

# DOLPHIN LR

Liquid Ring Vacuum Pumps

LR 0110 A, LR 0140 A, LR 0210 A, LR 0300 A

LR 0420 A, LR 0580 A

## Instruction Manual



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# 1 Safety

Prior to handling the machine, this instruction manual should be read and understood. If anything needs to be clarified, please contact your Busch representative.

Read this manual carefully before use and keep for future reference.

This instruction manual remains valid as long as the customer does not change anything on the product.

The machine is intended for industrial use. It must be handled only by technically trained personnel.

Always wear appropriate personal protective equipment in accordance with the local regulations.

The machine has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain, as described in the following chapters and in accordance with the chapter *Intended Use* [→ 8]. This instruction manual highlights potential hazards where appropriate. Safety notes and warning messages are tagged with one of the keywords DANGER, WARNING, CAUTION, NOTICE and NOTE as follows:



## DANGER

... indicates an imminent dangerous situation that will result in death or serious injuries if not prevented.



## WARNING

... indicates a potentially dangerous situation that could result in death or serious injuries.



## CAUTION

... indicates a potentially dangerous situation that could result in minor injuries.



## NOTICE

... indicates a potentially dangerous situation that could result in damage to property.

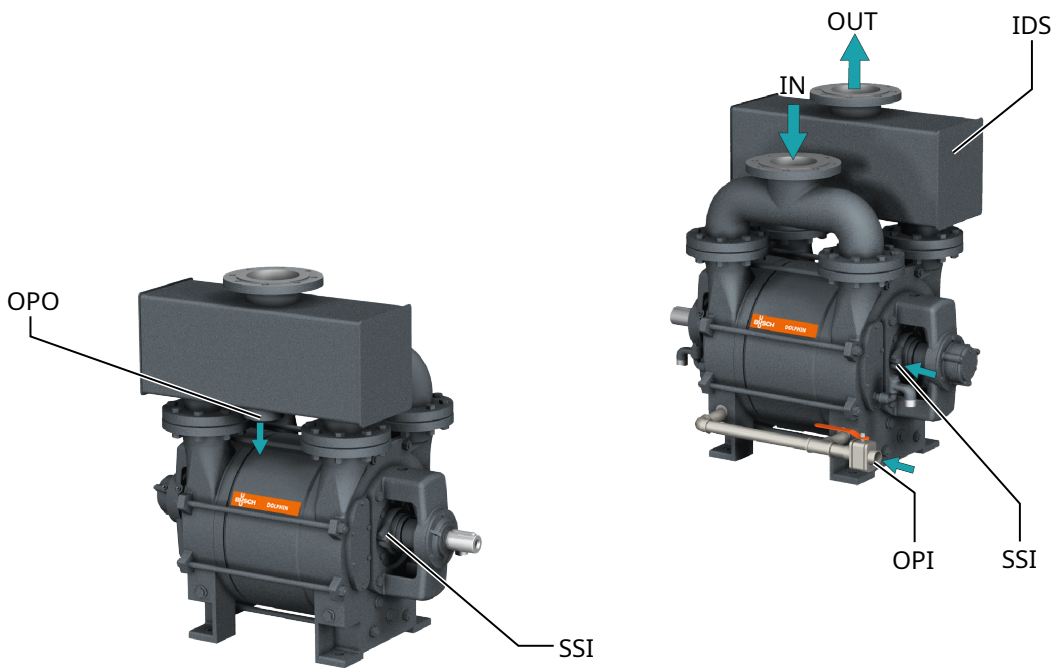


## NOTE

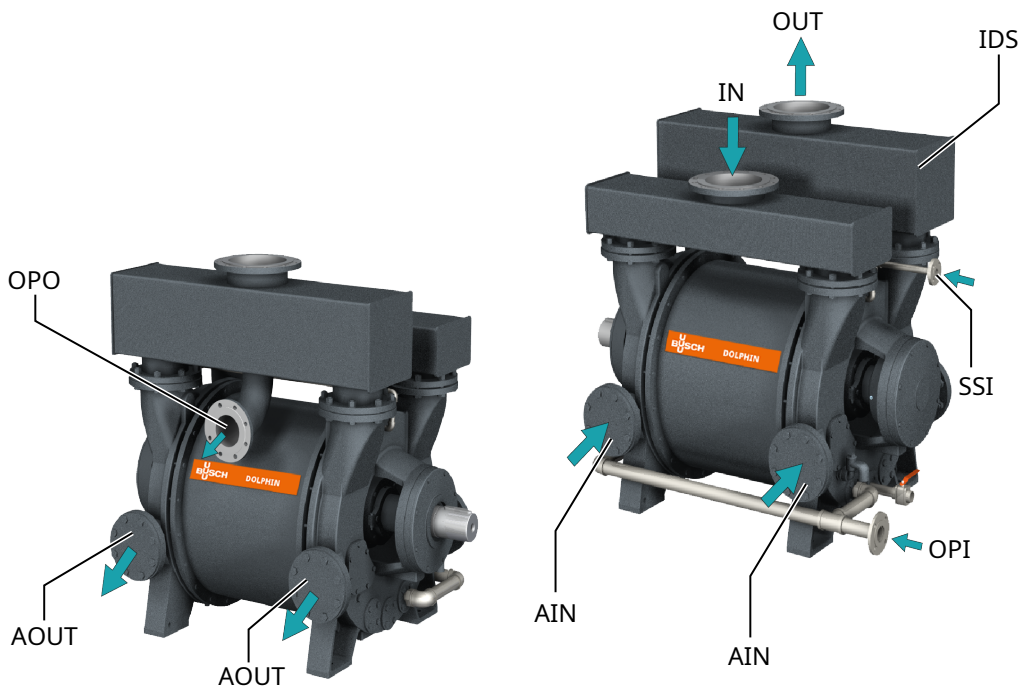
... indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

## 2 Product Description

DOLPHIN LR 0110 A - LR 0300 A



DOLPHIN LR 0420 A, LR 0580 A



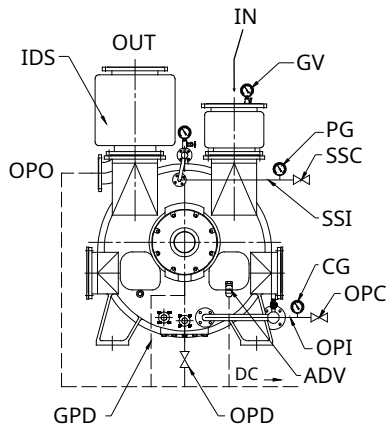
Description			
AIN	Alternative side suction connections*	AOUT	Alternative side discharge connections**
IDS	Integral discharge separator	IN	Suction connection
OPI	Operating liquid inlet	OPO	Operating liquid outlet
OUT	Discharge connection	SSI	Shaft seal flushing inlet***

\* No manifold, both connections to be used.

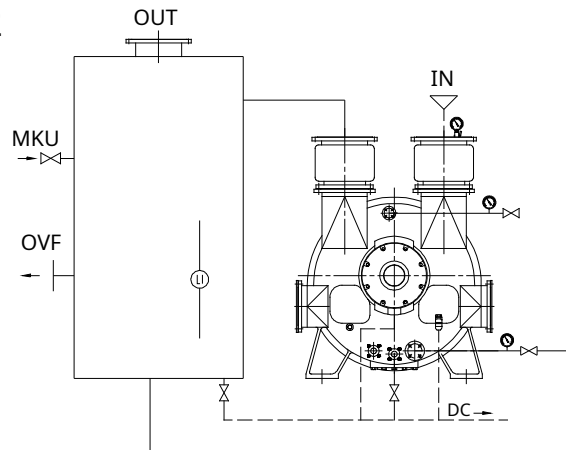
\*\* For installations where gas and liquid are discharged to open gutter, both connections open.

\*\*\* Supplied only when no internal flushing.

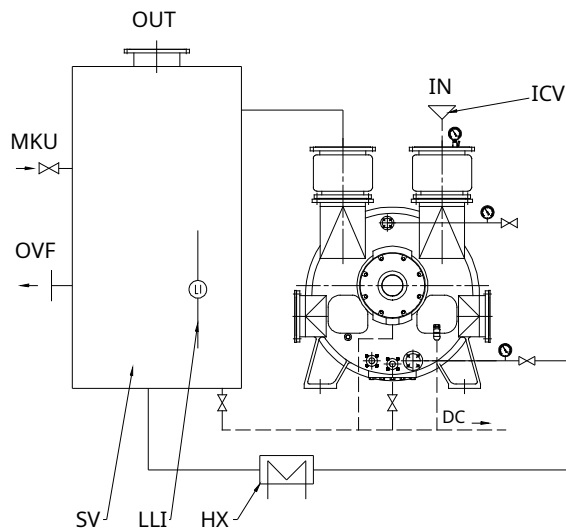
1



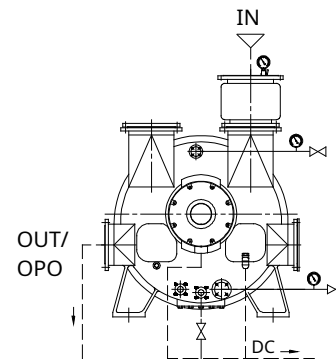
2



3



4



Description			
ADV	Automatic drain valve	CG	Compound pressure gauge
DC	Drain connection	GPD	Gland packing drain
GV	Vacuum gauge	HX	Heat exchanger
ICV	Inlet check valve	IDS	Integral discharge separator
IN	Inlet	LLI	Liquid level indicator
MKU	Makeup	OPC	Operating liquid control
OPD	Operating liquid drain	OPI	Operating liquid inlet

Description			
OPO	Operating liquid outlet	OVF	Overflow
OUT	Gas discharge	PG	Pressure gauge
SSC	Shaft seal flushing control	SSI	Shaft seal flushing inlet
SV	Separator vessel		



**NOTE**

**Technical term.**

In this instruction manual, we consider that the term ‘machine’ refers to the ‘vacuum pump’.



**NOTE**

**Illustrations**

In this instruction manual the illustrations may differ from the machine appearance.

## 2.1 Description of Figures 1 - 4

- Figure 1 shows the general standard once through arrangement with integral discharge separator manifold.
- The arrangements of figure 2 (partial recirculation) and 3 (total recirculation) are for handling combustible, corrosive and explosive gases as well as the gas which is required to be recycled. If the working liquid is recirculated in the system as shown in figure 3, then a heat exchanger should be used for cooling the liquid.
- Figure 4 (option for LR 0420 A and LR 0580 A only) shows the arrangement where gas and water leave from the side flange of the vacuum pump and discharge directly into the gutter.



**NOTICE**

**If applying the configuration shown in figure 4.**

**The discharge pressure will rise and lead to an increase in shaft power.**

- Make sure the cross-sectional area of the gutter is large enough.



**NOTICE**

**If recirculation of the service liquid is not required.**

**Drainage of the liquid should comply with the appropriate environmental regulations.**



**WARNING**

**If handling gas that is flammable or toxic.**

**Risk of severe injury!**

- The drained liquid should be separated twice and transferred to a safe place when applying the figure 1 arrangement. Particular care should be taken to avoid any leakage of dangerous gases from the water drain outlet.

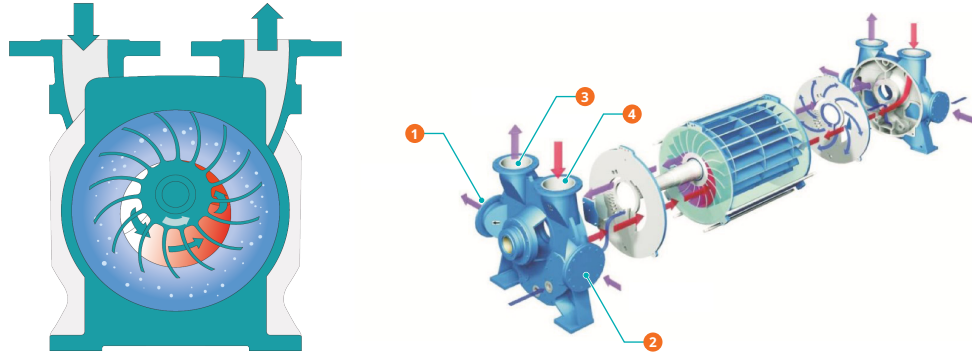


## WARNING

If applying the configuration shown in figures 2 and 3.

The gas leakage should be controlled according to the local conditions.

## 2.2 Operating Principle



### Description

1	Alternative side outlet flange	2	Alternative side inlet flange
3	Standard top outlet flange	4	Standard top inlet flange

The machine works on the liquid ring principle.

An eccentrically mounted impeller rotates in a housing partially filled with operating liquid (usually water). The impeller blades dip into the fluid, and the centrifugal force exerted by their rotation forms a so-called liquid ring within the housing. The pumped medium is transported in the spaces between the blades and the liquid ring. The eccentric rotation of the impeller alters the volume of these spaces, causing gas to be drawn in, compressed and expelled.

## 2.3 Intended Use



### WARNING

**In case of foreseeable misuse outside the intended use of the machine.**

**Risk of injuries!**

**Risk of damages to the machine!**

**Risk of damages to the environment!**

- Make sure to follow all instructions described in this manual.
- 

The machine is intended for the suction of air, vapor and other gases.

For explosive gases and vapors (if a "Ex(inside)" sign is written on the nameplate), please refer to the ATEX supplement for additional safety information on operation in hazardous zones.

Conveying of other media leads to an increased thermal and/or mechanical load on the machine and is permissible only after a consultation with Busch.

The machine is intended for the placement in a non-potentially explosive environment.

The machine is capable of maintaining ultimate pressure, see *Technical Data* [→ 32].

The machine is suitable for continuous operation.

Permitted environmental conditions, see *Technical Data* [→ 32].

## 2.4 Start Controls

The machine comes without start controls. The control of the machine is to be provided in the course of installation.



### 3 Transport

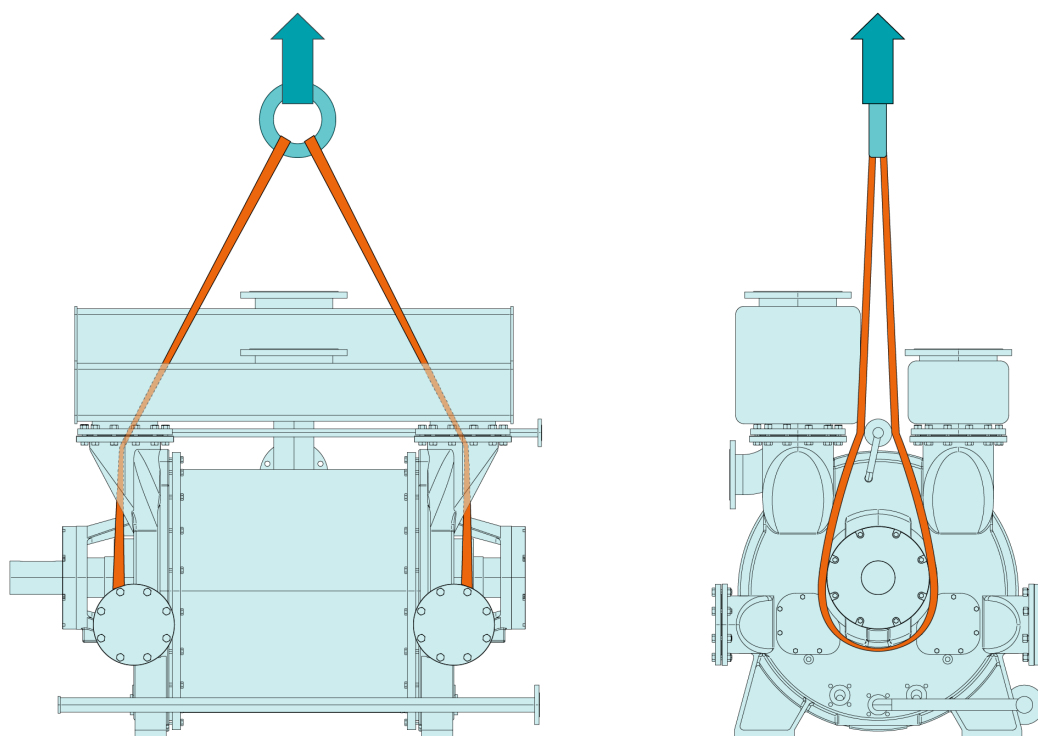


#### WARNING

##### Suspended load.

##### Risk of severe injury!

- Do not walk, stand or work under suspended loads.
  - The crane and slings must be capable of lifting the weight of the pump.
- 
- To find out the weight of the machine, refer to the chapter *Technical Data* [→ 32] or the nameplate (NP).
  - Use appropriate slings.



- Generally, the lifting point should be on the baseplate on which the machine is installed.
- The lifting point of a bare shaft pump is shown above.
- Check the machine for transport damage.

## 4 Storage



### NOTICE

**Storage temperature below +5°C.**

**Risk of damage to the machine!**

- Drain the operating liquid from the machine and the system before storage.
- Or add an anti-freeze solution.

---

After testing, all Busch DOLPHIN vacuum pumps are vented and drained.

### 4.1 Short Term (Up to 3 Months)

- Seal all apertures with adhesive tape or provided caps.

If possible:

- Store the machine indoors, dry, dust free and if possible in original packaging preferably at temperatures between +5 ... 55 °C.

### 4.2 Medium Term (3 Months to 6 Months)

- Remove the shaft coupling guard (if not supplied as a bare shaft machine).
- Rotate the machine shaft by hand weekly to prevent bearing indentation.
- Leave the shaft at approximately 90 degrees to the original position, using a temporary mark on the shaft to assist.
- Replace the coupling guard, taking care to align correctly and ensure that all fasteners are replaced and fully tightened.
- Where shaft seal is gland packing, loosen the packing gland plate.

### 4.3 Long Term (Over 6 Months)

If the machine is constructed in cast iron material:

- Preserve internals by using a combined VPI (Vapor Phase Inhibitor) and Contact Inhibitor Oil at a recommended concentration of 1 liter per m<sup>3</sup> to prevent the machine from corroding. Ensure all apertures are sealed after application.
- Remove the shaft coupling guard (if not supplied as a bare shaft machine).
- Rotate the machine shaft by hand weekly to prevent bearing indentation.
- Leave the shaft at approximately 90 degrees to the original position, using a temporary mark on the shaft to assist.
- Coat the exposed shaft ends and shaft coupling with wax preservative or heavy grease.
- Replace the coupling guard, taking care to align correctly and ensure that all fasteners are replaced and fully tightened.

## 5 Installation

### 5.1 Installation Conditions



#### NOTICE

**Use of the machine outside of the permitted installation conditions.**

**Risk of premature failure!**

**Loss of efficiency!**

- Take care that the installation conditions are fully complied with.
- 
- Make sure that the environment of the machine is not potentially explosive.
  - Make sure that the ambient conditions comply with the *Technical Data* [→ 32].
  - Make sure that the environmental conditions comply with the protection class of the motor.
  - Make sure that the installation space or location is protected from weather and lightning.
  - Make sure that the installation space or location is vented such that sufficient cooling of the machine is provided.
  - Make sure that cooling air inlets and outlets of the motor fan are not covered or obstructed and that the cooling air flow is not affected adversely in any other way.
  - Make sure that enough space remains for maintenance work.
  - Make sure that the machine is placed or mounted horizontally on a flat surface.
  - Make sure that the machine is connected to an operating liquid system, see Operating Liquid Connection.
  - Make sure that all provided covers, guards, hoods, etc. are mounted.

In case of a machine delivery without motor:

- Make sure that the coupling is correctly aligned, see *Fitting the Coupling* [→ 17].

If the machine is installed at an altitude greater than 1000 meters above sea level:

- Contact your Busch representative, the motor should be derated or the ambient temperature limited.

### 5.2 Connecting Lines / Pipes

- Remove all protective covers before installation.
- Make sure that the connection lines cause no stress on the machine's connection; if necessary use flexible joints.
- Make sure that the line size of the connection lines over the entire length is at least as large as the connections of the machine.

In case of long connection lines it is advisable to use larger line sizes in order to avoid a loss of efficiency. Seek advice from your Busch representative.

## 5.2.1 Suction Connection

### NOTICE

**Ingress of foreign objects.**

**Risk of damage to the machine!**

If the inlet gas contains foreign solid particles:

- Install a suitable inlet screen (smaller than 0.2 mm mesh size) upstream of the machine.

Connection size(s):

- DN125 PN10 (for LR 0110 A and LR 0140 A)
- DN150 PN10 (for LR 0210 A and LR 0300 A)
- DN200 PN10 (for LR 0420 A)
- DN250 PN10 (for LR 0580 A)

## 5.2.2 Discharge Connection

### NOTICE

**Discharge gas flow obstructed.**

**Risk of damage to the machine!**

- Make sure that the discharged gas will flow without obstruction. Do not shut off or throttle the discharge line or use it as a pressurized air source.

### NOTICE

**Too high elevation or lack of separation.**

**Will cause back pressure and possible drive motor overload!**

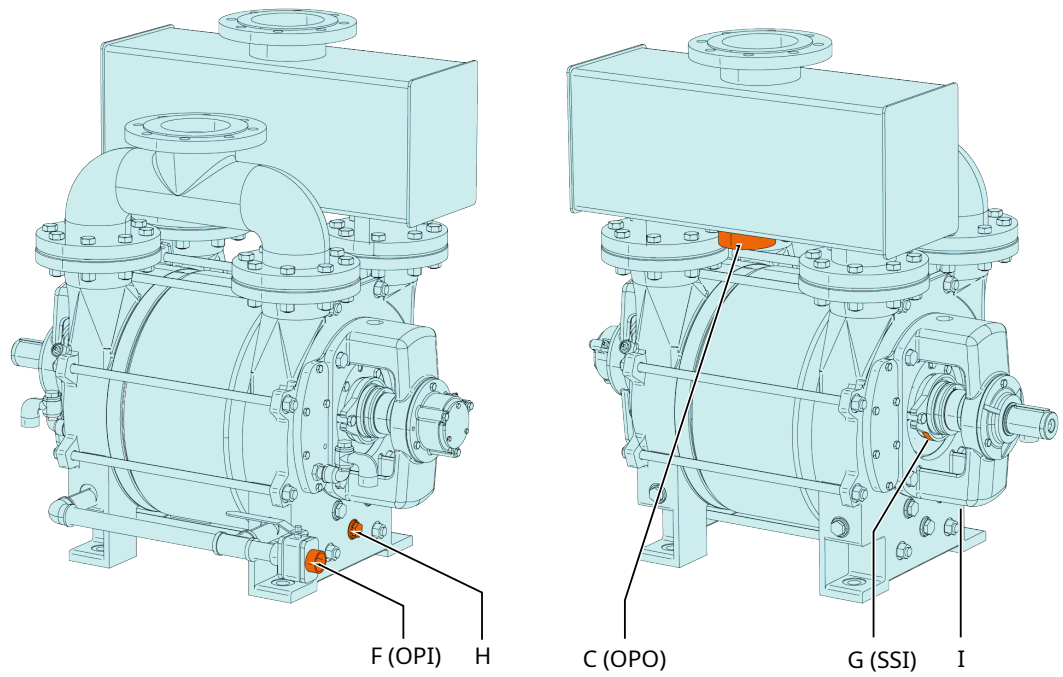
- The discharge piping on machines without integral separator manifold should not exceed an elevation of more than 1000 mm above the discharge flange (OUT) of the machine until the liquid is separated.

Connection size(s):

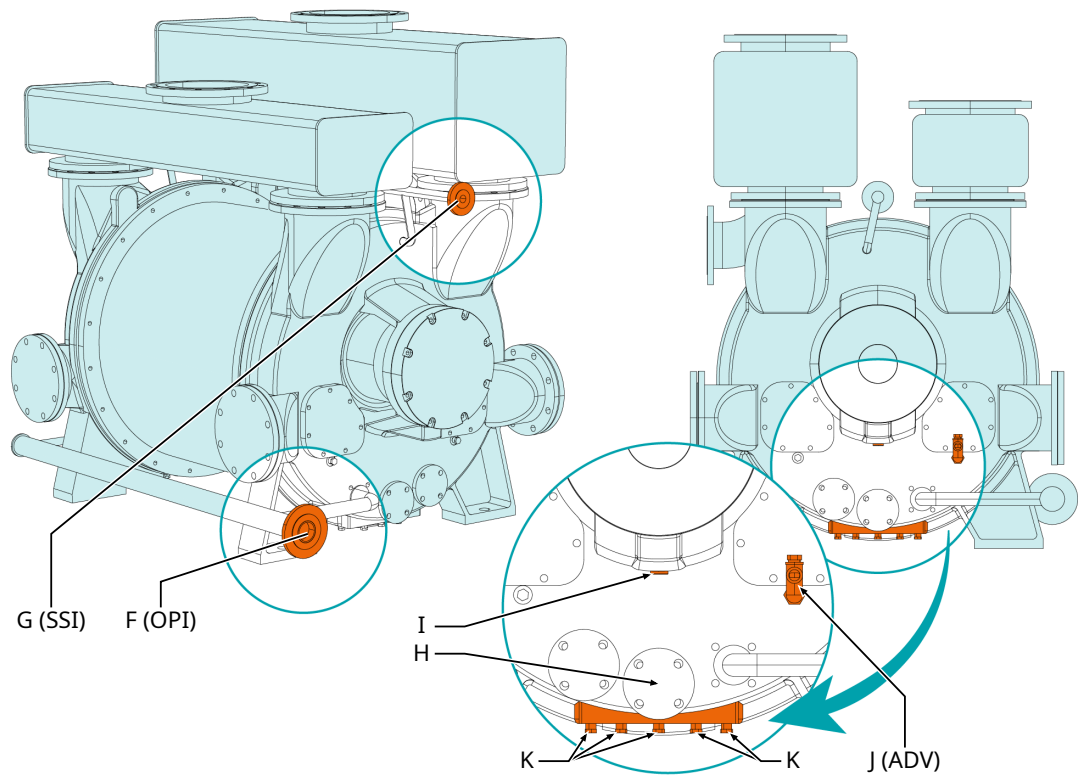
- DN125 PN10 (for LR 0110 A and LR 0140 A)
- DN150 PN10 (for LR 0210 A and LR 0300 A)
- DN200 PN10 (for LR 0420 A)
- DN250 PN10 (for LR 0580 A)

### 5.2.3 Operating Liquid Connection

DOLPHIN LR 0110 A - LR 0300 A



DOLPHIN LR 0420 A, LR 0580 A



Description			
C	Operating liquid outlet (OPO)	F	Operating liquid inlet (OPI)
G	Shaft seal flush connection (SSI)	H	Clean and drain plug
I	Stuffing box drain plug	J	Automatic drain valve (ADV)
K	Casing drain plugs		

Connection sizes:

Machine type	C	F	G	H	I
LR 0110 A	G3"	G1"	G <sub>1/4</sub> "	G <sub>3/4</sub> "	G <sub>3/4</sub> "
LR 0140 A	G3"	G1"	G <sub>1/4</sub> "	G <sub>3/4</sub> "	G <sub>3/4</sub> "
LR 0210 A	G3"	G <sub>1 1/4</sub> "	G <sub>1/2</sub> "	G1"	G <sub>3/4</sub> "
LR 0300 A	G3"	G <sub>1 1/4</sub> "	G <sub>1/2</sub> "	G1"	G <sub>3/4</sub> "

Machine type	C	F	G	H	I	J	K
LR 0420 A	DN100	DN25	G <sub>1/2</sub> "	DN25	G <sub>1/2</sub> "	G1"	G <sub>1/2</sub> "
LR 0580 A	DN125	DN50	DN20	G <sub>1 1/4</sub> "	G <sub>1/2</sub> "	G1"	G <sub>1/2</sub> "

- Make sure that the operating liquid complies with the requirements, see Operating Liquid Settings.

## 5.3 Operating Liquid Settings

The machine cannot operate without an operating liquid system. The actual scope of delivery is always contractually agreed upon.

The condition of both the operating liquid and the conveyed media depend on the physical conditions pressure and temperature.

At a very low pressures and sufficiently high temperatures the operating liquid can locally transfer into the vapor phase, creating bubbles within the operating liquid. This process is called "cavitation" and may deteriorate the machine and its performance, see *Preventing Cavitation* [→ 22].

Recommended operating liquid (water) settings at various inlet pressures:

LR 0110 A				
Speed r/min	< 200 mbar m <sup>3</sup> /h	200 - 400 mbar m <sup>3</sup> /h	400 - 600 mbar m <sup>3</sup> /h	> 600 mbar m <sup>3</sup> /h
790	1.36 - 1.70	0.88 - 1.36	0.68 - 0.88	0.57 - 0.68
880	1.52 - 1.90	1.01 - 1.52	0.75 - 1.01	0.63 - 0.75
980	1.68 - 2.10	1.12 - 1.68	0.84 - 1.12	0.70 - 0.84
1100	1.84 - 2.30	1.22 - 1.84	0.92 - 1.22	0.77 - 0.92
1170	2.00 - 2.50	1.34 - 2.00	1.00 - 1.34	0.83 - 1.00
1300	2.16 - 2.70	1.44 - 2.16	1.08 - 1.44	0.90 - 1.08
1450	2.40 - 3.00	1.60 - 2.40	1.20 - 1.60	1.00 - 1.20

<b>LR 0140 A</b>				
<b>Speed r/min</b>	<b>&lt; 200 mbar m<sup>3</sup>/h</b>	<b>200 - 400 mbar m<sup>3</sup>/h</b>	<b>400 - 600 mbar m<sup>3</sup>/h</b>	<b>&gt; 600 mbar m<sup>3</sup>/h</b>
790	1.68 – 2.10	1.12 – 1.68	0.84 – 1.12	0.7 – 0.84
880	1.84 – 2.30	1.22 – 1.84	0.92 – 1.22	0.77 – 0.92
980	2.08 – 2.6	1.38 – 2.08	1.04 – 1.38	0.87 – 1.04
1100	2.32 – 2.9	1.54 – 2.32	1.16 – 1.54	0.97 – 1.16
1170	2.48 – 3.1	1.66 – 2.48	1.23 – 1.66	1.03 – 1.23
1300	2.72 – 3.4	1.84 – 2.72	1.32 – 1.84	1.10 – 1.32
1450	3.03 – 3.79	2.05 – 3.03	1.47 – 2.05	1.23 – 1.47

<b>LR 0210 A</b>				
<b>Speed r/min</b>	<b>&lt; 200 mbar m<sup>3</sup>/h</b>	<b>200 - 400 mbar m<sup>3</sup>/h</b>	<b>400 - 600 mbar m<sup>3</sup>/h</b>	<b>&gt; 600 mbar m<sup>3</sup>/h</b>
565	2.64 – 3.30	1.76 – 2.64	1.32 – 1.76	1.10 – 1.32
660	3.12 – 3.90	2.08 – 3.12	1.56 – 2.34	1.30 – 1.56
740	3.52 – 4.40	2.34 – 3.52	1.76 – 2.34	1.47 – 1.76
820	3.92 – 4.90	2.62 – 3.92	1.96 – 2.62	1.63 – 1.96
880	4.16 – 5.2	2.78 – 4.16	2.08 – 2.78	1.73 – 2.78
920	4.40 – 5.50	2.96 – 4.4	2.16 – 2.96	1.80 – 2.16
980	4.69 – 5.86	3.15 – 4.69	2.30 – 3.15	1.92 – 2.30

<b>LR 0300 A</b>				
<b>Speed r/min</b>	<b>&lt; 200 mbar m<sup>3</sup>/h</b>	<b>200 - 400 mbar m<sup>3</sup>/h</b>	<b>400 - 600 mbar m<sup>3</sup>/h</b>	<b>&gt; 600 mbar m<sup>3</sup>/h</b>
565	3.12 – 3.90	2.08 – 3.12	1.56 – 2.08	1.30 – 1.56
660	3.68 – 4.60	2.46 – 3.68	1.84 – 2.46	1.53 – 1.84
740	4.16 – 5.20	2.78 – 4.16	2.08 – 2.78	1.73 – 2.08
820	4.64 – 5.80	3.10 – 4.64	2.32 – 3.10	1.93 – 2.32
880	4.96 – 6.20	3.31 – 4.96	2.47 – 3.31	2.06 – 2.47
920	5.20 – 6.50	3.44 – 5.20	2.64 – 3.44	2.20 – 2.64
980	5.54 – 6.93	3.67 – 5.54	2.82 – 3.67	2.35 – 2.82

<b>LR 0420 A</b>				
<b>Speed r/min</b>	<b>&lt; 200 mbar m<sup>3</sup>/h</b>	<b>200 - 400 mbar m<sup>3</sup>/h</b>	<b>400 - 600 mbar m<sup>3</sup>/h</b>	<b>&gt; 600 mbar m<sup>3</sup>/h</b>
472	4.9 – 6.1	4.1 – 4.9	2.4 – 4.1	2.1 – 2.4
500	5.1 – 6.4	4.3 – 5.1	2.6 – 4.3	2.2 – 2.6
530	5.4 – 6.8	4.6 – 5.4	2.7 – 4.6	2.3 – 2.7
590	6.1 – 7.6	5.1 – 6.1	3.1 – 5.1	2.6 – 3.1
660	6.8 – 8.5	5.7 – 6.8	3.4 – 5.7	2.9 – 3.4
710	7.3 – 9.1	6.1 – 7.3	3.7 – 6.1	3.1 – 3.7
740	7.6 – 9.5	6.4 – 7.6	3.8 – 6.4	3.2 – 3.8
790	8.1 – 10.1	6.8 – 8.1	4.0 – 6.8	3.4 – 4.0

LR 0580 A				
Speed r/min	< 200 mbar m <sup>3</sup> /h	200 - 400 mbar m <sup>3</sup> /h	400 - 600 mbar m <sup>3</sup> /h	> 600 mbar m <sup>3</sup> /h
372	6.3 - 7.9	5.3 - 6.3	3.2 - 5.3	2.7 - 3.2
420	7.1 - 8.9	6.0 - 7.1	3.6 - 6.0	3.0 - 3.6
472	8.0 - 10.0	6.7 - 8.0	4.0 - 6.7	3.4 - 4.0
500	8.5 - 10.6	7.1 - 8.5	4.3 - 7.1	3.6 - 4.3
530	9.0 - 11.2	7.5 - 9.0	4.5 - 7.5	3.8 - 4.5
590	10.0 - 12.5	8.4 - 10.0	5.1 - 8.4	4.3 - 5.1
660	11.2 - 14.0	9.4 - 11.2	5.7 - 9.4	4.8 - 5.7

Water pressure before flow regulation valve (once through operation only)	bar(g)	1
Max. allowable supply temperature	°C	80
Max. allowable kinematic viscosity	mm <sup>2</sup> /s	20 <i>Consider the motor power for anything other than water - consult Busch.</i>
Max. allowable particle size	mm	0.2*

\* For all operating systems make sure that no particles with a diameter larger than 0.2 mm will intrude the machine, neither via the process gas nor via the operating liquid. Use suitable filtration as necessary.

The table below lists the recommended maximum levels of soluble compounds for use with machine in cast iron construction.

Calcium carbonate	mg/l (ppm)	< 300**
PH value		6.5 ... 9.5
Chloride	mg/l (ppm)	< 700
Sulphates	mg/l (ppm)	< 200
Nitrites	mg/l (ppm)	< 500***
Total dissolved solids	mg/l (ppm)	< 1000

\*\* to prevent excessive built-up of scale

\*\*\* provided long period of exposure to stagnant water is not foreseen



## NOTE

### Stainless steel version.

**Please note that machines in all stainless steel material offer higher levels of corrosion resistance and can be used for operation outside of the above limits. Chemical compatibility should always be checked by competent personnel before use, particular attention should be paid to elastomer material selection. If in doubt, please consult Busch.**



## 5.4 Fitting the Coupling



### WARNING

**Unprotected coupling.**

**Risk of severe injury!**

- Make sure that the coupling is protected by a cover or a guard.

In case of a machine supplied without a motor:

- Fit a suitable coupling that matches the machine and motor shaft size.
- Make sure that the coupling is sized to withstand the full motor torque.
- Make sure that the coupling is correctly aligned according to the coupling instructions.
- Install a protective cover or a guard.

Machine type	Machine shaft size (mm)
LR 0110 A & LR 0140 A	50
LR 0210 A & LR 0300 A	70
LR 0420 A	100
LR 0580 A	120

## 6 Electrical Connection



### DANGER

**Live wires.**

**Risk of electrical shock.**

- Electrical installation work must only be executed by qualified personnel.

#### CURRENT PROTECTION OF THE CUSTOMER INSTALLATION:



### DANGER

**Missing current protection.**

**Risk of electrical shock.**

- Current protection according to EN 60204-1 must be insured by the customer on its installation.
- The electrical installation must comply with the applicable national and international standards.



### NOTICE

**Electromagnetic compatibility.**

- Make sure that the motor of the machine will not be affected by electric or electro-magnetic disturbance from the mains, if necessary seek advice from Busch.
- Make sure that the EMC of the machine is compliant with the requirements of your supply network system, if necessary provide further interference suppression (EMC of the machine, see *EU Declaration of Conformity* [→ 35] or *UK Declaration of Conformity* [→ 36]).

### 6.1 Machine delivered without Control Box or Variable Speed Drive (VSD)



### DANGER

**Live wires.**

**Risk of electrical shock.**

- Electrical installation work must only be executed by qualified personnel.
- Make sure that the power supply for the motor is compatible with the data on the nameplate of the motor.
- If the machine is equipped with a power connector, install a residual current protective device to protect persons in case of isolation default.
  - Busch recommends installing a type B residual protective device suitable for the electrical installation.
- Provide a lockable disconnect switch or an emergency stop switch on the power line so that the machine is completely secured in case of an emergency situation.

- Provide a lockable disconnect switch on the power line so that the machine is completely secured during maintenance tasks.
- Provide an overload protection according to EN 60204-1 for the motor.
- Connect the protective earth conductor.
- Electrically connect the motor.

## 6.2 Machine delivered with a Variable Speed Drive (Option)

- If the machine is equipped with a power connector, install a residual current protective device to protect persons in case of isolation default.
  - Busch recommends installing a type B residual protective device suitable for the electrical installation.
- If the variable speed drive is not equipped with a lockable disconnect switch, provide it on the power line so that the machine is completely secured during maintenance tasks.
- Provide an overload protection according to EN 60204-1.
- Connect the protective earth conductor.

### NOTICE

**Incorrect connection.**

**Risk of damage to the variable speed drive!**

- The wiring diagrams given below are typical. Check the connection instructions/diagrams.

## 6.3 Wiring Diagram Three-Phase Motor

### NOTICE

**Incorrect direction of rotation.**

**Risk of damage to the machine!**

- Operation in the wrong direction of rotation can destroy the machine in a short time! Prior to start-up, ensure that the machine is operated in the right direction.

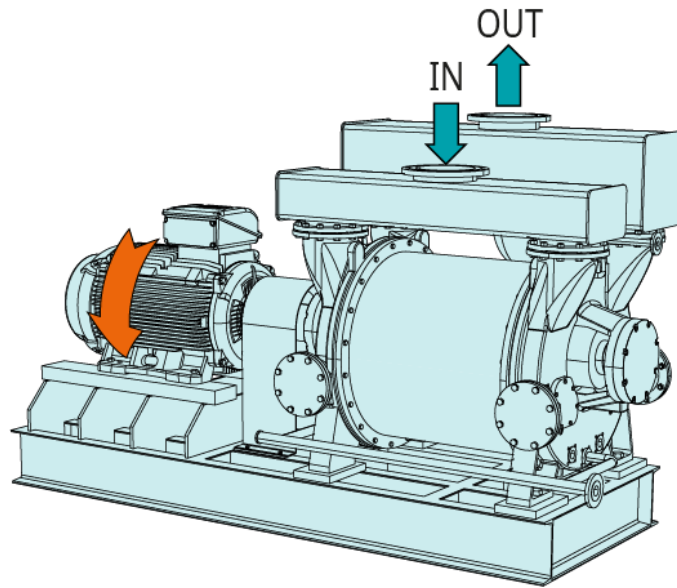
### NOTICE

**Incorrect direction of rotation.**

**Risk of damage to the vacuum system!**

- Operating the vacuum system with the rotation in the wrong direction can result in the operating liquid flowing back to the vacuum system. Prior to start-up, check for correct direction of rotation.

The intended rotation direction of the motor is defined by the illustration below:



- Watch the fan wheel of the motor and determine the direction of rotation just before the fan wheel stops.

If the rotation of the motor must be changed:

- Switch any two of the motor phase wires.

**For motor wiring and wiring diagrams, please refer to motor manufacturers instruction manuals.**

## 7 Commissioning



### CAUTION

During operation the surface of the machine may reach temperatures of more than 70°C.

**Risk of burns!**

- Avoid contact with the machine during and directly after operation.



### NOTICE

**The machine is running without operating liquid system.**

**Will ruin the machine in short time!**

- Prior to commissioning, the operating and shaft seal flushing liquid system must be connected and open.



### NOTICE

**Ingress of foreign objects.**

**Risk of damage to the machine!**

- It is recommended to install a temporary stainless steel inlet screen (smaller than 0.2 mm mesh size) during commissioning.  
Temporary screen should be checked monthly and cleaned until no debris is observed, after which the screen can be removed to prevent loss of suction capacity, or left in place with regular checking.

- Make sure that the installation conditions (see *Installation Conditions* [→ 11]) are met.

Before operating the machine:

- Make sure that the operating liquid level is at the machine shaft center.
- Check the operation of all automatic valves before start up
- Machines with gland packing for shaft sealing: loosen the packing gland plate and apply a few drops of oil to the packing for lubricating purpose.
- Ensure external shaft sealing liquid is available to packing gland or double cartridge mechanical seal before switching on the machine. Supply pressure for packing gland 0.1 to 0.3 bar(g) with flow rate to suitably lubricate the packing.
- For mechanical seal supply pressure and flow rate, see manufacturers instructions for the contract.
- Switch on the machine.
- Make sure that the maximum permissible number of starts does not exceed the recommendation from the motor manufacturer.

After a few seconds of operation:

- Turn on/activate the operating liquid system device.
- Make sure that the operating conditions comply with the *Technical Data* [→ 32].

As soon as the machine is operated under normal operating conditions:

- Measure the motor current and record it as reference for future maintenance and trouble-shooting work.

- Machines with gland packing for shaft sealing require the gland to be adjusted during operation. Uniformly tighten the gland plate so that the liquid leakage along the shaft from the packing is 20 to 40 drips per minute.

## 7.1 Preventing Cavitation



### **Cavitation.**

#### **Risk of damage to the machine!**

If you hear crackling noise:

- Control the pressure.

At very low pressures and sufficiently high temperatures the operating liquid can locally transfer into the vapor phase, creating bubbles within the operating liquid. As the pressure rises towards the outlet slot the bubbles collapse. This process is called cavitation.

In case of bubbles that have been located on surfaces the operating liquid cannot intrude the cavity left by the bubble equally from all directions. Instead the inflowing liquid hits the surface with high speed. This causes erosion, which can destroy the machine rapidly. The formation of bubbles also deteriorates the pump performance. Cavitation is clearly audible by its crackling noise.

The working pressure of the vacuum pump shall therefore be sufficiently above the vapor pressure of the operating liquid. In particular the pressure control in the vacuum system must by no means be achieved by throttling or even closing of the suction line!

The vapor pressure of the operating liquid and consequently the ultimate pressure can be reduced by cooling. However, this increases the cooling water flow considerably. In most cases the low ultimate pressure is not required and cavitation shall be avoided by means of vacuum limitation rather than cooling.

## 8 Maintenance



### DANGER

**Live wires.**

**Risk of electrical shock.**

- Electrical installation work must only be executed by qualified personnel.



### WARNING



**Machines contaminated with hazardous material.**

**Risk of poisoning!**

**Risk of infection!**

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.



### CAUTION

**Hot surface.**

**Risk of burns!**

- Prior to any action requiring touching the machine, let the machine cool down first.

- Shut down the machine and lock against inadvertent start up.
- Turn off the operating liquid system.
- Vent the connected lines to atmospheric pressure.

If necessary:

1. Drain the operating liquid
2. Disconnect all connections

## 8.1 Maintenance Schedule

The maintenance intervals depend very much on the individual operating conditions. The intervals given below are considered as starting values which should be shortened or extended as appropriate. Particularly harsh applications or heavy duty operation, such as high dust loads in the environment or in the process gas, other contamination or ingress of process material, can make it necessary to shorten the maintenance intervals significantly.

Interval	Maintenance work
Monthly	<ul style="list-style-type: none"> <li>• Check for abnormal noise, see <i>Troubleshooting</i> [→ 28].</li> <li>• Check for excessive vibration, see <i>Operating Conditions</i>.</li> <li>• Check the operating liquid temperature, see <i>Operating Liquid Connection</i>.</li> <li>• Check the machine for liquid leaks - in case of leaks have the machine repaired (contact Busch).</li> </ul> <p>If applicable check gland packing leakage rate (20 to 40 drips per minute) and adjust as required.</p>
Every 2500 operating hours	<ul style="list-style-type: none"> <li>• Regrease the bearings. The amount of grease accounts for 2/3 of the free space of the bearing chamber.</li> <li>• Check the tension on the v-belt (if applicable).</li> </ul>
Every year	<ul style="list-style-type: none"> <li>• Carry out a visual inspection on the machine to check for dust and dirt. Avoid using any cleaning products which may result in damage to the pump label or paint.</li> <li>• If applicable, gland packing has to be replaced annually or sooner if readjustment is no longer possible.</li> </ul> <p>If an inlet screen or filter is installed:</p> <ul style="list-style-type: none"> <li>• Check it and clean if necessary.</li> </ul>
Every 5 years	<ul style="list-style-type: none"> <li>• Have a major overhaul (contact Busch).</li> </ul>



## 9 Overhaul



### WARNING



**Machines contaminated with hazardous material.**

**Risk of poisoning!**

**Risk of infection!**

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.



### NOTICE

**Improper assembly.**

**Risk of premature failure!**

**Loss of efficiency!**

- Any dismantling of the machine that goes beyond anything that is described in this manual should be done by Busch authorized technicians.

In case of the machine having conveyed gas that was contaminated with foreign materials which are dangerous to health:

- Decontaminate the machine as much as possible and state the contamination status in a 'Declaration of Contamination'.

Busch will only accept machines that come with a completely filled in and legally binding signed 'Declaration of Contamination' (form downloadable from [www.buschvacuum.com](http://www.buschvacuum.com)).

# 10 Decommissioning



## DANGER

**Live wires.**

**Risk of electrical shock.**

- Electrical installation work must only be executed by qualified personnel.



## CAUTION

**Hot surface.**

**Risk of burns!**

- Prior to any action requiring touching the machine, let the machine cool down first.

- Shut down the machine and lock against inadvertent start up.
- Disconnect the power supply.
- Vent the connected lines to atmospheric pressure.
- Disconnect all connections.

If the machine is going to be stored:

- See Storage.

## 10.1 Dismantling and Disposal

- Separate special waste from the machine.
- Dispose of special waste in compliance with applicable regulations.
- Dispose of the machine as scrap metal.

# 11 Spare Parts



## NOTICE

**Use of non-Busch genuine spare parts.**

**Risk of premature failure!**

**Loss of efficiency!**

- The exclusive use of Busch genuine spare parts and consumables is recommended for the correct functioning of the machine and to validate the warranty.

Spare parts kit	Description	Part no.
Service kit for: LR 0110 A LR 0140 A	Intended for standard applications with gland packing shaft seal 2x lip seal 2x valve retaining plate 2x valve plate 1x gasket set (includes V-seal, O-ring and shim ring) 1x Gland packing	0992 700 723
Service kit for: LR 0210 A LR 0300 A	Intended for standard applications with gland packing shaft seal 2x lip seal 2x valve retaining plate 2x valve plate 1x gasket set (includes V-seal, o-ring and shim ring) 1x gland packing	0992 700 724
Service kit for: LR 0420 A	Intended for standard applications with gland packing shaft seal 2x lip seal 2x valve retaining plate 2x valve plate 1x gasket set (includes V-seal, o-ring and shim ring) 1x gland packing	0992 700 725
Service kit for: LR 0580 A	Intended for standard applications with gland packing shaft seal 2x lip seal 2x valve retaining plate 2x valve plate 1x gasket set (includes V-seal, o-ring and shim ring) 1x gland packing	0992 700 726

If other parts are required:

- Contact your Busch representative.

# 12 Troubleshooting

Problem	Possible Cause	Remedy
The machine does not start.	The motor is not supplied with the correct voltage.	<ul style="list-style-type: none"> <li>• Check the power supply.</li> </ul>
	Corrosion between the rotor and the housing.	<ul style="list-style-type: none"> <li>• Eliminate by use of anti-corrosion liquid.</li> <li>• Repair the machine (contact Busch).</li> </ul>
	Solid foreign matter has entered the machine.	<ul style="list-style-type: none"> <li>• Remove the solid foreign matter or repair the machine (contact Busch).</li> <li>• Install an inlet screen if necessary.</li> </ul>
	Ice in the machine, the operating liquid has frozen.	<ul style="list-style-type: none"> <li>• Carefully warm up the machine.</li> <li>• Defrost the operating liquid.</li> </ul>
	The motor is defective.	<ul style="list-style-type: none"> <li>• Replace the motor.</li> </ul>
	Water level too high inside when starting	<ul style="list-style-type: none"> <li>• Start with the water level specified.</li> </ul>
	Packing gland too tight	<ul style="list-style-type: none"> <li>• Loosen the gland adequately.</li> </ul>
	Belt too tight	<ul style="list-style-type: none"> <li>• Loosen the belt adequately.</li> </ul>
	Wear developing in the pump	<ul style="list-style-type: none"> <li>• Turn the impeller with force and flush with water.</li> </ul>
	Discharge pressure too high	<ul style="list-style-type: none"> <li>• Make sure the vent line is free of restrictions and is at least same size as pump connection.</li> </ul>
Pump trip	If seized during commissioning, welding slag or other foreign matter may have been drawn in from new pipes with incoming gas.	<ul style="list-style-type: none"> <li>• Flush the machine and check rotation by hand. If trouble persists, contact Busch.</li> </ul>
	Heavy lime deposit build-up	<ul style="list-style-type: none"> <li>• Flush the machine and check rotation by hand. If trouble persists, contact Busch.</li> </ul>
	Discharge pressure too high	<ul style="list-style-type: none"> <li>• Make sure the vent line is free of restrictions.</li> </ul>

Problem	Possible Cause	Remedy
<p>The machine does not reach the usual pressure on the suction connection.</p>	<p>Suction or discharge lines too long or section diameter too small.</p>	<ul style="list-style-type: none"> <li>• Use larger diameter or shorter lines.</li> <li>• Seek advice from your local Busch representative.</li> </ul>
	<p>The operating liquid is too warm or insufficient operating liquid. (the characteristic curves are based on 15°C warm water as operating liquid, with higher temperatures the achieved pressure and the flow rate deteriorate)</p>	<ul style="list-style-type: none"> <li>• Reduce the temperature of the operating liquid or adjust the flow of operating liquid.</li> </ul>
	<p>The mechanical seal leaks.</p>	<ul style="list-style-type: none"> <li>• Repair the machine (contact Busch).</li> </ul>
	<p>Partial clogging in the suction, discharge or pressure line.</p>	<ul style="list-style-type: none"> <li>• Remove the blockage.</li> </ul>
	<p>If an inlet screen is installed, it can be partially clogged.</p>	<ul style="list-style-type: none"> <li>• Clean the inlet screen.</li> </ul>
	<p>Internal parts are worn or damaged.</p>	<ul style="list-style-type: none"> <li>• Repair the machine (contact Busch).</li> </ul>
	<p>Excessive leakage from the gland packing.</p>	<ul style="list-style-type: none"> <li>• Tighten the packing gland</li> </ul>
	<p>Speed low due to slippage of the belt.</p>	<ul style="list-style-type: none"> <li>• Tighten the belt.</li> </ul>
	<p>Heavy lime deposits in the pump.</p>	<ul style="list-style-type: none"> <li>• Remove the lime deposit.</li> </ul>
	<p>Leakage occurring in the system.</p>	<ul style="list-style-type: none"> <li>• Check the joints are sealed sufficiently.</li> </ul>
<p>Excessive clearance in the pump due to corrosion or corrosive substances in the medium.</p>	<ul style="list-style-type: none"> <li>• Clean the medium preventing solids from entering and replace the worn parts.</li> </ul>	
<p>Axial clearance not conforming with the requirements following a repair.</p>	<ul style="list-style-type: none"> <li>• Recalibrate the axial clearance.</li> </ul>	

Problem	Possible Cause	Remedy
The machine runs very noisily or rattles.	The operating liquid level is too high.	<ul style="list-style-type: none"> <li>Adjust the regulating valves to drain the pump down to center line.</li> </ul>
	Density or viscosity of the operating liquid too high.	<ul style="list-style-type: none"> <li>Check Operating Liquid Settings.</li> <li>Provide a different operating liquid or a stronger drive motor.</li> </ul>
	The machine runs in the wrong direction.	<ul style="list-style-type: none"> <li>Check the direction of rotation, see <i>Wiring Diagram Three-Phase Motor</i> [→ 19].</li> </ul>
	Defective bearings.	<ul style="list-style-type: none"> <li>Repair the machine (contact Busch).</li> </ul>
	The vacuum pump cavitates (periodic formation and collapsing of steam bubbles in the operating liquid).	<ul style="list-style-type: none"> <li>Consult the chapter <i>Preventing Cavitation</i> [→ 22].</li> <li>Adjust cooling liquid flow rate to reduce the temperature of the operation liquid.</li> </ul>
	Worn coupling element.	<ul style="list-style-type: none"> <li>Check the coupling and repair it if necessary.</li> </ul>
	Belts loose.	<ul style="list-style-type: none"> <li>Tighten the belts.</li> </ul>
	Suction and discharge piping is too thin.	<ul style="list-style-type: none"> <li>Use thicker piping.</li> </ul>
The machine runs too hot.	Insufficient air ventilation.	<ul style="list-style-type: none"> <li>Make sure that the cooling of the machine is not impeded by dust/dirt.</li> <li>Clean the fan cowling, the fan, the ventilation grill and the cooling fins of the motor.</li> </ul>
	Ambient temperature too high.	<ul style="list-style-type: none"> <li>Observe the permitted ambient temperature, see <i>Technical Data</i> [→ 32].</li> </ul>
	Temperature of the process gases at the inlet too high.	<ul style="list-style-type: none"> <li>Observe the permitted gas inlet temperature, see <i>Technical Data</i> [→ 32].</li> </ul>
	Insufficient gas transfer.	<ul style="list-style-type: none"> <li>Introduce a suitable inert gas or air via the anti-cavitation connection.</li> </ul>
	Partial blockage in the suction, discharge or pressure line.	<ul style="list-style-type: none"> <li>Remove the blockage.</li> </ul>
Bearing temperature too high.	Belts are too tight.	<ul style="list-style-type: none"> <li>Loosen the belts.</li> </ul>
	Alignment fail.	<ul style="list-style-type: none"> <li>Adjust alignment.</li> </ul>
	Bearing lubricated insufficiently, the grease is dry or there is too much.	<ul style="list-style-type: none"> <li>Ensure the bearings are lubricated sufficiently.</li> </ul>
	The bearings have been installed incorrectly.	<ul style="list-style-type: none"> <li>Reinstall the bearings.</li> </ul>
	Bearing is damaged.	<ul style="list-style-type: none"> <li>Replace the damaged bearing.</li> </ul>

Problem	Possible Cause	Remedy
Vibration is high.	Loose contact between the baseplate and the foundation, or the anchor bolts are loose.	<ul style="list-style-type: none"> <li>• Fill the space with concrete, tighten the anchor bolts.</li> </ul>
	Alignment fail.	<ul style="list-style-type: none"> <li>• Adjust alignment.</li> </ul>

# 13 Technical Data

		LR 0110 A	LR 0140 A
Nominal pumping speed range (Dry air)	m <sup>3</sup> /h	570 / 960	840 / 1430
Ultimate pressure	hPa (mbar) abs.	33	
Maximum overpressure	bar(g)	0.2 (consult Busch for pressures outside this range)	
Nominal motor rating	kW	18.5 / 22 / 30 / 45	30 / 37 / 45 / 55
Nominal pump running speed	min <sup>-1</sup>	790 / 980 / 1170 / 1450	790 / 980 / 1170 / 1450
Noise level (EN ISO 2151)	dB(A)	< 80	
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.5 (≤0.18), 1450 min <sup>-1</sup> ≤6 (≤0.24)	
Max. allowable gas inlet temperature	°C	Gas dry ► 120	
		Gas saturated ► 100	
Ambient temperature range	°C	5 ... 40	
Relative humidity	at 30 °C	90%	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See Operating Liquid Settings	
Weight without motor (bare shaft machine) - cast iron / full stainless steel	kg	454 / 482	511 / 542
Dimensions (bare shaft machine) – L x W x H	mm	975 x 700 x 985	1095 x 700 x 985



		LR 0210 A	LR 0300 A
Nominal pumping speed range (Dry air)	m <sup>3</sup> /h	1175 / 2100	1670 / 3010
Ultimate pressure	hPa (mbar) abs.	33	
Maximum overpressure	bar(g)	0.2 (consult Busch for pressures outside this range)	
Nominal motor rating	kW	30 / 45 / 75 / 75	45 / 75 / 90 / 110
Nominal pump running speed	min <sup>-1</sup>	565 / 740 / 880 / 980	565 / 740 / 880 / 980
Noise level (EN ISO 2151)	dB(A)	< 85	
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.5 (≤0.18)	
Max. allowable gas inlet temperature	°C	Gas dry ► 120	
		Gas saturated ► 100	
Ambient temperature range	°C	5 ... 40	
Relative humidity	at 30 °C	90%	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See Operating Liquid Settings	
Weight without motor (bare shaft machine) - cast iron / full stainless steel	kg	910 / 965	1025 / 1087
Dimensions (bare shaft machine) – L x W x H	mm	1225 x 800 x 1245	1375 x 800 x 1245

		LR 0420 A	LR 0580 A
Nominal pumping speed range (Dry air)	m <sup>3</sup> /h	2250 / 3830	2900 / 5300
Ultimate pressure	hPa (mbar) abs.	33	
Maximum overpressure	bar(g)	0.2 (consult Busch for pressures outside this range)	
Nominal motor rating	kW	55 / 75 / 110 / 132	75 / 110 / 132 / 185
Nominal pump running speed	min <sup>-1</sup>	500 / 590 / 740 / 790	372 / 472 / 530 / 660
Noise level (EN ISO 2151)	dB(A)	< 85	
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.5 (≤0.18)	
Max. allowable gas inlet temperature	°C	Gas dry ► 120	
		Gas saturated ► 100	
Ambient temperature range	°C	5 ... 40	
Relative humidity	at 30 °C	90%	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See Operating Liquid Settings	
Weight without motor (bare shaft machine) - cast iron / full stainless steel	kg	1572 / 1667	2233 / 2367
Dimensions (bare shaft machine) – L x W x H	mm	1580 x 1010 x 1360	1745 x 1160 x 1570

# 14 EU Declaration of Conformity

This Declaration of Conformity and the CE-markings affixed to the nameplate are valid for the machine within the Busch scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the CE-marking.

The manufacturer **Busch GVT Ltd.**  
**Westmere Drive, Crewe Business Park**  
**Crewe, Cheshire, CW1 6ZD**  
**United Kingdom**

declares that the machine: DOLPHIN LR 0110 A; DOLPHIN LR 0140 A; DOLPHIN LR 0210 A; DOLPHIN LR 0300 A; DOLPHIN LR 0420 A; DOLPHIN LR 0580 A

fulfill(s) all the relevant provisions from EU directives:

- 'Machinery' 2006/42/EC
- 'Electromagnetic Compatibility' (EMS) 2014/30/EU
- 'RoHS' 2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment (incl. all related applicable amendments)

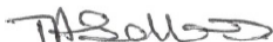
and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

Standards	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
ISO 21940-1 : 2019	Mechanical vibration – Rotor balancing

Legal person authorized to compile the technical file and authorized representative in the EU (if the manufacturer is not located in the EU):

Busch Dienste GmbH  
 Schauinslandstr. 1  
 DE-79689 Maulburg

Crewe, 16.04.2021



**Tracey Sellars, General Director**

# 15 UK Declaration of Conformity

This Declaration of Conformity and the UKCA-markings affixed to the nameplate are valid for the machine within the Busch scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the UKCA-marking.

The manufacturer

**Busch GVT Ltd.**  
**Westmere Drive, Crewe Business Park**  
**Crewe, Cheshire, CW1 6ZD**  
**United Kingdom**

declares that the machine: DOLPHIN LR 0110 A; DOLPHIN LR 0140 A; DOLPHIN LR 0210 A; DOLPHIN LR 0300 A; DOLPHIN LR 0420 A; DOLPHIN LR 0580 A

fulfill(s) all the relevant provisions from UK legislations:

- Supply of Machinery (Safety) Regulations 2008
- Electromagnetic Compatibility Regulations 2016
- Restriction of the use of certain hazardous substances in Electrical and Electronic Equipment Regulations 2021

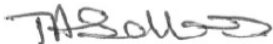
and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

Standards	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
ISO 21940-1 : 2019	Mechanical vibration – Rotor balancing

Legal person authorized to compile the technical file and importer in the UK (if the manufacturer is not located in the UK):

Busch GVT Ltd  
 Westmere Drive, Crewe Business Park  
 Crewe, Cheshire - UK

Crewe, 16.04.2021



**Tracey Sellars, General Director**

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# Notes

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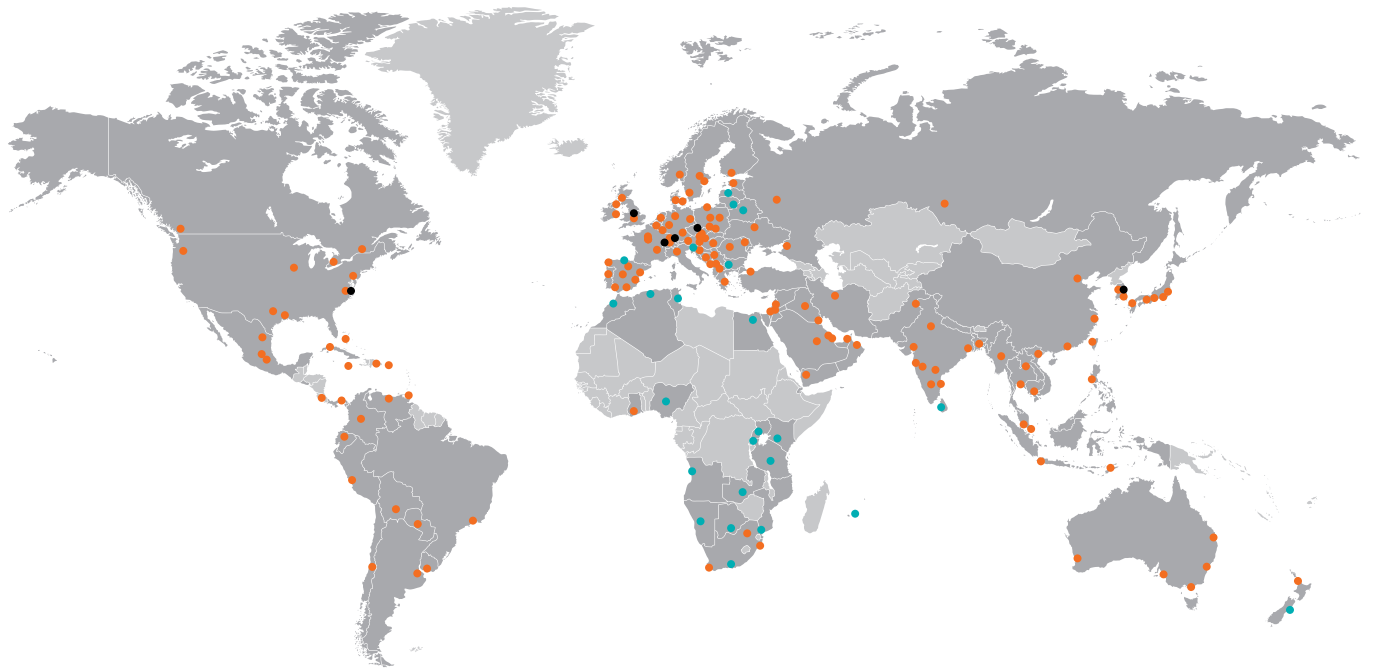




# Busch

## Vacuum Solutions

With a network of over 60 companies in more than 40 countries and agencies worldwide, Busch has a global presence. In every country, highly competent local personnel delivers custom-tailored support backed by a global network of expertise. Wherever you are. Whatever your business. We are there for you.



● Local representatives and distributors    ● Busch companies and Busch employees    ● Busch production site

[www.buschvacuum.com](http://www.buschvacuum.com)