Declaration on standard CLC/TS 50537-3:2010

Water pumps for the cooling of traction converters in the railway industry

using the example of the LC pump series

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LEDERLE Hermetic

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1. Outlook

The following should explain the CLC/TS 50537-3:2010 standard by using the LC pump series as an example. This standard originating from the CLC/TS 50537 series of standards applies specifically to the use of water pumps for the cooling of traction converters in the railway industry and should be read in conjunction with CLC/TS 50534. There may be changes to the standard that are not yet incorporated in this paper. This paper should give a first insight and cannot guarantee completeness.

2. Operating conditions

During the operation of converters and transformers, high heat emissions develop that must be dissipated to allow continuous operation. To ensure this, water pumps are used in the railway industry to cool the traction converters. General interferences, such as corrosive gas or carbon dust from the brakes must be considered during normal operation of a railway. These factors should not lead to the failure of the water pump.

The LC pump series has a very robust design that dispenses with the susceptible interface between motor and hydraulics thanks to the technology employed. Motor and hydraulics form one unit. A high-quality C5 coating and the IP55 protection class guarantee the functionality of the pumps.

2.1 External environmental conditions

The pump should be functional and not be damaged under the following conditions:

Outside temperature:	–25 °C to +80 °C (standard, may vary depending on the customer)
Transport and storage temperature:	–50 °C to +80 °C up to 1,400 hm (EN 50125-1:1999, Class A1)
Height:	up to 1,400 hm (EN 50125-1:1999, Class A1)
Humidity:	0 % to 100 %
Climate class:	EN 60721-3-5:1997, 5K2
Biological class:	EN 60721-3-5:1997, 5B2
Chemical class:	EN 60721-3-5:1997, 5C3
Contamination:	EN 60721-3-5:1997, 5F3
Mechanical conditions:	EN 60721-3-5:1997, 5S3
Rain:	EN 60721-3-5:1997, 5K3
Sun exposure	EN 60721-3-5:1997, 5K3
Shock and vibration:	Shock and vibration tests according to EN 61373

The LC series can be operated beyond the required temperature range up to operating temperatures of –40 °C. This makes it possible to improve the operational reliability of the pump and cooling unit and to avoid failure in low winter temperatures.

2. Operating conditions

2.2 Medium / refrigerant

The refrigerant is generally a water-glycol mixture consisting of the components water and an Antifrogen. When selecting the correct mixing ratio, the operating and outside temperatures must be considered, and the medium should provide adequate corrosion protection. The customer specifies, however, what the quality and mixing ratio of the refrigerant should be. This must be communicated individually between buyer and pump manufacturer.

The LC pump series can handle almost all mixing ratios. Typical mixing ratios of water and Antifrogen are, for example, 56:44 or 48:52 depending on the required temperature range. As the motor is already integrated into the hydraulic system of the canned motor pump, the refrigerant is used not only to cool the converters but also the pump motor. The heat input is marginal. The advantage lies in the robust, hermetically sealed design that ensures permanent cooling of the pump and avoids the escaping of refrigerant.

2.3 Requirements for pump delivery

The pump supplier must provide a pump free of foreign particles and contamination for transport or storage. For example, covers on the pump flanges may help. For the storage, the manufacturer should provide instructions that should be followed, such as the orientation of the pump. The inside of the pump should be protected against corrosion. This can be achieved, for example, with a preserving agent that must be environmentally friendly and, in case of oils, may take up only a volume share of up to 0.2 % of the water pump.

As recommended by the standard, both suction and discharge ports are equipped with a plastic cover as a protection against foreign particles. The LC pump is also supplied with an anti-corrosive agent that allows storage of the pump for longer periods if required. An environmentally friendly cardboard packaging is standard. It is possible to adapt the packaging to individual customer requirements.

3. Pump types

Various pump types, such as peripheral or centrifugal pumps, magnetic drive pumps or canned motor pumps, can be used to cool traction converters. Thanks to high MTBF values and the long service life, canned motor pumps are almost always used today. In this type of pump, the motor is integrated into the housing of the hydraulics. The medium cools both the bearings and the motor. This design eliminates the need for seals and couplings between the motor and hydraulics compared to magnetic drive pumps. For this reason, it is possible to operate the canned motor pump for an extremely long period without maintenance or leakage.

As the world market leader in canned motor pumps, HERMETIC also offers the right pump for railway applications. The LC series pumps are canned motor pumps specially designed for railway applications. Figure 1 shows a sectional view of this pump. Between the stator in the housing and the rotor connected to the drive shaft is a so-called rotor lining that separates the media section from the stator and thus from the environment. Together with the housing wall, this ensures an absolute leak-tightness of the system. Highly dynamic and robust bearings are chosen to achieve a long service life of the pump.

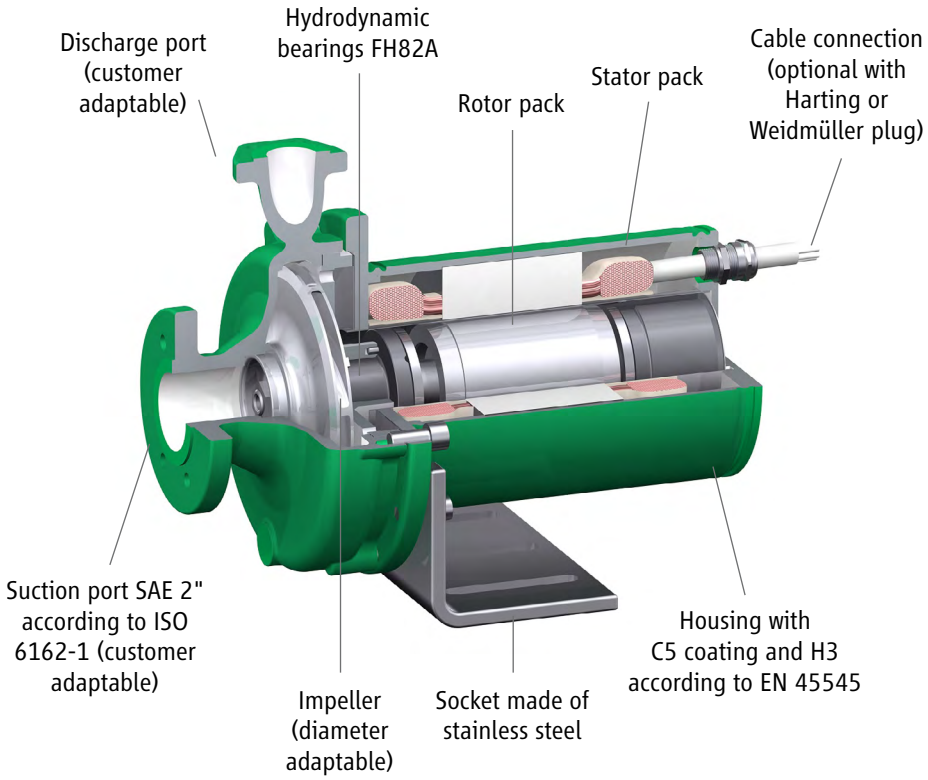


Figure 1: 3D sectional view of LC32-160 with AGX3.0 and standard cable connection

4. Electrical requirements

4.1 Energy supply

The preferred values and properties of the energy supply are available in standard EN 50533. The pump manufacturer and the customer may agree on alternative arrangements. The pump must be ready for the agreed operating voltage and current when switched on. Even when applying 110 % of the voltage under the defined temperature conditions and the agreed refrigerant is used, excessive heating should not take place. To avoid overload and overheating, an upper limit of the motor voltage should be signalled.

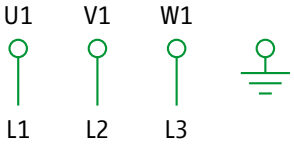
The AGX1.8 and AGX3.0 asynchronous motors characterised by high performance and long service life are specially designed by HERMETIC. The energy supply is ensured at all times considering the conditions mentioned. The maximum motor voltage can be specified as 600 V. The integrated PTC thermistor prevents the motor from overheating.

4.2 Electrical connection

The electrical connection of the pump is a matter of agreement between the pump manufacturer and the customer. In principle, the electrical power supply should be ensured. This can be achieved by various connections, such as an electrical cable and a Harting or Weidmüller connector.

The LC pump allows any type of connection options. Cable connection is the standard and most frequently used solution. Figure 2 shows the cable connection diagram of the standard solution. All important information on the electrical connection is available in the operating instructions included with the product.

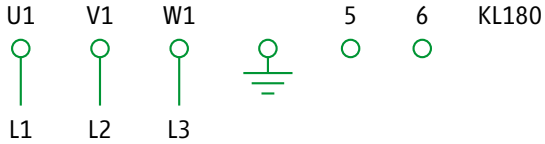
Without PTC thermistor



Mains

For the circuit of winding, see the rating plate

With PTC thermistor KL180



Mains

For the circuit of winding, see the rating plate

PTC thermistor – temperature sensor, do not apply more than 2.4 V!

When not used, the cable for the PTC thermistor can be cut off and replaced with a shrink tubing cap.

Figure 2: Cable connection diagram of LC pumps from HERMETIC

4. Electrical requirements

4.3 Temporary power supply failure

Malfunctions or failures in the power supply may happen occasionally during rail operations. A water pump must tolerate a power failure of 30 seconds and the following start-up to approximately 90 % of the voltage without damage. It is also necessary to consider the pump's bearings that are exposed to high loads in the case of strong vibrations and possible loss of lubricant. Further information on shock and vibration tests according to EN 61373 are available in Section 13.

The LC pump series can withstand temporary failures without further damage. The pump's impeller attached to the short motor shaft and the HERMETIC ZART® System result in fewer internal vibrations and better absorption of vibrations from the outside. The drive shaft is suspended tightly in large, hydrodynamic plain bearings. Therefore, vibrations and oscillations do not cause any bearing damage.

4.4 Insulation class and temperature rise

The stator windings should be insulated at least according to EN 60085 Class F and not be hygroscopic. The canned motor must not heat up above the values specified by the insulation class.

Thanks to the many years of experience of HERMETIC, the LC pump series is designed in such a way that the medium warms up only slightly without exceeding any critical temperatures.

4.5 Inrush current

The inrush current at a specified voltage must not exceed seven times the motor current specified. Tolerances are available in standard EN 60034-1.

This also applies to the LC pump series.

4.6 Electrical discharge machining (EDM)

To avoid electrical discharge, the pump manufacturer must examine whether the storage of the water pump is suitable for use in railway applications.

The LC pump runs smoothly thanks to the HERMETIC ZART® system. If electrical discharge nevertheless takes place, the rotor lining and the pump housing protect in two ways against sparks escaping from the pump housing.

5. Mechanical requirements

5.1 General

Centrifugal pumps should preferably be designed with the rotating shaft aligned horizontally. Other alignments should be coordinated with the pump manufacturer. All parts of the cooling circuit must continuously withstand an operating pressure of 10 bar. The pumps must meet at least IP55 according to EN 60529. Pumps installed in the undercarriage of the rolling stock must meet IP66. Depending on where the pump is installed, it is necessary to provide appropriate corrosion protection.

In addition to a horizontal orientation with the screw-on base pointing downwards, the LC pump series can also be mounted with a turned base or in a vertical orientation. If mounted vertically, the motor must be below the hydraulics to ensure that the bearings are continuously lubricated by the refrigerant. The LC series is designed for a continuous pressure of 10 bar; this is sufficient in most cases. Higher continuous pressure is possible through technical adaptations. All pumps meet at least IP55 according to EN 60529. It is possible to meet higher requirements by arrangement. Depending on the place of use, various paint finishes up to the highest protection Class C5 can be applied.

5.2 Vibration measurement

It should be possible to attach accelerometers to the pump and the motor area to carry out regular vibration measurements.

5.3 Preferred dimensions – centrifugal pumps

In principle, the pump manufacturer and the buyer must agree on the dimensions of the water pump. However, the standard suggests, for example, the following interface dimensions for the typical pump size 32-125:

Discharge port (N1):	DN50
Suction port (N2):	DN32
Distance from suction to discharge port:	80 cm
Length of the pump casing:	330 cm

For the discharge and suction sides, operating pressures of PN10 or PN16 are recommended according to standard EN 1093 for centrifugal pumps. A base for the pump is also recommended.

5. Mechanical requirements

The LC pump series follows this recommendation. The LC32-125 with AGX1.8 motor has the proposed interface and casing length. If a more powerful pump is required, the LC32-160 with AGX3.0 motor can be used. The advantage is that both pump interfaces are identical and only the pump housing length and size differ. Both sizes have a stainless-steel base and can be attached to the train in almost any position.

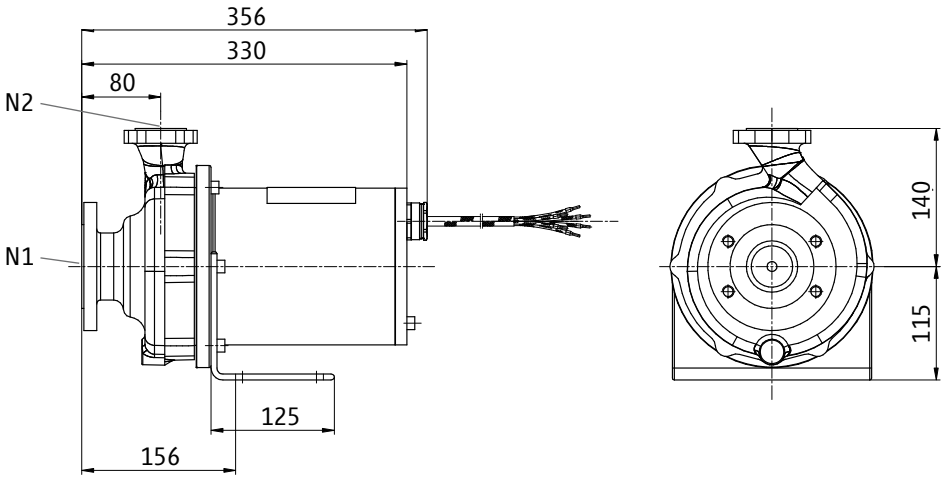


Figure 3: Dimensional drawing of LC32-125 with AGX1.8 motor from HERMETIC

5.4 Plugs – mechanical requirements

The plug connections must follow CLC/TS 50467. In principle, the installation position of the plug on the pump requires an agreement between the manufacturer and the buyer. However, it is recommended that all connector components are supplied by the same manufacturer.

The Harting and Weidmüller connectors for the LC pump series are high-quality components provided by qualified suppliers.

6. Hydraulic requirements

The standard suggests requesting the hydraulic characteristics at a coolant temperature of 60 °C with the operating voltage applied. The pump manufacturer should mark the operating range in the characteristic curves. Cavitation must not occur at any operating point and the pump must be operated in the correct direction of rotation.

If a coolant temperature of 60 °C is present under normal operating conditions, a characteristic curve with these parameters makes sense. In the case of deviations from this operating temperature, HERMETIC recommends choosing the prevailing characteristic data for the design of the pump and the resulting characteristic curves. Several operating points can also be included in the pump design. Cavitation must be avoided in any case to ensure the long service life of the LC series. The specified rotation direction of the pump must be observed. The correct connection is ensured by a random rotation test before delivery.

6.1 Selection of the pump by operating point

In principle, the design of the pump is an agreement between the pump manufacturer and the buyer. The buyer must specify the operating parameters to enable the pump manufacturer can design the pump. Selecting the right impeller size is the last step.

The following parameters are important for an initial pump design:

Medium / composition:	e.g. Water-glycol mixture (48/52)
Operating temperature range:	e.g. –30 °C to +75 °C
Operating temperature point 1:	e.g. –20 °C
Pump capacity point 1:	e.g. 15 m^3/h (250 l/min)
Pumping head point 1:	e.g. 10 m
Orientation of the pump:	e.g. horizontal
Mains connection:	e.g. Harting plug
Frequency:	e.g. 50 Hz
Application site:	e.g. Outdoors, railway

By specifying these parameters, it is possible to select the correct pump size and adapt the impeller. It is also possible to specify several operating points that must be considered in the design.

6. Hydraulic requirements

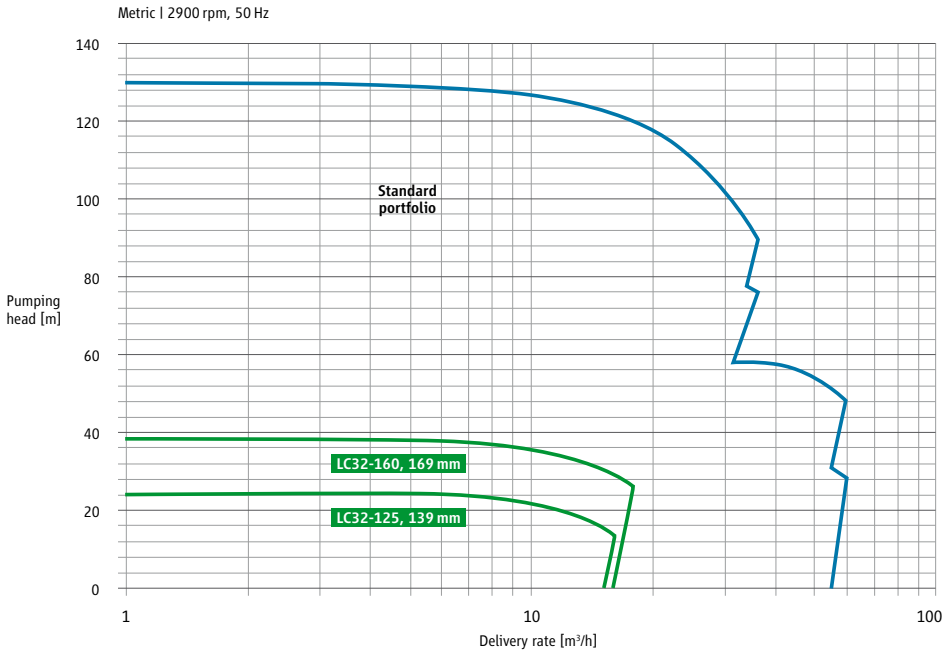


Figure 4: Operating range of the LC pump series and standard portfolio at 2900 rpm, 50 Hz from HERMETIC

Figure 4 shows the operating range of the LC pump series and alternative standard pumps from HERMETIC.

6.2 Hydraulic interchangeability

When replacing an existing water pump, the delivery rate and pump capacity of the new one must not differ significantly. According to standard CLC/TS 50537-3, this is achieved when the delivery rate does not deviate more than +/– 10 % and the pump capacity does not deviate more than +/– 8 %. It is also necessary to check the electrical interchangeability.

Our technical sales department can also check whether the characteristic curves match. When replacing a failed pump, we recommend determining the cause of the failure. When replacing a pump in a cooling unit that has been in operation for many years, we recommend checking the operating points again.

7. Fire protection

The national fire protection guidelines should be followed depending on the customer specification. It is generally recommended to carry out a fire protection test according to EN 45545. In the first step, the required hazard level according to EN-45545-2 is determined. The hazard level is classified according to the use and type of train in hazard levels HL1 (low) to HL3 (high) and material requirements in R1 to R7. Based on this classification, tests are carried out regarding flame spread, heat release rate and smoke density / toxicity.

To meet the fire protection standard, the LC series has a C5 paint finish that considers hazard levels HL1, HL2 and HL3 for R1 and R7 according to EN 45545-2:2013. This offers the greatest possible protection for underfloor applications, indoor installations and outdoor attachments. This allows a flexible selection of the installation location on or in the train.

8. Reliability and durability

When using roller bearings, a service life of 40,000 h without maintenance is assumed under normal conditions. When using end shields, the use of steel or harder materials is recommended. For steel-carbon plain bearings, a lifespan of 55,000 h and for ceramic-ceramic plain bearings, a lifespan of 75,000 h is assumed. As the converters have a life expectancy of 30 years, the pumps should also have a mean time between failure (MTBF) of more than 125,000 h. To check the bearings over the entire service life of the pump requires a maintenance plan from the pump manufacturer.

HERMETIC has drawn up a specific maintenance schedule for the LC series that results in an MTBF of over 130,000 h, see Figure 5. This means that the LC pump not only exceeds the requirements of the standard in terms of the mean time between failure but also in terms of bearing durability. Thanks to many years of experience, the individual pump components work together optimally.

Maßnahmen nach Betriebsstunden oder Intervall je nachdem was zuerst eintrifft / Measures after operating hours or interval whichever comes first	Betriebsstunden / Operating hours	16.000	80.000	120.000
	Jahre / Years	2	10	15
Beschädigung / Damage		●	●	●
Leckage / Leakage		●	●	●
Prüfung während des Betriebs / Check during operation				
Vibration / Vibrations		●	●	●
Geräusche / Noise		●	●	●
Temperatur / Temperature		●	●	●
Demontage der Pumpe nach Betriebsanleitung / Disassembly the pump according operating instructions				
Lagerspiele prüfen / Check the clearances			●	●
Sichtkontrolle auf Beschädigung / Visually inspection for damage			●	●
Dichtungen tauschen / Replace gaskets			●	●
Lager tauschen / Replace bearings				●
Motorteil tauschen / Replace motor kit				●

Figure 5: Maintenance schedule for LC pump series from HERMETIC

9. Material

The material of the pump casing depends very much on the ambient temperatures. The following materials are recommended:

–25 °C:	Cast iron (GJL-250 according to EN 1561)
–40 °C:	Spheroidal graphite cast iron (GJS-400-18-LT according to EN 1563)
–50 °C:	Stainless steel (EN 10283) or G-AlSi7 Mg (EN 1706)

Only high-quality materials are used in the LC series to ensure the longest possible service life of the pump. Therefore, the hydraulic casing is made of high-quality spheroidal graphite cast iron and the motor casing is made of stainless steel. This ensures the operability of the canned motor pump at all times, even at –40 °C.

10. Noise

Canned motor pumps should not exceed the following noise levels depending on the output:

1.0 to 2.2 kW:	61 dB (50 Hz) / 64 dB (60 Hz)
2.2 to 5.5 kW:	65 dB (50 Hz) / 68 dB (60 Hz)
5.5 to 11 kW:	70 dB (50 Hz) / 73 dB (60 Hz)

The requirements of standard EN 60034-9 are met.

The LC pump series meets the values specified in the standard. The pump LC32-125 with AGX1.8 motor and 1.8 kW output power is below 65 dB at 50 Hz and 68 dB at 60 Hz. The pump LC32-160 with AGX3.0 is classified in the next larger performance range and also meets the requirements of the standard. In particular, the design of the canned motor pump makes this possible. The short drive shaft avoids unnecessary interfaces and imbalance ensuring low-noise operation.

11. Identification:

The rating plate must be installed on the pump. The language may vary according to customer requirements, but the following data should be given:

- Name of manufacturer
- Pump type / descriptions
- Serial number
- Year of Manufacture
- Nominal values (such as current, voltage, pumping head, delivery rate...)

The rating plates of the LC series are clearly visible on the pump casing and contain all relevant information. Custom or OEM rating plates are also possible after consultation.

12. Documentation

The following basic documents should be provided by the pump manufacturer:

- Operating manual of the pump
- Pump drawing
- Data on mechanical and electrical interfaces
- Maintenance schedule
- Overview of certificates / tests

The transfer of further data can be agreed between the pump manufacturer and the buyer.

The documentation of HERMETIC includes the operating and installation instructions, pump drawing, mechanical and electrical interfaces, the maintenance schedule and any certificates. The documentation is sent with the pump or shortly afterwards by E-mail. Other documents or certificates required can be presented upon request.

13. Tests

The objective of the tests carried out should be to ensure the smooth operation of the water pump. As some tests involve major investments, details should be discussed between the pump manufacturer and the customer considering the special requirements of the railway industry.

A distinction is made between two different types of tests; individual test and routine test. Individual tests are one-off tests carried out to check the general pump design and suitability. Routine checks take place cyclically during the assembly of the pump.

The following routine tests are suggested:

- Dielectric test (according to EN 60349-2)
- Measurement of the motor winding resistance
- Rotation test (according to EN 50216-7)
- No-load test
- Verification of the hydraulic characteristic
- Leak test (according to ISO 15783)

13. Tests

The following individual tests are listed:

- Shock and vibration test (according to EN 61373, Category 1, Class B)
- Noise tests (according to EN 60034-9)
- Temperature tests (according to EN 60349-2)
- Tests with excessive rotation speed (according to EN 60349-2)
- Motor characteristics tests (according to EN 60349-2)
- Intermittent periodic duty (S3 according to EN 60034-1)
- Vibration tests by imbalance (according to EN 60349-2)
- Blocked rotor shaft
- Hydrostatic test of pressure-retaining components (Q2 according to EN 12162)

All proposed routine tests are carried out as standard on HERMETIC including the LC pump series.

We have also carried out shock and vibration tests according to EN 61373 as well as noise tests. Thanks to the design and past test results, we have an almost vibration-free system. Motor characteristics are verified regularly. All other tests have already been carried out with comparable pump types in the past.

Contact and information

Other information, such as the Series Booklet on LC pumps

Learn more

If you have any questions, just send us a short E-mail.

Contact us now

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All information in this document conforms to the latest specifications at the time of printing. We reserve the right to make technical improvements and changes at any time.

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