Technical Information TI-B10
Safety Brakes

☑ For small to medium loads
☑ DGUV approved
☑ One load direction

Table of Contents

1 Where do I find what?

For technical data of the various series and optional accessories, refer to these Technical Data Sheets:

- *Technical Data Sheet TI-B11*: Series KSP
- *Technical Data Sheet TI-B20*: Spring base for Safety Brakes
- *Technical Information TI-B40*: Information about the DGUV Test certificate
- *Operating manual BA-B10*: detailed description of actuation, mounting and performance test

2 Purpose

Safety Brakes ensure personal protection and accident prevention if a suspension element supporting raised loads or tools should break. This may occur when a pneumatic pressure system fails, for example.

Safety Brakes take over falling loads continuously at any position of the stroke and in a mechanically secure and absolutely reliable manner. The functional principle of self-intensifying clamping ensures an extremely high safety level.

Safety Brakes are designed for static holding of loads and for emergency braking of loads and forces.

2.1 Static holding of loads and forces

The Safety Brake is a mechanical restraint device for static loads.

2.2 Emergency braking of loads

The Safety Brake can be used for emergency braking of a load in load direction. The braking force in load direction is higher than the admissible load M, but it is limited to ensure that energy is absorbed in a defined manner.

Emergency braking is understood to mean a rarely occurring braking process that stops a machine movement in an exceptional circumstance.

3 Function

You can find a simulation showing the function of Safety Brakes on our website, *www.sitema.com*, under the Safety Brake product description.

3.1 Clamping released

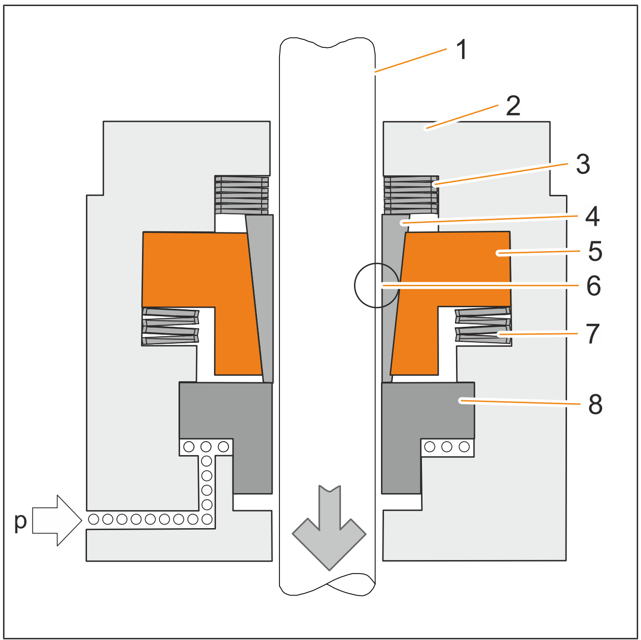

Fig. 1: Clamping released

The housing (2) encloses the clamping rod (1). Inside the housing is the clamping system, which consists of a clamping sleeve (4) with an outer cone and a clamping ring (5) with an inner cone. The clamping ring can slide in the housing. The overload springs (7) press the clamping ring against a stop.

When the annular piston (8) is pressurized (p), the clamping is released. The pressurized annular piston keeps the clamping sleeve in the released position against the force of the tensioning springs (3). This results in a defined air gap (6) between the clamping sleeve and the rod. The rod can move freely in both directions.

3.2 Static holding of the load

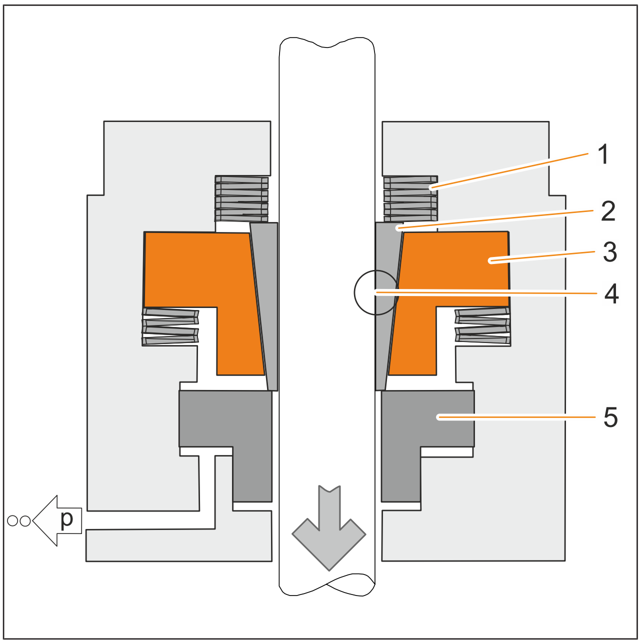

Fig. 2: Load secured

3.2.1 Securing the load

The Safety Brake secures the load when the pressure is switched off and the annular piston (5) becomes depressurized. The tensioning springs (1) then press the clamping sleeve (2) into the cone of the clamping ring (3). The clamping sleeve is in contact (4), resulting in an initial friction force between the rod and the clamping sleeve.

At this point, the Safety Brake secures the load but has not yet taken over the load.

3.2.2 Taking up the load

The holding force does not build up until the rod moves in the load direction. When this happens, the clamping system contracts and the self-intensifying clamping force builds up. The rod movement is relatively small, typically less than 0.5 mm, as long as the force does not exceed the admissible load M. The clamping ring remains in its original position because the preload V of the overload springs exceeds the admissible load M.

3.3 Emergency braking: braking a load during movement

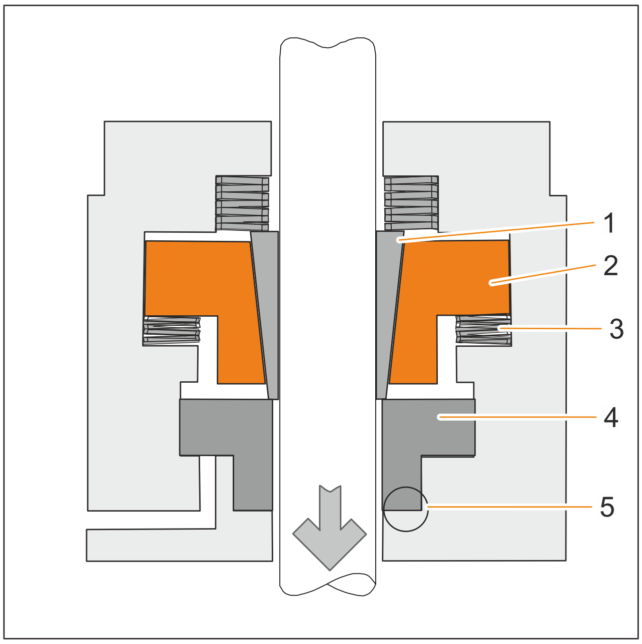

Fig. 3: After emergency braking

A moving load is braked during emergency braking. In this process, the kinetic energy must be dissipated by friction. Braking a moving load generates forces that exceed the weight of the suspended mass.

The package consisting of clamping sleeve (1), clamping ring (2) and annular piston (4) moves if the preload force V of the overload springs (3) is exceeded. The annular piston reaches the lower stop (5) after moving around 2 mm. The overload springs compress slightly without reaching point at which further compression is no longer possible. From this point, the clamping force of the clamping sleeve cannot increase any further.

The slipping force for the rod is thus limited and calculable: it is between 2 and 3.5 times the admissible load M. The resulting braking deceleration (when the load is equivalent to M) is thus between g (gravitational acceleration) and 2.5 g.

After stopping, the overload springs will raise the load again slightly.

Force-distance curve

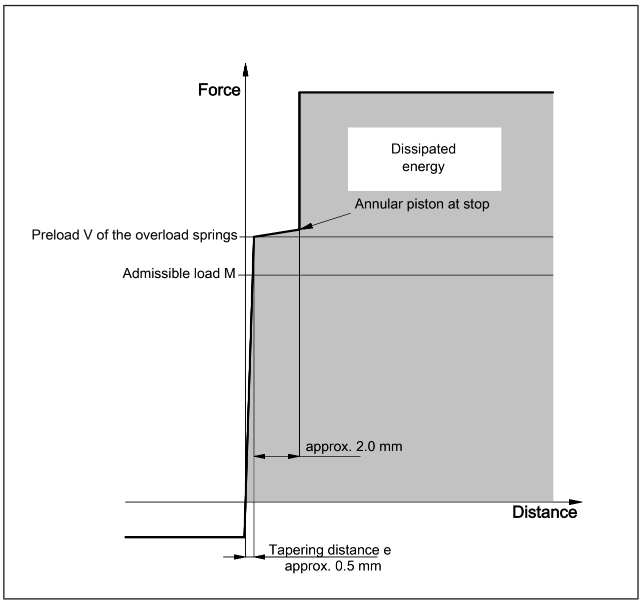

Fig. 4: Force-distance curve

The area under the force-distance curve in Fig. 4 represents the dissipated energy.

3.4 Releasing the clamping

Release with “load secured”

When the Safety Brake secures the load, pressure port L must be pressurized to release the clamping.

Release with “load taken over”

Once the Safety Brake has taken over or braked the load, pressure port L must be pressurized and the rod moved opposite to the load direction by tapering distance e at the same time. The force used must correspond to the load. This provides the safety advantage that the clamping can be released only if the lifting drive is intact and actuated. An increased force (e.g. for breaking loose) is normally not required.

This advantage does not come into play when relatively small loads coincide with a high release pressure. For more information, see minimum load F6 in “Technical Data Sheet TI-B11”.

Movement opposite to the load direction

Pressure port L is pressurized to move opposite to the load direction. This releases the clamping, and the rod is freely movable.

In exceptional cases, brief movement opposite to the load direction is possible even in the clamped state without the application of pressure to pressure port L. The holding force is then approx. 15 to 20% of the admissible load M.

3.5 Correct function of the Safety Brake

The following is important for correct functioning of the Safety Brake:

- A correct design of the Safety Brake for the respective application.
- Consideration of delay times such as the response times of the control system, a valve or the Safety Brake.

4 Operating conditions

Condition	Value
Permissible surface temperature	0 to + 60 °C (32 to 140 °F)
Relative humidity at 20 °C (68 °F), no condensation	20 to 75 %

Table 1: Operating conditions

The Safety Brake has been designed for use in dry and clean surroundings. A heavily contaminated operating location requires special protective measures.

Modified standard design: Observe the information in the enclosed *Supplementary information*.

Special design: Observe the information on the dimensional drawing.

5 Pressurizing medium

Use only dried and filtered compressed air according to ISO 8573-1:2010 [7:4:4]. Other pressurizing media may be used only in consultation with SITEMA.

6 Choosing the right type

An admissible load M is stated for all types on Technical Data Sheet TI-B11. Normally (for vertical movement), the following condition must be met:

$$M \geq \frac{\textit{moving weigth}}{\textit{number of Safety Brakes}}$$

The holding force with a dry rod or a rod wetted with hydraulic oil is at least 2 x M but does not exceed 3.5 x M.

7 Requirements of the clamping rod and fastening elements

The Safety Brake will function correctly only if the clamping rod is properly designed.

Requirement	Diameter	Value
ISO tolerance zone	all	f7 or h6
Induction hardened	all	min. HRC 56
Surface hardening depth	ø up to 30 mm	min. 1 mm
	ø over 30 mm	min. 1.5 mm
Surface roughness	all	Rz = 1 to 4 µm (Ra 0.15 to 0.3 µm)
Protection from corrosion	all	Hard chromium plating, for example: 20 ± 10 µm 800 - 1,000 HV
Lead-in chamfer rounded	ø 16 to 32 mm	min. 4 x 30°

Table 2: Clamping rod requirements

The rod must not be greased.

Manufacturers of cylinder piston rods or rods for linear ball bearings usually offer suitable clamping rods.
The actual holding force of the Safety Brake is higher than the admissible load (M) indicated on the data sheets and dimensional drawings. It does not exceed 3.5 times this value, however.
Accordingly, the fastening elements taking over the load (rod and its linkage, etc.) have to be dimensioned for at least 3.5 x M. This maximum force can occur during dynamic braking and also if, in case of control errors, the drive force is exerted against the closed Safety Brake.
The rod will slip in case of overload, which normally does damage the rod or the Safety Brake.
Generally, the basic rod material needs to have sufficient strength. In the case of compression-loaded rods, the buckling resistance must be observed.

8 Actuation

Actuation and function monitoring are the responsibility of the machinery manufacturer.

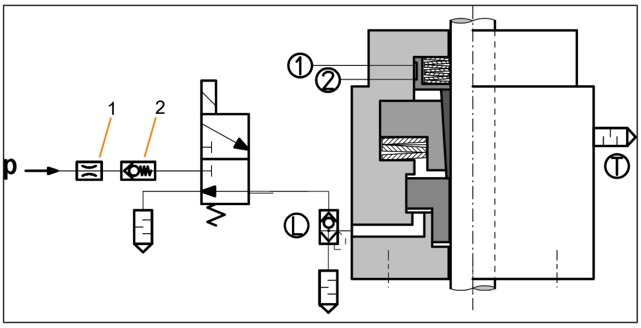

Fig. 5: Example for KSP actuation

1	A throttle in the p-line can suppress any impact noises occurring during the application of pressure (depending on the set release pressure).
2	If the pressure (p) is not constant enough (e.g. pressure drop at the beginning of downward movements), a check valve in the p-port of the valve is advisable.

If a quick response time of the Safety Brake is required, the following preconditions must be met:

- Installation of a dump valve directly on pressure port L
- Short lines
- Fast valve response times
- Suitable control system

8.1 Actuation using 3/2-way valve

In most cases, actuation as described in Fig. 5 is used.
During all normal operational travel, the 3/2-way valve is actuated electrically and releases the clamping.
The control system must be designed so that the Safety Brake is activated and holds the rod or brakes the load in all other operating states, as well as in case of power failure, supply pipe breakage, emergency stop, etc. If necessary, the valve can also be switched by another safety signal such as an overspeed or contouring error, etc.

8.2 Proposal for integration into the machine control system

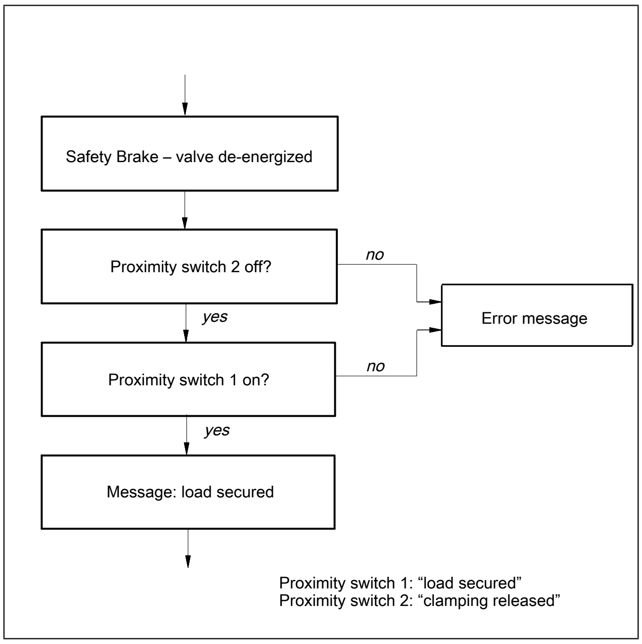

Fig. 6: Securing the load

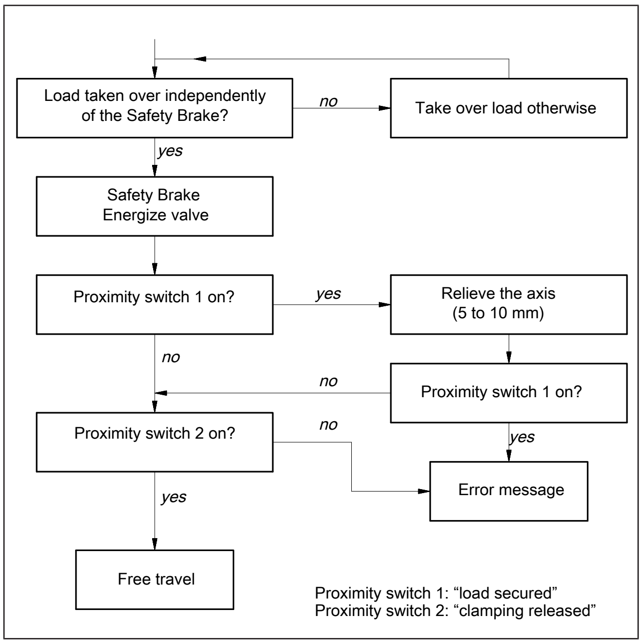

Fig. 7: Clamping released

9 Status monitoring by proximity switches

The proximity switches monitor the Safety Brake operating state. The proximity switches send the following signals to the machine control system:

Proximity switch	Signal	Purpose
1	Load secured	Enabling access to the danger zone.
2	Clamping released	Enabling drive movement in load direction.

To check the correct functioning of the proximity switches, the switching of the signals has to be tested. There is an error if both proximity switches indicate a signal or no signal at the same time (apart from short overlapping periods during switching).

The machine control system must process the signals from the proximity switches correctly.

10 Service life

The frequency with which certain operating states occur plays an important role for the Safety Brake service life.

State	Stress
Securing the load	When a stationary load is being secured, the occurring material stresses are negligible and can be withstood millions of times over.
Taking over the load	When the load is being taken over (see *Chapter 3.2.2 Taking up the load* [▶ 2]), the maximum Safety Brake holding force can be reached. Forces and material stresses in accordance with the design occur. The rod does not slip.
Emergency braking	The Safety Brake can withstand braking processes with a slipping rod from several hundred times to a few thousand times. It is suitable for braking from speed ranges up to max. 1.5 m/s.

Table 3: Operating states and stress

For an extended service life, the following operating modes should be avoided:

- Constant braking during movement
- Incorrect operation of the drive with the clamping closed
- Moving opposite to the load direction without the simultaneous application of pressure

If you avoid these operating modes, the holding force can be kept above its nominal value even after many years of use. The clamping rod normally shows no relevant dimensional or surface changes even after many clamping cycles at the same position.

You can additionally take the following measures to extend the service life:

- Make sure the rod is not exposed to any transverse forces.
- Use a rod with a finish that is not too rough.
- Protect the interior of the housing against penetration of corrosive media and dirt.
- Only use dried compressed air.
- Clamp the rod only after it has completely stopped. Ensure the correct sequencing of the operating states by appropriate actuation and control.

11 DGUV Test Certificate

The SITEMA Safety Brake is certified by DGUV Test (testing and certification body) for installation in the following machines for holding up a load from a standstill:

- Presses according to DIN EN 289
- Mechanical “Group 1” presses according to DIN EN ISO 1692-1/-2
- Hydraulic presses according to DIN EN ISO 16092-1/-3
- Injection-molding machinery according to DIN EN ISO 20430

You can find the DGUV Test certificate and additional information about this in the *Technical Information TI-B40* document in the download area of our website, *www.sitema.com*.

12 Safety of machinery - risk assessment

Safety Brakes that are intended to be used in safety-relevant applications must be selected and arranged in accordance with the *EN ISO 12100:2010* standard*, Safety of machinery – General principles for design – Risk assessment and risk reduction,* and additional standards and regulations applicable to the specific application. Based on its principle, the Safety Brake cannot constitute a complete safety solution on its own. It is suitable as part of such a solution, however. Furthermore, all attachments and connections have to be dimensioned correspondingly. This is generally the duty of the machinery manufacturer/user.

On request, we can provide the B_{10D} value for calculating the Performance Level in accordance with ISO 13849.

13 Regular performance tests

A performance test of the Safety Brake must be carried out at regular intervals. Regular checking is the only way to ensure that it will operate safely in the long run.

Please see the Operating manual for further details.

14 Maintenance

Maintenance is limited to the regular performance tests. Should the Safety Brake cease to comply with the required characteristics, the safety for working with the machine or system may no longer be given. In this case the Safety Brake must be immediately and professionally repaired by SITEMA.

To ensure the function as safety-related component, any repair or refurbishing must be carried out by SITEMA. SITEMA cannot take any responsibility for repairs by another party.

15 Installation

15.1 Fixed installation or radially floating installation

The Safety Brake can be installed radially floating or fixed. The type of installation depends on how the rod is installed.

Rod is installed fixed:

a) Mount the Safety Brake radially floating.
   You can use the spring base for Safety Brakes for this purpose, see *TI-B20 Spring base for Safety Brakes*.

Rod is installed floating:

a) Mount the Safety Brake securely with a direct screw connection.
   You can use the SITEMA rod attachment STB for this purpose, see *TI-STB10 SITEMA rod attachment*.

15.2 Unit stationary or travelling with the load

If the Safety Brake is integrated into the machine as a stationary component, the load (e.g. the slide of a press) is generally movable.

If the Safety Brake moves with the load, the rod is usually stationary.

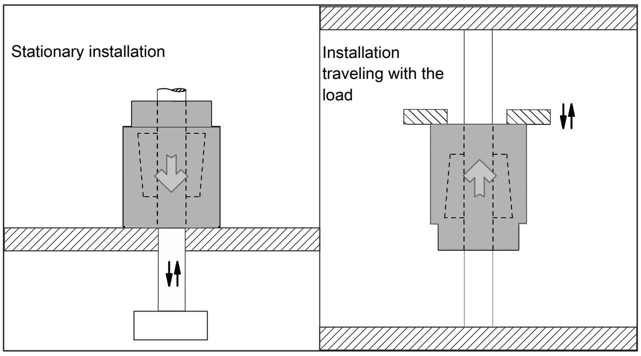

Fig. 8: Installation stationary or traveling with the load

	Stationary installation: direction of movement of load and clamping rod
	Installation traveling with the load: direction of movement of load and Safety Brake
	Load direction