
30	250	2083.0	0.120	
12	40	12	3.6	3.333
		20	10.0	2.000
		24	14.4	1.667
	40.5	32	25.26	1.267
	40	42	44.128	0.952
		70	122.5	0.571
		96	230.4	0.417
		103	265.2	0.388
		127	403.2	0.315
		150	562.5	0.267
		170	722.5	0.235
		180	810.0	0.222
		190	902.5	0.211
		205	1051.0	0.195
		215	1156.0	0.186
225	1266.0	0.178		
42	250	1488.0	0.168	

Tab. 4: Rated data for coil power

Type	Electrical power P_{20} ¹⁾ [W]	Coil voltage U [V]	Coil resistance R_{20} $\pm 8\%$ [Ω]	Rated current I_N [A]	
14	61	24	9.443	2.542	
		103	176.817	0.583	
	60	180	540.0	0.333	
		63	205	667.063	0.307
			288	1316.571	0.219
16	68	24	8.471	2.833	
		103	156.015	0.660	
		180	476.471	0.378	
		205	618.015	0.332	
		288	1219.765	0.236	
18	85	24	6.776	3.542	
		103	124.8	0.825	
		180	381.176	0.472	
		205	494.412	0.415	

Tab. 4: Rated data for coil power

¹⁾ Coil power at 20°C in W, deviation up to +10% is possible depending on the selected connection voltage.

Type	Braking torques at relative speed of rotation Δn				
	Rated torque [NM] 100 rpm	Brake torque X [%] of the rated torque			Maximum speed horizontal mounting position rpm
1.500 rpm		3000 rpm	maximum		
BFK470-06	2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.5, 6.0, 6.5, 7.0, 7.5	87	80	74	6000
BFK470-08	3.5 / 5 / 6 / 7 / 8 / 10 / 11 / 12 / 14 / 15	85	78	73	5000
BFK470-10	9 / 11 / 14 / 16 / 18 / 21 / 23 / 25 / 28 / 30 / 33 / 36	83	76		4000
BFK470-12	12 / 14 / 15 / 16 / 18 / 23 / 27 / 32 / 36 / 40 / 45 / 46 / 48 / 50 / 55	81	74	72	3600
BFK470-14	40 / 50 / 60 / 65 / 70 / 75 / 80 / 100 / 110	80	73		
BFK470-16	55 / 70 / 80 / 90 / 100 / 105 / 125 / 150	79	72		
BFK470-18	100 / 125 / 150 / 165 / 185 / 200 / 235 / 250	77	70		

Tab. 5: Rated torques

Switching times

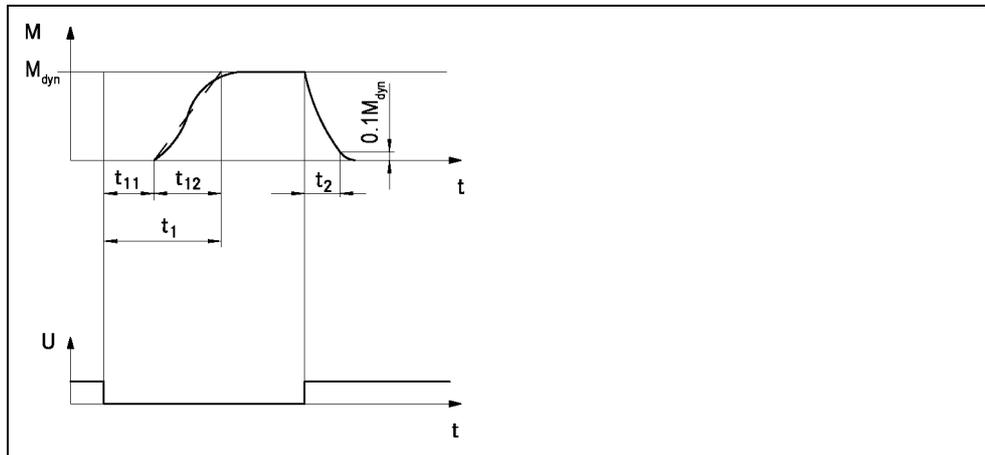


Fig. 2 Operating/switching times of the spring-applied brakes

- t_1 Engagement time
- t_2 Disengagement time (up to $M = 0.1 M_{dyn}$)
- M_{dyn} Rated torque
- t_{11} Reaction delay of engagement
- t_{12} Rise time of the braking torque
- U Voltage

Type	Rated torque M_K [NM]	Max. perm. switching energy Q_E [J]	Transitional switching frequency S_{hue} [h ⁻¹]	Switching times [ms] ¹⁾ at s_{LN} and $0.7 I_N$			
				DC engagement ²⁾			Disengage t_2
				t_{11}	t_{12}	t_1	
BFK470-06	4	3000	79	16	25	41	32
BFK470-08	8	7500	50	30	26	56	52
BFK470-10	16	12000	40	40	46	86	107
BFK470-12	32	24000	30	47	34	81	121
BFK470-14	60	30000	28	30	47	76	162
BFK470-16	80	36000	27	46	62	109	225
BFK470-18	150	60000	20	62	92	155	343

Tab. 6: Switching energy - operating frequency - operating times

¹⁾ Typical values

²⁾ Measured with induced voltage limitation of -800 V DC

Engagement time

The transition from brake-torque free state to holding braking torque is not free of time lags.

- The engagement times are valid for DC switching with a spark suppressor.
 - Spark suppressors are available for the rated voltages.
 - Connect the spark suppressors in parallel to the contact. If this switching is not admissible for safety reasons (e.g. with hoists and lifts), the spark suppressor can also be connected in parallel to the brake coil.
 - Circuit proposals:  28
- The engagement times are approx. 10 times longer with AC switching.
 - Connection:  28

Disengagement time

The disengagement time is the same for DC-side and AC-side switching. The disengagement time can be shortened by special equipment for fast-response excitation or overexcitation.

3.4 Switching energy / operating frequency

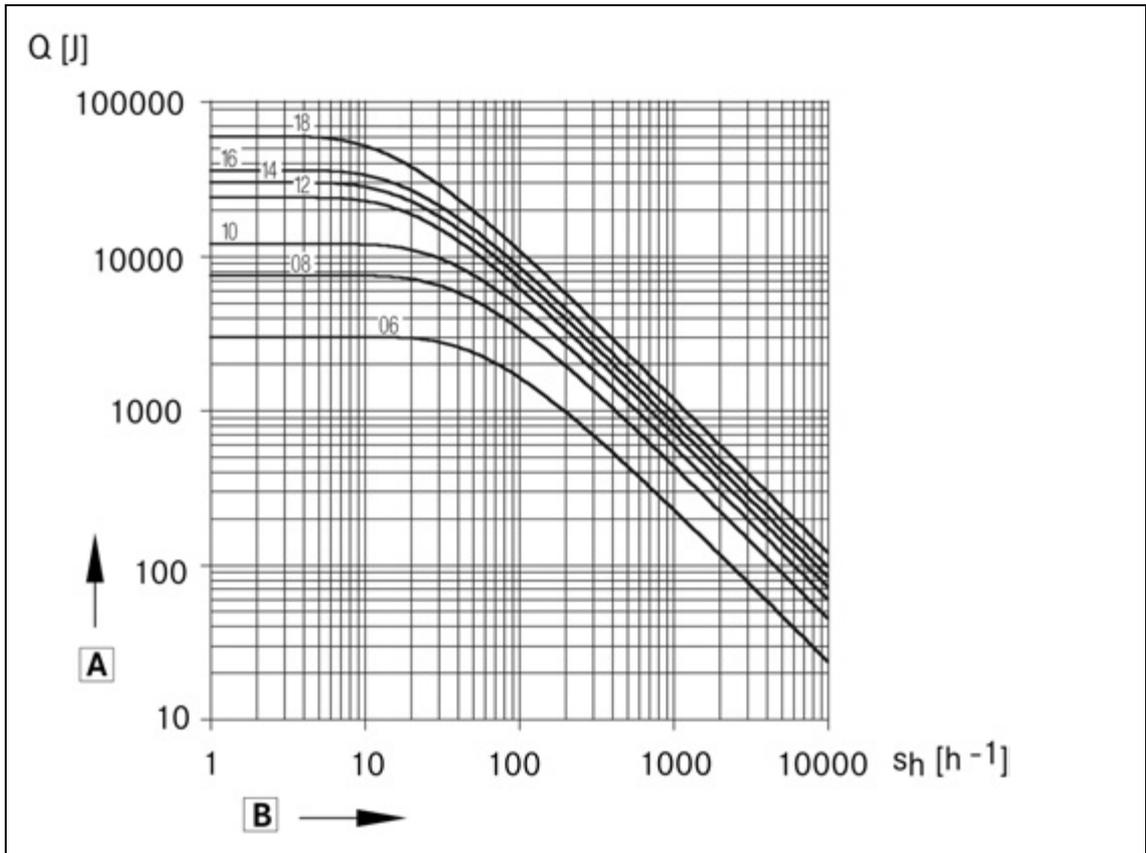


Fig. 3 Switching energy as a function of the switching frequency

A Switching energy

B Switching frequency

$$S_{hmax} = \frac{-S_{hue}}{\ln\left(1 - \frac{Q_R}{Q_E}\right)}$$

$$Q_{smax} = Q_E \left(1 - e^{-\frac{S_{hue}}{S_h}} \right)$$

The permissible switching frequency S_{hmax} depends on the amount of heat Q_R (refer to Figure 3). At a pre-set switching frequency S_h , the permissible amount of heat is Q_{smax} .

With high speeds of rotation and switching energy, the wear increases strongly, because very high temperatures occur at the friction surfaces for a short time.

3.5 Emissions

Electromagnetic compatibility

**NOTICE**

The user must ensure compliance with EMC Directive 2004/108/EC using appropriate controls and switching devices.

If an INTORQ rectifier is used for the DC switching of the spring-applied brake and if the switching frequency exceeds five switching operations per minute, the use of a mains filter is required.

If the spring-applied brake uses a rectifier of another manufacturer for the switching, it may become necessary to connect a spark suppressor in parallel with the AC voltage. Spark suppressors are available on request, depending on the coil voltage.

Heat

Since the brake converts kinetic energy as well as mechanical and electrical energy into heat, the surface temperature varies considerably, depending on the operating conditions and possible heat dissipation. Under unfavourable conditions, the surface temperature can reach 130 °C.

Noise

The switching noise during engagement and disengagement varies depending on the air gap, braking torque and brake size.

Depending on the natural oscillation after installation, operating conditions and the state of the friction surfaces, the brake may squeak during braking.

Others

The abrasion of the friction parts produces dust.

4 Mechanical installation

4.1 Important notes

4.1.1 Design of end shield and motor shaft

- Comply with the mentioned minimum requirements regarding the end shield and the motor shaft to ensure a correct function of the brake.
- The diameter of the shaft shoulder must not be greater than the tooth root diameter of the hub.
- The form and position tolerances apply only to the materials mentioned. Contact INTORQ if you are using other materials.
- The brake flange must be supported by the end shield across the full surface.

Design of the end shield

Type	Minimum requirements: Use as counter friction surface					
	Material	Flatness [mm]	Axial run-out [mm]	Roughness		Others
				without flange	with flange	
BFK470-06	S235JR; C15; EN-GJL-250	≤ 0.03	0.05	Rz 10	Rz 16	<ul style="list-style-type: none"> ■ Threaded holes with minimum thread depth  15 ■ Free of grease and oil
BFK470-08						
BFK470-10						
BFK470-12		≤ 0.05				
BFK470-14		≤ 0.08				
BFK470-16		≤ 0.10	0.08			
BFK470-18						

Tab. 7: End shield as counter friction surface

4.1.2 Necessary tools

Type	Torque wrench  Measuring range [Nm]	Bit for hexagon socket screws  Wrench width [mm] *
BFK470-06	1 - 12	3
BFK470-08		4
BFK470-10		5
BFK470-12		
BFK470-14	20 - 100	6
BFK470-16		
BFK470-18		

* For attaching flange inner bit with pin guide

Multimeter	Calliper gauge	Feeler gauge
		

4.2 Assembly

4.2.1 Preparation

1. Unpack the spring-applied brake.
2. Check for completeness.
3. Verify the name plate data (especially the rated voltage).

4.2.2 Brake assembly

	NOTICE
	The toothed hub and screws must not be lubricated with grease or oil.

Installation of the hub onto the shaft



NOTICE

The customer is responsible for dimensioning the shaft-hub connection. Make sure that the supporting length of the key is identical to the length of the hub.



NOTICE

Check the tensile strength of the hub material: When operating with high torque, consult with INTORQ and use a steel hub with a higher tensile strength.

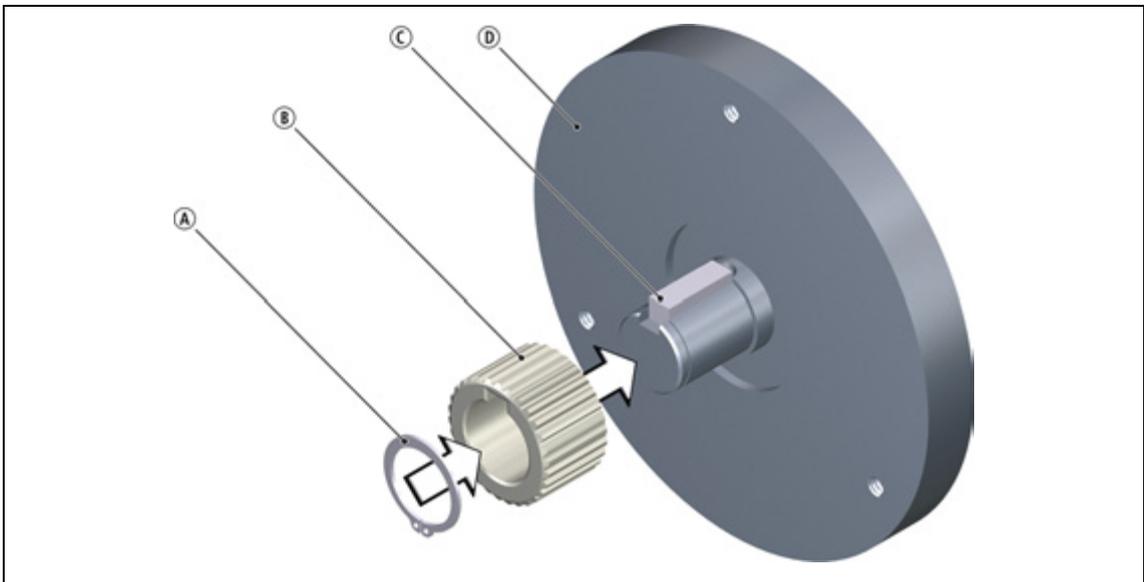


Fig. 4 Mounting the hub onto the shaft

- | | | |
|--------------|-------|-------|
| A Circlip | B Hub | C Key |
| D End shield | | |

1. Press the hub with a moderate amount of force to the shaft.

Secure the hub against axial displacement (for example, by using a circlip).

	NOTICE
	If you are using the spring-applied brake for reverse operations, glue the hub to the shaft.

Mounting the flange

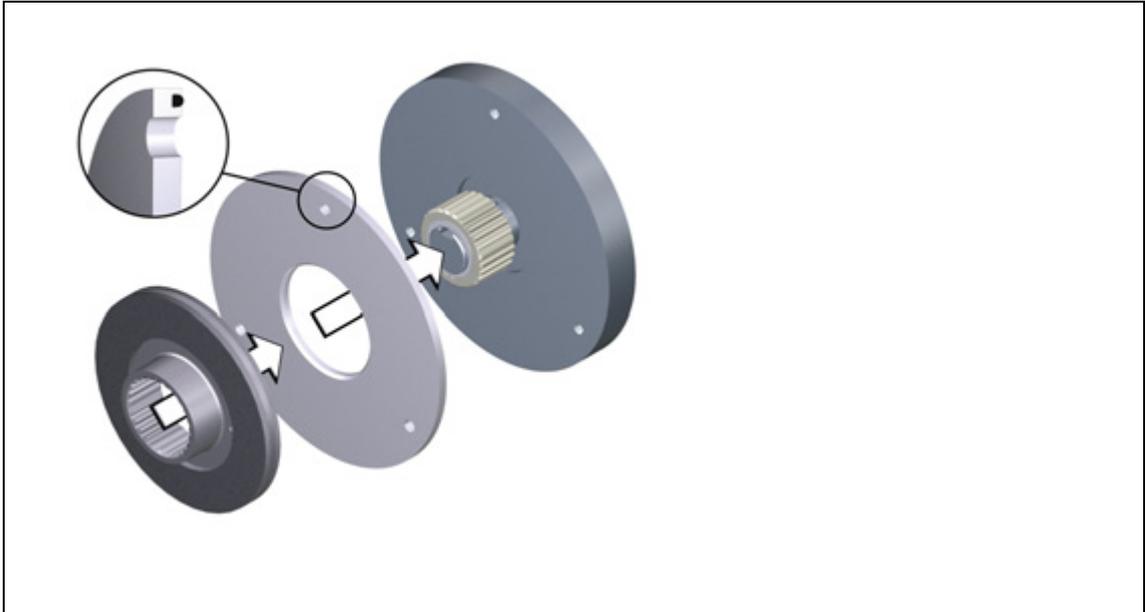


Fig. 5 Flange and rotor mounting

1. If required, slide the optional flange (6) onto the shaft.
 - The chamfer on the flange must point towards the brake so that the O-ring is positioned at the motor end shield.
 - Align the through holes of the flange (6) with fixing holes in the end shield (15).

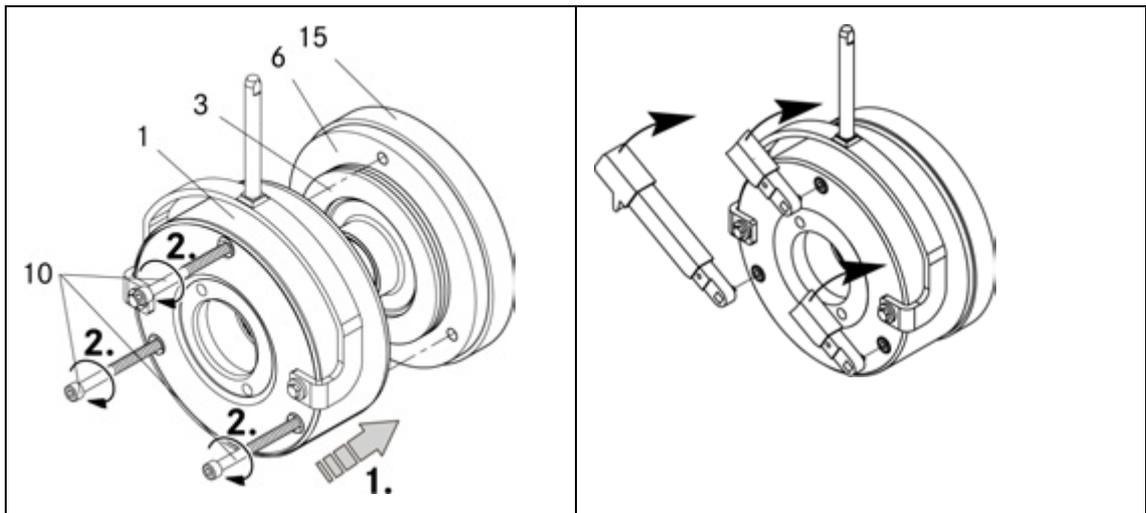


Fig. 6 Mounting the brake

1	Brake	6	Flange	15	End shield
3	Rotor	10	Socket head cap screws		

	NOTICE
	<p>When using a shaft sealing ring, the brake has to be mounted so that it is centered properly! The shaft diameter must be implemented in accordance with ISO tolerance h11, with a radial eccentricity tolerance according to IT8 and an averaged surface roughness of $Rz \leq 3.2 \mu\text{m}$ in the sealing area.</p>



NOTICE

Please note the following for the version "brake with shaft sealing ring":

- Lightly lubricate the lip of the shaft sealing ring with grease.
- No grease should be allowed to contact the friction surfaces.
- When assembling the stator, push the shaft sealing ring carefully over the shaft. The shaft should be located concentrically to the shaft sealing ring

2. Slide the brake onto the shaft.
 - Align supplied socket head cap screws (10) with fixing holes in the end shield (15).
3. Use a torque wrench to tighten the socket head cap screws (10) with the required tightening torque,  15.



NOTICE

The customer must seal the brake in this position himself if **no** shaft sealing ring or sealing cover is in use.



NOTICE

If it is necessary to loosen the screws with the seal again, the seals or the complete screw set must be replaced.

5 Electrical installation

5.1 Important notes

	 DANGER
	<p>There is a risk of injury by electrical shock!</p> <ul style="list-style-type: none"> ■ Electrical connection must only be carried out by skilled personnel! ■ Only carry out connection work when no voltage is applied (no live parts)! There is a risk of unintended start-ups or electric shock.

	NOTICE
	<ul style="list-style-type: none"> ■ Make sure that the supply voltage corresponds to the name plate data.

5.2 Electrical connection

Circuit suggestions

	NOTICE
	<p>The terminal pin sequence shown here does not match the actual order.</p>

AC switching at the motor – extremely delayed engagement

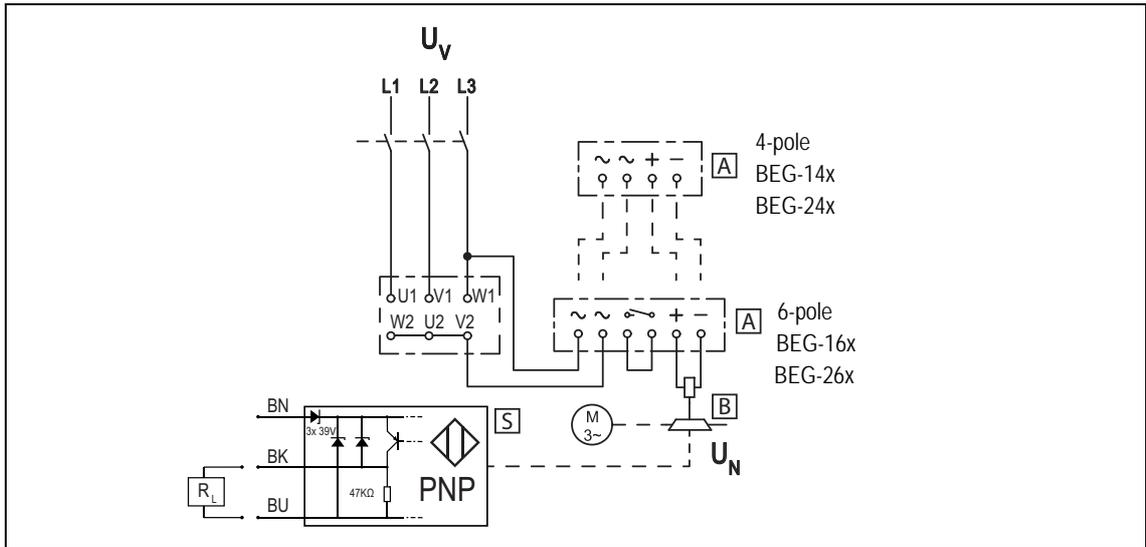


Fig. 7 Supply: Phase-neutral

A Bridge rectifiers

$$\text{BEG-1xx: } U_N [\text{VDC}] = 0.9 \cdot \frac{U_V}{\sqrt{3}} [\text{VAC}]$$

B Brake

A Half-wave rectifiers

$$\text{BEG-2xx: } U_N [\text{VDC}] = 0.45 \cdot \frac{U_V}{\sqrt{3}} [\text{VAC}]$$

S Inductive proximity sensor

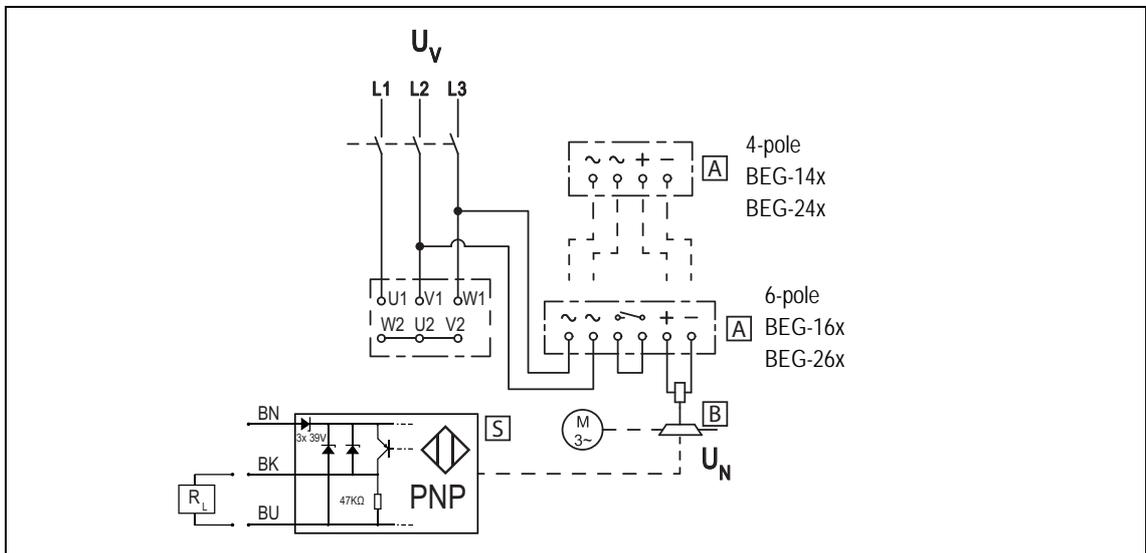


Fig. 8 Supply: Phase-phase

A Bridge rectifier ¹⁾

$$\text{BEG-1xx: } U_N [\text{VDC}] = 0.9 \cdot U_V [\text{VAC}]$$

B Brake

A Half-wave rectifiers

$$\text{BEG-2xx: } U_N [\text{VDC}] = 0.45 \cdot U_V [\text{VAC}]$$

S Inductive proximity sensor

¹⁾ Not recommended for most regional/national high-voltage mains voltages.

DC switching at the motor – fast engagement

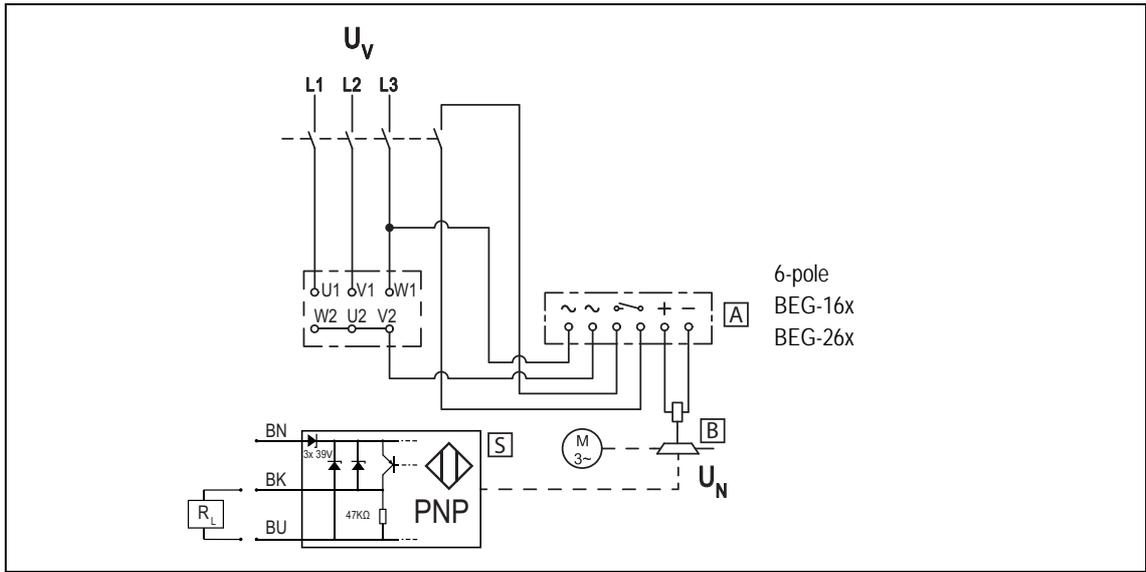


Fig. 9 Supply: Phase-neutral

A Bridge rectifiers

$$\text{BEG-1xx: } U_N [\text{VDC}] = 0.9 \cdot \frac{U_V}{\sqrt{3}} [\text{VAC}]$$

A Half-wave rectifiers

$$\text{BEG-2xx: } U_N [\text{VDC}] = 0.45 \cdot \frac{U_V}{\sqrt{3}} [\text{VAC}]$$

B Brake

S Inductive proximity sensor

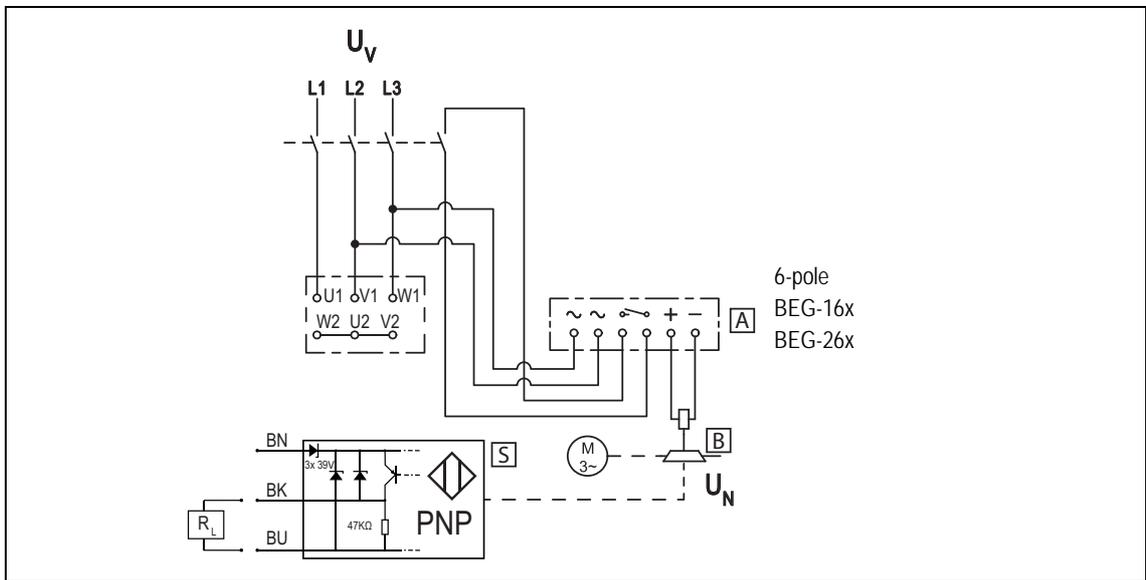


Fig. 10 Supply: Phase-phase

A Bridge rectifier ¹⁾

$$\text{BEG-1xx: } U_N [\text{VDC}] = 0.9 \cdot U_V [\text{VAC}]$$

A Half-wave rectifiers

$$\text{BEG-2xx: } U_N [\text{VDC}] = 0.45 \cdot U_V [\text{VAC}]$$

B Brake

S Inductive proximity sensor

¹⁾ Not recommended for most regional/national high-voltage mains voltages.

AC switching at mains – delayed engagement

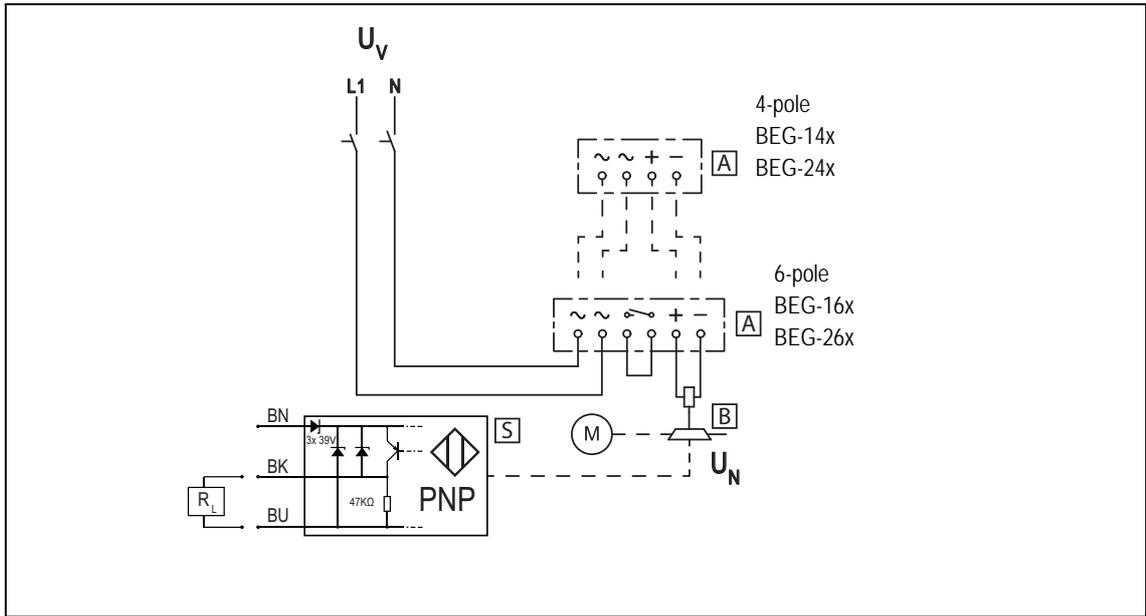


Fig. 11 Supply: Phase-N

- | | |
|--|--|
| A Bridge rectifiers
BEG-1xx: $U_N [VDC]=0.9 \cdot U_V [VAC]$ | A Half-wave rectifiers
BEG-2xx: $U_N [VDC]=0.45 \cdot U_V [VAC]$ |
| B Brake | S Inductive proximity sensor |

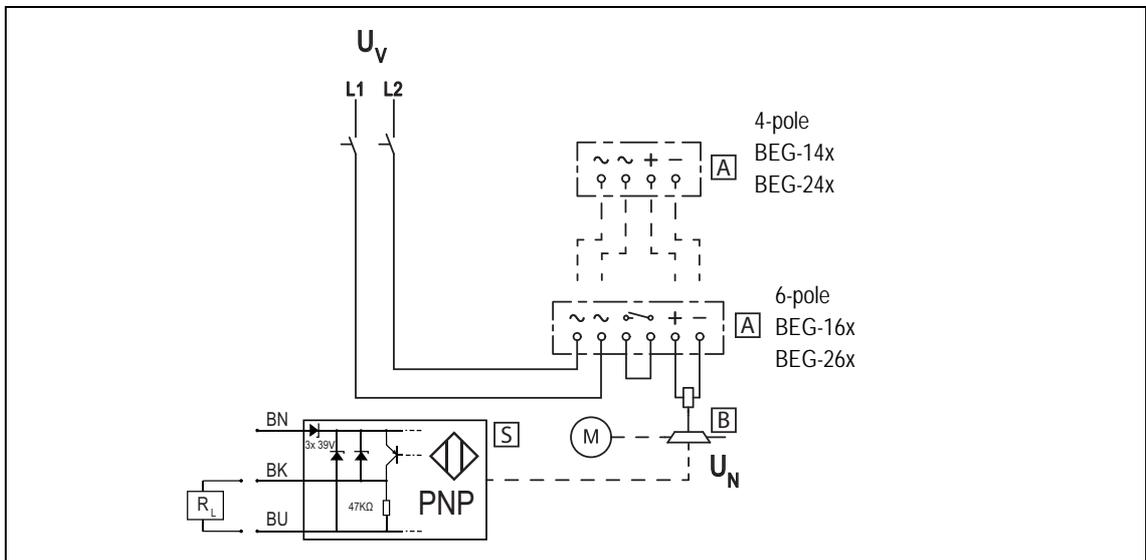


Fig. 12 Supply: Phase-phase

- | | |
|---|--|
| A Bridge rectifier ¹⁾
BEG-1xx: $U_N [VDC]=0.9 \cdot U_V [VAC]$ | A Half-wave rectifiers
BEG-2xx: $U_N [VDC]=0.45 \cdot U_V [VAC]$ |
| B Brake | S Inductive proximity sensor |

¹⁾ Not recommended for most regional/national high-voltage mains voltages.

DC switching at mains – fast engagement

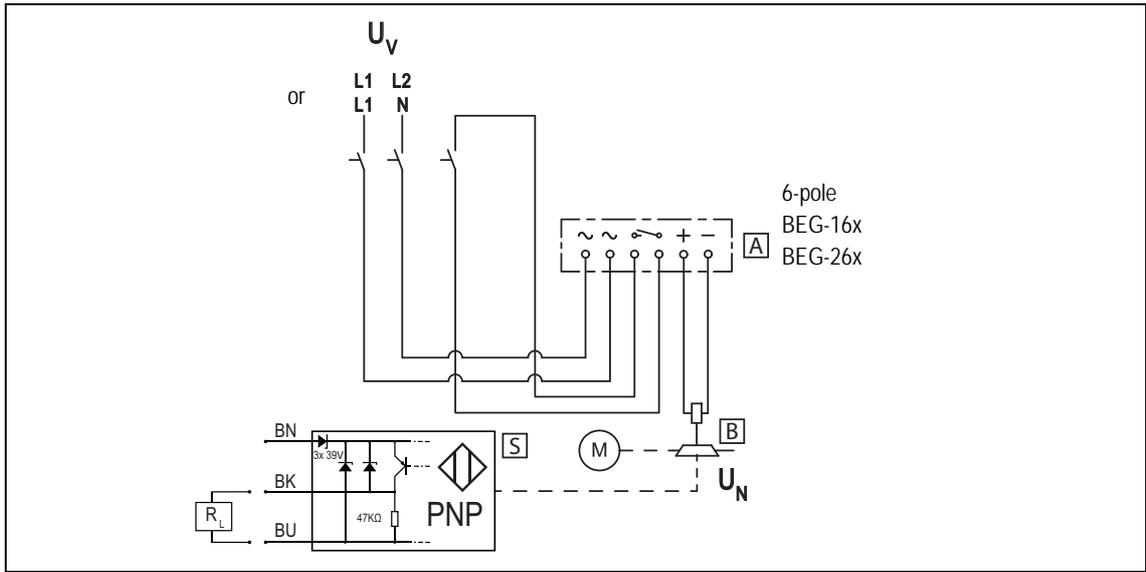


Fig. 13 Supply: Phase-phase or phase-N via 6-pole rectifier

- | | |
|---|--|
| A Bridge rectifier ¹⁾
BEG-16x: $U_N [VDC]=0.9 \cdot U_V [VAC]$ | A Half-wave rectifiers
BEG-26x: $U_N [VDC]=0.45 \cdot U_V [VAC]$ |
| B Brake | S Inductive proximity sensor |

1) For most regional/national high-voltage mains voltages, this only makes sense for supplies on L1 and N.

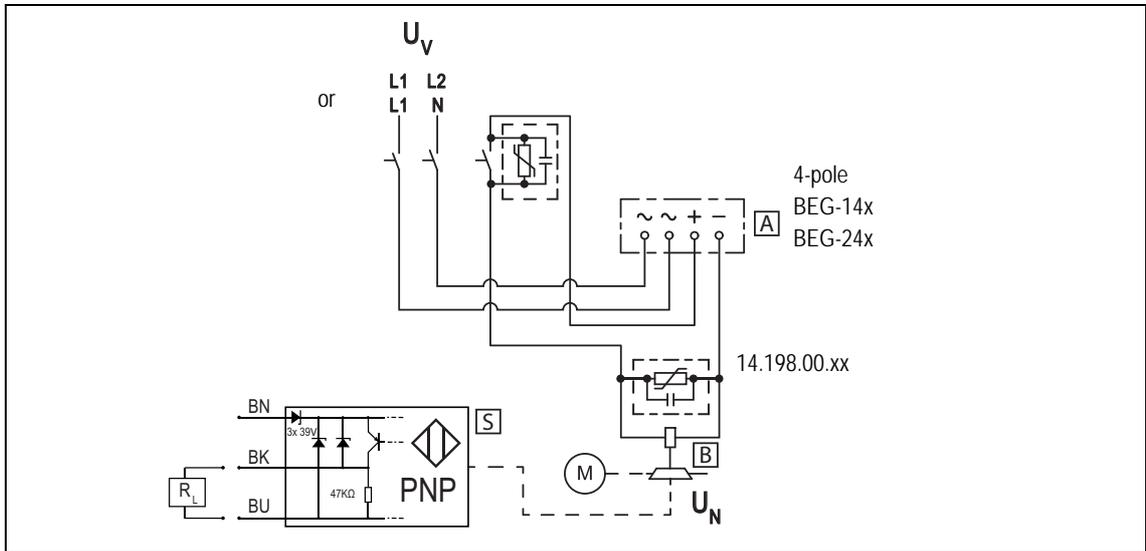


Fig. 14 Supply: Phase-phase or phase-N via 4-pole rectifier

- | | |
|---|--|
| A Bridge rectifier ¹⁾
BEG-14x: $U_N [VDC]=0.9 \cdot U_V [VAC]$ | A Half-wave rectifiers
BEG-24x: $U_N [VDC]=0.45 \cdot U_V [VAC]$ |
| B Brake | S Inductive proximity sensor |

Spark suppressor
14.198.00.xx (required once, select position)

1) For most regional/national high-voltage mains voltages, this only makes sense for supplies on L1 and N.

5.3 Technical data for inductive proximity sensors

5.3.1 Proximity sensor for release check

Design	PNP, N/O contact
Operating voltage	10 to 30 VDC
Permitted residual ripple	20% U_B
No-load current	Max. 10 mA
Output current	Max. 200 mA
Voltage drop at outputs	Max. 2.0 V at 200 mA
Short circuit protection	integrated
Reverse polarity protection	integrated
Induction protection	integrated
Protection class	IP67
Cable configuration and parameters	
Cable (diameter / length / AWG)	Ø 3.3 mm / L = 2 m / AWG 26
Maximum cable length	100 m
Grey	Colour of sheath insulation
Brown (BN)	+ U_B
Black (BK)	Signal (with released armature plate - brake energised)
Blue (BU)	- U_B
Operating conditions	
Ambient temperature range T_A	From -40°C to +120°C (no component damage) From -25°C to + 120°C (information evaluation)
Shock and vibration	IEC 60947-5-2 / 7.4
EMC protection	
IEC 60947-5-2 (7.2.3.1)	1 kV
IEC 61000-4-2	Level 2
IEC 61000-4-3	Level 3
IEC 61000-4-4	Level 2

Tab. 8: Technical data for inductive proximity sensors (release check)

5.4 Minimum bend radius for the brake connection line

Brake size	Wire cross-section	Minimum bendradius
06	AWG 20	28
08		
10		
12		
14		
16	AWG 16	46
18		

Tab. 9: Minimum bend radius for the brake connection line

5.5 Bridge/half-wave rectifier (optional)

BEG-561-□□□-□□□

The bridge-half-wave rectifiers are used to supply electromagnetic DC spring-applied brakes which are approved for use with such rectifiers. Other use is only permitted with the approval of INTORQ.

Once a set overexcitation period has elapsed, the bridge-half-wave rectifiers switch over from bridge rectification to half-wave rectification.

Terminals 3 and 4 are located in the DC circuit of the brake. The induction voltage peak for DC switching (see "DC switching - fast engagement" circuit diagram) is limited by an integrated overvoltage protection at terminals 5 and 6.

5.5.1 Assignment: Bridge/half-wave rectifier – brake size

Rectifier type	Connection voltage [V AC]	Over-excitation		Holding current reduction	
		Coil voltage [V DC]	Size	Coil voltage [V DC]	Size
BEG-561-255-030	230	103	06 – 18	205	06 – 12
BEG-561-255-130			–		14 – 18
BEG-561-440-030-1	400	180	06 – 18	–	–

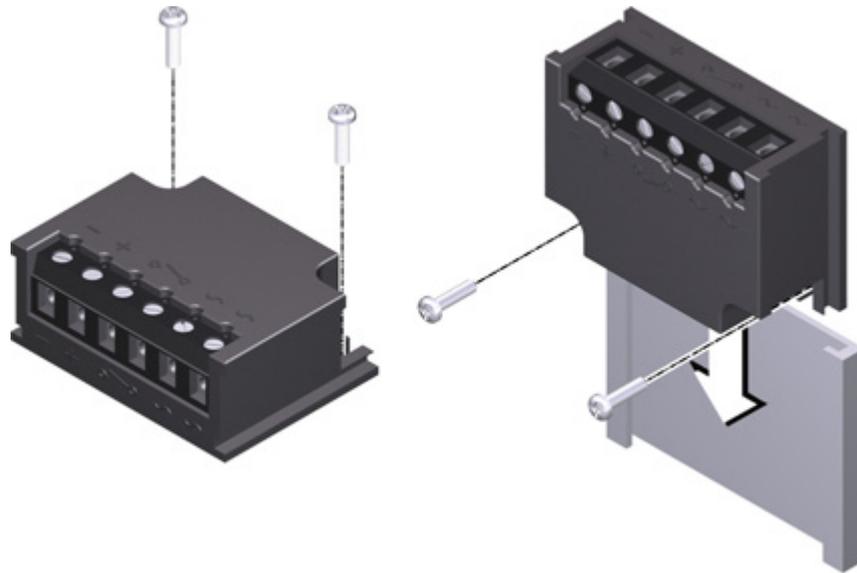


Fig. 15 BEG-561 fastening options

5.5.2 Technical specifications

Rectifier type	Bridge / half-wave rectifier
Output voltage for bridge rectification	$0.9 \times U_1$
Output voltage for half-wave rectification	$0.45 \times U_1$
Ambient temperature (storage/operation) [°C]	-25 – +70

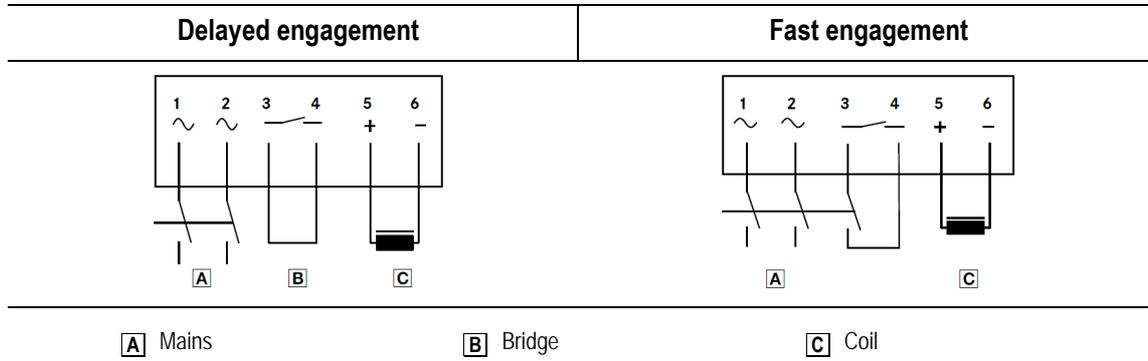
Type	Input voltage U_1 (40 Hz – 60 Hz)			Max. current I_{max}		Over-excitation period t_{ue} ($\pm 20\%$)		
	Min. [V ~]	Rated [V ~]	Max. [V ~]	Bridge [A]	half-wave [A]	at U_{1min} [s]	at U_{1Nom} [s]	at U_{1max} [s]
BEG-561-255-030	160	230	255	3.0	1.5	0.430	0.300	0.270
BEG-561-255-130						1.870	1.300	1.170
BEG-561-440-030-1	230	400	440	1.5	0.75	0.500	0.300	0.270

Tab. 10: Data for bridge/half-wave rectifier type BEG-561

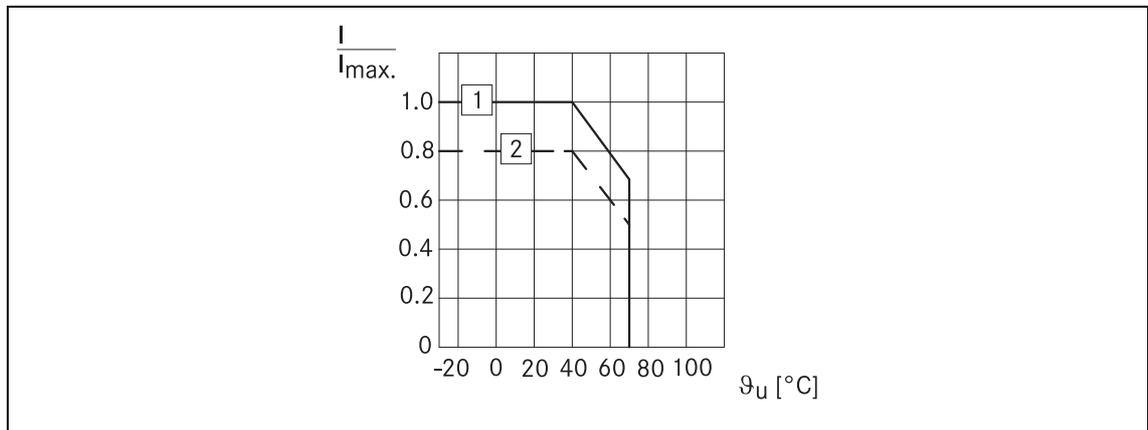
U_1 input voltage (40 – 60 Hz)

5.5.3 Reduced switch-off times

AC switching must also be carried out for DC switching (fast engagement)! Otherwise, there will be no over-excitation when it is switched back on.



5.5.4 Permissible current load at ambient temperature



- 1 For screw assembly with metal surface (good heat dissipation)
- 2 For other assembly (e.g. adhesive)

6 Commissioning and operation

6.1 Important notes

	 DANGER
	<p>There is a risk of injury by electrical shock!</p> <ul style="list-style-type: none"> ■ Electrical connection must only be carried out by skilled personnel! ■ Only carry out connection work when no voltage is applied (no live parts)! There is a risk of unintended start-ups or electric shock.
	 DANGER
	<p>Danger: rotating parts!</p> <p>The brake must be free of residual torque. The drive must not be running when checking the brake.</p>
	 CAUTION
	Danger: hot surfaces. Do not touch!

- The brake is designed for operation under the environmental conditions that apply to IP66 protection. Because of the numerous possibilities of using the brake, it is still necessary to check the functionality of all mechanical components under the corresponding operating conditions.
- The brake facilitates corrosion class C4 or C5. It has a paint-compliant design, according to the EN ISO 12944 standard. The corrosion class C4 or C5 depends on the coating system used by the facility manufacturer.



NOTICE

Functionality for different operating conditions

- The brakes are dimensioned in such a way that the specified rated torques are reached safely after a short run-in period.
- However, as the organic friction linings used do not all have identical properties and because environmental conditions can vary, deviations from the specified braking torques are possible. These must be taken into account in the form of appropriate dimensioning tolerances. Increased breakaway torque is common, in particular after long downtimes in humid environments where temperatures vary.



NOTICE

Operation without dynamic loads (functioning as a pure holding brake)

- If the brake is used as a pure holding brake without any dynamic load, the friction lining must be reactivated regularly.

6.2 Function checks before commissioning

1. The switching contact for the brake must be open.
2. Remove two bridges from the motor terminals to de-energise the motor.
 - Do **not** disconnect the supply voltage for the brake.

	 DANGER
	<p>There is a risk of electric shock!</p> <p>If the rectifier is connected to the neutral point of the motor, the neutral conductor must also be connected to this point.</p>

3. Apply DC voltage to the brake.
4. Measure the AC voltage at the motor terminals. The measured level must be zero.
5. Close the switching contact for the brake.
 - The brake is released.
6. Measure the DC voltage at the brake.
 - Compare the DC voltage with the voltage indicated on the name plate. A deviation of 10 % is permissible.
 - If the measured value deviates:  48
7. Open the switching contact for the brake.
 - The brake is applied.
8. Switch off DC voltage for the brake.
9. Screw the bridges onto the motor terminals.
10. If necessary, remove the neutral conductor from the neutral point (step 2).

The preparations for commissioning are completed.

If faults occur, refer to the the error search table,  47. If the fault cannot be fixed or eliminated, please contact your customer service.

6.3 Brake with proximity sensor

	 DANGER
	<p>There is a risk of injury by electrical shock!</p> <ul style="list-style-type: none"> ■ Electrical connection must only be carried out by skilled personnel! ■ Only carry out connection work when no voltage is applied (no live parts)! There is a risk of unintended start-ups or electric shock.

	 WARNING
	<p>Danger: rotating parts!</p> <p>The brake must be free of residual torque. The motor must not run!</p>

1. The switching contact for the brake must be open.
2. Remove two bridges from the motor terminals to de-energise the motor.
 - Do not switch off the voltage supply to the brake.
 - When connecting the rectifier to the neutral point of the motor, the PE conductor must also be connected to this point.
3. Apply DC voltage to the brake.
4. Measure the AC voltage at the motor terminals. The measured level must be zero.
5. Close the switching contact for the brake.
 - The brake is released.
6. Measure the DC voltage at the brake:
 - Compare the DC voltage with the voltage indicated on the name plate. A deviation of $\pm 10\%$ is permissible.
7. Check the air gap "s_L".
 - It must be zero and the rotor must rotate freely.
8. Check the switching status of the proximity sensor (refer to Table 11).
9. Open the switching contact for the brake.
 - The brake is applied.
10. Check the switching status of the proximity sensor (refer to Table 11).
11. Switch off DC voltage for the brake.
12. Screw the bridges onto the motor terminals. Remove additional PE conductor, if necessary.

Contact type	Connection	Brake released	Proximity sensor is closed
N/O contact	black / blue	no	no

Tab. 11: Switching status of the proximity sensor

6.4 Commissioning

1. Switch on drive system.
2. Carry out a braking test.

6.5 During operation

- Checks must be carried out regularly. Pay special attention to:
 - unusual noises or temperatures
 - loose fixing elements
 - the condition of the electrical cables
 - The armature plate must be attracted and the rotor must move without residual torque.
- Measure the DC voltage at the brake.
 - Compare the DC voltage with the voltage indicated on the name plate. A deviation of 10 % is permissible.
- If faults occur, refer to the the error search table,  47. If the fault cannot be fixed or eliminated, please contact your customer service.

7 Maintenance and repair

7.1 Wear of spring-applied brakes

The table below shows the different causes of wear and their impact on the components of the spring-applied brake. The influential factors must be quantified so that the service life of the rotor and brake can be calculated and so that the prescribed maintenance intervals can be specified accurately. The most important factors in this context are the applied friction energy, the initial speed of rotation of braking and the operating frequency. If several of the causes of friction lining wear occur in an application at the same time, the influencing factors should be added together when the amount of wear is calculated.

Component	Cause	Effect	Influencing factors
Friction lining	Braking during operation	Wear of friction lining	Friction work
	Emergency stops		
	Overlapping wear during start and stop of drive		
	Active braking via the drive motor with support of brake (quick stop)		
	Starting wear in case of motor mounting position with vertical shaft, even when the brake is not applied		Number of start/stop cycles
Armature plate and counter friction surface	Rubbing of brake lining	Run-in of armature plate and counter friction surface	Friction work
Gear teeth of brake rotor	Relative movements and shocks between brake rotor and brake shaft	Wear of gear teeth (primarily on the rotor side)	Number of start/stop cycles
Brake support	Load reversals and shocks in backlash on reversal between armature plate and cylinder pin	Play of armature plate and cylinder pin	Number of start/stop cycles, braking torque
Springs	Axial load cycle and shear stress of springs through radial backlash on reversal of armature plate	Reduced spring force or fatigue failure	Number of switching operations of brake

Tab. 12: Causes for wear

7.2 Inspections

7.2.1 Important notes

To ensure safe and trouble-free operations, the spring-applied brakes must be checked at regular intervals and, if necessary, replaced. Servicing will be easier at the plant if the brakes are made accessible. This must be considered when installing the drives in the plant.

Primarily, the required maintenance intervals for industrial brakes result from their load during operation. When calculating the maintenance interval, all causes for wear must be taken into account,  41. For brakes with low loads (such as holding brakes with emergency stop function), we recommend a regular inspection at a fixed time interval. To reduce costs, the inspection can be carried out along with other regular maintenance work in the plant.

Failures, production losses or damage to the system may occur when the brakes are not serviced. Therefore, a maintenance strategy that is adapted to the particular operating conditions and brake loads must be defined for every application. For the spring-applied brakes, the maintenance intervals and maintenance operations listed in the table below must be followed. The maintenance operations must be carried out as described in the detailed descriptions.

7.2.2 Maintenance intervals

Time interval	for operating brakes:	for holding brakes with emergency stop:
	<ul style="list-style-type: none"> ■ according to the service life calculation ■ or else every six months ■ after 4000 operating hours at the latest 	<ul style="list-style-type: none"> ■ at least every 2 years ■ after 1 million cycles at the latest ■ plan shorter intervals for frequent emergency stops
Inspections with assembled brake	<ul style="list-style-type: none"> ■ Check release function and control 	 45
Inspections after removing the brake	<ul style="list-style-type: none"> ■ Check rotor ■ Check hub ■ Check armature plate and counter friction surface 	 43

7.3 Maintenance



NOTICE

Brakes with defective armature plates, springs or flanges must be completely replaced. Observe the following for inspections and maintenance works:

- Contamination by oils and greases should be removed using brake cleaner, or the brake should be replaced after determining the cause. Dirt and particles in the air gap between the stator and the armature plate endanger the function and should be removed.
- After replacing the rotor, the original braking torque will not be reached until the run-in operation for the friction surfaces has been completed. After replacing the rotor, the run-in armature plates and the flanges have an increased initial rate of wear.

7.3.1 Check the brake

1. Air gap control (only for sizes 12 to 18):
 - Do not energise the brake when checking the air gap.
 - When checking the air gap s_L , the plug (item 1.3 in Figure 1) must be levered out manually. Sharp-edged tools will destroy the plug!
 - Use a feeler gauge to determine the actual air gap. It can then be compared to the max. permissible air gap s_{Lmax} . 14.

At $s_L < s_{Lmax}$, the brake remains operational.

	NOTICE
	After the procedure, the plug (item 1.3) must be pushed in straight so that it is firmly inserted. Make sure that the plug does not become tilted.

If further tests are required, the brake must be disassembled 44 (only for sizes 6-18).

	DANGER
	Switch off the voltage. The brake must have no load torque on it when it is being dismantled.

	DANGER
	There is a risk of injury by electrical shock! Live connections must not be touched.

	WARNING
	Danger: rotating parts! The brake must be free of residual torque. The motor must not run!

	 CAUTION
	Danger: hot surfaces. Do not touch!

1. Dismantling the brake,  44.
2. Check rotor: Rotor thickness
 - Measure the rotor thickness using a caliper gauge.
 - Compare the measured rotor thickness with the minimally permissible rotor thickness,  14.
 - If necessary, exchange the rotor.
 - Check the gear teeth of the rotor.
 - If the gear teeth are damaged, replace the rotor.

7.3.2 Dismantling the brake

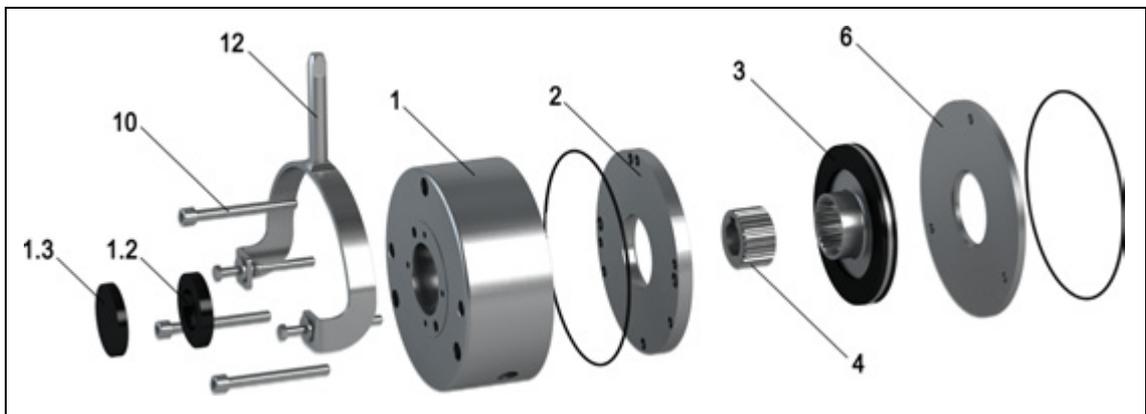


Fig. 16 Dismantling the brake

1 Stator	1.2 Shaft sealing ring	1.3 Screw-on cover
2 Armature plate	3 Rotor	4 Hub
6 Flange	10 Socket head cap screws	12 Complete hand-release
15 End shield		

1. Disconnect the connection cable.
2. Loosen the socket head cap screws (10) and remove them.
3. Detach stator (1) from the shaft.
4. Detach rotor (3) from the hub.
5. Check hub: Gear teeth
 - Check the gear teeth of the hub.
 - If the gear teeth are damaged, dismount and replace the hub.
6. Check armature plate: Thermal damage
 - In the case of thermal damage (dark blue tarnishing), replace the stator.

7. Check counter friction surface:
 - A Flange
 - Maximum run-in depth = 30 % of rated air gap  13.
 - In the case of strong scoring, replace the flange.
 - In the case of thermal damage (dark blue tarnishing), replace the flange.
 - B End shield
 - Maximum run-in depth = 30 % of rated air gap  13.
 - In case of strong scoring, reprocess the end shield  23.
8. Assemble the brake,  25.
9. Connect the connection cable.
10. Recommission the brake,  37.

**NOTICE**

After replacing the rotor, the original braking torque will not be reached until the run-in operation for the friction surfaces has been completed. After replacing the rotor, the run-in armature plates and the flanges have an increased initial rate of wear.

7.3.3 Release / voltage

1. Observe the brake functionality while the drive is operating. The armature plate must be attracted and the rotor must move without residual torque.
2. Measure the DC voltage at the brake.
 - Compare the DC voltage with the voltage indicated on the name plate. A deviation of 10 % is permissible.

7.4 Spare-parts list

Spring-applied brake INTORQ BFK470-06 to 18

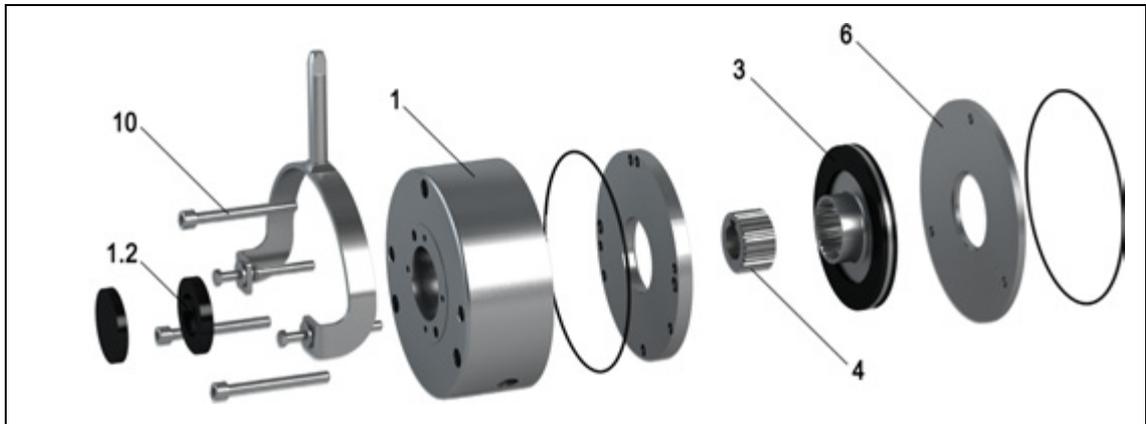


Fig. 17 Spring-applied brake BFK470

_____ material number of the brake (PLEASE INCLUDE: refer to the name plate)!

Only parts with item numbers are available.

Item	Designation	Variant
1.2	Shaft sealing ring	Shaft diameter
3	Complete rotor	
4	Hub	Bore diameter
6	Complete flange (incl. O-ring)	
10	Fastening screws with sealing rings Socket head cap screw set, DIN EN ISO 4762	for mounting to the motor for flange with through hole

7.5 Electrical accessories

Rectifier

Refer to the Operating Instructions "Electrical switching devices and accessories", on page 15.

8 Troubleshooting and fault elimination

If any malfunctions should occur during operations, please check for possible causes based on the following table. If the fault cannot be fixed or eliminated by one of the listed measures, please contact customer service.

Brake malfunctioning

Fault	Cause	Remedy
Brake does not release	Coil interruption	<ul style="list-style-type: none"> ■ Measure coil resistance using a multimeter: <ul style="list-style-type: none"> - If resistance is too high, replace the complete stator.
	Coil has contact to earth or between windings	<ul style="list-style-type: none"> ■ Measure coil resistance with multimeter: <ul style="list-style-type: none"> - Compare measured value with rated resistance. - Values:  16 - If resistance is too low, replace the complete stator. ■ Check coil for short circuit to ground using a multimeter: <ul style="list-style-type: none"> - If there is a short to ground, replace the complete stator. ■ Check brake voltage (refer to "defective rectifier, voltage too low").
	Wiring defective or wrong	<ul style="list-style-type: none"> ■ Check the wiring and correct. <ul style="list-style-type: none"> - Check cable for continuity using a multimeter: ■ Replace the complete stator if a cable is defective.
	Rectifier defective or incorrect	<ul style="list-style-type: none"> ■ Measure rectifier DC voltage using a multimeter. If DC voltage is zero: <ul style="list-style-type: none"> ■ Check AC rectifier voltage. If AC voltage is zero: <ul style="list-style-type: none"> - Switch on power supply - Check fuse - Check wiring. If AC voltage is okay: <ul style="list-style-type: none"> - Check rectifier, - Replace defective rectifier If DC voltage is too low: <ul style="list-style-type: none"> - Check rectifier, - Diode defective - install an appropriate undamaged rectifier. ■ Check coil for inter-turn fault or short circuit to ground. ■ If the rectifier defect occurs again, replace the entire stator, even if you cannot find any fault between turns or short circuit to ground. The fault may occur later during heating-up.
	Air gap too large	Replace rotor  44
	Rotor thickness too small	Replace rotor  44

Deviations in measured values

Measured value	Cause	Remedy
Voltage too high	Brake voltage does not match the rectifier	Adjust rectifier and brake voltage to each other.
Voltage too low	Brake voltage does not match the rectifier	Adjust rectifier and brake voltage to each other.
	Defective rectifier diode	Replace defective rectifier with a suitable undamaged one.
AC voltage is not mains voltage	Fuse is missing or defective	Install fuse. Exchange fuse.

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