SITEMA
Expertise in Safety

TI-S10-EN-09/2015

Technical Information TI-S10
Safety Locks

- ☑ high holding force by self-intensifying clamping
- ☑ hydraulic or pneumatic actuation
- ☑ for static loads

For further information on technical data please see:
- ***"Technical Data Sheet TI-S11"*** (hydraulic pressure version: series KRG)
- ***"Technical Data Sheet TI-S12"*** (pneumatic pressure version: series KRGP)

A detailed description of control, mounting and performance test of the SITEMA Safety Locks can be found in:
- ***"Operating Manual BA-S11"*** *(hydraulic version)*
- ***"Operating Manual BA-S12"*** *(pneumatic version)*

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1 Purpose

Safety Locks secure static loads infinitely variable at any position of the stroke, in a mechanically secure and absolutely reliable manner. The design principle of the self-intensifying clamping ensures an extremely high safety level.

At pressure loss, Safety Locks block a static load in load direction on a cylinder rod or a separate rod.

For example, Safety Locks can be used as a infinitely variable mechanical fixation of:

- support cylinders at heavy-load vehicles
- lift cylinders in scissor-type lifting panels and theater lifting podiums
- tool trays
- lifting tables in packaging machinery and palletizers

2 Function

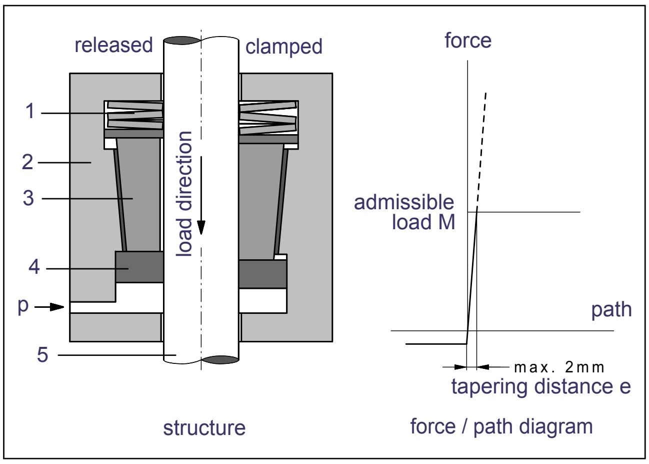

Fig. 1: Functional principle

2.1 Clamping released

The clamping system consists of a conical clamping sleeve (3) movable within the conical housing (2).

In released condition, the annular piston (4) is pressurized (p) and keeps the clamping sleeve pushed against the set of disc springs (1). The rod (5) can move freely in both directions.

2.2 Secure the load

The Safety Lock secures the load as soon as pressure is released from the annular piston (4). Then, the disc springs (1) push the clamping sleeve (3) into the cone of the housing, whereby an initial friction contact between rod and clamping sleeve is achieved (contact condition).

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

2.3 Take the load

The holding force, however, is not built up until the rod has been moved by the load. Due to the self-intensifying static friction at the rod, the clamping systems contracts.

During this process, the movement of the rod is very small. Even at larger sizes the movement does not exceed 2 mm when the admissible load M is applied (see tapering distance e in *Fig. 1*).

CAUTION
Danger of damage
The rod does not slip if there is an overload (see force / path diagram in *Fig. 1)*. Loads that exceed twice the admissible load M can lead to damage on the rod and Safety Lock.

- Choose the right type.
- Do not overload the Safety Lock.

2.4 Release the clamping

To release the clamping after securing the load (see *Chapter 2.2 "Secure the load"*), it is sufficient to apply the operating pressure to pressure port L.

To release the clamping after taking up the load (see *Chapter 2.3 "Take the load"*), the rod must additionally be moved back in opposite direction to the load direction (travelling back the tapering distance e) with a force corresponding the load. Thus providing the safety advantage that the clamping can generally only be released as far as the hoist drive is intact and controlled. An excess force (e.g. for breaking loose) is normally not required.
Applying pressure to the annular piston at the same time moves the clamping system in the raised (e. g. released) position.

However this advantage does not necessarily apply to small loads with a simultaneously high release pressure (for details see minimal loads F6 and F100 in *"Technical Data Sheets TI-S11 and TI-S12"*).

2.4.1 Movement in opposite direction

To move the rod in opposite direction, pressure port L is usually pressurized and the clamping released so that the rod can move freely.

In exceptional cases, a momentary movement in opposite direction while the rod is clamped (without release pressure at L) is possible. The braking force then achieves approx. 10 – 20 % of the admissible load M. Under certain circumstances, this feature can be used to perform a reversing stop. Please contact SITEMA for details.

Under normal operating conditions, pressure port L must always be pressurized to release the clamping during movement in opposite direction. Proximity switch 2 signals "clamping released".

2.4.2 Movement in load direction during normal operation

During normal operation, movements in load direction are only possible when and as long as the clamping is released. The Safety Lock's operating conditions are monitored by proximity switches. For normal movements in load direction, signal 2 "clamping released" is active. It is therefore imperative that this signal be processed accordingly in the control unit.

3 Series

Depending on the pressure fluid, there are 2 different designs of Safety Locks. They are identical as far as function and application are concerned.

Due to the self-intensifying principle both designs attain the same holding forces regardless of the pressure fluid (especially regardless of the lower pneumatic pressure levels).

3.1 Series KRG

For hydraulic actuation

3.2 Series KRGP

For pneumatic actuation

4 Control

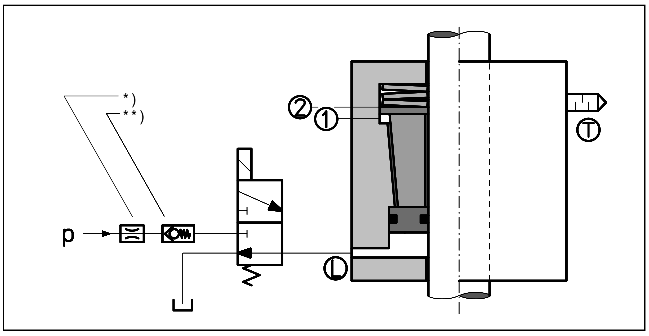

Fig. 2: Schematic circuit diagram

* In case impact noises due to excess pressure are audible when pressurizing the Safety Lock, these can be suppressed by means of a flow control valve in the p-line.

** In case the pressure is not sufficiently constant (e.g. pressure drop at the beginning of a downward stroke), we recommend a check valve in the p-connection of the valve.

WARNING!
Risk due to slowed discharge of pressure medium!
Slowed discharge of the pressure medium may cause a dangerous situation. The clamping then only locks with a time delay.

- Do not integrate any components which impair discharge of the fluid from pressure port L.
- Route all connection lines without any kinks.
- If there is any danger of kinking, take appropriate precautions (protective tube, thicker hose, etc.).

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

- short line distances
- fast valve response times
- appropriate control
- large valve and line cross-sections (esp. when actuated hydraulically)
- installation of a dump valve at L (when actuated pneumatically)

4.1 Pressure fluids

Safety Locks mostly are hydraulically actuated. For smaller sizes, also pneumatic versions are available.

For hydraulic series KRG:
Hydraulic oil (HLP) in accordance with DIN 51524-2:2006 must be used as pressure fluid. Please consult SITEMA before using any other fluids.

For pneumatic series KRGP:
The compressed air must be dried and filtered. SITEMA recommends compressed air according to ISO 8573-1:2010 [7:4:4].

4.2 Actuation using 3/2-way valve

In most applications an actuation as suggested in *Fig. 2* is used.

During every operational cycle, the 3/2-way valve is actuated electrically and releases the Safety Lock. In all other operational conditions, as well as in cases of power failure, pressure line breakage, emergency stop, etc. the Safety Lock becomes effective, secures the rod.

4.3 Monitoring by proximity switches

Proximity switch 1 "load secured" signals the secure state and is used to authorize entrance to the danger area.

Proximity switch 2 "clamping released" is used to activate the downward movement (in load direction) of the drive.

For automatic detection of failures both signals are compared. In case both switches indicate the same state - apart from minor overlapping periods - there is a defect present.

5 Choosing the right type

The admissible load M is stated for all types in the *"Technical Data Sheets TI-S11 and TI-S12"*. Normally (for vertical movement), the condition as below is to be fulfilled:

$$M \geq \frac{\textit{moving weight}}{\textit{number of Safety Locks}}$$

The rod will be totally blocked against forces in load direction (see *Fig. 1*). In case of overload, the rod does not slip either. Therefore forces exceeding 2 x admissible load M may cause damages. (see also *Chapter 6 "Design and attachment of the rod"*).

6 Design and attachment of the rod

The Safety Lock will operate correctly only if the rod has a suitable surface:

- ISO tolerance field f7 or h6
- induction hardened min. HRC 56, surface hardening depth:
  ø up to 30 mm: min. 1 mm
  ø over 30 mm: min. 1.5 mm
- surface roughness: Rz = 1 to 4 µm (Ra 0.15 - 0.3 µm)
- protection against corrosion, e.g. hard chromium plating: 20 ±10 µm, 800 – 1 000 HV
- lead-in chamfer, rounded:
  ø 18 mm up to ø 80 mm: min. 4 x 30 °
  ø over 80 mm up to ø 180 mm: min. 5 x 30 °
  ø over 180 mm up to ø 380 mm: min. 7 x 30 °

Often, the following standard rods fulfill the above mentioned requirements and can then be used:

- piston rods (ISO tolerance field f7), hard chrome plated
- rods for linear ball bearings (ISO tolerance field h6)

The rod must not be lubricated with grease.

The Safety Lock withstands overloading up to 2 x admissible load (M).

Therefore, all **fixation elements** which take up the load (such as the rod and its linkage, etc.) must therefore be dimensioned to a loading of at least **2 x M**. Forces exceeding 2 x M may cause damages, because the rod will be totally blocked when overloaded and will not slip.

Generally, the basic rod material needs to have sufficient yield strength. In the case of compression-loaded rods, sufficient buckling resistance must be assured.

7 Service life

When estimating service life, a distinction is made between the following categories of stress:

1. Stress when securing the load
When securing a stationary load (see *Chapter 2.2 "Secure the load"*), the occurring material stresses are negligible and can be withstood millions of times over.

2. Stress when taking the load
When taking up the load (*Chapter 2.3 "Take the load"*) the Safety Lock may reach the maximum holding force. During operation this occurs, for example, when the drive is switched off and in the event of leakage or a line break. The design forces and material stresses then occur. The rod does not slip when this happens.

For a longer service life, the following operating conditions should be avoided:

- incorrect operation of the (press)cylinder with the clamp engaged
- driving the rod against the load direction without applying pressure simultaneously

Based on the results of fatigue tests, it can be assumed that under usual operating conditions (type of use 1 and occasionally type of use 2), the holding force will not drop below the nominal value after several years in use. Even after lots of clamping cycles, no relevant changes in the diameter or surface quality will be observed on the clamping rod either.

Additionally, you can extend the Safety Lock's service life by considering the following points:

- Ensure that no transverse forces or side loads due to misalignment act on the rod.
- Use a rod with a finish that is not too rough.
- Protect the housing from penetration of corrosive substances and dirt.
- Use only the specified pressure fluids, see *Chapter 4.1 "Pressure fluids"*.
- Clamp the rod only when it is completely stopped. Ensure the correct sequencing of the operational states by programming the control adequately.

8 Required risk assessment

It must be ensured that the dimensions and arrangement of a Safety Lock used in safety-relevant applications meet the requirements of the risk evaluation EN ISO 12100:2010 and also comply with any further standards and regulations applicable for the intended use. The Safety Lock alone principally cannot form a complete safety solution. It is however suitable to be part of such a solution. Furthermore, all attachments and fixations have to be dimensioned correspondingly. This is generally the duty of the system manufacturer and the user.

9 Operating conditions

SITEMA Safety Locks are designed to operate in normal clean and dry workshop atmosphere.

Heavy soiling conditions like grinding dust, chips, other liquids, etc. may require special protective measures. In such cases, please contact SITEMA.

The permissible surface temperature is 0 – 60°C.

10 Regular performance tests

The Safety Lock must be functionally checked at regular intervals. Regular checking is the only way to ensure that the Safety Lock will operate safely in the long run.

Please see the *operating manual* for further details.

11 Maintenance

The maintenance is limited to the regular performance tests.

Should the Safety Locks 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 Locks must be immediately and professionally repaired by SITEMA.

The Safety Locks are safety components. Any repair or refurbishing must be carried out by SITEMA. SITEMA cannot take any responsibility for repairs by another party.

12 Attachment

The Safety Lock may be integrated into the machine as a **stationary** component or as a movable component **moving with the load**.

When configuring the layout, attention must be paid to how the **load** acts on the rod and to the Safety Lock particularly.

The standard series KRG and KRGP are **pressure versions**. When under load, the load pushes the Safety Lock onto the machine part. The load is transmitted into the machine via the mounting surface of the Safety Lock.

ℹ *All fixation elements carrying the load (rod, its attachment, etc.) have to be dimensioned for the maximum load of at least 2 x admissible load M, see also Chapter 6 “Design and attachment of the rod”.*

ℹ *To avoid side load (constraint forces) on the rod, install either the Safety Lock or the rod with a floating attachment. For a floating attachment of the pneumatic series KRGP, use a spring base, see also “Technical Data Sheet TI-B20”.*

12.1 Stationary Safety Lock

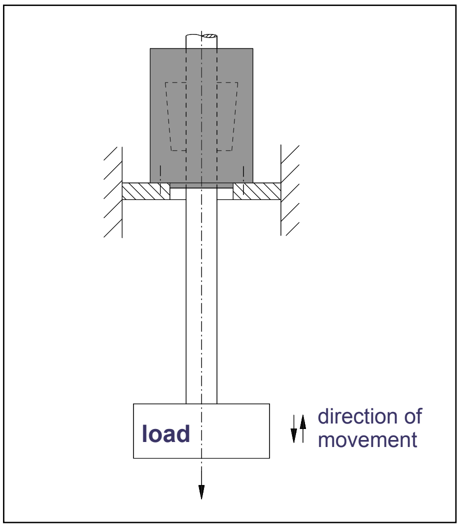

Fig. 3: Attachment of stationary Safety Lock

If the Safety Lock is installed stationary, the load is usually movable.

12.2 Safety Lock moves along with the load

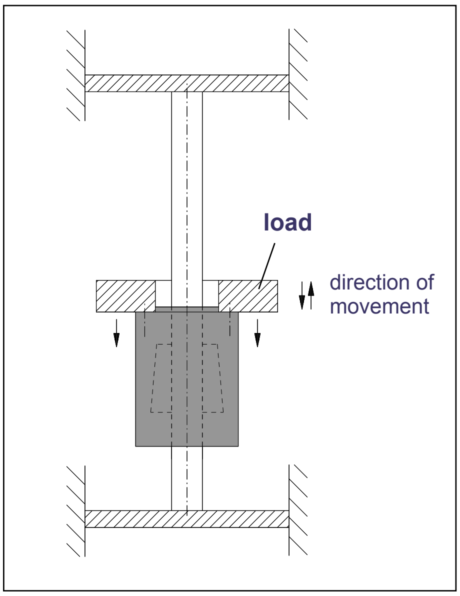

Fig. 4: Attachment of movable Safety Lock

If the Safety Lock is movable and travels with the load, the rod is usually stationary.