

# DOLPHIN LM/LT

Liquid Ring Vacuum Pumps

LM 0100 A, LM 0180 A, LM 0270 A, LM 0530 A, LM 0800 A,

LT 0130 A, LT 0170 A, LT 0220 A, LT 0320 A, LT 0430 A, LT 0510 A, LT 0630 A, LT 0750 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* [→ 5]. 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.

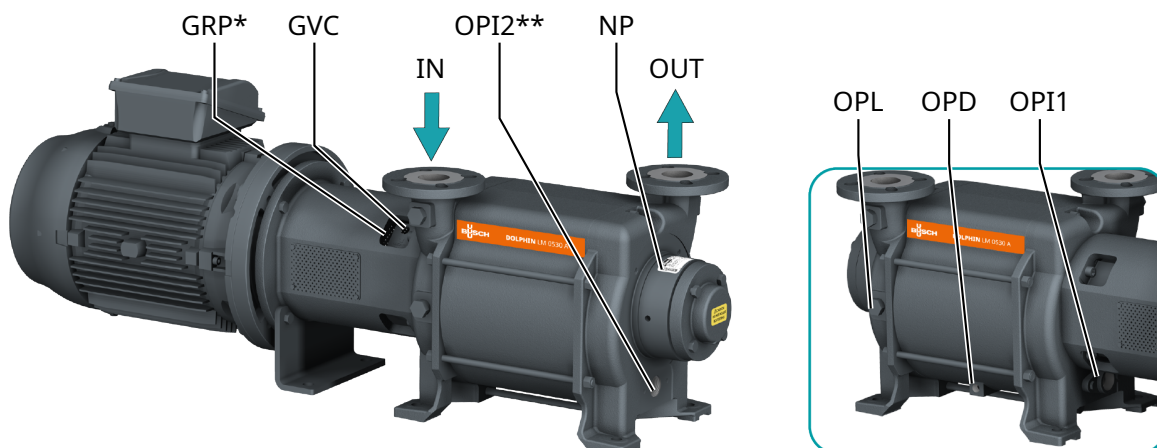


## NOTE

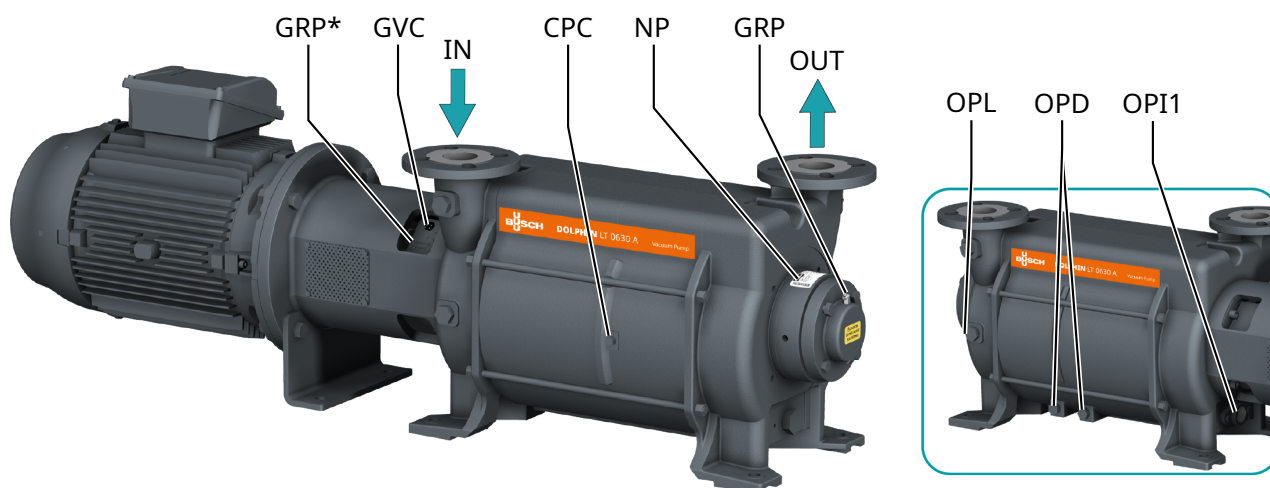
... indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

## 2 Product Description

### DOLPHIN LM 0100-0800 A



### DOLPHIN LT 0130-0750 A



#### Description

CPC	Cavitation protection connection	IN	Suction connection
GRP*	Grease point	GVC	Vacuum gauge or relief valve connection
NP	Nameplate	OPD	Operating liquid drain
OPI	Operating liquid inlet	OPL	Operating liquid level plug
OUT	Discharge connection		

\* GRP available on LM 0800 A, LT 0630 A and LT 0750 A only

\*\* OPI2 required for LM 0270 A, LM 0530 A and LM 0800 A only



### NOTE

Technical term.

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

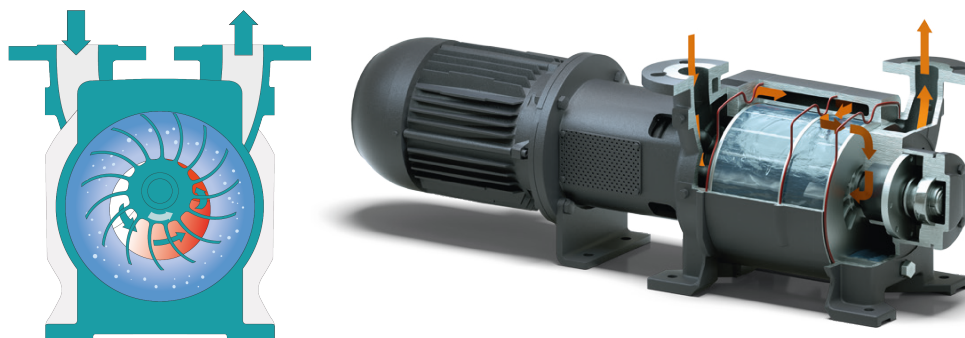


## NOTE

### Illustrations

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

## 2.1 Operating Principle



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.

## 2.2 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 unless a "Ex(outside)" sign is written on the nameplate, in this case please refer to the ATEX supplement for additional safety information.

The machine is capable of maintaining ultimate pressure, see *Technical Data* [→ 30].

The machine is suitable for continuous operation.

Permitted environmental conditions, see *Technical Data* [→ 30].

## 2.3 Start Controls

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

## 2.4 Variants

### 2.4.1 LM Series

DOLPHIN LMs are single-stage vacuum pumps and operate from atmospheric pressure to 130 hPa (mbar) ultimate pressure.

### 2.4.2 LT Series

DOLPHIN LTs are two-stage vacuum pumps and operate from atmospheric pressure to 33 hPa (mbar) ultimate pressure.

### 2.4.3 VL System

VL System consists of a DOLPHIN machine either LM or LT and an operating liquid supply system.

Three different layouts are possible:

- Once through cooling / no recovery.
- Partial recovery (open circuit).
- Total recovery (closed circuit).

All of these arrangements have four basic elements:

- Source of the operating liquid (from the water main or reservoir).
- Regulating device to control flow of liquid.
- Means of stopping the flow when the machine is shut off (manual or with solenoid valve).
- Means of separating the gas-liquid exhaust mixture to prevent the build-up of unnecessary back-pressure.

If the machine is equipped with a VL System (see reference on the nameplate):

- Consult the supplement to the instruction manual of the VL System for additional information.

### 3 Transport

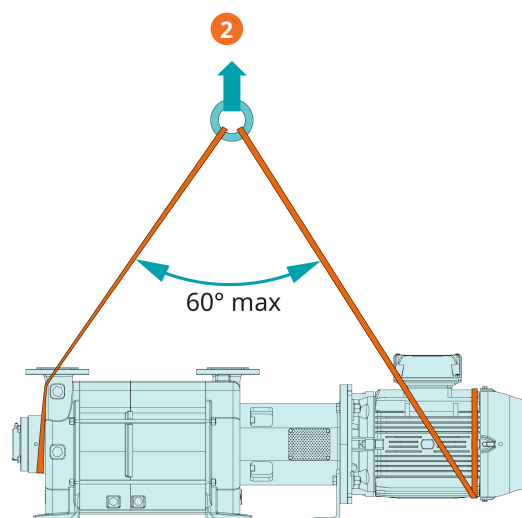
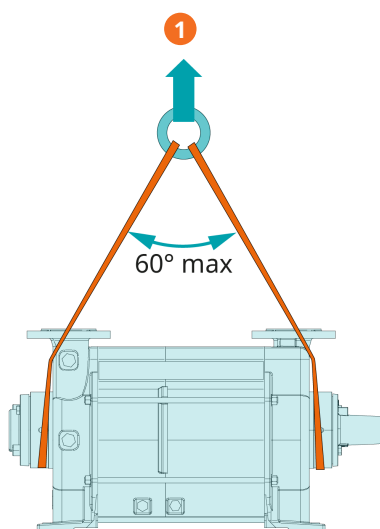


## WARNING

**Suspended load.**

**Risk of severe injury!**

- Do not walk, stand or work under suspended loads.
- To find out the weight of the machine, refer to the chapter *Technical Data* [→ 30] or the nameplate (NP).
- Use appropriate slings.



#### Description

1	DOLPHIN LM or LT without motor (bare shaft pump)	2	DOLPHIN LM or LT with motor
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- Check the machine for transport damage.

If the machine is secured to a base plate:

- Remove the machine from the base plate.

## 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. Pumps containing ferrous materials are preserved using a combined VPI (Vapor Phase Inhibitor) and Contact Inhibitor Oil (Vaporol™ or equivalent) at a recommended concentration of 1 liter per m<sup>3</sup>.

### 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.

### 4.3 Long Term (Over 6 Months)

If the machine is constructed in cast iron material:

- Fill the pump with a liquid preservative (e.g. 'Shell Ensis Fluid') to prevent the machine from corroding.
- 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.

If there is Ex(o) sign written on the nameplate:

- Please refer to the ATEX supplement for additional safety information.
- Make sure that the ambient conditions comply with the *Technical Data* [→ 30].
- Make sure that the environmental conditions comply with the protection class of the motor and the electrical elements.
- 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* [→ 11].
- 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* [→ 14].

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 0.1 mm mesh size) upstream of the machine.

Connection size(s):

- DN40 PN10 (for LM 0100-0270 A and LT 0130-0220 A)
- DN50 PN10 (for LM 0530 A and LT 0320-0510 A)
- DN65 PN10 (for LM 0800 A and LT 0630-0750 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 should not exceed an elevation of more than 600 mm above the discharge flange (OUT) of the machine until the liquid is separated.

Connection size(s):

- DN40 PN10 (for LM 0100-0270 A and LT 0130-0220 A)
- DN50 PN10 (for LM 0530 A and LT 0320-0510 A)
- DN65 PN10 (for LM 0800 A and LT 0630-0750 A)

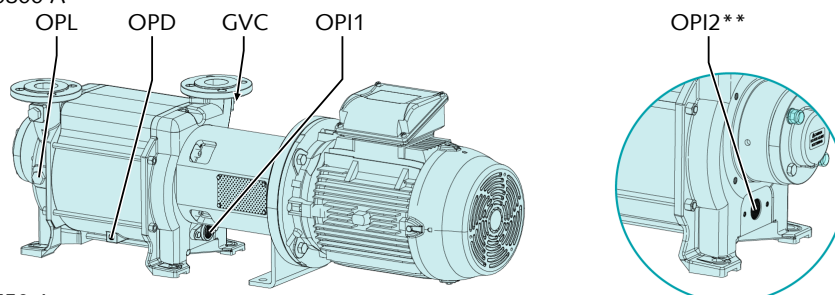
## 5.2.3 Operating Liquid Connection

The machine cannot be operated without an operating liquid system. The following diagrams show examples of typical installations. The actual scope of delivery is always contractually agreed upon.

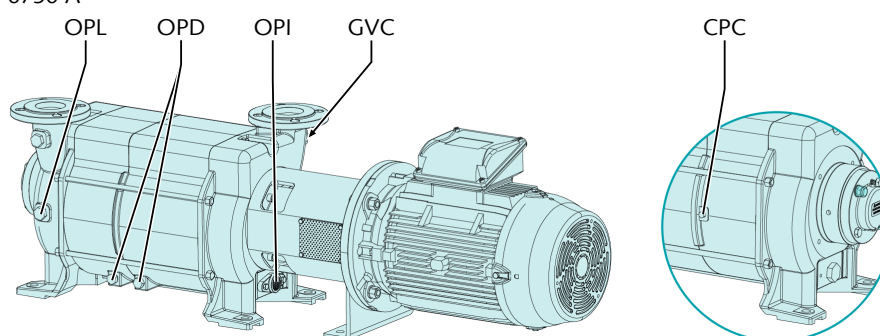
If the machine is equipped with a VL System (see reference on the nameplate):

- Consult the supplement to the instruction manual of the VL System for additional information.

DOLPHIN LM 0100-0800 A



DOLPHIN LT 0130-0750 A



### Description

CPC	Cavitation protection connection	GVC	Vacuum gauge or relief valve connection
OPD	Operating liquid drain	OPI	Operating liquid inlet
OPL	Operating liquid level plug		

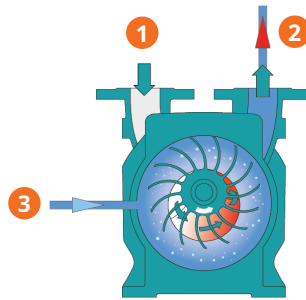
\*\* OPI2 required for LM 0270 A, LM 0530 A and LM 0800 A only

Connection size:

Machine type	OPI1	OPI2	OPD	OPL	CPC	GVC
LM 0100-0180 A	Rc 1/2	N/A	Rc 1/8	Rc 1/4	N/A	Rc 1/4
LM 0270 A	Rc 1/2	Rc 1/2	Rc 1/8	Rc 1/4	N/A	Rc 1/4
LM 0530 A	Rc 1	Rc 1	Rc 1/4	Rc 3/4	N/A	Rc 3/4
LM 0800 A	Rc 1	Rc 1	Rc 1/2	Rc 3/4	N/A	Rc 3/4
LT 0130-0220 A	Rc 1/2	N/A	2 x Rc 1/8	Rc 1/4	Rc 1/8	Rc 1/4
LT 0320-0510 A	Rc 1	N/A	2 x Rc 1/4	Rc 3/4	Rc 1/4	Rc 3/4
LT 0630-0750 A	Rc 1	N/A	2 x Rc 1/2	Rc 3/4	Rc 1/4	Rc 3/4

- Make sure that the operating liquid complies with the requirements, see *Operating Liquid Settings* [→ 13].

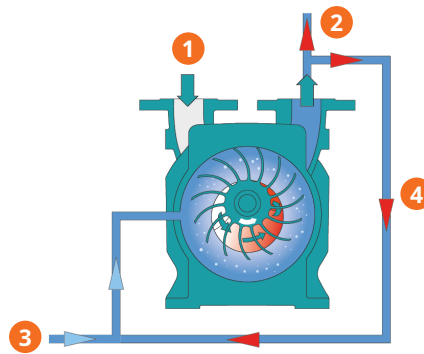
### 5.2.3.1 Once-Through Operation / No recovery



Description			
1	Process inlet (IN)	2	Gas discharge (OUT)
3	Operating liquid inlet (OPI)		

Continuous flow liquid system does not recover the operating liquid which flows out with the discharge gases.

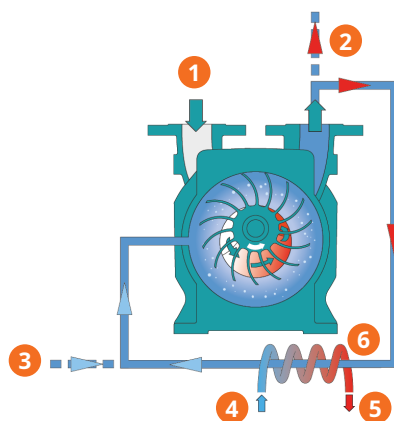
### 5.2.3.2 Partial Recovery (Open Circuit)



Description			
1	Process inlet (IN)	2	Gas discharge (OUT)
3	Operating liquid inlet (OPI)	4	50% of operating liquid liquid recovered

Partial recirculation liquid system reduces the consumption of fresh liquid by recovering and recirculating 50% of the operating liquid.

### 5.2.3.3 Total Recovery (Closed Circuit)



#### Description

1	Process inlet (IN)	2	Gas discharge (OUT)
3	Topping-up operating liquid	4	Cooling water inlet (CWI)
5	Cooling water outlet (CWO)	6	Heat exchange (HE)

Total recirculation liquid system recovers all of the operating liquid which is cooled by a heat exchanger.

The recommended maximum pressure drop across the total recirculation system heat exchanger is 150 mbar on the machine side.

This arrangement provides for total recirculation of the operating liquid. A heat exchanger is added to remove the heat of compression, friction and condensation from the operating liquid before it is reintroduced back into the machine. For prolonged operation at suction pressure above 300 hPa abs (300 mbar abs), a circulating pump is recommended. At suction pressure above 400 hPa abs (400 mbar abs) or when suction pressure varies during cycling operations, a circulating pump is mandatory.

## 5.3 Operating Liquid Settings

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* [→ 21].

Recommended operating liquid settings:

Fresh water flow rate (once through operation only)	m <sup>3</sup> /h	See <i>Technical Data</i> [→ 30]
Water pressure before flow regulation valve (once through operation only)	bar	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	0.1*


\* For all operating systems make sure that no particles with a diameter larger than 0.1mm 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 are recommended for operation outside of the above limits, or where the application is known to corrode cast iron.

## 5.4 Fitting the Coupling

 **WARNING**

**Unprotected coupling.**

**Risk of severe injury!**

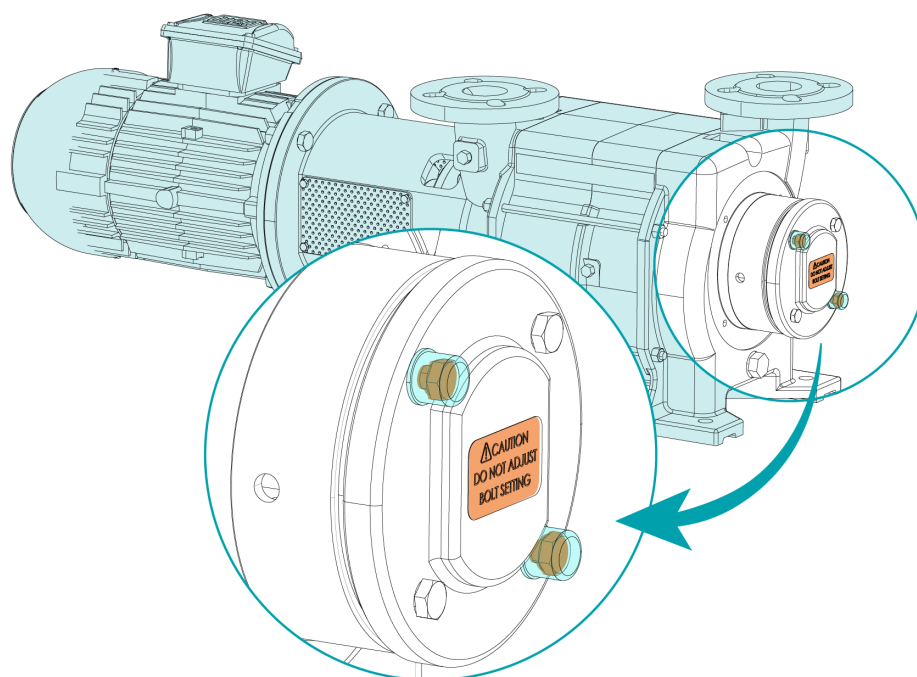
- Make sure that the coupling is protected by a cover or a guard.

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)
LM 0100-0270 A	28
LM 0530-0800 A	38
LT 0130-0220 A	28
LT 0320-0750 A	38

## 5.5 Bolt Setting



By design, two of the bolt heads on the non-drive end bearing cap do not sit flush with the outer surface. This is normal for this machine type and the bolt heads are covered with plastic caps.



### CAUTION

**Bolt heads with plastic caps.**

**Risk of damage to the machine!**

- Do not adjust these bolts setting otherwise the shaft will move and the machine could seize.

## 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.



### NOTE

The operation with variable speed, i.e. with a variable speed drive or a soft starter unit, is allowed as long as the motor is capable and the permitted motor speed range is respected (see *Technical Data* [→ 30]).

Seek advice from your Busch representative.



- 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.



## NOTICE

**Incorrect connection.**

**Risk of damage to the motor!**

- The wiring diagrams given below are typical. Check the inside of the terminal box for motor connection instructions/diagrams.

## 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.

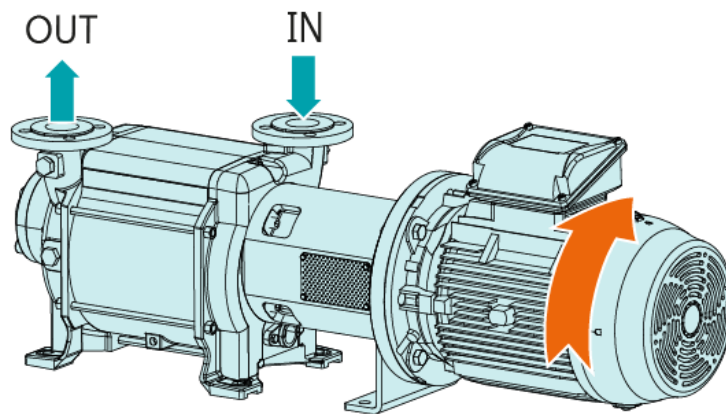
### NOTICE

**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:

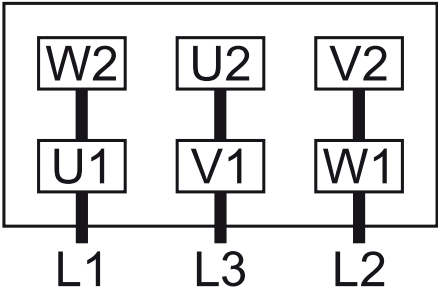


- Watch the fan wheel of the motor and determine the direction of rotation just before the fan wheel stops.

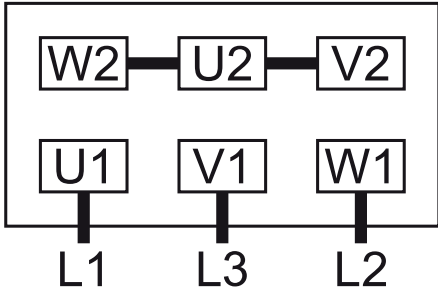
If the rotation of the motor must be changed:

- Switch any two of the motor phase wires.

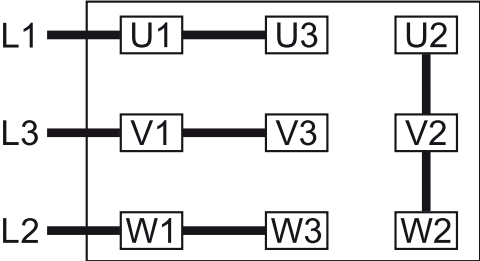
Delta connection (low voltage):



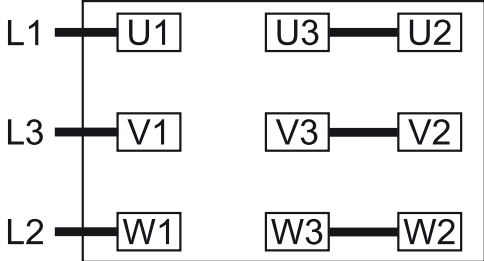
Star connection (high voltage):



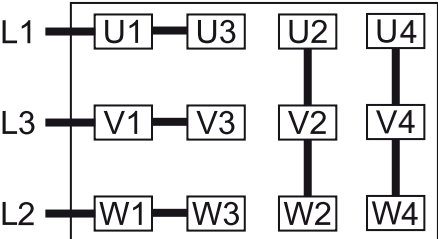
Double star connection, multi-voltage motor with 9 pins (low voltage):



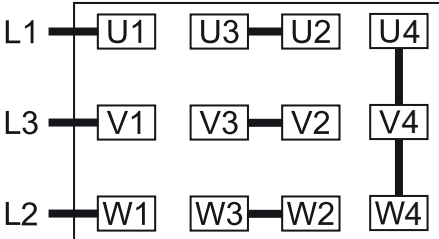
Star connection, multi-voltage motor with 9 pins (high voltage):



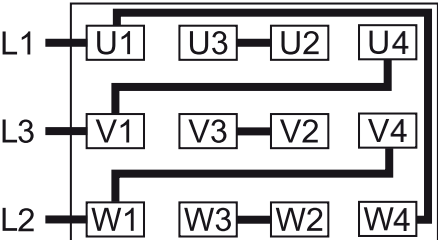
Double star connection, multi-voltage motor with 12 pins (low voltage):



Star connection, multi-voltage motor with 12 pins (high voltage):



Delta connection, multi-voltage motor with 12 pins (middle voltage):



## 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 liquid system must be connected and open.

- Make sure that the installation conditions (see *Installation Conditions* [→ 9]) 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
- Switch on the machine.
- Make sure that the maximum permissible number of starts does not exceed 12 starts per hour. Those starts should be spread within the hour.

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* [→ 30].

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.

## 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> [→ 11].</li> <li>• Check the machine for liquid leaks - in case of leaks have the machine repaired (contact Busch).</li> </ul>
Every 1000 operating hours*	<ul style="list-style-type: none"> <li>• Regrease the bearings (add 15g of lithium based grease NLGI class 2 to each bearing).</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> </ul> <p>If an inlet screen 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>

\* For DOLPHIN LM 0800 A, LT 0630-0750 A only. Smaller DOLPHIN LM/LT use bearings which are greased for life.

## 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: LM 0100 A LM 0180 A LM 0270 A LT 0130 A LT 0170 A LT 0220 A	Intended for standard applications 2x bearing ball 2x o-ring (Viton) 2x mechanical seal 1x locknut M30	0993 700 057
Service kit for: LM 0100 A LM 0180 A LM 0270 A LT 0130 A LT 0170 A LT 0220 A	Intended for chemical applications 2x bearing ball 2x o-ring (PTFE/Viton) 2x mechanical seal (Chemraz®) 1x locknut M30	0993 700 058
Service kit for: LM 0530 A	Intended for standard applications 2x bearing ball 2x o-ring (Viton) 1x flat seal washer (nitrile) 2x mechanical seal 1x locknut M40	0993 700 078
Service kit for: LT 0320 A LT 0430 A LT 0510 A	Intended for standard applications 2x bearing ball 2x o-ring (Viton) 1x flat seal washer (nitrile) 2x mechanical seal 1x locknut M40	0993 700 059
Service kit for: LM 0530 A	Intended for chemical applications 2x bearing ball 2x o-ring (PTFE/Viton) 1x flat seal washer (PTFE) 2x mechanical seal (Chemraz®) 1x locknut M40	0993 700 079
Service kit for: LT 0320 A LT 0430 A LT 0510 A	Intended for chemical applications 2x bearing ball 2x o-ring (PTFE/Viton) 1x flat seal washer (PTFE) 2x mechanical seal (Chemraz®) 1x locknut M40	0993 700 060

Spare parts kit	Description	Part no.
Service kit for: LM 0800 A LT 0630 A LT 0750 A	Intended for standard applications 1x bearing spherical roller 1x bearing spherical roller with adaptor sleeve 2x o-ring (Viton) 1x flat seal washer (nitrile) 2x mechanical seal 1x locknut M45 3x oil seal	0993 700 061
Service kit for: LM 0800 A LT 0630 A LT 0750 A	Intended for chemical applications 1x bearing spherical roller 1x bearing spherical roller with adaptor sleeve 2x o-ring (PTFE/Viton) 1x flat seal washer (PTFE) 2x mechanical seal (Chemraz®) 1x locknut M45 3x oil seal	0993 700 062

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>
The machine does not reach the usual pressure on the suction connection.	Suction or discharge lines too long or section diameter too small.	<ul style="list-style-type: none"> <li>• Use larger diameter or shorter lines.</li> <li>• Seek advice from your local Busch representative.</li> </ul>
	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)	<ul style="list-style-type: none"> <li>• Reduce the temperature of the operating liquid or adjust the flow of operating liquid.</li> </ul>
	The mechanical seal leaks.	<ul style="list-style-type: none"> <li>• Repair the machine (contact Busch).</li> </ul>
	Partial clogging in the suction, discharge or pressure line.	<ul style="list-style-type: none"> <li>• Remove the blockage.</li> </ul>
	If an inlet screen is installed, it can be partially clogged.	<ul style="list-style-type: none"> <li>• Clean the inlet screen.</li> </ul>
	Internal parts are worn or damaged.	<ul style="list-style-type: none"> <li>• Repair the machine (contact Busch).</li> </ul>

Problem	Possible Cause	Remedy
<p>The machine runs very noisily or rattles.</p>	<p>The operating liquid level is too high.</p>	<ul style="list-style-type: none"> <li>Adjust the regulating valves to drain the pump down to center line.</li> </ul>
	<p>Density or viscosity of the operating liquid too high.</p>	<ul style="list-style-type: none"> <li>Check <i>Operating Liquid Settings</i> [→ 13].</li> <li>Provide a different operating liquid or a stronger drive motor.</li> </ul>
	<p>The machine runs in the wrong direction.</p>	<ul style="list-style-type: none"> <li>Check the direction of rotation, see <i>Wiring Diagram Three-Phase Motor</i> [→ 18].</li> </ul>
	<p>Defective bearings.</p>	<ul style="list-style-type: none"> <li>Repair the machine (contact Busch).</li> </ul>
	<p>The vacuum pump cavitates (periodic formation and collapsing of steam bubbles in the operating liquid).</p>	<ul style="list-style-type: none"> <li>Consult the chapter <i>Preventing Cavitation</i> [→ 21].</li> <li>Adjust cooling liquid flow rate to reduce the temperature of the operation liquid.</li> </ul>
	<p>Worn coupling element.</p>	<ul style="list-style-type: none"> <li>Check the coupling and repair it if necessary.</li> </ul>
<p>The machine runs too hot.</p>	<p>Insufficient air ventilation.</p>	<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>
	<p>Ambient temperature too high.</p>	<ul style="list-style-type: none"> <li>Observe the permitted ambient temperature, see <i>Technical Data</i> [→ 30].</li> </ul>
	<p>Temperature of the process gases at the inlet too high.</p>	<ul style="list-style-type: none"> <li>Observe the permitted gas inlet temperature, see <i>Technical Data</i> [→ 30].</li> </ul>
	<p>Insufficient gas transfer.</p>	<ul style="list-style-type: none"> <li>Introduce a suitable inert gas or air via the anti-cavitation connection.</li> </ul>
	<p>Partial blockage in the suction, discharge or pressure line.</p>	<ul style="list-style-type: none"> <li>Remove the blockage.</li> </ul>

# 13 Technical Data

		LM 0100 A	LM 0180 A	LM 0270 A
Pumping speed (50Hz / 60Hz)	m <sup>3</sup> /h	82 / 98	144 / 180	220 / 267
Ultimate pressure (50Hz / 60Hz)	hPa (mbar) abs.	130 / 130		
Maximum overpressure (50Hz / 60Hz)	bar(g)	0.8 / 0.8	1.5 / 1.5	1.5 / 1.5
Nominal motor rating IEC (50Hz / 60Hz)	kW	2.2 / 3.0	4.0 / 5.5	5.5 / 7.5
Nominal motor speed (50Hz / 60Hz)	min <sup>-1</sup>	1450 / 1750		
Permitted motor speed range	min <sup>-1</sup>	1000 ... 1750 (~34 ... 60 Hz)		
Noise level (EN ISO 2151) (50Hz / 60Hz)	dB(A)	≤70 / ≤71		
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.0 (≤0.16)		
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)	m <sup>3</sup> /h	130 mbar ▶ 0.8	130 mbar ▶ 0.8	130 mbar ▶ 1.8
		400 mbar ▶ 0.7	400 mbar ▶ 0.7	400 mbar ▶ 1.6
		800 mbar ▶ 0.4	800 mbar ▶ 0.4	800 mbar ▶ 0.7
Weight without motor (bare shaft machine) Cast iron / full stainless steel	kg	56 / 59	63 / 67	68 / 72
Weight with motor 50 Hz Europe motor / 50 & 60 Hz multi-voltage	kg	110 / 124	122 / 151	157 / 166

		LM 0530 A	LM 0800 A
Pumping speed (50Hz / 60Hz)	m <sup>3</sup> /h	440 / 556	722 / 867
Ultimate pressure (50Hz / 60Hz)	hPa (mbar) abs.	130 / 130	
Maximum overpressure (50Hz / 60Hz)	bar(g)	1.5 / 1.5	1.5 / 1.5
Nominal motor rating (50Hz / 60Hz)	kW	11.0 / 15.0	18.5 / 22.0
Nominal motor speed (50Hz / 60Hz)	min <sup>-1</sup>	1450 / 1750	
Permitted motor speed range	min <sup>-1</sup>	1000 ... 1750 (~34 ... 60 Hz)	
Noise level (EN ISO 2151) (50Hz / 60Hz)	dB(A)	≤72 / ≤73	≤75 / ≤76
Vibration velocity - unfiltered (RMS)	mm/s (in/s)	≤4.0 (≤0.16)	
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)	m <sup>3</sup> /h	130 mbar ▶ 2.8	130 mbar ▶ 4.0
		400 mbar ▶ 2.0	400 mbar ▶ 3.4
		800 mbar ▶ 1.6	800 mbar ▶ 2.0
Weight without motor (bare shaft machine) Cast iron / full stainless steel	kg	164 / 174	178 / 189
Weight with motor 50 Hz Europe motor / 50 & 60 Hz multi-voltage	kg	317 / 337	340 / 357

		LT 0130 A	LT 0170 A	LT 0220 A
Pumping speed (50Hz / 60Hz)	m <sup>3</sup> /h	105 / 128	144 / 165	203 / 232
Ultimate pressure (50Hz / 60Hz)	hPa (mbar) abs.	33 / 33		
Maximum overpressure (50Hz / 60Hz)	bar(g)	1.5 / 1.5	1.5 / 1.5	1.2 / 1.2
Nominal motor rating (50Hz / 60Hz)	kW	3.0 / 4.0	4.0 / 5.5	5.5 / 7.5
Nominal motor speed (50Hz / 60Hz)	min <sup>-1</sup>	1450 / 1750		
Permitted motor speed range	min <sup>-1</sup>	1000 ... 1750 (~34 ... 60 Hz)		
Noise level (EN ISO 2151) (50Hz / 60Hz)	dB(A)	≤70 / ≤71		
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.0 (≤0.16)		
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)	m <sup>3</sup> /h	33 mbar ▶	33 mbar ▶	33 mbar ▶
		1.0	1.0	1.4
		400 mbar ▶	400 mbar ▶	400 mbar ▶
		0.8	0.8	1.1
800 mbar ▶	800 mbar ▶	800 mbar ▶		
0.7	0.7	0.9		
Weight without motor (bare shaft machine) Cast iron / full stainless steel	kg	73.5 / 78	77 / 82	86 / 91
Weight with motor 50 Hz Europe motor / 50 & 60 Hz multi-voltage	kg	139 / 153	149 / 178	188 / 197



		LT 0320 A	LT 0430 A	LT 0510 A
Pumping speed (50Hz / 60Hz)	m <sup>3</sup> /h	265 / 320	361 / 426	430 / 510
Ultimate pressure (50Hz / 60Hz)	hPa (mbar) abs.	33 / 33		
Maximum overpressure (50Hz / 60Hz)	bar(g)	1.5 / 1.5	1.5 / 1.3	1.1 / 1.1
Nominal motor rating (50Hz / 60Hz)	kW	7.5 / 11.0	11.0 / 15.0	11.0 / 15.0
Nominal motor speed (50Hz / 60Hz)	min <sup>-1</sup>	1450 / 1750		
Permitted motor speed range	min <sup>-1</sup>	1000 ... 1750 (~34 ... 60 Hz)		
Noise level (EN ISO 2151) (50Hz / 60Hz)	dB(A)	≤72 / ≤73		
Vibration velocity - unfiltered (RMS)	mm/s (in/s)	≤4.0 (≤0.16)		
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)	m <sup>3</sup> /h	33 mbar ▶	33 mbar ▶	33 mbar ▶
		3.0	3.0	3.0
		400 mbar ▶	400 mbar ▶	400 mbar ▶
		1.3	1.6	2.1
800 mbar ▶	800 mbar ▶	800 mbar ▶		
0.8	1.0	1.1		
Weight without motor (bare shaft machine) Cast iron / full stainless steel	kg	144 / 153	154 / 163	184 / 195
Weight with motor 50 Hz Europe motor / 50 & 60 Hz multi-voltage	kg	242 / 299	294 / 314	324 / 344

		LT 0630 A	LT 0750 A
Pumping speed (50Hz / 60Hz)	m <sup>3</sup> /h	500 / 578	617 / 710
Ultimate pressure (50Hz / 60Hz)	hPa (mbar) abs.	33 / 33	
Maximum overpressure (50Hz / 60Hz)	bar(g)	2.0 / 2.0	2.0 / 2.0
Nominal motor rating (50Hz / 60Hz)	kW	15 / 22	18.5 / 30
Nominal motor speed (50Hz / 60Hz)	min <sup>-1</sup>	1450 / 1750	
Permitted motor speed range	min <sup>-1</sup>	1000 ... 1750 (~34 ... 60 Hz)	
Noise level (EN ISO 2151) (50Hz / 60Hz)	dB(A)	≤75 / ≤76	
Vibration velocity – unfiltered (RMS)	mm/s (in/s)	≤4.0 (≤0.16)	
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)	m <sup>3</sup> /h	33 mbar ▶ 3.0	33 mbar ▶ 3.0
		400 mbar ▶ 1.8	400 mbar ▶ 1.6
		800 mbar ▶ 1.4	800 mbar ▶ 1.3
Weight without motor (bare shaft machine) Cast iron / full stainless steel	kg	207 / 219	223 / 236
Weight with motor 50 Hz Europe motor / 50 & 60 Hz multi-voltage	kg	389 / 439	430 / 447

# 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 LM 0100 A; DOLPHIN LM 0180 A; DOLPHIN LM 0270 A; DOLPHIN LM 0530 A; DOLPHIN LM 0800 A; DOLPHIN LT 0130 A; DOLPHIN LT 0170 A; DOLPHIN LT 0220 A; DOLPHIN LT 0320 A; DOLPHIN LT 0430 A; DOLPHIN LT 0510 A; DOLPHIN LT 0630 A; DOLPHIN LT 0750 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)

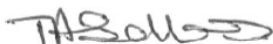
and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

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 LM 0100 A; DOLPHIN LM 0180 A; DOLPHIN LM 0270 A; DOLPHIN LM 0530 A; DOLPHIN LM 0800 A; DOLPHIN LT 0130 A; DOLPHIN LT 0170 A; DOLPHIN LT 0220 A; DOLPHIN LT 0320 A; DOLPHIN LT 0430 A; DOLPHIN LT 0510 A; DOLPHIN LT 0630 A; DOLPHIN LT 0750 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

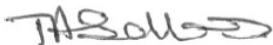
and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

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

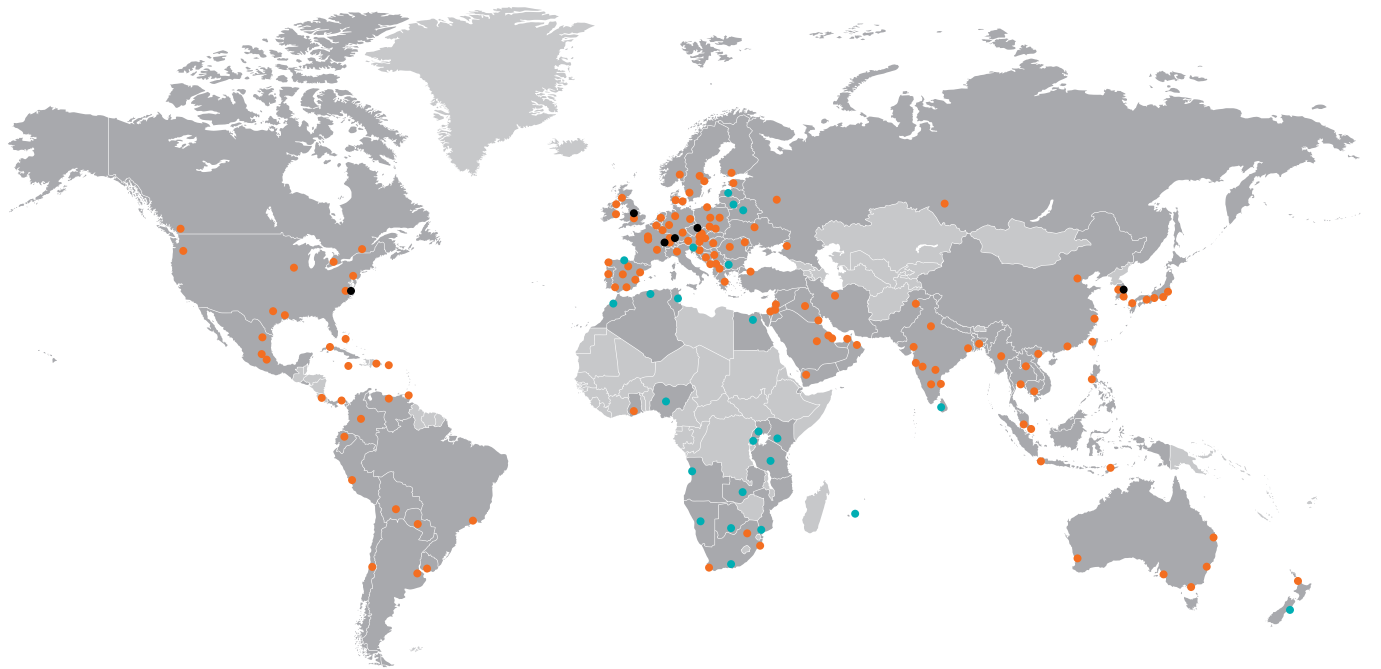
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# Busch Vacuum Solutions

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)