KENDRION

KENDRION INDUSTRIAL BRAKES

SERVO SLIM LINE

Spring-applied single-disc brake

Operating Instructions SL 500..A00

Types:

SL 50003A00	SL 50009A00	SL 50207A00
SL 50004A00	SL 50010A00	SL 50209A00
SL 50005A00	SL 50012A00	SL 50210A00
SL 50007A00	SL 50205A00	

PRECISION. SAFETY. MOTION.

Contents

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1. General

1.1 Introduction

These operating instructions describe the operating principle and features of the spring-applied single-disc brake types SL 500..A.. and SL 502..A... The spring-applied single-disc brakes are intended to be directly incorporated into electric motors (e.g. servomotors), hereinafter referred to as **machines**. They are designed to stop and firmly lock or secure the drive system driven by the electric motor.

The information and safety messages provided in this manual must be strictly observed during the set-up of the machine and during the putting into service, use and maintenance of the spring-applied brakes.

Should any queries arise with respect to torques, torque variations, installation position, wear, wear reserve, switching work, break-in conditions, release range, ambient conditions and the like, please contact Kendrion (Villingen) and ask for clarification before starting to use the brake. Spring-applied brakes are not ready-to-use products, but are intended to be incorporated into or assembled with machinery. Consequently, they will be referred to as **components** in the following sections.

1.2 Manufacturer

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Email: sales-IDS@kendrion.com

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Tel: +86 512 8398-1819
Email: CHN@kendrion.com

1.3 Product, types, versions and product numbers

Product: Electromagnetically released spring-applied single-disc brake

Types: SL 50003A00 SL 50004A00 SL 50005A00 SL 50007A00 SL 50009A00 SL 50010A00
SL 50012A00 SL 50205A00 SL 50207A00 SL 50209A00 SL 50210A00

Type	Version number	Product number [1)]	Versions
SL 50003A00	XXXX	SL 50003A00-XXXX	Transmissible torque M_4
SL 50004A00	XXXX	SL 50004A00-XXXX	Rated voltage U_N
SL 50005A00	XXXX	SL 50005A00-XXXX	Hub (7) version
SL 50007A00	XXXX	SL 50007A00-XXXX	Hub (7) bore
SL 50009A00	XXXX	SL 50009A00-XXXX	
SL 50010A00	XXXX	SL 50010A00-XXXX	
SL 50012A00	XXXX	SL 50012A00-XXXX	

Table 3/1: List of SL 500..A00 spring-applied single-disc brake types and versions (hub (7) to be mounted with its cylindrical part facing away from the magnet housing (1.1) (see Fig. 14/1))

Type	Version number	Product number [1)]	Versions
SL 50205A00	XXXX	SL 50205A00-XXXX	Transmissible torque M_4
SL 50207A00	XXXX	SL 50207A00-XXXX	Rated voltage U_N
SL 50209A00	XXXX	SL 50209A00-XXXX	Hub (7) version
SL 50210A00	XXXX	SL 50210A00-XXXX	Hub (7) bore

Table 3/2: List of SL 502..A00 spring-applied single-disc brake types and versions (hub (7) to be mounted with its cylindrical part preferably facing the magnet housing (1.1) (see Fig. 14/2))

[1)] Please refer to Section 12 for more details on the product number.

1.4 Standards and directives

The state-of-the-art brakes have been designed, built and tested in accordance with the requirements of DIN VDE 0580 concerning electromagnetic devices and components.

Being classified as “electromagnetic components”, spring-applied brakes are also subject to the Low Voltage Directive 2014/35/EU. The user is required to employ suitable switching devices and controls to ensure use of the brakes in accordance with EMC Directive 2014/30/EU.

1.5 Conventions used in these operating instructions

The conventions used in these operating instructions for the representation of information make the manual easier to read and understand. The conventions are listed in Table 4/1.

Conventions / Examples	Type of information	Meaning
Table 5/1	Table	Reference to information provided in a table
Fig. 4/1	Figure	Reference to information provided in a figure
•	Numbered items	Tasks or steps to be performed and/or additional information
Section 2.1	Section	Reference to one or more sections
[1)]	Footnote	Additional information
(1.2)	Reference numeral	Reference to an item in a figure or table, accompanied by additional information relating to the designation or identification of a component part
(e.g. motor shaft)	Addition	Supplementary information
..	Wildcard	Wildcard for different brake sizes
XXXX	Wildcard	Wildcard for different versions
Components	Highlighting (bold text)	Highly relevant information

Table 4/1: Conventions used for the representation of information

Special conventions used for the representation of safety messages and safety-related information are explained in Section 2.1.

1.6 Manufacturer’s liability

The manufacturer will not assume any responsibility for damage caused by failure to use the components in accordance with their intended use or by failure to observe safety information and other instructions provided in this document. The information in the product description was correct and up-to-date before going to print. The information contained herein shall not entitle users to raise claims with respect to components purchased at an earlier date.

1.7 Relevant documents

- Offer drawings SL 500..A00-O
- Offer drawings SL 502..A00-O

1.8 Declaration of Incorporation (in accordance with Annex II, part 1, Section B of Machinery Directive 2006/42/EC)

We hereby declare that the products below comply with the essential health and safety requirements specified in Annex I of Machinery Directive 2006/42/EC:

Annex I, General Principles and sections 1.1.2, 1.1.3, 1.1.5, 1.3.2, 1.5.1

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Machinery Directive 2006/42/EC. The relevant technical documentation required for the partly completed machinery has been compiled in accordance with Annex VII, part B of Machinery Directive 2006/42/EC. The manufacturer undertakes to submit an electronic copy of the relevant technical documentation compiled for the partly completed machinery if reasonably requested by national authorities.

Manufacturer:

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Person authorized to compile the documentation:

Dominik Hettich
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Wilhelm-Binder-Str. 4-6
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Germany

Applied harmonized standards and other technical standards and regulations:

EN 60529	Enclosure protection ratings
DIN VDE 0580	Electromagnetic devices and components
EN ISO 12100	Safety of machinery - General principles for design - Risk evaluation and risk reduction

Product: Electromagnetically released spring-applied single-disc brake

Types: SL 50003A00 SL 50004A00 SL 50005A00 SL 50007A00 SL 50009A00 SL 50010A00 SL 50012A00 SL 50205A00 SL 50207A00 SL 50209A00 SL 50210A00

Kendrion (Villingen) GmbH Villingen 29/06/2023

Authorized signatory: .....

Dominik Hettich
(Head of Development)

1.9 Declarations of Conformity

1.9.1 EU Declaration of Conformity

We hereby declare that the products below, specifically the product versions placed on the market, have been designed and built in accordance with the requirements of the following EU directives.

EU directives:

2014/35/EU	Directive on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (Low Voltage Directive)
2011/65/EU	Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive)

The products are classified as category 11 equipment subject to Directive 2011/65/EU (RoHS Directive). This declaration will cease to be valid if modifications are made to the product without prior permission from the manufacturer. The sole responsibility for issuing this Declaration of Conformity lies with the manufacturer.

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Authorized representative:

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Kendrion (Villingen) GmbH Villingen 29/06/2023 Authorized signatory: .....D. Hettich.....
Dominik Hettich
(Head of Development)

1.9.2 UK Declaration of Conformity

We hereby declare that the products below, specifically the product versions placed on the market, have been designed and built in accordance with the requirements of the following UK statutory instruments:

UK statutory instruments:

SI 2016 No. 1101	Consumer Protection, Health and Safety; The Electrical Equipment (Safety) Regulations 2016
SI 2012 No. 3032	Environmental Protection; The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

This declaration will cease to be valid if modifications are made to the product without prior permission from the manufacturer. The sole responsibility for issuing this Declaration of Conformity lies with the manufacturer.

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Kendrion (Villingen) GmbH Villingen 29/06/2023 Authorized signatory: .....

Dominik Hettich
(Head of Development)

2. Safety

The components described in these operating instructions have been designed and built on the basis of an analysis of hazards and in accordance with the requirements of the applicable harmonized standards and technical specifications. They correspond to the state of the art and provide maximum safety. However, safety hazards can only be avoided if the machine owner takes adequate precautions and makes sure that safety instructions are strictly adhered to. It is the duty of the machine owner to plan these measures and to monitor their implementation.

The machine owner is required to ensure that:

- the components are only used in accordance with their intended use (see Section 2.2 – Intended use, and Section 3 – Product description).
- the components are in perfect working order and checked at regular intervals.
- a complete and fully legible copy of these operating instructions is kept available at the place of installation and use of the components at all times.
- putting into service, maintenance and repair are only performed by authorized and suitably qualified personnel.
- such personnel are kept informed on all relevant occupational safety and environmental protection issues and familiar with the operating instructions and with the safety information contained herein.
- the components are not exposed to other strong magnetic fields.

IMPORTANT

READ THESE OPERATING INSTRUCTIONS CAREFULLY
BEFORE STARTING TO USE THE PRODUCTS!

KEEP THESE OPERATING INSTRUCTIONS IN A SAFE PLACE FOR FUTURE REFERENCE!

2.1 Symbols, signs and signal words in safety messages

Safety messages that warn users of potential risks of personal injury or property damage or indicate other important information are highlighted by the safety alert symbols, information signs and signal words shown in Table 8/1.

Personal injury			
Symbol	**Signal word**	**Indicates...**	**Potential consequences**
	**DANGER**	an imminent hazardous situation which, if not avoided, will result in death or serious injury	Death or serious injury
	WARNING	a potentially hazardous situation which, if not avoided, could result in death or serious injury	Death or serious injury
	CAUTION	a potentially hazardous situation which, if not avoided, could result in minor or moderate injury	Minor or moderate injury
Property damage			
Symbol	**Signal word**	**Indicates...**	**Potential consequences**
	**NOTICE**	potential property damage or environmental damage	Damage to the component or to the environment
Information			
Symbol	**Signal word**	**Provides…**	
	**IMPORTANT**	information on the safe use and operation of the component	

Table 8/1: Safety alert symbols, information signs and signal words used in safety messages

Structure and colour of hazard alerting, non-hazard alerting and instructional safety messages

Hazard alerting safety messages (potential personal injury):

Signal word: DANGER

Hazard type and source

- Potential consequences if not avoided
- Hazard prevention measures

Signal word: WARNING

Hazard type and source

- Potential consequences if not avoided
- Hazard prevention measures

Signal word: CAUTION

Hazard type and source

- Potential consequences if not avoided
- Hazard prevention measures

Non-hazard alerting safety messages (potential property damage):

Signal word: NOTICE

Type and source of potential property damage

- Potential consequences if not avoided
- Property damage prevention measures

Instructional safety messages:

Signal word: IMPORTANT

Information for the safe use and operation of the component

Other warning signs used:

Symbol	Warning	Symbol	Warning
	Magnetic field hazard		Hot surface hazard
	Electricity hazard		Hand injury hazard

Table 9/1: Specific warning signs used in this manual

The safety information provided in these operating instructions with regard to potential personal injury and its consequences (death, serious injury, minor or moderate injury) applies **exclusively** if the brakes are incorporated into and operated in electric motors (e.g. servomotors) (see Section 2.2 – Intended use).

2.2 Intended use

The brakes described in these operating instructions are intended to be incorporated into electric motors (e.g. servomotors) for use in industrial installations.

IMPORTANT

The components must be used in accordance with the operating requirements detailed in these operating instructions. The specified rated power limits must not be exceeded. Operation in potentially explosive or firedamp atmospheres is strictly forbidden.

2.3 General safety information

Built-in brakes feature hazardous live components and rotating parts and may exhibit hot surfaces. Any work associated with the transport, connection, putting into service and periodical maintenance of the brakes must be carried out by authorized and suitably qualified specialist personnel in accordance with EN 50110-1, EN 50110-2 and IEC 60364-1. Failure to observe safety, operating and maintenance instructions may cause serious personal injury and property damage. Whenever special measures are required in accordance with the instructions contained herein, such measures should be agreed with the brake manufacturer before setting up the machinery into which the brake is to be incorporated. Should any queries arise with respect to torques, torque variations, installation positions, wear, wear reserve, switching work, break-in conditions, release range, ambient conditions and the like, please contact the manufacturer and ask for clarification before using the brake. Retrofitting or modification of the brake is subject to the approval from Kendrion (Villingen). Accident prevention regulations applying to the specific field of application must be strictly observed.

IMPORTANT

The components described in this manual are **not designed for use as "safety brakes"**. This means that negative effects on the brake torque (e.g. brake torque variations, reduced torque stability) arising from adverse ambient conditions that are beyond the user's control (e.g. higher ambient temperatures or humidity, contaminated ambient air etc.) cannot be ruled out. If such phenomena occur, the system user is required to ensure that the brake is subjected to a break-in process at regular intervals to restore the full braking torque. The break-in process parameters specified in Table 43/1 apply.

2.3.1 Set-up

Requirements in terms of the permissible number of switching operations per hour and the maximum switching work per switching operation specified in the technical specifications (see Table 42/1) must be strictly observed during the set-up of machinery and installations (jog mode). Failure to observe these instructions may irreversibly diminish the braking effect and cause malfunctions. The rated operating conditions are those specified in DIN VDE 0580. The protection rating conforms to EN 60529. In case of deviations, special measures must be taken after prior consultation with the brake manufacturer.

IMPORTANT

Depending on the humidity and the degree of condensation, ensure that the friction disc (5) cannot freeze to the surfaces of the armature (2) or flange (6) involved in the friction process, e.g. due to ice formation and crystallization if ambient temperatures fall below -5°C or if the machinery remains unpowered for prolonged periods of time.

The gradual brake wear (e.g. of dynamic brakes or holding brakes with emergency stop function; see Table 42/1 – Technical specifications) and the associated torque reduction of spring-applied brakes must be taken into consideration in the set-up of the machinery.

2.3.2 Putting into service

Do not put the components into service if:

- power supply cables/wires or connections (e.g. wire leads (1.3)) are damaged,
- the magnet housing (1.1) or the electrical insulation of the field coil (1.2) is damaged.
- other defects are suspected.

DANGER

Electricity hazards from incorrect electrical connection of the component!

- Fatal electric shock hazard.
- All work must be performed by qualified specialist personnel only. Check that no voltage is present when connecting the component to the power supply. The specifications on the rating plate and the information provided in the circuit diagram, which (if available) may be located in the terminal box of the machine or included in the operating instructions, must be strictly observed.

2.3.3 Assembly

The voltage level and voltage type specified on the rating plate (15) must be strictly observed when connecting the components described in these operating instructions. Sufficient heat dissipation must be ensured when the component is mounted to or incorporated into machinery. Adequate precautions must be taken to avoid overvoltage during disconnection or voltage peaks. The magnetic field of the brake may cause interference outside the brake or even feedback to the brake in case of adverse installation conditions. Should you have queries concerning mounting and fitting conditions, please contact the brake manufacturer and ask for clarification.

Adequate safety measures (to DIN 31000 / DIN VDE 0100-420) must be taken by the brake user to avoid hazards to persons or property damage caused by:

- direct or indirect effects of electromagnetic fields,
- heated components,
- moving parts.

2.3.4 Operation and use

Ensure that live components such as the wire leads (1.3), field coil (1.2) and similar parts are not exposed to water. The brake cable connections must not be crushed, squeezed or exposed to mechanical loads. Make absolutely sure that the friction surfaces of the friction linings are not contaminated with grease, oil or other fluids to avoid substantial torque reduction. Bear in mind that the original torque cannot be restored even if the friction surfaces are cleaned after contact with fluids. Due to the diverse ambient conditions in which the brakes may be used, always check that the brake is in perfect working order before putting it into service.

The components are factory-treated with corrosion inhibitor to provide basic corrosion protection during storage and operation in dry environments (no condensation).

IMPORTANT

The balance quality of the component's friction disc (5) has not been classified in accordance with DIN ISO 21940-11. Consequently, the required balance quality must be agreed between the manufacturer and customer in each individual case.

IMPORTANT

The maximum air gap s_{max} (see Table 42/1 – Technical specifications) must not be exceeded throughout the entire brake service life. Please refer to Section 5 (Maintenance, repair and replacement) for details. The M_{4min} minimum transmissible torque (see Table 42/1 – Technical specifications) is not safely reached until the break-in process has been completed (burnishing of friction surfaces). The break-in parameters are specified in Table 43/1. The brake torque may drop during the operating phase if the brake is operated as a mere holding brake with little or no friction work or if adverse factors occur in the brake environment (see Section 2.3). In this case, the brake user should ensure that a break-in process as specified in Table 43/1 is conducted at regular intervals.

NOTICE

Risk of damage to the field coil (1.2) in case of brake operation beyond the permissible limits!

- Release of the spring-applied single-disc brake may no longer be possible.
- Potential malfunction of the machine.

- During brake operation, ensure that the coil temperature does not rise above the permissible limit temperature applicable to the insulating materials of the specified insulation class (see Table 42/1 – Technical specifications). Fast cooling of the field coil (1.2) with scavenging air is not allowed. Ensure that the relative humidity and ambient temperature remain within the permissible range (see rated operating conditions in Table 43/2).

DANGER

Electromagnetic field hazards during brake operation!

- Indirect effects of electromagnetic fields may cause disturbances and failures of cardiac pacemakers and other implants.
- Serious or even fatal injury hazard.

- Keep at a safe distance from the component during operation.

2.3.5 Maintenance, repair and replacement

Service, maintenance, repair or replacement of the components must only be carried out by qualified specialist personnel in accordance with EN 50110-1, EN 50110-2 and IEC 60364-1. Failure to perform repairs in accordance with the specifications may cause serious personal injury or property damage. Make sure that the components are unpowered when carrying out maintenance work.

3. Product description

3.1 Operating principle

The spring-applied single-disc brake is designed to operate dry. The force generated by an electromagnetic field is utilized to overcome the braking effect produced by the spring force.

The spring-applied single-disc brake engages in unpowered condition and releases when DC voltage is applied to the field coil (1.2). When the coil is energized, the force of the electromagnetic field counteracts the spring force. As a result, the armature (2) is moved axially and the braking effect is neutralized. When the brake is engaged, the spring force produced by the compression springs (3) causes the friction disc (5) to be clamped between the armature (2) and flange (6), thus producing the braking action.

The machine shaft to be braked or secured (e.g. motor shaft) (11) is not exposed to any axial loads exerted by the spring-applied single-disc brake.

3.2 Brake design

The magnet housing (1.1) of the spring-applied single-disc brake accommodates the firmly fitted field coil (1.2) with wire leads (1.3) that exit from the magnet housing (1.1) at defined positions. The wire leads (1.3) of the field coil (1.2) exit from the circumference of the magnet housing (1.1) or from its rear side. A heat-shrink tube (1.4) is fitted over the two wire leads (1.3) at the exit points to provide additional protection against mechanical damage. The compression springs (3) located in the magnet housing (1.1) press the armature (2) and friction disc (5) against the flange (6). The axially moveable, positive-locking friction disc (5) is spline connected with the hub (7) (spline as defined by DIN 5480). The bushes (4) ensure permanent adjustment of the brake's rated air gap s_N and tangential fixation of the armature (2). The flange (6) is firmly connected to the magnet housing (1.1) with three countersunk screws (14). Depending on the brake design, it is possible to connect the spring-applied single-disc brake to the motor end shield (8) on the flange side (see Fig. 14/1) or on the front side (see Fig. 14/2). The magnet housing (1.1) has through-holes for flange side mounting of the brake (see Fig. 14/1). Brake versions designed for front side mounting [3)] have tapped holes on the rear side of the magnet housing (1.1) (see Fig. 14/2). The hub (7) and machine shaft (e.g. motor shaft) (11) can be firmly assembled by interference fit (see Section 4.1.2) or by means of a feather key (see Section 4.1.3).

The brake is firmly connected to the mounting surface (motor end shield) (8) of the servomotor using two [2)] or three mounting screws (9 or 10) (see Fig. 14/1 and Fig. 14/2).

List of reference numerals in Fig. 14/1, Fig. 14/2, Fig. 15/1, Fig. 15/2 and Fig. 15/3			
1.1	Magnet housing	8	Mounting surface (e.g. motor end shield)
1.2	Field coil	9	Mounting screws for flange side mounting
1.3	Wire leads	10	Mounting screws for front side mounting [3)]
1.4	Heat-shrink tube	11	Machine shaft (e.g. motor shaft)
2	Armature	12	Bearing (e.g. motor bearing)
3	Compression spring	13	Feather key
4	Bushes	14	Countersunk screw
5	Friction disc	15	Rating plate
6	Flange	16	Circlip for (short-version) hub
7	Hub		

Table 13/1: List of reference numerals of spring-applied single-disc brake

[2)] Brake sizes 03 and 04
[3)] Brake sizes 05, 07, 09, 10

Spring-applied single-disc brake SL 500..A00 and SL 502..A00

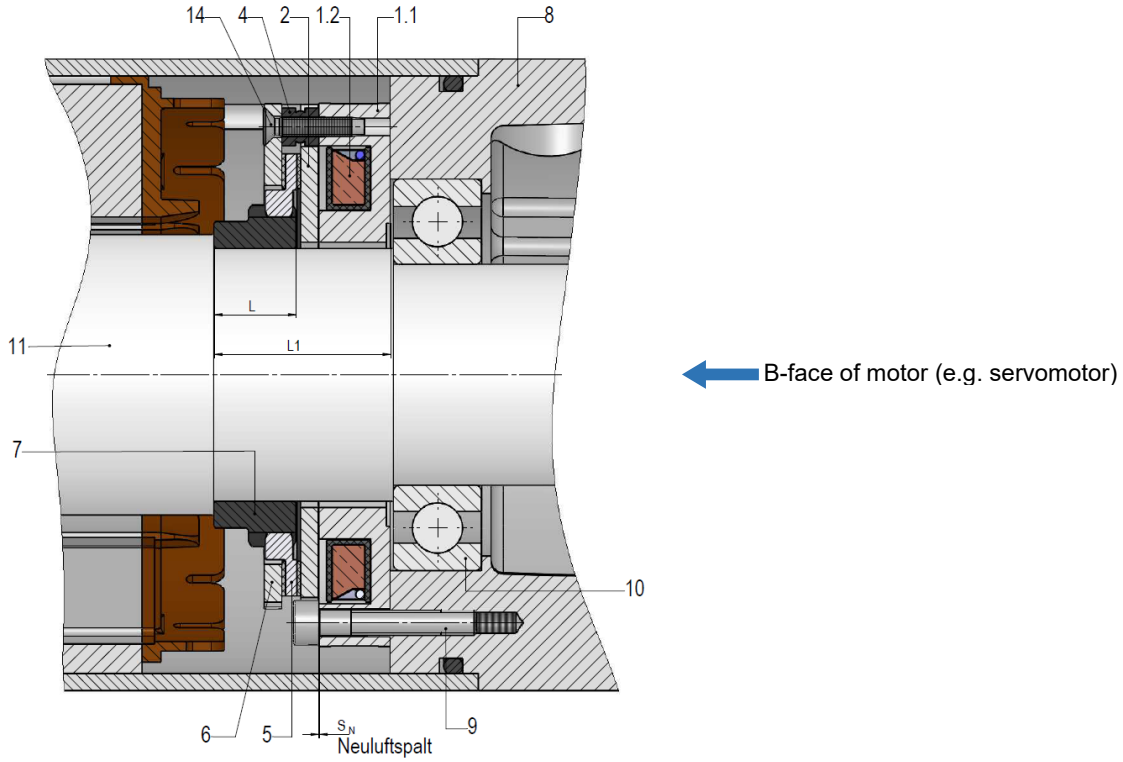


Fig. 14/1: Flange side mounting of spring-applied single-disc brake SL 500..A00 (example) to the motor (e.g. servomotor); contact of hub (7) with stop shoulder of machine shaft (e.g. motor shaft) (11); assembly of hub (7) and machine shaft (e.g. motor shaft) (11) by interference fit (see Section 4.1.2)

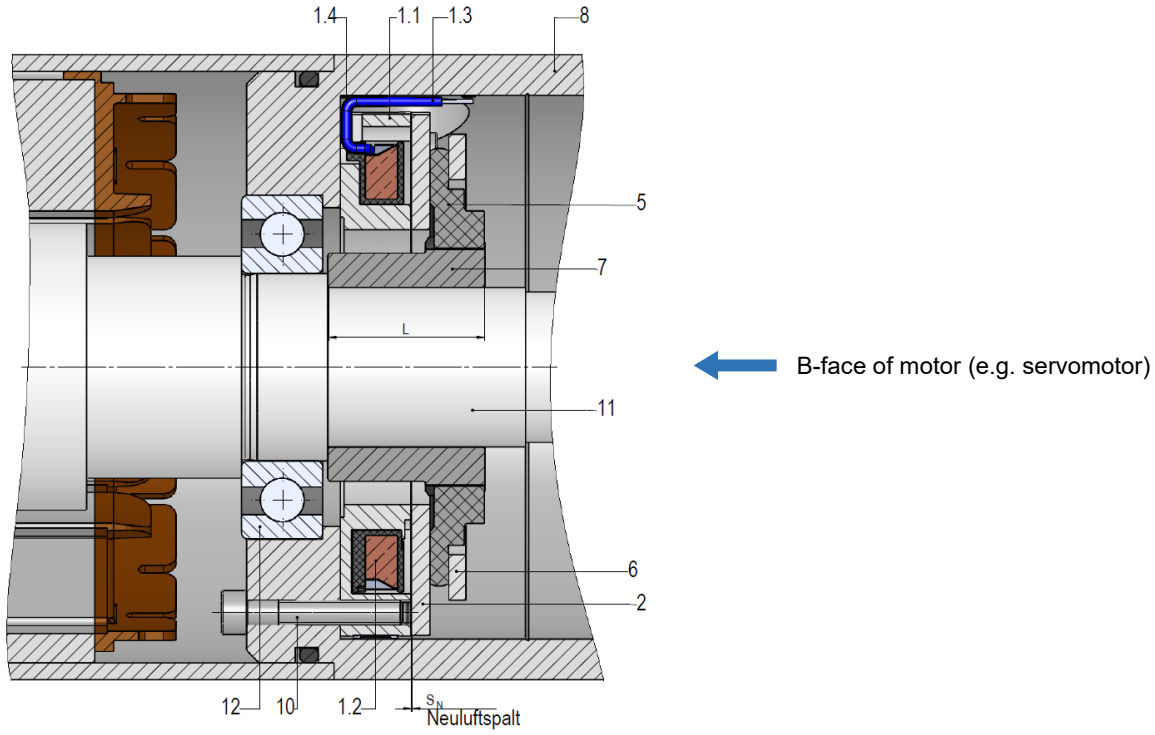


Fig. 14/2: Front side mounting of spring-applied single-disc brake SL 502..A00 (example) to the motor (e.g. servomotor); contact of hub (7) with stop shoulder of machine shaft (e.g. motor shaft) (11); assembly of hub (7) and machine shaft (e.g. motor shaft) (11) by interference fit (see Section 4.1.2)

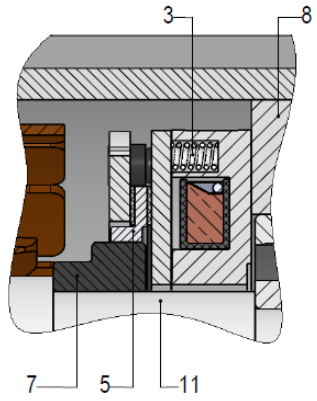


Fig. 15/1: Interference fit assembly of hub (7) and machine shaft (e.g. motor shaft) (11)

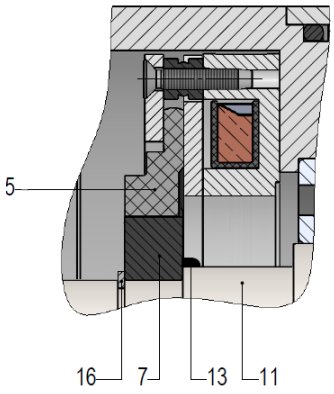
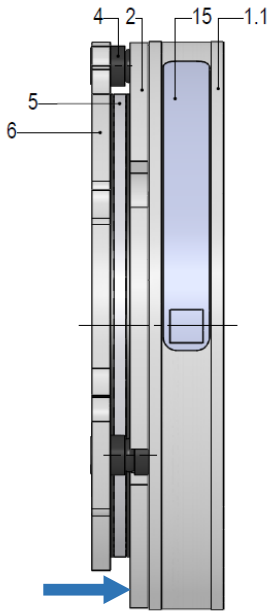
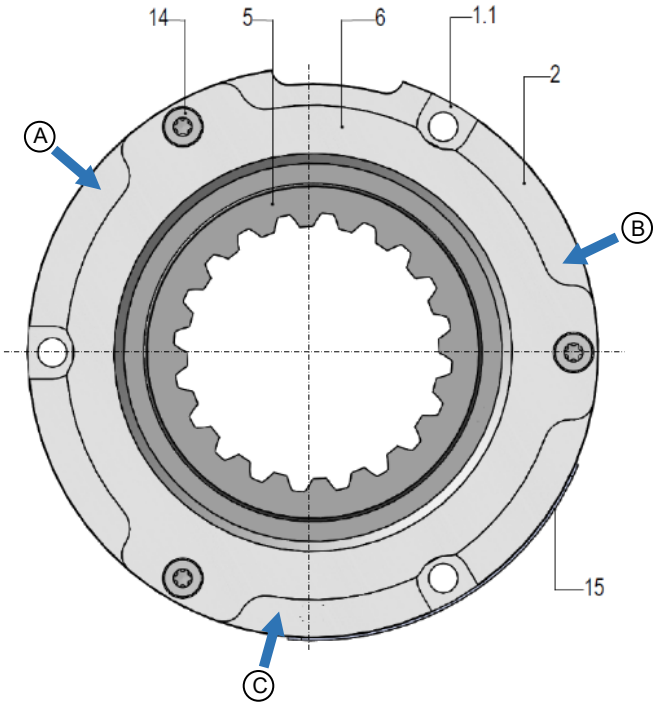


Fig. 15/2: Feather key assembly of hub (7) and machine shaft (e.g. motor shaft) (11)



Measuring points (A to C) on front side along armature (2) circumference for measurement of air gap 's'



Measuring points (A to C) (x3 offset by approx. 120°) on front side along armature (2) circumference for measurement of air gap 's'

Fig. 15/3: Location of the measuring points (arrow marks) for measuring the air gap 's' of brake type SL 502..A00 (example), shown without hub (7)

4. Installation

4.1 Mechanical installation

4.1.1 General information for mechanical brake installation

The brakes can be installed in the motor (e.g. servomotor) by mounting them either to the A-face or B-face motor end shield. If the brake is mounted to the B-face end shield of the servomotor, flange side mounting (Fig. 14/1) or front side mounting (Fig. 14/2) is possible.

Brake type SL 500..A00 can be fixed to the inside of the B-face end shield of the motor (e.g. servomotor) by front side mounting [4)] or flange side mounting (see Fig. 14/1). In this case, flange side mounting of the brake as shown in Fig. 14/1 is preferred, which means that the magnet housing (1.1) is positioned on the inside of the motor end shield (8). The mounting screws (9) are used to fasten the brake on the flange side as shown in Fig. 14/1.

Brake type SL 502..A00 can be fixed to the outside of the B-face end shield of the motor (e.g. servomotor) by front side mounting [4)] (see Fig. 14/2) or flange side mounting. In this case, the magnet housing (1.1) is positioned on the outside of the B-face motor end shield (8) using the hub (7). The mounting screws (10) are used to fasten the brake on the front side as shown in Fig. 14/2. In case of flange side mounting (see Fig. 14/1), the mounting screws (9) are used instead.

IMPORTANT

The M_A tightening torques of the mounting screws (9, 10) for flange or front side mounting are specified in Table 16/1. If the M_A tightening torques specified in the offer drawing are different from those listed in Table 16/1, the specifications in the offer drawing prevail. To ensure secure fastening of the brake in case of front side mounting to the motor end shield (8), the mounting screws (10) must be tightened to the magnet housing (1.1) observing both the maximum possible thread reach as well as the required minimum thread reach values specified in Table 16/1. Socket head cap screws (not supplied) to ISO 4762, property class 8.8, are recommended for both mounting options and for all mounting screws (9 or 10).

	Brake size						
	03	04	05	07	09	10	12
Maximum possible thread reach (front side mounting) [mm]	-	-	3.6	8	8	8	8
Required minimum thread reach (front and flange side mounting [mm]	4.5	4.5	3	4	4	4	4
Mounting screw (10) thread (front side mounting)	-	-	M2.5 (x3)	M4 (x3)	M4 (x3)	M4 (x3)	M4 (x3)
M_A tightening torque [Nm] for mounting screws (10)	-	-	0.7	3	3	3	3
Mounting screw (9) thread (flange side mounting)	M2 (x2)	M2 (x2)	M3 (x3)	M4 (x3)	M4 (x3)	M4 (x3)	M4 (x3)
M_A tightening torque [Nm] for mounting screws (9)	0.4	0.4	1.2	3	3	3	3

Table 16/1: Threads of mounting screws (9, 10); M_A tightening torques for mounting screws (9, 10) for flange or front side mounting; required minimum thread reach for front side and flange side mounting and maximum possible thread reach for front side mounting; tightening torques tolerance ±10%

[4)] Brake sizes 05, 07, 09, 10

NOTICE

Risk of damage to the brake or mounting screws (9, 10) due to failure to observe the specified M_A tightening torques!

- Putting into service of the spring-applied single-disc brake and machine may not be possible.
- Potential malfunction of the spring-applied single-disc brake and machine.
- Potential reduction of the service life of the spring-applied single-disc brake.

- The M_A tightening torques specified for the mounting screws (9, 10) (Table 16/1) must be strictly observed. Tighten the mounting screws (9, 10) evenly in several steps. The required minimum thread reach of the mounting screws (9, 10) (see Table 16/1) for front side or flange side mounting of the brake must be observed.

NOTICE

Risk of damage to the wire leads (1.3) and heat-shrink tube (1.4) in case of incorrect brake assembly!

- Putting into service of the spring-applied single-disc brake and motor may not be possible.

- During machine installation, the wire leads (1.3) of the field coil (1.2) must be connected as specified by the machine manufacturer. Avoid damage to the wire leads (1.3), e.g. by kinking the lead insulation, or to the heat-shrink tube (1.4).

IMPORTANT

The minimum thread reach of the mounting screws (9) used for flange side mounting of the brake to the motor end shield (8) must be dimensioned by the brake user in such a way that the M_A tightening torques (see Table 16/1) specified for the mounting screws (9) can be securely applied. The assembled brake components, especially the friction surfaces of the friction disc (5), must be free of grease and oil during operation. Ensure that lubricants or similar substances cannot seep from the bearing into the brake. (Sealed bearings can be used to prevent lubricant leaks.) The rated air gaps s_N (see Table 42/1 – Technical specifications) are factory-adjusted by means of the bushes (4). Minor axial bearing play after completion of motor assembly will not affect the safe and reliable operation of the spring-applied single-disc brake.

IMPORTANT

The friction disc (5) is factory-centred and firmly secured inside the brake to facilitate axial brake assembly with the machine shaft (e.g. motor shaft) (11). The spring-applied single-disc brake should not be released electromagnetically until installation has been completed and the brake is put into service and checked. Install the wire leads (1.3) during overall motor assembly as specified by the motor manufacturer. Avoid damage to the wire leads (1.3) e.g. by kinking the lead insulation.

To ensure perfect brake operation, check that the motor end shield (mounting surface) (8) and the machine shaft (e.g. motor shaft) (11) meet the following requirements before starting to install the brake:

Requirements of mounting surface (motor end shield) (8):

- Axial runout (simple runout) relative to machine shaft (e.g. motor shaft) (11) max. 0.1 mm (measuring radius = pitch circle diameter of brake, measurement to EN 50347)
- Positional deviation of tapped mounting holes on pitch circle for flange side mounting of brake: max. Ø 0.2 mm; reference element: axis of machine shaft (e.g. motor shaft) (11)
- Positional deviation of mounting holes on pitch circle for front side mounting of brake: max. Ø 0.5 mm; reference element: axis of machine shaft (e.g. motor shaft) (11)
- Material: steel, aluminium, cast iron – with excellent thermal conductivity
- Absence of oil and grease
- Surface hardness min. 100 HB, surface roughness Rzmax16

IMPORTANT

The maximum permissible positional deviation of the tapped mounting holes (flange side mounting) and mounting holes (front side mounting) in the mounting surface (motor end shield) (8) must not be exceeded. This is crucial to prevent the friction disc (5) from rubbing along the bushes (4) during operation and to allow the brake to be mounted to the mounting surface (motor end shield) (8).

NOTICE

Risk of brake damage caused by incorrect design of the mounting surface (motor end shield) (8)!

- Putting into service of the spring-applied single-disc brake and motor may not be possible.
- Potential malfunction of the spring-applied single-disc brake and motor.
- Potential reduction of the service life of the spring-applied single-disc brake.

- The mounting surface (motor end shield) (8) must be dimensioned in such a way that the screw connection is not affected by setting effects or similar phenomena. The specifications listed under “Requirements of mounting surface (motor end shield) (8)” must be complied with.

IMPORTANT

Magnetic interference fields may adversely affect reliable brake operation. Consequently, the brake should always be installed outside the reach of magnetic interference fields.

Requirements of machine shaft (e.g. motor shaft) (11):

- No impact marks or other damage to machine shaft (e.g. motor shaft) (11)
- Radial runout (simple runout) of machine shaft (e.g. motor shaft) (11) max. 0.05 mm (test according to EN 50347)
- Absence of oil and grease
- Please refer to Sections 4.1.2 and 4.1.3 for further details.

IMPORTANT

The machine shaft (e.g. motor shaft) (11) should be made of suitable materials of sufficient strength, ductility and grade such as E335, S355, or 42CrMoS4 steels etc.

WARNING

Hazards from brake failure caused by incorrect design of the machine shaft (e.g. motor shaft) (11)!

- Uncontrolled movements of the machine shaft (e.g. motor shaft) (11) may cause injury hazards if persons are present within the confines and/or working range of the installation.
- Uncontrolled **extremely fast** movements of the machine shaft (e.g. motor shaft) (11) may cause death if persons are present within the confines and/or working range of the installation.

- The brake user is required to ensure that the tolerance, strength and quality of the machine shaft (e.g. motor shaft) (11) (in case of interference fit assembly of the hub (7) with the machine shaft (e.g. motor shaft) (11)) and the type of feather key (if used for hub/shaft assembly) are suitable to achieve reliable transmission of the generated brake torques from the hub (7) to the machine shaft (motor shaft) (11) over the entire brake service life.
- Ensure that the brake is mounted correctly and with maximum care.

4.1.2 Brake mounting with hub (7) – interference fit assembly

The hub (7) and machine shaft (e.g. servomotor shaft) (11) can be firmly assembled by interference fit (shrink fit or force fit). If the hub (7) is assembled with the machine shaft (e.g. motor shaft) (11) by shrink fitting, the hub (7) needs to be heated to the required joining temperature. This is done taking account of the component tolerances of the machine shaft (e.g. motor shaft) (11) and hub (7) (hub bore tolerance as specified in brake offer drawing). Once heated, the hub is slipped over the machine shaft (e.g. motor shaft) (11) until it stops at the stop shoulder (see Fig. 15/1) of the machine shaft (e.g. motor shaft) (11). The shrink fit is achieved after the hub (7) has cooled down. If the hub (7) is assembled with the machine shaft (e.g. motor shaft) (11) by force fitting, the hub (7) needs to be pressed onto the machine shaft (e.g. motor shaft) (11) in axial direction.

To ensure reliable assembly of the machine shaft (e.g. motor shaft) (11) and hub (7), the shaft has to meet the requirements specified in Table 19/1 (in accordance with DIN 7190-1:2017-02):

	Brake size						
	03	04	05	07	09	10	12
Shaft tolerance	s6	s6	s6	s6	s6	s6	s6
Max. surface roughness Rzmax [mm]	3	3	3	3	3	3	3
Diameter of machine shaft (e.g. motor shaft) (11), brake type SL 500..A00 [mm]	6 – 8	6 – 10	8 – 20	8 – 25	20 – 40	30 – 55	30 – 60
Diameter of machine shaft (e.g. motor shaft) (11), brake type SL 502..A00 [mm]	-	6	6 – 12	8 – 20	tbd	tbd	tbd
Material properties of machine shaft (e.g. motor shaft) (11)	steel, modulus of elasticity E = 210000 N/mm^2; min. yield point R_e = 325 N/mm^2						

Table 19/1: Requirements of machine shaft (e.g. motor shaft) (11) for assembly of hub (7) by interference fit

Apart from assembling the hub (7) and shaft, the entire brake must be positioned on the inside of the motor end shield (8) and fixed by means of two [5)] or three mounting screws (9 or 10) from the flange side (see Fig. 14/1) or front side (see Fig. 14/2). This is done in a separate mounting procedure. For information on the M_A tightening torques of the mounting screws (9 or 10) for flange side or front side [6)] mounting, please refer to Table 16/1.

The final third mounting procedure involved in the overall motor assembly process entails coupling the hub (7) with the friction disc (5) of the spring-applied brake. This is achieved by inserting the machine shaft (e.g. motor shaft) (11) with the externally toothed hub (7) into the internally toothed friction disc (5) (see Fig. 14/1) and installing the complete motor assembly as specified by the motor manufacturer.

[5)] Brake sizes 03 and 04
[6)] Brake sizes 05, 07, 09, 10

IMPORTANT

Check that you feel no resistance when sliding the friction disc (5) along the hub (7) in axial direction and that the axial position L1 of the hub (7) (see Table 20/2 & Fig. 14/1) is maintained after the brake has been installed in the servomotor.

	Brake size						
	03	04	05	07	09	10	12
Hub (7) length L	4.1	4.7	8.5	10	13	13	13
Axial hub (7) position L1 [mm]	16.3 ±0.2	17 ±0.3	20.6 ±0.3	23.8 ±0.3	28 ±0.3	28 ±0.3	35.5 ±0.3

Table 20/2: Length and axial position of hub (7) for brake types SL 500..A00

	Brake size						
	03	04	05	07	09	10	12
Hub (7) length L	-	4.7	12	18	tbd	tbd	tbd
Axial hub (7) position L1 [mm]	-	16.5 ±0.3	17.4 ±0.3	20 ±0.3	tbd	tbd	tbd

Table 20/3: Length and axial position of hub (7) for brake types SL 502..A00

4.1.3 Brake mounting with hub (7) – feather key / keyway assembly

Instead of assembling the hub (7) and machine shaft (e.g. motor shaft) (11) by interference fit, it is also possible to use a feather key according to DIN 6885, sheet 1, to join the parts in a tangentially fixed position. In an initial mounting step, the complete brake without hub (7) must be positioned on the outside of the motor end shield (8) and fixed by means of two [7] or three mounting screws (9 or 10) from the flange side or front side [8] (see Fig. 14/1 / Fig. 14/2). The M_A tightening torques for the mounting screws (9, 10) are specified in Table 16/1.

Before installing the machine shaft (e.g. motor shaft) (11) into the machine (e.g. motor), the feather key (13) must be inserted into the keyway machined into the machine shaft (e.g. motor shaft) (11). After that, the motor end shield (8) and machine shaft (e.g. motor shaft) (11) can be mounted to the preassembled motor unit following the instructions provided by the motor manufacturer. In the final third step of the mounting procedure, the hub (7) is slipped over the machine shaft (e.g. motor shaft) (11) provided with the feather key (13) and secured permanently in axial direction by means of a stop shoulder on the machine shaft (e.g. motor shaft) (11) or by using a circlip (16). Check that you feel no resistance when sliding the friction disc (5) along the hub (7) in axial direction and that the axial position L1 of the hub (7) (see Table 20/3) is maintained after the brake has been mounted inside the servomotor.

IMPORTANT

The brake user is required to ensure that the tolerance, strength and quality of the machine shaft (e.g. motor shaft) (11) and the type of feather key (13) used are suitable to achieve reliable transmission of the generated brake torques from the hub (7) to the machine shaft (e.g. motor shaft) (11). In order to avoid any undesired play of the feather key connection during brake operation, which would cause the keyway to wear out, the length of the feather key (13) must be dimensioned in such a way that transmission of the brake torques to the machine shaft (e.g. motor shaft) (11) takes place along the entire length L of the hub (7) (see Table 20/3).

[7] Brake sizes 03 and 04
[8] Brake sizes 05, 07, 09, 10

4.2 Electrical connection

4.2.1 Electrical connection of the spring-applied single-disc brake

The spring-applied single disc brake must be connected directly to a DC power source, connecting the wire leads (1.3) to the power supply. The specifications on the rating plate (15) must be observed. Connection to an AC power source is only possible by means of a bridge or half-wave rectifier (only possible with brake sizes 09 and higher). Various Kendrion rectifier types (see Table 21/1 – list not exhaustive) can be provided for this purpose.

IMPORTANT

During operation, any contact of the wire leads (1.3) with the rotating friction disc (5) or other rotating parts must be avoided. Depending on the brake size and torque, voltage ripple due to intermittent power supply may cause humming or incorrect brake operation. Reliable operation must be ensured by the user or system manufacturer by providing suitable electrical controls.

Rectifier series	Rectifier type	Rated input voltage range U_1 (±10%) [VAC] (40 – 60 Hz)	Output voltage U_2 [VDC]	Max. output current I_2 [ADC]
32 07103B53	bridge	0 – 240	$U_1 \cdot 0.89$	0.8
32 07103B50	bridge	0 – 500		0.7
32 07102B53	half-wave	0 – 240	$U_1 \cdot 0.445$	0.5
32 07102B50	half-wave	0 – 500		0.5
The relevant rectifier specification sheets must be observed!				

Table 21/1: Recommended rectifiers for single-phase AC voltage supply

Perform the following checks when connecting the brake:

- Check that the connecting cables are suitable for the intended use and for the voltage and amperage requirements.
- Check that the connecting cables are secured with screws, clamps or other suitable fixtures to avoid interruptions in the power supply.
- Check that the connecting cables are long enough for the intended use and that suitable torsion, strain and shear relief features as well as bending protections are provided.
- Check that the PE conductor (only for protection class I) is connected to the earthing point.
- Check that no foreign matter, dirt or humidity is trapped inside the terminal box of the machine or brake.
- Check that unused cable entries and the terminal box (if present) of the machine or brake are suitably sealed to ensure compliance with the protection class requirements to EN 60529.

DANGER

Electricity hazards from incorrect electrical connection of the component!

- Fatal electric shock hazard.
- All work must be performed by qualified specialist personnel only. Check that no voltage is present when connecting the component to the power supply. The specifications on the rating plate and the information provided in the circuit diagram, which (if available) may be located in the terminal box of the machine or included in the operating instructions, must be strictly observed.

NOTICE

Risk of damage to the field coil (1.2) from incorrect electrical connection of the component!

- Release of the spring-applied single-disc brake may no longer be possible.
- Putting into service of the spring-applied single-disc brake and machine may not be possible.

- The brake is a DC operated system. The permissible permanent voltage variations on the power source of the electromagnetic brake are specified in Table 43/2.

4.2.2 DC power supply

The figure to the right shows the voltage and torque curves after the field coil (1.2) has been de-energized without protective circuit (time t_{c1} specified in Section 10).

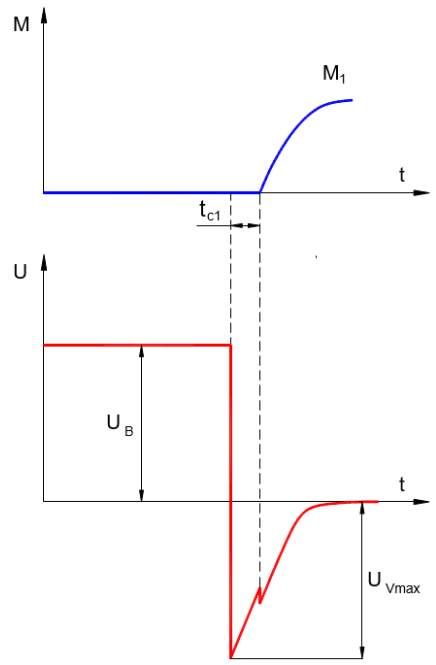
NOTICE

Risk of damage to or destruction of the brake field coil (1.2) from overvoltage!

- Release of the spring-applied single-disc brake may no longer be possible.
- Potential motor failure.

- The peak voltage U_{Vmax} during turn-off without protective circuit may reach **several thousand volts** in the millisecond region. This may cause irreversible damage to the field coil (1.2), switching contacts and electronic components. Sparking will occur on the switch during turn-off. Consequently, a protective circuit must be provided to reduce the current during turn-off and to limit the voltage. The maximum permissible overvoltage during turn-off is 1500 V.

Voltage and torque curves



U_B operating voltage (coil voltage)
U_{Vmax} turn-off voltage

NOTICE

Risk of damage to or destruction of electronic components from overvoltage!

- Release of the spring-applied single-disc brake may no longer be possible.
- Potential motor failure.

- The maximum permissible overvoltage during turn-off is 1500 V. If Kendrion rectifiers are used (see Table 21/1), the protective circuit required for the built-in electronic components and field coil (1.2) is included in the rectifier. This does not apply to the external contacts required for DC side switching as there would be no galvanic isolation of the external contact. Sensitive electronic components (e.g. logical components) may also be damaged at a lower voltage.

AC side (slow) switching with DC power supply:

Switching on the AC side means the slow, delayed switch-off of the brake when connected to DC. AC side switching of the brake is achieved by using a free-wheeling diode connected in parallel to the field coil (1.2), without any further necessary protective elements against overvoltage (see Table 23/1 and Fig. 24/1, b)). With this type of circuit, no or only very low turn-off voltage occurs during turn-off. However, when operating the spring-applied single-disc brake in this way, bear in mind that the closing times t_{c1} (see Table 42/1, definition in Section 10) of the brake are extended due to the use of the free-wheeling diode. The opening times t_o (see Table 42/1, definition in Section 10) are not extended.

DC side (fast) switching with DC power supply:

Switching on the DC side means the fast, shorted switch-off of the brake when connected to DC. DC side switching of the brake takes place without the use of a single freewheeling diode connected in parallel to the field coil (1.2). When switching off, very high turn-off voltages occur with this type of switching. Therefore, switching on the DC side is only possible with the use of further protective elements for voltage limitation (see Table 23/1 and Fig. 24/1, a)). When the spring-applied single-disc brake is operated in this manner, bear in mind that the significant reduction of the electric time constant causes the brake to close quickly and the switching noise to increase (see Section 7 – Emissions).

NOTICE

Risk of damage to or destruction of electronic components and the brake field coil (1.2) if protection measures are insufficient or inadequate!

- Release of the spring-applied single-disc brake may no longer be possible.
- Potential malfunction of the machine.

- In case of DC side switching, the brake must be provided with a protective circuit to avoid overvoltage (see Section 4.2.2). Additional protective elements (e.g. varistors, spark arresters etc.) must be installed to avoid damage such as burns or fusing of contacts to external circuitry. (Circuit example and electrical components for protective circuitry: see Table 23/1 and Fig. 24/1)

Ref.	Designation	Ref.	Designation	Ref.	Designation
①	Field coil (1.2)	②	Free-wheeling diode e.g. type 1N5400 (for power supply up to 24VDC)	③	Varistor e.g. type S10K30 (for power supply up to 24VDC)
S	Switch				

Table 23/1: Recommended external protective measures for DC side switching (varistor, see Fig. 24/1, a) or AC power switching (free-wheeling diode, see Fig. 24/1, b)) of the brake and when connecting the field coil (1.2) directly to DC voltage

Protective circuitry for DC power supply

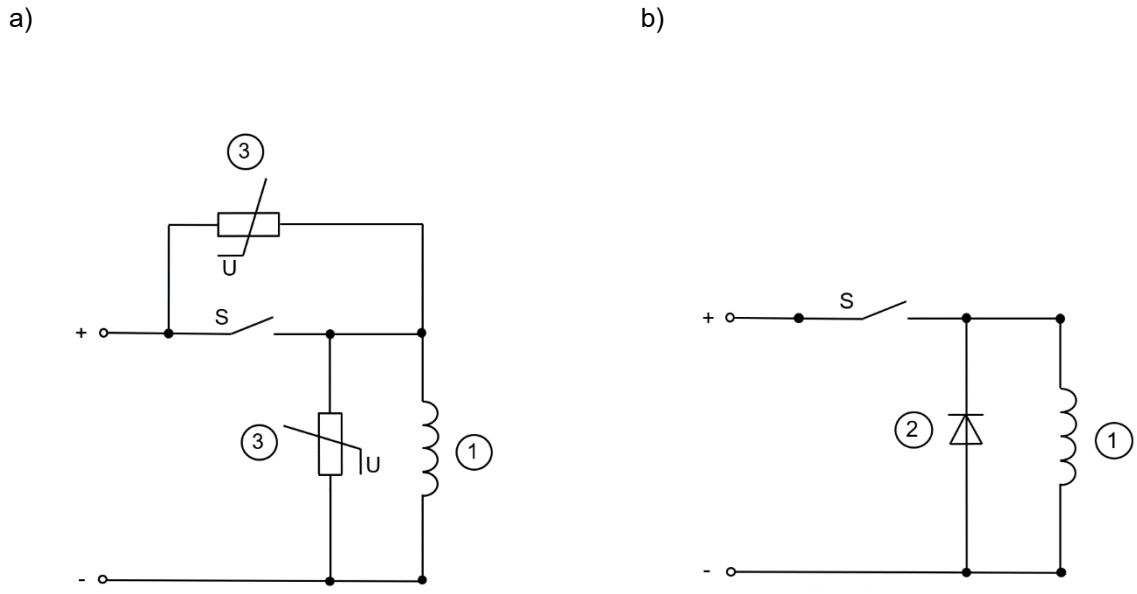


Fig. 24/1: DC side and AC side switching of the spring-applied single-disc brake and direct connection of the field coil (1.2) to a DC power source (circuit examples)

a) DC side switching and direct connection of the field coil (1.2) to a DC power source with recommended protective measures

b) AC side switching and direct connection of the field coil (1.2) to a DC power source without additional protective measures, only with free-wheeling diode

4.2.3 DC power supply via PWM control

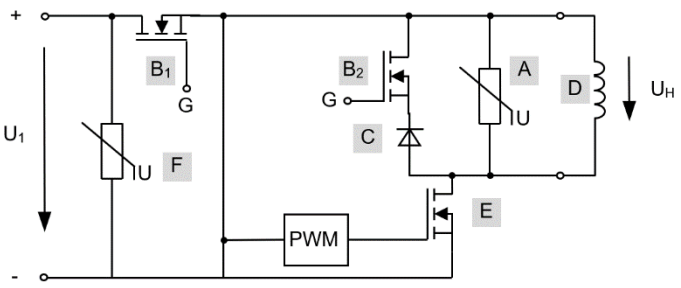
It is possible to control the power supply to the brake by pulse-width modulation (PWM) in order to enhance brake operation (see electrical block diagram in Fig. 25/1). Using pulse-width modulation, the voltage supplied to the brake can be controlled over an extensive input voltage and temperature range or kept constant. This enables temporary electronic overexcitation of the brake. As a result, the pull-in behaviour of the armature and, consequently, the brake opening performance are significantly improved and the brake service life is extended. After the selected overexcitation time has elapsed, the voltage is reduced to holding voltage U_H by an electronic module. With this solution, the brake operating temperature can be significantly reduced, providing substantial energy savings. Specific PWM control modules are available from Kendrion for this purpose (see Table 24/1). Fast turn-off (see Table 24/1) is possible as an option to reduce closing times t_{c1} (see definitions in Section 10).

PWM module type	Functional principle	Rated input voltage U_1 [9] [VDC] (±20%)	Max. output current I_{OE} / I_H [11] (ADC)	Frequency f [kHz]	Fast turn-off	Holding voltage U_H [VDC] at RT [10] (±5%)
34 10125C02	PWM	24 – 48	4 / 2	17	no	12
34 70125C02	PWM	24 – 48	4 / 2	17	yes	12
The relevant specification sheets for the specific PWM module must be observed!						

Table 24/1: PWM module types for brake operation by pulse-width modulation

[9] Overexcitation voltage U_{OE} of component
[10] RT = 20°C room temperature
[11] I_{OE} = overexcitation current, I_H = holding current

Electrical block diagram for PWM control



Brake turn off via free-wheeling diode C (extended closing time t_{c1}):

- Free-wheeling diode C parallel to field coil (1.2)
- Varistor A and MOS-FET B_2 not required

Fast brake turn-off via varistor A (shorter closing time t_{c1}):

- Free-wheeling diode C parallel to field coil (1.2)
- Additional varistor A parallel to field coil (1.2)
- Free-wheeling diode with additional MOS-FET B_2 required; common triggering of MOS-FET B_1 and B_2

Fig. 25/1: PWM control of the spring-applied single-disc brake with direct connection of the field coil (1.2) to a DC power source (example)

Ref.	Designation	Ref.	Designation
A	Varistor	D	Field coil (1.2)
B_1	MOS-FET (turning on and off)	E	MOS-FET, PWM
B_2	MOS-FET (disconnection free-wheeling diode)	F	Varistor (protective circuit)
C	Free-wheeling diode		

Table 25/2: Electrical components with PWM control of the spring-applied single-disc brake and direct connection of the field coil (1.2) to a DC power source (example)

4.2.4 AC power supply

Direct brake connection to an AC power source is only possible if a rectifier is used. The closing times t_{c1} (as defined in Section 10) vary depending on the switching type (DC side switching or AC side switching).

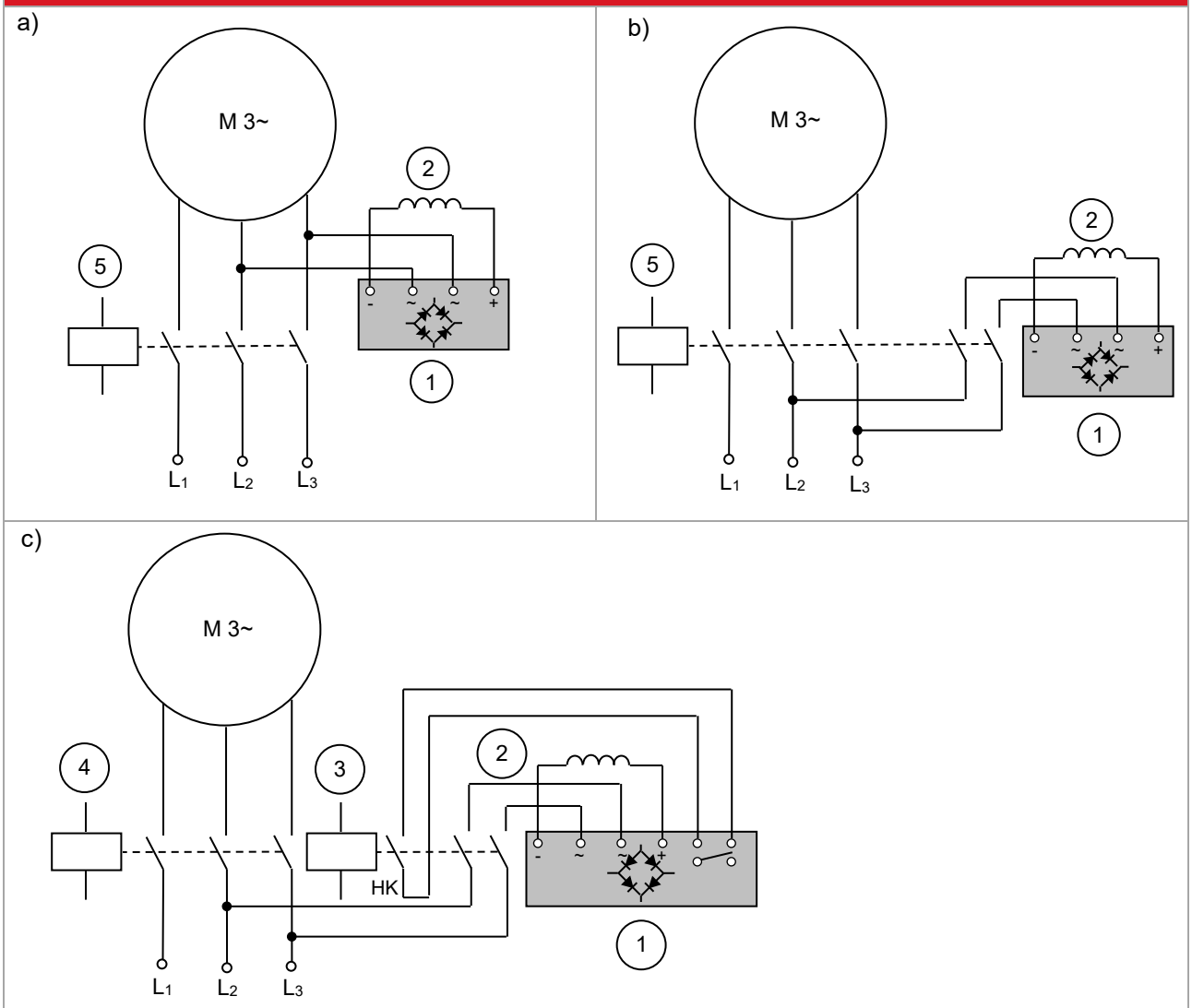
Half-wave rectification:

In case of half-wave rectification, the U_2 coil voltage is lower by factor 0.445 than the rectifier input voltage U_1. Half-wave rectifiers produce voltage with high residual ripple which, depending on the brake size, may slightly reduce the opening time t_o (as defined in Section 10) when compared to bridge rectifiers. This (plus the lower coil voltage) is the reason why half-wave rectifiers are generally preferred to bridge rectifiers. However, brake humming may occur when small size brakes are used.

Bridge rectification:

Bridge rectifiers provide voltage with minimum residual ripple. This means that brake humming can be avoided even if small size brakes are used. In case of bridge rectification, the U_2 coil voltage is lower by factor 0.89 than the rectifier input voltage.

Circuitry variants for AC power supply



1. Rectifier, e.g. bridge type
2. Field coil (1.2)
3. Actuating relay (contactor) for brake
4. Actuating relay (contactor) for machine (e.g. motor)
5. Actuating relay (contactor) for machine (e.g. motor) and brake

Fig. 26/1: DC side and AC side switching of the spring-applied single-disc brake with connection of the field coil (1.2) to an AC power source via a rectifier (example)

a) AC side switching and connection of the rectifier (e.g. bridge rectifier) to an AC power source in parallel with the machine (e.g. motor)

b) AC side switching and direct connection of the rectifier (e.g. bridge rectifier) to an AC power source

c) DC side switching with additional auxiliary contact (HK) and direct connection of the rectifier (e.g. bridge rectifier) to an AC power source

AC side (slow) switching with AC power supply:

AC-side switching of the brake is carried out e.g. by connecting rectifier an brake in parallel The easiest wiring method is to connect the rectifier in parallel in terminal box of the machine (e.g. motor) (see Fig. 26/1, a)).
It must be considered, however, that the motor may act as a generator after AC voltage has been removed and thus extend the closing times t_{c1} (see definitions in Section 10) significantly (by factor 5 or over). The opening times t_o (see definitions in Section 10) remain unchanged.

DC side (fast) switching with AC power supply:

DC-side switching of the brake is carried out e.g. by using an additional auxiliary contact which interrupts the current supply to the brake on the DC side (brake side) (see Fig. 26/1, c)). When the spring-applied single-disc brake is operated in this manner, bear in mind that the significant reduction of the electric time constant causes the brake to close quickly and the switching noise to increase (see Section 7 – Emissions).

NOTICE

Risk of damage to or destruction of electronic components and the brake field coil (1.2) if protection measures are insufficient or inadequate!

- Release of the spring-applied single-disc brake may no longer be possible.
- Potential malfunction of the motor.

- When using rectifiers without internal protective circuitry elements and in case of DC side switching, the brake must be operated with a protective circuit to avoid overvoltage (see Section 4.2.2). Additional protective elements (e.g. varistors, spark arresters etc.) must be installed to avoid damage such as burns or fusing of contacts to external circuitry. (Circuit example and electrical components for protective circuitry: see Table 27/1 and Fig. 27/1)

Ref.	Designation	Ref.	Designation
①	Field coil (1.2)	③	Varistor e.g. type S10K550 (for power supply up to 400VAC)
②	Rectifier (without internal protective circuitry)	④	Free-wheeling diode e.g. type 1N4006 (for power supply up to 400VAC)
S_1 .. S_3	Switch	⑤	Free-wheeling diode e.g. type 1N4006, only for half-wave rectifier without integrated free-wheeling diode (for power supply up to 400VAC)

Table 27/1: Recommended external protective measures for DC side switching (varistor, see Fig. 27/1, a)) or AC power switching (free-wheeling diode, see Fig. 27/1, b)) of the brake and when connecting the field coil (1.2) via rectifier to AC voltage

Protective circuitry for AC power supply

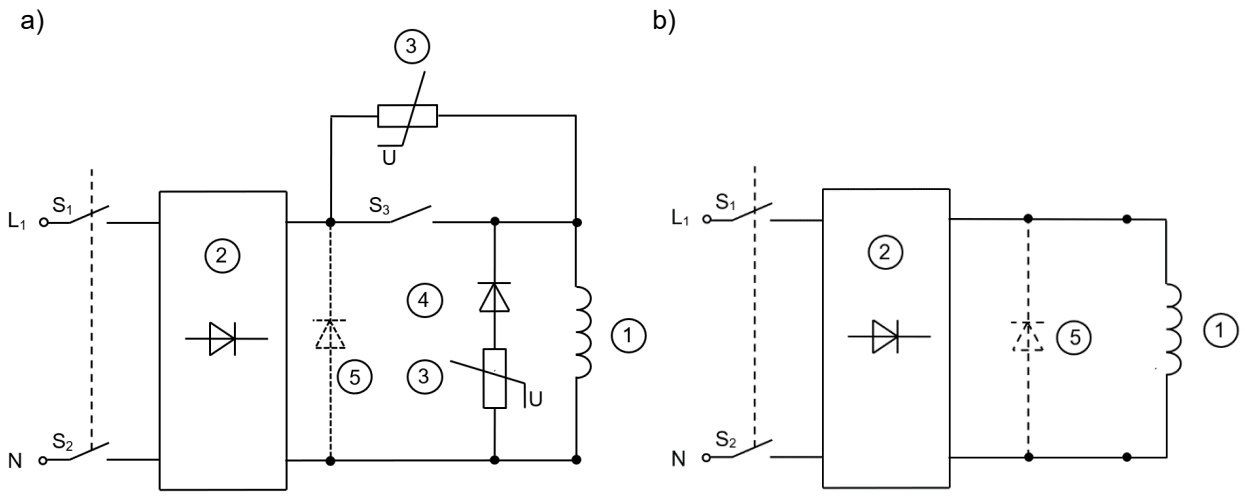


Fig. 27/1: DC side and AC side switching of the spring-applied single-disc brake and connection of the field coil (1.2) via rectifier to a AC power source (circuit examples)

a) DC side switching and connection of the field coil (1.2) via rectifier to a AC power source with recommended protective measures

b) AC side switching and connection of the field coil (1.2) via rectifier to a AC power source without additional protective measures, only with free-wheeling diode

4.3 Electromagnetic compatibility

As required by the German Electromagnetic Compatibility Act (EMVG), electromagnetic compatibility is essential to ensure immunity to external electromagnetic fields and conducted interference. Furthermore, the emission of electromagnetic fields and line-conducted interference during brake operation must be minimized. Since the brake features depend on the circuitry and operation, a declaration of conformity with the applicable EMC standard can only be furnished for the wiring type, but not for a specific brake. The spring-applied single-disc brakes in the SL 500..A00 and SL 502..A00 series are designed for industrial applications to which the following EMC standards apply: Generic Immunity Standard EN 61000-6-2 and Generic Emission Standard EN 61000-6-3 / EN 61000-6-4. Other applications may be subject to different generic standards which must be considered by the manufacturer of the installation. The requirements in terms of electromagnetic compatibility of devices and components are determined by basic standards derived from the generic standards. Wiring recommendations will be provided in the following sections to ensure compliance with the individual basic standards that are relevant for industrial use and other applications. Please refer to the relevant specification sheets for additional information on electromagnetic compatibility, especially with respect to the recommended electronic rectifiers specified in Section 4.2.1.

Immunity according to EN 61000-4:

EN 61000-4-2 Electrostatic discharge:
The brakes comply at least with severity level 3 without requiring additional measures. The recommended rectifiers specified in Section 4.2.1 conform to severity level 3 without additional measures.

EN 61000-4-3 Electromagnetic fields:
The brakes comply at least with severity level 3 without requiring additional measures. The recommended rectifiers specified in Section 4.2.1 conform to severity level 3 without additional measures.

EN 61000-4-4 Fast transients (burst):
The brakes comply at least with severity level 3 without requiring additional measures. The recommended rectifiers specified in Section 4.2.1 conform to severity level 3 without additional measures.

EN 61000-4-5 Surge:
The brakes comply at least with severity level 3 without requiring additional measures. The recommended rectifiers specified in Section 4.2.1 conform to severity level 3 without additional measures.

EN 61000-4-9 Pulse magnetic fields, EN 61000-4-10 Damped oscillatory magnetic fields:
Since the operating magnetic fields of the electromagnetic brakes are stronger many times over than interference fields, the brake function will remain unaffected. The brakes comply at least with severity level 4. The recommended rectifiers specified in Section 4.2.1 conform to severity level 3 without additional measures.

EN 61000-4-11 Voltage dips, short interruptions, and short supply voltage variations:

a) Voltage interruptions:
Brakes that comply with the requirements of DIN VDE 0580 are de-energized after the specified switching times at the latest. The switching time depends on the control and mains conditions (e.g. generator effect of running down motors). Voltage interruptions of shorter duration than the response delay specified by DIN VDE 0580 will not cause any malfunctions. The user is required to take adequate precautions to avoid consequential damage. The functional reliability of the electromagnetic component and its electronic accessories remains unaffected if consequential damage is avoided.

b) Voltage dips and short supply voltage variations:
Electromagnetically released systems:
Voltage dips and supply voltage variations to below 60% of the rated voltage and lasting longer than the response delay specified by DIN VDE 0580 may cause the brake to be de-energized temporarily. Consequential damage must be avoided by the user by taking adequate precautions.
Electromagnetically engaged systems:
Voltage dips and supply voltage variations to below the minimum tolerance threshold will cause torque reductions. The user is required to take adequate precautions to avoid consequential damage.

Radio interference suppression in accordance with EN 55011:
The brakes and the recommended electronic rectifiers are classified as Group 1 equipment in accordance with EN 55011. As far as the emissions from this equipment are concerned, one distinguishes between field guided radiated interference and line-conducted interference.

a) Radiated interference:
When operated with DC voltage or rectified 50/60 Hz AC voltage, all brakes comply with the limit values applicable to Class B equipment.

b) Conducted interference:
When connected to a DC power source, the electromagnetic brakes meet the limit values applicable to Class A equipment. If the brakes are connected to a 50/60 Hz AC power source and equipped with electronic rectifiers or other electronic controls, interference suppression measures as shown in Fig. 29/1 must be taken to ensure compliance with the limit values applicable to Class A equipment. Interference suppression capacitors should be used which must be dimensioned to suit the connection data of the electromagnetic components and the specific mains conditions. The recommended rectifiers specified in Section 4.2.1 are CE mark certified in accordance with the EMC Directive. They have built-in interference suppression components and comply at least with the requirements of EN 55011 for Class A equipment, unless otherwise specified in the specification sheet. Interference suppression components should be installed as close as possible to the consumer. Interference caused during switching operations of the electromagnetic component is generally attributable to the inductive load. Where necessary, devices designed to limit the turn-off voltage (e.g. anti-parallel diode) or voltage limiting components (e.g. varistors, suppressor diodes, resistance diodes and the like) can be installed. However, such components will inevitably change the switching times of the brake and increase the generated noise level. The rectifiers specified in Section 4.2.1 are equipped with free-wheeling diodes and/or varistors to limit the turn-off voltage. In case of DC side switching, a varistor rated for the type-specific maximum operating voltage and connected in parallel with the field coil (1.2) limits the peak voltage to the values specified in Table 29/1.

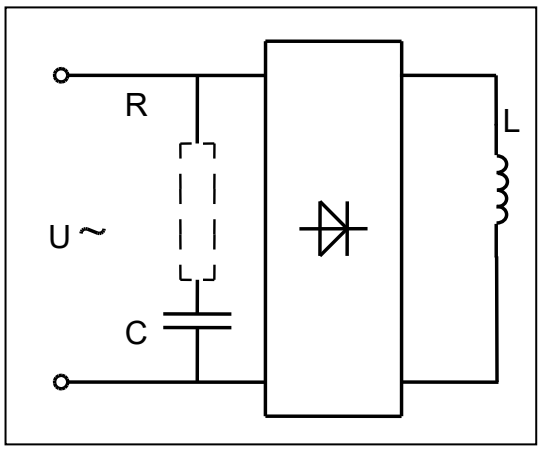


Fig. 29/1

If the brake is used in connection with other electronic accessories, the user is responsible to ensure compliance with EMC requirements. Compliance with applicable standards concerning the design and operation of components, sub-assemblies or equipment employed will not relieve the user and manufacturer of the installation from their obligation to furnish proof of conformity of the installation with such standards.

Max. rectifier operating voltage [VAC]	Recommended turn-off voltage in case of DC side switching [V]
250	700
440	1200
550	1500

Table 29/1: Recommended turn-off voltage in case of DC side switching for rectifiers specified in Table 21/1

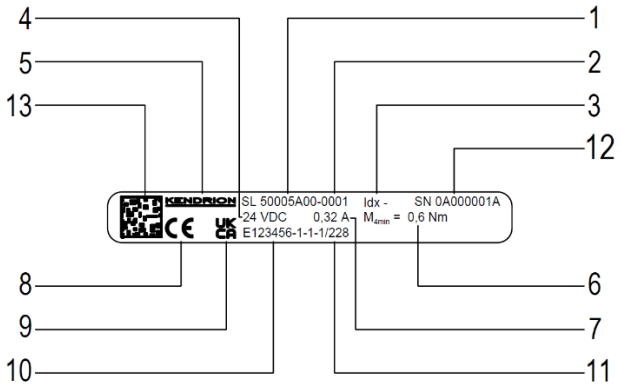
4.4 Putting into service

Check compliance with the specifications provided on the rating plate (15) with respect to the mounting position and protection class. Before putting the brake into service, perform a functional test to check that the friction disc (5) moves smoothly. For this purpose, turn the shaft while the brake is energized and the machine (e.g. motor) is unpowered. After completion of mounting, all necessary covers and guards must be installed. At the end of the installation procedure or whenever necessary within the brake service life, a break-in process is required in accordance with the parameters specified in Table 43/1.

IMPORTANT

For functional testing, the brake should be released electrically via a separate power source. After completion of the functional tests, connect the brake to the power source as described in Section 4.2.

Specifications on rating plate (order-specific, example brake type SL 50005A00-0001):



1	Type number
2	Version number (4-digit)
3	Offer drawing index
4	Rated voltage
5	Manufacturer
6	Transmissible torque
7	Rated current
8	CE mark
9	UKCA mark
10	Production ID code
11	Manufacturing date (year and month, 3-digit)
12	Series number
13	2D data matrix code (ECC Level 200) Kendrion DMC

Note: The product number of the spring-applied single-disc brake consists of the type number followed by the version number, e.g. SL 50005A00-0001.

DANGER

Electricity hazards from incorrect electrical connection of the component!

- Fatal electric shock hazard.
- All work must be performed by qualified specialist personnel only. Check that no voltage is present when connecting the component to the power supply. The specifications on the rating plate and the information provided in the circuit diagram, which (if available) may be located in the terminal box of the machine (e.g. motor) or in the operating instructions, must be strictly observed.

CAUTION

Hazards from contact with rotating parts during operation of the brake and/or machine!

- Physical injury hazard (e.g. chafing, cuts etc.) to hands and limbs.
- Functional testing of the brake must not be performed unless the machine (e.g. motor) has been turned off and secured so that it cannot be turned back on inadvertently or by unauthorized persons. Do not touch rotating parts such as the machine shaft (e.g. motor shaft) (11), friction disc (5) etc.

CAUTION

Hazards from contact with loose parts during operation of the brake and/or machine!

- Physical injury hazard (e.g. cuts etc.) to limbs and other parts of the body.

- Before starting the motor test run without driven components, the feather key (if used) must be secured in such a way that it cannot be hurled out. The machine shaft (e.g. motor shaft) (11) must not be exposed to load torques. Ensure that the brake is unpowered before restarting the machine.

CAUTION

Hazards from contact with hot parts during brake operation!

- Injury hazard (e.g. skin burns) to hands, limbs and other parts of the body.

- Depending on the operating state of the brake, its surface temperature may rise to over 60°C. If necessary, suitable protections and hand guards must be installed to avoid accidental contact with hot surfaces.
- Wear protective gloves, if necessary.

NOTICE

Risk of property damage caused by hot parts during brake operation!

- Release of the spring-applied single-disc brake may no longer be possible.
- Irreversible damage to heat-sensitive parts (e.g. cables) may occur.
- Putting into service of the spring-applied single-disc brake and machine may not be possible.

- The brake surface temperature may rise to over 60°C. Heat-sensitive parts such as conventional cables or electronic components must not be fixed to or be in contact with hot surfaces.

NOTICE

Risk of damage to or destruction of the brake field coil (1.2) if the high-voltage test is not performed correctly!

- Release of the spring-applied single-disc brake may no longer be possible.
- Putting into service of the spring-applied single-disc brake and machine may not be possible.

- High-voltage tests performed when mounting the brake in an installation or when putting the brake into service must be carried out in such a way that damage to the built-in electronic accessories is avoided. The limits for high-voltage tests and follow-up tests specified in DIN VDE 0580 must be observed.

NOTICE

Risk of damage to the field coil (1.2) from incorrect electrical connection of the component!

- Release of the spring-applied single-disc brake may no longer be possible.
- Putting into service of the spring-applied single-disc brake and machine may not be possible.

- Check that the brake has been connected in accordance with the specifications provided on the rating plate (15) before it is put into service. Even short-term operation outside the specified supply voltage limits may cause irreversible damage to the brake or electronic accessories. Such damage may not be apparent immediately. DC side brake switching without protective circuit as described in Section 4.2.2 will cause irreversible damage to electronic rectifiers, electronic accessories, switching contacts and to the field coil (1.2).

5. Maintenance, repair and replacement

5.1 Maintenance and checks

The spring-applied single-disc brakes are generally maintenance-free over the entire service life. Any tests conducted to confirm the correct function, operational safety and reliability of the brakes must be performed during the regular inspection and service of the machine (e.g. motor) and when the brake is first put into service. The tests, test procedures and test criteria are specified in Table 32/1, Table 33/1 and Table 33/2.

Required tests:

Switching function of spring-applied single-disc brake	
Test procedures / criteria	Assessment of brake release and engagement: To assess the functionality of the brake, the reliable and safe release and engagement of the brake must be tested as part of the functional test of the machine. Test criterion: Brake release: Brake operation at a supply voltage within the permissible voltage range (see Table 43/2). Check that the brake is fully released. Check that the machine shaft (e.g. motor shaft) (11) moves freely without residual torque. Brake engagement: Power supply (supply voltage) turned off. Check that the brake is fully engaged. Check that the machine shaft (e.g. motor shaft) (11) is firmly locked. Note: The switching function can be checked by manually moving the machine shaft (e.g. motor shaft) (11).

IMPORTANT

If correct brake release and engagement is not possible or if defects are suspected, the brake **must be** replaced. A new spring-applied single-disc brake must be mounted as described in Section 4. To put the new brake into service, follow the instructions in Section 4.4.

Table 32/1: Checking the switching function of the brake

Further recommended checks to be performed within the brake service life during service or maintenance of the machine:

Electrical connection and overall appearance	
Test procedures / criteria	Checking the electrical connection: Perform a visual inspection of the power connections of the brake. Test criterion: Complete absence of damage or defects to the power connections and wire leads (1.3).
	Checking the overall appearance: Perform a visual inspection of the mechanical components of the spring-applied single-disc brake and check them. If dirt has accumulated in the brake or on the rating plate (15) due to abrasion, foreign matter or other phenomena, clean the affected surfaces with oil-free compressed air or by using a brush. Test criterion: Complete absence of damage or defects to the mechanical brake components.

IMPORTANT

If defects are suspected, brake replacement is **imperative**. A new spring-applied single-disc brake must be mounted as described in Section 4. To put the new brake into service, follow the instructions in Section 4.4.

Table 33/1: Checking the electrical connection and overall appearance

Air gap ‘s’ (see Fig. 14/1)	
Test procedures / criteria	**Test method A (checking the air gap ‘s’ when the brake is incorporated into the machine (e.g. motor):** Checking the air gap ‘s’ of the brake: For a quick check of the air gap ‘s’ of the installed brake, an opening should be provided in the machine housing (e.g. motor housing) in the area of the magnet housing (1.1) and armature (2). When the brake is engaged, the air gap ‘s’ between the magnet housing (1.1) and the armature (2) can be checked **at one point** on the circumference of the brake inserting a feeler gauge (see Section 9) into the opening. Test criterion: The measured air gap ‘s’ must not exceed the limit values specified for the operating air gap s_B (see Table 42/1).
Test procedures / criteria	**Test method B (checking the air gap ‘s’ when the brake is not incorporated into the machine (e.g. motor):** Checking the air gap ‘s’ of the brake: If it is not possible to check the air gap ‘s’ when the brake is incorporated into the machine (e.g. motor), the brake can be removed during maintenance work on the machine and the stroke of the armature (2) can be determined at the measuring points A to C (see Fig. 15/3), e.g. using a measuring probe (see Section 9), when the brake is engaged and released. The arithmetic mean of the three measuring values gives the size of the air gap ‘s’. Test criterion: The measured air gap ‘s’ must not exceed the limit values specified for the operating air gap s_B (see Table 42/1).

IMPORTANT

The brake should be replaced (see Section 5.2) when the maximum operating air gap s_{Bmax} (see Table 42/1) is reached. Brake replacement is **imperative** (see Section 5.2) when the maximum air gap s_{max} is reached (see Table 42/1). Replace the brake if any defects are suspected. To remove the brake for replacement, follow the instructions in Section 5.2. To install the new brake and put it into service, proceed as described in Sections 4 and 4.4 respectively.

Table 33/2: Checking the air gap ‘s’ of the brake

DANGER

Electricity hazards from incorrect electrical connection or disconnection of the component!

- Fatal electric shock hazard.

- All work must be performed by qualified specialist personnel only. Check that no voltage is present before connecting or disconnecting the component to/from the power supply. The specifications on the rating plate and the information provided in the circuit diagram, which (if available) may be located in the terminal box of the machine or included in the operating instructions, must be strictly observed.

WARNING

Hazards from insufficient braking effect due to failure to comply with the specified service, maintenance and inspection requirements and intervals!

- Uncontrolled movements of the machine shaft (e.g. motor shaft) (11) may cause injury hazards if persons are present within the confines and/or working range of the installation.
- Uncontrolled **extremely fast** movements of the machine shaft (e.g. motor shaft) (11) may cause death if persons are present within the confines and/or working range of the installation.

- Ensure that the maximum operating air gap s_{Bmax} (see Table 42/1) is not exceeded during brake operation. Therefore, the test intervals must be determined by the manufacturer of the machine or by the user of the component in such a way that correct brake operation is ensured throughout the entire service life.
- When the maximum operating air gap s_{Bmax} is reached (see Table 42/1), the brake should be replaced. Brake replacement is **imperative** when the maximum air gap s_{max} is reached (see Table 42/1).

CAUTION

Hazards from contact with rotating parts during operation of the brake and/or machine!

- Physical injury hazard (e.g. chafing, cuts etc.) to hands and limbs.

- Functional testing of the brake must not be performed unless the motor has been turned off and secured so that it cannot be turned back on inadvertently or by unauthorized persons. Do not touch rotating parts such as the machine shaft (e.g. motor shaft) (11), friction disc (5) etc.
- Ensure that the lock used to prevent accidental start-up of the machine is removed after completion of inspection and maintenance work.

NOTICE

Risk of brake damage due to failure to comply with the specified service, maintenance and inspection requirements and intervals!

- The correct function and operation of the spring-applied single-disc brake may be compromised.
- Potential malfunction of the machine.

- The test intervals must be determined by the manufacturer of the machine or by the user of the component in such a way that correct brake operation is ensured throughout the entire service life.
- Any tests conducted to confirm correct function, operational safety and reliability of the spring-applied single-disc brake must be performed with extreme caution and by qualified specialist personnel only. The information on the rating plate (15) attached to the brake must be strictly observed during maintenance and when putting the brake back into service.

IMPORTANT

Brake service, maintenance and inspection during operation is performed by the manufacturer of the machine in accordance with their specific maintenance instructions. The specific maintenance instructions provided by the machine manufacturer must take account of the requirements specified in Section 5.1 (Maintenance and checks) of this manual.

5.2 Brake repair and replacement in case of failure

If a failure occurs or the maximum air gap s_{max} (see Table 42/1 – Technical specifications and definition in Section 10) is reached, brake replacement by the motor manufacturer is imperative. The brake cannot be repaired.

IMPORTANT

Brake replacement must be performed in accordance with the specific maintenance instructions provided by the machine manufacturer. In addition, the requirements specified in Section 4 (Installation) and Section 5.2 (Brake repair and replacement in case of failure) of this manual must be strictly complied with.

DANGER

Electricity hazards from incorrect electrical connection or disconnection of the component!

- Fatal electric shock hazard.
- All work must be performed by qualified specialist personnel only. Check that no voltage is present before connecting or disconnecting the component to/from the power supply. The specifications on the rating plate and the information provided in the circuit diagram, which (if available) may be located in the terminal box of the machine or included in the operating instructions, must be strictly observed.

WARNING

Hazards from incorrect brake replacement!

- Uncontrolled movements of the machine shaft (e.g. motor shaft) (11) may cause injury hazards if persons are present within the confines and/or working range of the installation.
- Uncontrolled **extremely fast** movements of the machine shaft (e.g. motor shaft) (11) may cause death if persons are present within the confines and/or working range of the installation.

- The machine must be turned off by the manufacturer's service and/or maintenance personnel before starting to replace the brake. Brake replacement must not be performed unless the machine has been turned off and secured so that it cannot be turned back on inadvertently or by unauthorized persons. Do not touch rotating parts such as the machine shaft (e.g. motor shaft) (11), friction disc (5) etc.

WARNING

Hazards from insufficient braking effect due to delayed replacement of the component!

- Uncontrolled movements of the machine shaft (e.g. motor shaft) (11) may cause injury hazards if persons are present within the confines and/or working range of the installation.
- Uncontrolled **extremely fast** movements of the machine shaft (e.g. motor shaft) (11) may cause death if persons are present within the confines and/or working range of the installation.

- The brake torque may drop and the braking effect may be compromised when the maximum air gap s_{max} (see Table 42/1) is exceeded. Depending on the operating condition, it may be difficult or impossible to release the brake. The brake should be replaced when the maximum operating air gap s_{Bmax} is reached. Brake replacement is **imperative** when the maximum air gap s_{max} is reached (see Table 42/1).

NOTICE

Risk of damage to the machine due to delayed replacement of the component!

- Potential malfunction of the machine.

- The brake should be replaced when the maximum operating air gap s_{Bmax} is reached. Brake replacement is **imperative** when the maximum air gap s_{max} is reached (see Table 42/1).
- If defects are suspected, brake replacement is **imperative**.

Replacement of the spring-applied single-disc brake:

The brake must be replaced in the event of defects or irreparable failures or malfunctions (see Section 8), or – at the latest – when the maximum air gap s_{max} (see Table 42/1) is reached.

IMPORTANT

To remove the spring-applied single-disc brake, dismantle the machine in accordance with the machine manufacturer's instructions and regulations in order to enable brake replacement.

Follow the instructions below to remove the spring-applied single-disc brake:

- Before removing the brake, disconnect the power supply.
- Loosen the mounting screws (9, 10) and pull the complete brake off the mounting surface (motor end shield) (8).

To install the new brake and put it into service, proceed as described in Sections 4 and 4.4 respectively.

NOTICE

Risk of brake damage caused by incorrect replacement!

- The correct function and operation of the spring-applied single-disc brake may be compromised.
- Putting into service of the spring-applied single-disc brake and machine may not be possible.

- Brake replacement requires extreme caution and must be performed by qualified and specifically trained specialist personnel only.

5.3 Spare parts and accessories

Individual spare parts or accessories are not available for the spring-applied single-disc brake.

6. Condition at delivery, transport and storage

The spring-applied single-disc brake is delivered ready for mounting. Upon receipt of the shipment, the brake must be checked for transit damage before storage. If the brake is not installed immediately upon delivery, it must be stored in a dry, dust-free and vibration-proof place.

	Environmental conditions	
	Conditions for storage to EN IEC 60721-3-1	Conditions for transport to EN IEC 60721-3-2
Mechanical conditions (M)	1M11	2M4
Climatic conditions (K)	1K21 and 1Z2	2K12
Biological conditions (B)	1B1	2B1
Mechanically active substances (S)	1S11	2S5
Chemically active substances (C)	1C1	2C1

Table 37/1: Environmental conditions for storage and transport as specified in EN IEC 60721-3-1 and EN IEC 60721-3-2

IMPORTANT

The environmental conditions specified in Table 37/1 and in EN IEC 60721-3-2 / EN IEC 60721-3-1 must be observed during transport and storage of the brake, especially when long-term storage is envisaged. The specified environmental conditions apply only if the brake is stored in its original packaging.

7. Emissions

7.1 Noise

The spring-applied single-disc brake produces switching noise during engagement and release. The noise level is determined by the mounting and installation conditions, circuitry and air gap ‘s’. Depending on the mounting position, operating conditions and condition of the friction surfaces, audible vibrations (squealing) may occur during braking.

7.2 Heat

Braking operations and gradual heating of the field coil (1.2) cause the brake temperature to increase substantially. Under adverse conditions, the surface temperature may rise to well over 60°C.

CAUTION

Hazards from contact with hot parts during brake operation!

- Injury hazard (e.g. skin burns) to hands, limbs and other parts of the body.
- Depending on the operating state of the brake, its surface temperature may rise to over 60°C. If necessary, suitable protections and hand guards must be installed to avoid accidental contact with hot surfaces.
- Wear protective gloves, if necessary.

8. Troubleshooting

Fault	Cause	Corrective actions
Brake release failure	• Air gap ‘s’ too large	Check the air gap ‘s’ (see Section 5.1). Install a new brake, if necessary (see Section 5.2).
	• No voltage applied to brake	Check the power connections (see Section 4.2) and correct faults, if found.
	• Voltage applied to field coil (1.2) too low	Check the supply voltage of the field coil (1.2) and correct faults, if found.
	• Armature (2) blocked mechanically	Eliminate mechanical blocks. Install a new brake, if necessary (see Section 5.2).
	• Overexcitation rectifier and/or PWM module defective	Check the overexcitation rectifier and/or PWM module. Replace them, if necessary.
	• Damaged field coil (1.2)	Check the resistance of the field coil (1.2). Install a new brake, if necessary (see Section 5.2).
	• Thermal damage to friction disc (5) linings	Install a new brake (see Section 5.2).
Delayed brake release	• Air gap ‘s’ too large	Check the air gap ‘s’ (see Section 5.1). Install a new brake, if necessary (see Section 5.2).
	• Voltage applied to field coil (1.2) too low	Check the supply voltage of the field coil (1.2) and correct faults, if found.
Brake engagement failure	• Voltage applied to field coil (1.2) in unpowered condition too high (residual voltage)	Check whether residual voltage is applied to the field coil (1.2) and correct faults, if found.
	• Armature (2) blocked mechanically	Eliminate mechanical blocks. Install a new brake, if necessary (see Section 5.2).
Delayed brake engagement	• Voltage applied to field coil (1.2) too high	Check the supply voltage of the field coil (1.2) and correct faults, if found.
Brake torque too low	• Air gap ‘s’ too large	Check the air gap ‘s’ (see Section 5.1). Install a new brake, if necessary (see Section 5.2).
	• Oily, greasy or dirty friction surface(s)	Install a new brake (see Section 5.2).

Table 38/1: Possible faults, causes and corrective actions (list not exhaustive)

9. Tools and measuring instruments for installation, maintenance and troubleshooting

Special tools and measuring instruments are required for installation (Section 4), maintenance and checks (Section 5.1) and troubleshooting (Section 8, non-exhaustive list of potential faults). The individual tools and instruments and their applications are described in Table 39/1.

Tools, measuring instruments	Description and application	Suitable for brake size	Design details
	Calibrated torque wrench for precise torque-controlled tightening and loosening of all screws to a defined M_A tightening torque	03, 04	• 0 – 1 Nm
		05, 07, 09, 10, 12	• 0 – 5 Nm
	Hex drive hexagon insert bit for use with calibrated torque wrench for tightening and loosening the mounting screws (9, 10)	03, 04	AF 1.5 mm
		05	AF 2 mm AF 2.5 mm
		07, 09, 10, 12	AF 3 mm
	Allen key for mounting screws (9, 10)	See information on hex drive hexagon insert bit	
	Circlip pliers when using a circlip (16) for securing the hub (7) in axial direction	03, 04, 05, 07, 09, 10, 12	For circlips to DIN 471
	Feeler gauges for checking and measuring the air gap ‘s’	03, 04, 05, 07, 09, 10, 12	Leaf thickness from 0.05 mm to 0.5 mm by 0.05 mm steps
	Measuring probe for measuring the air gap ‘s’	03, 04, 05, 07, 09, 10, 12	Measuring range from 0 to min. 1 mm; max. resolution 0.01 mm
	Multimeter (voltage, current, resistance) for measuring the supply voltage and ohmic resistance of the field coil (1.2)	03, 04, 05, 07, 09, 10, 12	-

Table 39/1: Tools and measuring instruments for installation, maintenance and troubleshooting

IMPORTANT

Brake inspections and tests as well as service and maintenance operations must be carried out by the machine manufacturer and by qualified specialist or service personnel only. The specific maintenance instructions provided by the machine manufacturer must take account of the requirements specified in Section 5.1 (Maintenance and checks) of this manual.

10. Definitions

(based on: DIN VDE 0580:2011-11, not exhaustive)

Switching torque M_1	torque acting on the shaft during brake or clutch slip
Rated torque M_2	switching torque specified by the manufacturer to identify the brake. The rated torque M_2 is the mean value of at least 3 measurements of the maximum switching torque M_1 after completion of the transient response.
Transmissible torque M_4	highest torque that can be applied to the engaged brake or clutch without causing the brake/clutch to slip. Note: In the case of brakes and clutches exposed to purely static loads, the M_4 torque is commonly referred to as rated torque.
Residual torque M_5	torque transmitted by the released brake or clutch
Load torque M_6	torque acting on the drive of the engaged brake or clutch; determined by the power requirement of the driven machine at a given speed
Switching work W	heat generated by friction inside the brake or clutch as a result of the switching operation
Maximum switching work W_{max}	maximum switching work to which the brake or clutch may be exposed
Switching power P	switching work converted into heat per unit of time
Maximum switching power P_{max}	maximum permissible switching work converted into heat per unit of time
Coil ON time t_5	time between power on and power off
Coil OFF time t_6	time between power off and power on
Total cycle time t_7	coil ON time plus coil OFF time
Duty cycle	percentage relationship of coil ON time to total cycle time
Switching operation	one complete switching on and off operation
Switching frequency Z	number of regular switching operations per hour
Response delay during coupling t_{11}	time between power off (releasing systems) or power on (engaging systems) and beginning of torque increase
Rise time t_{12}	time it takes to reach 90% of the M_2 rated torque from the beginning of the torque increase
Coupling time t_1	response delay t_{11} plus rise time t_{12}
Response delay during disconnection t_{21}	time between power on (releasing systems) or power off (engaging systems) and beginning of torque decrease
Fall time t_{22}	time it takes for the torque from the beginning of the torque decrease to fall to 10% of the M_2 rated torque
Disconnection time t_2	response delay t_{21} plus fall time t_{22}
Slip time t_3	time from the beginning of the torque increase up to the end of the braking process (brakes) or until the synchronization torque M_3 has been reached (clutches)
Making time t_4	response delay t_{11} plus slip time t_3 (braking or acceleration time)
Operating condition at operating temperature	condition at which the steady-state temperature is reached. The operating temperature corresponds to the overtemperature according to DIN VDE 0580 plus the ambient temperature. Unless otherwise specified, the ambient temperature is 35°C.
Overtemperature $\Delta\vartheta_{31}$	difference between the temperature of the electromagnetic device or a part thereof and the ambient temperature
Limit temperatures of coil insulating materials	in accordance with DIN VDE 0580. The individual insulating materials are classified by insulation classes to DIN IEC 60085.
Rated voltage U_N	supply voltage specified by the manufacturer for field coils to identify the device or component

Rated current I_B	amperage determined by the manufacturer for the specified operating conditions. Unless otherwise specified, the rated current refers to the rated voltage, 20°C winding temperature and to the rated frequency for a given operating mode of field coils.
Rated power P_N	power value to identify the device or component

Other definitions (not included in DIN DE 0580) applicable to spring-applied single-disc brakes:

Air gap s	air gap of engaged spring-applied single-disc brake
Rated air gap s_N	air gap of engaged spring-applied single-disc brake when the brake is new
Operating air gap s_B	air gap range of engaged spring-applied single-disc brake in which the brake can be operated provided that the technical specifications are complied with
Max. air gap s_{max}	maximum air gap of engaged spring-applied single-disc brake at which the brake (just about) still opens
Closing time t_{c1}	time it takes for the spring-applied single-disc brake to close mechanically after power has been turned off (beginning of power drop) (see chart in Fig. 41/1)
Activation time t_{c2}	time it takes for the transmissible torque M_4 (holding torque) to be reached almost completely after power has been turned off (beginning of power drop) (see chart in Fig. 41/1)
Opening time t_o	time it takes for the spring-applied single-disc brake to open mechanically after power has been turned on (beginning of power rise) (see chart in Fig. 41/1)
Min. transmissible torque M_{4min}	lowest static torque of the brake at the specified rated operating conditions
Opening voltage U_1	voltage at which the spring-applied single-disc brake opens (determined at 20°C winding temperature)
Coupling voltage U_3	voltage at which the spring-applied single-disc brake closes (determined at 20°C winding temperature)
Holding voltage U_4	voltage at which the brake must remain open (determined at 20°C winding temperature)

The switching times (disconnection time t_2 and coupling time t_1) are defined in DIN VDE 0580. When using static systems (holding brakes), the switching times are determined on the basis of the current profile (see Fig. 41/1, AC side power on and off) instead of using the DIN VDE 0580 definitions.

Switching times for static operation of holding brakes

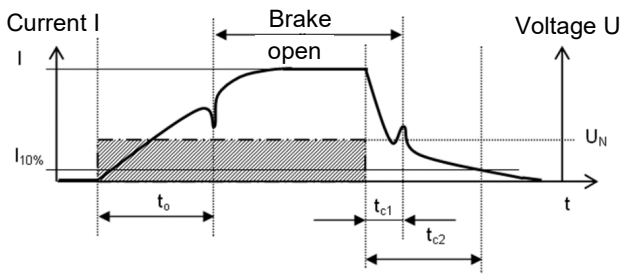


Fig. 41/1: Characteristic current curve and switching times t_o, t_{c1}, t_{c2}

11. Technical specifications

Product built and tested to DIN VDE 0580

	Brake size						
	03	04	05	07	09	10	12
Min. transmissible torque M_{4min} [Nm]	0.27	0.3	0.6	1.7	4.0	5.0	8
Transmissible torque M_4 [Nm]	0.4	0.4	1.0	2.4	5.0	6.5	11
Rated power P_N [W]	5.8	7.1	10.3	11.4	14	20	27.2
Rated overexcitation voltage U_{OEN} [VDC] [12)]	24	-					
Overexcitation time t_{OE} [ms] [12)]	200	-					
Max. limit speed n_G [rpm]	8000				6000		5000
Max. speed n_n [rpm]	6000	6000	5000	4000	3000	3000	2500
Maximum switching work W_{1max} (Z=20/h) [J]	0.5	5	20	50	250	300	800
Max. number of emergency stops Z per hour [1/h]	20						
Max. number of emergency stops Z_{total} with W_{1max}	200						
Max. total switching work W_{total} [kJ]	0.1	1	4	10	50	60	160
Rated air gap s_N [mm]	0.06–0.1	0.06–0.1	0.06–0.1	0.08–0.12	0.08–0.12	0.12–0.17	0.14–0.19
Max. operating air gap s_{Bmax} [mm]	0.15	0.15	0.16	0.19	0.18	0.24	0.28
Max. opening time t_o [ms]	25	30	30	45	50	60	160
Max. closing time t_{c1} [ms]	5	10	8	9	15	15	30
Opening voltage U_1 [VDC]	max. 12						
Coupling voltage U_3 [VDC]	min. 1						
Holding voltage U_4 [VDC]	max. 9.6						
Mass moment of inertia J – friction disc (5) and hub (7) [10^{-6} kgm^2] SL 500..A00	0.18	0.5	1.9	8.7	50	130	220
Mass moment of inertia J – friction disc (5) and hub (7) [10^{-6} kgm^2] SL 502..A00	-	0.3	1.7	7.2	tbd	tbd	tbd
Weight (without hub) m [kg]	0.1	0.1	0.15	0.32	0.53	0.68	1.7
Duty cycle [%]	100%						
Thermal class	F						
Pollution degree	2						
Protection rating	IP00						
Duty type / Brake type	S1, S2, S3						
	holding brake with emergency stop function						

Table 42/1: Technical specifications

[12)] Brake size 03 only; operation only with PWM module

	Brake size						
	03	04	05	07	09	10	12
Speed n [rpm]	380	380	380	370	300	300	300
Coil ON time t_5 [s]	3						
Coil OFF time t_6 [s]	1						
Break-in period t_{total} [s]	40						

Table 43/1: Break-in process parameters for the spring-applied single-disc brake after installation and during brake service life

	Rated operating conditions
Rated voltage U_N [VDC]	24 / 12 [13)]
Overexcitation voltage U_{OE} [VDC]	24 [13)]
Rated voltage tolerance	±10%
Frequency range	±1% of rated frequency
Ambient temperature ϑ_{13} [°C]	–10 to +100
Relative humidity	30% to 80% within ambient temperature range
Other climatic conditions (Z)	3Z2 and 3Z14 to EN IEC 60721-3-3
Mechanical conditions (M)	3M12 to EN IEC 60721-3-3
Biological conditions (B)	3B1 to EN IEC 60721-3-3
Mechanically active substances (S)	3S6 to EN IEC 60721-3-3
Chemically active substances (C) or corrosivity category	C1 to EN ISO 9223
Installation height	up to 2000 m a.m.s.l.

Table 43/2: Required operating conditions for spring-applied single-disc brakes

Explanations of technical specifications:

W_{1max} (maximum switching work, see Table 42/1) is the switching work that must not be exceeded during braking operations at maximum speed n_n. The W_{1max} values are approximate values. They apply to built-in brakes without any additional cooling and to emergency stops. The specified transmissible torques M_4 characterize the torque level of the brake. Depending on the application the brake is used for, the dynamic torque (switching torque) M_1 and the effective transmissible torque M_4 may differ from the specified M_4 transmissible torque values. The specified minimum transmissible torque M_{4min} is the lowest static brake torque when the brake is operated at the specified rated operating conditions (see Table 43/2). The switching torque M_1 depends on the speed (rpm) and switching work. If the friction surfaces are contaminated with oil, grease or dirt and the ambient temperatures are below or above the specified range, the effective transmissible torque M_4 and the switching torque M_1 may drop. The technical specifications apply after the break-in process has been completed with the specified break-in parameters (see Table 43/1).

IMPORTANT

To prevent overheating and potential damage to the brake and friction disc (5), ensure that the switching operations (emergency stops) per hour Z are evenly distributed. If heat dissipation and cooling of the brake is not sufficient, the hourly number of switching operations (emergency stops) Z according to Table 42/1 may have to be reduced.

[13)] Brake size 03 only

Specific explanations of the terms opening voltage, coupling voltage and holding voltage:

Opening voltage U_1:

The defined maximum opening voltage U_1 values apply under the following conditions:

- Temperature of field coil (1.2): 20°C
- Operation at rated air gap s_N according to Table 42/1

Coupling voltage U_3 and holding voltage U_4:

The defined minimum coupling voltage U_3 values and the defined maximum holding voltage U_4 values apply under the following conditions:

- Temperature of field coil (1.2): 20°C

Specific explanations of the opening and closing times:

Opening time t_o:

The defined maximum opening time t_o values apply under the following conditions:

- Operation at rated voltage U_N within the permissible voltage range as specified in Table 43/2
- Temperature range of field coil (1.2): -10°C to 155°C
- Operation within the permissible operating air gap s_B according to Table 42/1

Closing time t_{c1}:

The defined maximum closing time t_{c1} values apply under the following conditions:

- Operation at rated voltage U_N within the permissible voltage range as specified in Table 43/2
- Temperature range of field coil (1.2): -10°C to 155°C
- DC side turn-off with varistor type S10K30 to limit the turn-off voltage
- Operation within the permissible operating air gap s_B according to Table 42/1

IMPORTANT

The closing time t_{c1} and the opening time t_o depend on the temperature of the field coil (1.2). If the field coil (1.2) temperature is above the specified temperature, the closing times t_{c1} are reduced and the opening times t_o are extended. If the field coil (1.2) temperature is below the specified temperature, the opening times t_o are reduced and the closing times t_{c1} are extended. As the air gap 's' of the brake increases, the opening times t_o and the closing times t_{c1} are extended.

The technical specifications in Table 42/1 and the rated operating conditions specified in Table 43/2 must be observed during operation of the spring-applied single-disc brake.

The information provided in the relevant offer drawings of the specific brake types must be followed!

IMPORTANT

If there is any conflict between the information provided in the offer drawing and the information given in Section 10 of these operating instructions, the offer drawing prevails.

Specifications subject to change without notice!

12. Product number / type number / version number

The product number to be quoted in purchase orders and required to identify the brake version consists of the type number followed by the 4-digit version number. Individual brake types may be available in different versions. So the version number identifies the relevant brake model.

Example:

Type number: SL 50005A00

Version number: 0002 (version without hub)

Product number: SL 50005A00-0002

13. Specialist repair shops

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14. Revision history

Date of issue	Changes
13/03/2020	First issue
11/05/2023	Operating instructions completely revised and updated. Added brake size 12. Section 4.2: added, information on protective circuitry for DC power supply, AC power supply and operation with PWM modul. Revision of safety information. Updated technical specifications in Section 11.
29/06/2023	Operating instructions updated. Section 4.2.2 and 4.2.3 revised and updated.

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