Personal restraint hydraulic lock LE

Maximum safety for passenger restraint systems in amusement rides
Innovation for lasting customer benefits

HOERBIGER is active throughout the world as a leading player in the fields of compression technology, drive technology and hydraulics. The HOERBIGER brand is synonymous with performance-defining components in compressors, industrial engines and turbines, automobile transmissions, and multifaceted mechanical engineering applications. Innovations in attractive technological market niches are the basis for components, systems and services that offer unique selling propositions and lasting benefits for the customer.

Table of Content

- Personal restraint hydraulic lock LE 04
- Main components 06
- Customer benefits at a glance 08
- Type distinction 09
- Range of products 10
- Quality and reliability 12
- The HOERBIGER Life Cycle Concept 14
- Contact persons 15
Personal restraint hydraulic lock LE

Unconditional fun thanks to maximum safety

Amusement park and fairground rides are popular among young and old alike. Roller coasters must become increasingly attractive to the public—and more often than not they challenge the physical limits of people and materials. Safety is absolutely essential—without compromises.

HOERBIGER hydraulic locks for passenger restraint systems make your amusement rides safe in every respect as a result of:

- Compliance with maximum safety standards
- Self-contained and low-maintenance hydraulic system
- Infinitely variable positioning and silent bar adjustment.

For decades, leading manufacturers of amusement rides have relied on HOERBIGER hydraulic locks and gained the confidence of numerous amusement park and ride operators.

The proven hydraulic components are implemented in a modular system, guaranteeing customized solutions and fast project engineering. The LE locking system developed by HOERBIGER specifically for amusement rides and mobile structures forms the core of the system, ensuring maximum safety in over-the-shoulder restraints, lap bars and abdominal restraints. A special feature is that maximum safety standards have allowed the product to achieve a “PLr E-ready” performance level status.

Tested standards:
- ISO 17842-01:2015
- DIN EN 13814
- ASTM 2291-15

Certification Report

Date: 2017-07-06
Report no. 2 749 967 PTU G1 Rev. 0

Project: Design Review for a Type approval
Hydraulic Locking Unit LE25-1 “Group 1”
for EN 13814 class 5 restraint systems of amusement rides

Normative References: DIN EN 13814:2005
Main components

Reliable materials for maximum safety

- **Bolted twin-pipe cylinder:** The inner pipe guides the piston rod with the piston; the outer pipe conducts the oil from the rod side to the flange-mounted connection block on the cylinder base.
- **Connection block:** Accommodates a diaphragm accumulator, an electromechanically piloted or manually operated check valve as well as two pressure ports.
- **Diaphragm accumulator:** Precharges the unit to a predefined pressure and accepts the oil volume displaced by the piston rod during retraction.
- **Poppet valve:** Allows oil flow only in one direction, blocks the flow in the other direction. Oil flow is possible in both directions by electromechanical activation during normal operation or manual activation in an emergency.
- **Pressure ports:** Are used for filling the unit with oil and setting the pressure configuration at the factory.

1. **Twin-pipe cylinder**
2. **Accumulator**
3. **Connection block with double S**
4. **Rod end, base-side**
5. **Port for factory-configuration and filling**
6. **AMP Super Seal 1.5 electrical connector**
7. **Solenoid-piloted poppet valve**
8. **Push button for manual emergency operation**
9. **Piston rod**
10. **Rod end, rod-side**
Customer benefits at a glance

Greater passenger comfort and all-round safety for riders

Primary function—bar lock
It blocks the movement of the cylinder, locking the restraining bar.

- Greater passenger comfort: Unlike mechanically latching systems, hydraulic cylinders ensure infinitely variable bar adjustment customized to the rider.
- Maximum reliability: Due to extremely low-leak specialty valve with hardened seat edge.

Secondary function—bar drive
The energy stored in the accumulator during closing is used to open the restraining bar.

- Only one system, no attachments: Additional gas springs, spring systems or pneumatic drives normally required to open the bar are completely eliminated.

Other advantages
- TÜV Süd homologation: Significantly simplified acceptance process as a result of approved design and calculation, including documentation for the standards ISO 17842-1:2015, DIN EN 13814 and ASTM 2291-15.
- Low wear: Hydraulic systems are low-maintenance and not subject to the mechanical wear and tear of a ratchet system.
- A safe feeling for riders: Silent bar adjustment eliminates rider discomfort.
- Plug & Play: Simple installation—the system is filled with oil, tested and immediately ready to use.
- Manual emergency operation: Unlocks and opens the bar without electrical power, even when not at the station.

Type distinction

The difference lies in size and blocking direction of the locking system

Size
LE25: The small and lightweight LE25 units have a piston diameter of 25 mm and an overall length of approximately 355 mm in the retracted state.
LE32: LE32 systems have a piston diameter of 32 mm and are generally 503 mm long.

Blocking direction
The second distinguishing feature within the portfolio is the blocking direction. This refers to the direction of movement of the piston rod blocked by valve technology.

Comfort adjustment option
In the open state of the restraint system, the bilateral block of the additional valve V2 prevents the cylinder from retracting under load.

Benefits: Passengers can use the restraint system as a handle for entering and exiting. During operation, further excessively tight closing of the restraint system is prevented. Both functions increase the comfort of the rider.
Range of products

An overview of available product types

Flexibility is crucial, allowing the pressure and retraction force configurations for this portfolio to be adapted to the needs of our customers’ ultimate design.

### LE25

<table>
<thead>
<tr>
<th>Piston diameter [mm]</th>
<th>Blocking direction</th>
<th>Safety valve</th>
<th>Secondary function: Extension force F2 [N]*1)3)</th>
<th>Installation length [mm]10)</th>
<th>Cylinder stroke [mm]10)</th>
<th>Retention force until (fatigue) [N]*2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Extend</td>
<td>Yes</td>
<td>210 – 530</td>
<td>355</td>
<td>80</td>
<td>3.700</td>
</tr>
<tr>
<td>25</td>
<td>Retract</td>
<td>Yes</td>
<td>Not relevant</td>
<td>355</td>
<td>80</td>
<td>10.500</td>
</tr>
<tr>
<td>25</td>
<td>Retract</td>
<td>Yes</td>
<td>Not relevant</td>
<td>393.5</td>
<td>110</td>
<td>10.500</td>
</tr>
<tr>
<td>25</td>
<td>Retract</td>
<td>Yes, flow-optimized</td>
<td>Not relevant</td>
<td>413.5</td>
<td>140</td>
<td>10.500</td>
</tr>
<tr>
<td>25</td>
<td>Retract</td>
<td>Yes, flow-optimized</td>
<td>Not relevant</td>
<td>443</td>
<td>80</td>
<td>10.500</td>
</tr>
</tbody>
</table>

### LE32

<table>
<thead>
<tr>
<th>Piston diameter [mm]</th>
<th>Blocking direction</th>
<th>Safety valve</th>
<th>Secondary function: Extension force F2 [N]*1)3)</th>
<th>Installation length [mm]10)</th>
<th>Cylinder stroke [mm]10)</th>
<th>Retention force until (fatigue) [N]*2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>Extend</td>
<td>Yes, with additional non-return value (comfort adjustment)</td>
<td>300 – 840</td>
<td>503</td>
<td>150</td>
<td>6.400</td>
</tr>
<tr>
<td>32</td>
<td>Extend</td>
<td>Yes</td>
<td>300 – 840</td>
<td>503</td>
<td>150</td>
<td>6.400</td>
</tr>
<tr>
<td>32</td>
<td>Extend</td>
<td>Yes</td>
<td>300 – 840</td>
<td>503</td>
<td>150</td>
<td>6.400</td>
</tr>
</tbody>
</table>

1) F2 denotes the maximum extension force. The range of values in the table shows the available scope at room temperature (20°C). The specific value is adapted within certain boundaries to the customer’s needs by way of the system’s pressure configuration. Extension forces are speed-dependent. See data sheet for further details.

2) Maximum cylinder load during normal operation according to ISO 17842-01:2015. Retention forces are additionally influenced by the pressure setting. The higher the forces of the secondary function, the lower the retention forces. Safety integrity for indicated value: PLr C

3) Adaptations and applications are billed separately.

Diverse adaptation options

We are able to modify a number of additional features for you as part of an application of the design:

- **Retraction forces and pressure configuration:**
  The configuration of the pneumatic and hydraulic precharge pressure influences both the maximum retention forces and the retraction and extension forces of the piston rod for the secondary function. Different seat and restraining bar designs generally result in different force requirements with respect to the bar drive function of LE locking systems. The planning of this pressure configuration is coordinated with our customers’ needs within physical design conditions. The adjacent table shows the range of possible retraction forces of each system by way of the pressure configuration. Due to hysteresis friction, the retraction forces are approximately 30 percent higher than the extension forces.

- **Coil:**
  In general, a 10W coil can be used for systems featuring standard valves as part of an application.

- **Installation length:**
  The total length L0 can be extended up to a maximum of 503 mm as part of an application.

- **Cylinder stroke:**
  The cylinder stroke can be adapted within the following boundaries as part of an application:
  - Blocking direction extend minimum 0 mm to maximum 300 mm
  - Blocking direction retract minimum 0 mm to maximum 200 mm

- **Angle of joint head housing, base end:**
  It is possible to continuously vary the joint head housing 180° about the axis of the cylinder housing.
Quality and reliability

HOERBIGER LE locking systems are subject to the highest quality standards

Safety and performance level

Based on an operating period of 35,000 hours as stipulated in DIN EN 1381—or 7 years according to HOERBIGER’s specification—and associated anticipated stress of 5 million loads, the LE locking systems undergo fatigue testing on a validation test bench installed specifically for this purpose.

In keeping with the safety standard DIN EN ISO 13849-1, HOERBIGER checks the safety function of the LE locking systems. This additionally meets the special requirements that are in effect for the safety integrity of passenger restraint systems under prEN 13814:2016.

For your final diagnostic monitoring process, this means that you are using a product already rated with a “PLr E-ready” status.

Assembly

Throughout the entire process—ranging from procurement, to production in an ISO 9001-certified plant, to delivery—HOERBIGER ensures stable and transparent processes to the highest degree. Particular emphasis is placed on quality and cleanliness.

• Strict packaging regulations for suppliers
• Comprehensive incoming goods inspections for oil-conducting parts using microscopy
• Additional individual parts cleaning
• Maximum purity of the added medium
• Maximum cleanliness by rinsing the locking systems in additional rinse cycles.

End-of-line testing

All system details relevant for the function and safety of every LE locking system are checked on an end-of-line test bench, and the results are documented:

• Inspection of length and stroke
• Determination of the force parameters
• Examination of the maximum load (leak testing)
• Inspection of the emergency actuation function (manual emergency actuation)

Burn-in test

And finally, a burn-in test is conducted on a test bench specifically developed for this purpose. Every LE locking system is subjected to more than 1,050 load cycles with a predefined force after installation for a certain duration. Under load, only a specific extension or retraction movement of the piston rod is permitted. With this, HOERBIGER ensures a failure rate of \( < 10^{-9} \) 1/h, equivalent to less than one expected failure per one billion operating hours.
The HOERBIGER Life Cycle Concept

The advantages for you at a glance

- **Low-maintenance design**: HOERBIGER locking systems are low-maintenance.
- **Short-notice exchange**: If a substitute unit is needed, new exchange systems can be available in a matter of days, preventing a shutdown of the amusement ride.
- **Planning reliability**: Within the product life cycle, customers have the option to replace old inventories in a predictable, cost-effective process.

- **Replacement systems**: Because HOERBIGER offers brand new replacement systems, repairs are generally not available. The replacement of complete systems eliminates risks that arise from partial repairs. You benefit at all times from maximum quality and reliability of the products, as well as the latest, tried and tested production processes.

What we offer

**Documentation**
- Operating manual
- Technical Drawings
- Data sheets
- Material Safety Data Sheet
- Certificate of Conformity
- TÜV homologation

**Accessories and spare parts**
- Tool for operating the emergency release or manual emergency operating function
- Electrical connection cable, including plug
- Replacement joint heads and solenoid coils
- Auxiliary fixture for correctly installing the base-side rod ends

Contact persons

*We have contacts available to assist you around the globe*

Kurt Danzer
Phone: +49 152 22 56 29 50
E-mail: kurt.danzer@hoerbiger.com
Territory responsibility: Europe

Justin Shelton
Phone: +1 334 321 4767
E-mail: justin.shelton@hoerbiger.com
Territory responsibility: USA

Stella Shao
Phone: +86 510 8520 3468
E-mail: stella.shao@hoerbiger.com
Territory responsibility: China