



VACUUM SOLUTIONS

Part of the **BUSCH** GROUP

DOLPHIN LG/LR

Liquid Ring Vacuum Pumps

LG 0890 A, LG 1200 A, LG 1910 A, LG 2680 A

LR 0700 A, LR 1190 A, LR 1560 A, LR 2200 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 manufacturer representative.

Read this instruction 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 in accordance with the state-of-the-art methods. Nevertheless, residual risks may remain, as described in the following chapters and in accordance with the chapter *Intended Use* [→ 7].

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

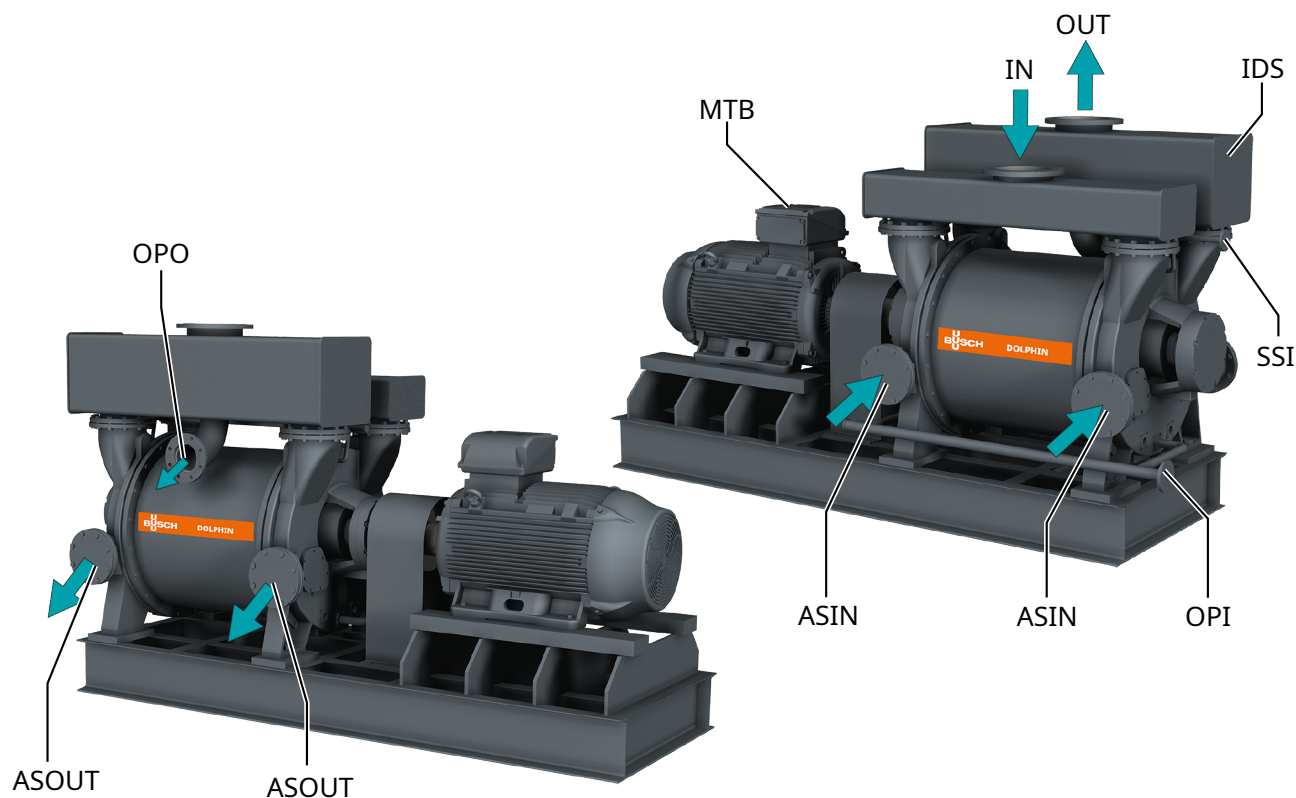
... indicates a potentially dangerous situation that could result in damage to property.



NOTE

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

2 Product Description



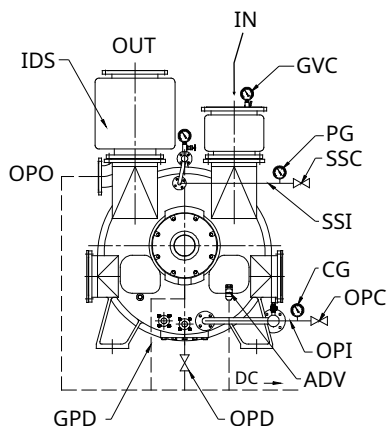
Description			
IN	Inlet connection	OUT	Discharge connection
ASIN	Alternative side inlet connections*	ASOUT	Alternative side discharge connection**
IDS	Integral discharge separator	MTB	Motor terminal box
OPI	Operating liquid inlet	OPO	Operating liquid outlet
SSI	Shaft seal flushing inlet***		

* No manifold, both connections to be used.

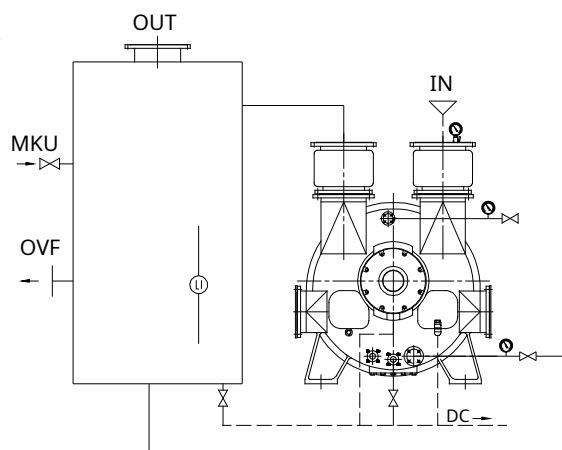
** For installations where gas and liquid are discharged to open gutter, both connections open.

*** Supplied only when no internal flushing.

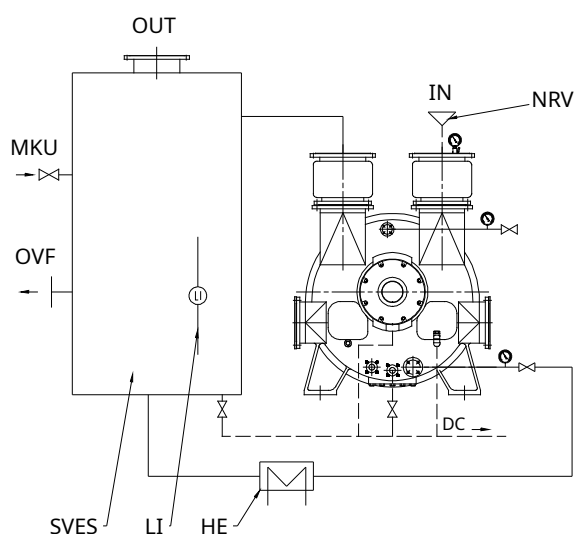
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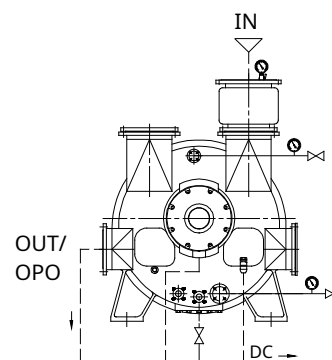
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3



4



Description

IN	Inlet connection	OUT	Discharge connection
ADV	Automatic drain valve	CG	Compound pressure gauge
DC	Drain connection	GPD	Gland packing drain
GVC	Vacuum gauge	HE	Heat exchanger
IDS	Integral discharge separator	LI	Level indicator
MKU	Makeup	NRV	Non-return valve
OPC	Operating liquid control	OPD	Operating liquid control valve
OPI	Operating liquid inlet	OPO	Operating liquid outlet
OVF	Overflow	PG	Pressure gauge
SSC	Shaft seal flushing control	SSI	Shaft seal flushing inlet
SVES	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 appearance of the machine.

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 operating liquid is recirculated in the system as shown in figure 3, then a heat exchanger should be used for cooling the liquid.
- Figure 4 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 operating 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!

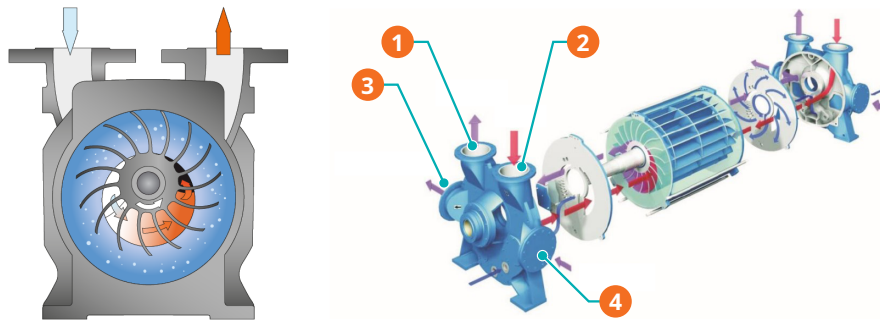
- The drained liquid should be separated twice and transferred to a safe place when applying the figure 1 arrangement. Particular care should be taken to avoid any leakage of dangerous gases from the water drain outlet.

**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	Standard top outlet flange	2	Standard top inlet flange
3	Alternative side outlet flange	4	Alternative side 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 liquid, 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 damage to the machine!

Risk of damage 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 "Ex(inside)" is displayed on the nameplate), refer to the ATEX supplement for additional safety information about 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 the manufacturer.

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

2.5 Variants

2.5.1 LG Series

DOLPHIN LG's are single-stage vacuum pumps and operate from atmospheric pressure to 160 hPa (mbar) ultimate pressure.

2.5.2 LR Series

DOLPHIN LR's are single-stage vacuum pumps and operate from atmospheric pressure to 33 hPa (mbar) ultimate pressure.

3 Transport and Handling

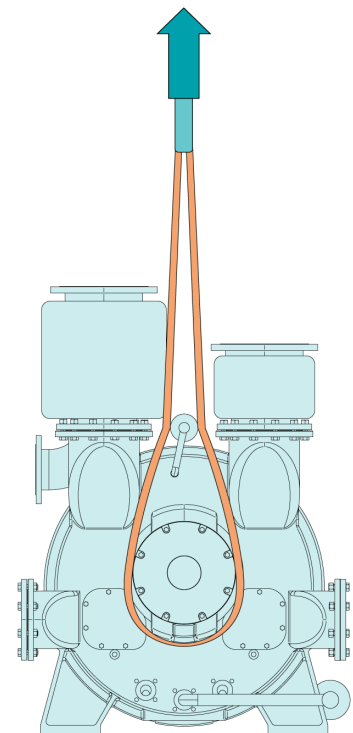
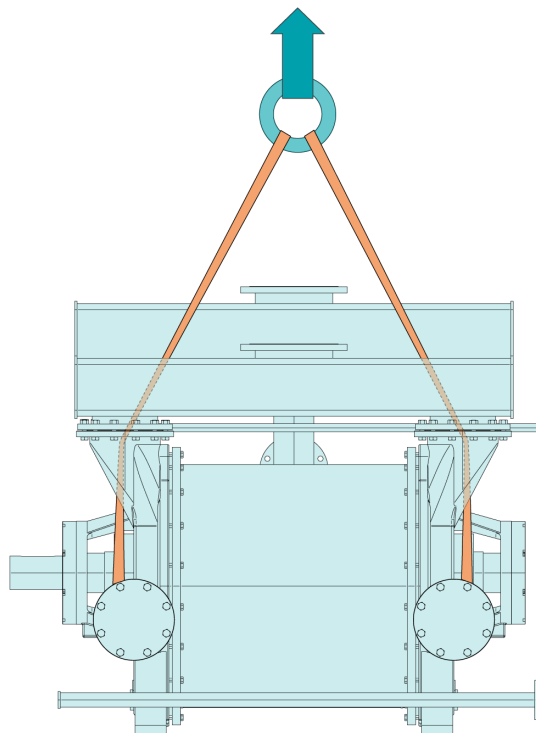


WARNING

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 vacuum pump.
-
- To find out the weight of the machine, refer to the chapter *Technical Data* [→ 32] or the name plate (NP).
 - Use appropriate slings.



- Generally, the lifting point should be on the base plate on which the machine is installed.
- The lifting point of a bare shaft vacuum pump is shown above.
- Check that the machine has not been damaged during transport.

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 motor fan cowl 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 vapor phase inhibitor and contact inhibitor oil at a recommended concentration of 1 liter per m³ 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 motor fan cowl 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!

- Make sure that the installation conditions are fully respected.
-
- 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* [→ 13].
 - 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 manufacturer representative, the motor must be derated or the ambient temperature limited.

5.2 Connecting Lines / Pipes

- Remove all protective covers before installation.
- Make sure that the diameter of the connecting lines over the entire length is at least as large as the connections of the machine.

In case of long connecting lines:

- Use larger diameters to avoid a loss of efficiency.
- Contact your manufacturer representative for more information.

5.2.1 Inlet 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 0.4 mm mesh size) upstream of the machine.

Connection size(s):

- DN300 PN10 (for LG 0890 A and LR 0700 A)
- DN350 PN10 (for LG 1200 A and LR 1190 A)
- DN400 PN10 (for LG 1910 A and LR 1560 A)
- DN500 PN10 (for LG 2680 A and LR 2200 A)

5.2.2 Discharge Connection

NOTICE

Discharge gas flow obstructed.

Risk of damage to the machine!

- Make sure that the discharge 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 motor overload!

- The discharge pipe 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.

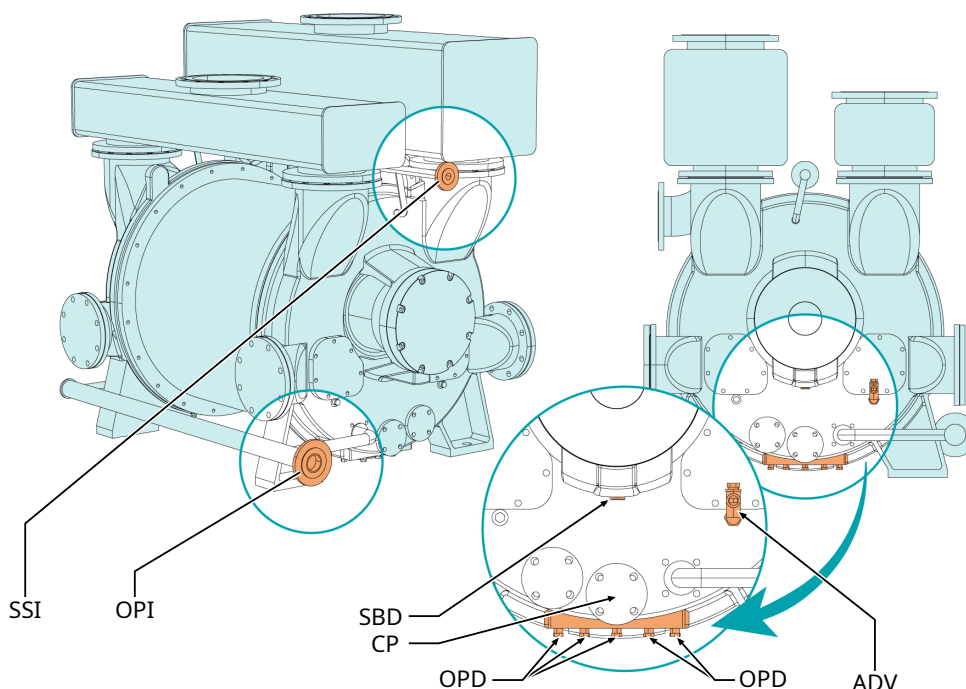
Connection size(s):

- DN300 PN10 (for LG 0890 A and LR 0700 A)
- DN350 PN10 (for LG 1200 A and LR 1190 A)
- DN400 PN10 (for LG 1910 A and LR 1560 A)
- DN500 PN10 (for LG 2680 A and LR 2200 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.



Description

ADV	Automatic drain valve	CP	Cleaning port
OPD	Operating liquid drain	OPI	Operating liquid inlet
SBD	Stuffing box drain	SSI	Shaft seal flushing inlet

Connection sizes:

Machine type	OPI	SSI	CP	SBD	ADV	OPD
LG 0890 A	DN 50 PN 10	DN 25 PN 10	G1½"	G¾"	G1"	G¾"
LG 1200 A	DN 65 PN 10	DN 25 PN 10	G1½"	G¾"	G1"	G¾"
LG 1910 A	DN 80 PN 10	DN 25 PN 10	G2"	G¾"	G1"	G¾"
LG 2680 A	DN 80 PN 10	DN 25 PN 10	G2½"	G¾"	G1"	G¾"
LR 0700 A	DN 50 PN 10	DN 20 PN 10	G1½"	G¾"	G1"	G¾"
LR 1190 A	DN 65 PN 10	DN 25 PN 10	G1½"	G¾"	G1"	G¾"
LR 1560 A	DN 80 PN 10	DN 25 PN 10	G2"	G¾"	G1"	G¾"
LR 2200 A	DN 80 PN 10	DN 25 PN 10	G2½"	G¾"	G1"	G¾"

- Make sure that the operating liquid complies with the requirements.
 - See *Operating Liquid Settings* [→ 14].

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 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:

LG 0890 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
490	16.60 - 17.50	14.70 - 16.60	10.80 - 14.70	7.50 - 10.80
472	16.00 - 17.00	14.20 - 16.00	10.30 - 14.20	6.70 - 10.30
420	14.50 - 15.00	12.60 - 14.50	9.20 - 12.60	5.90 - 9.20
372	12.80 - 13.50	11.20 - 12.50	8.10 - 11.20	5.30 - 8.10
330	11.50 - 12.00	9.90 - 11.50	7.20 - 9.90	4.70 - 7.20

LG 1200 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
420	23.50 - 24.10	20.50 - 23.50	15.00 - 20.50	9.60 - 15.00
372	20.50 - 21.30	18.20 - 20.50	13.30 - 18.20	8.50 - 13.30
330	18.50 - 18.90	16.10 - 18.50	11.80 - 16.10	7.50 - 11.80
298	16.50 - 17.10	14.50 - 16.50	10.60 - 14.50	6.80 - 10.60
266	14.50 - 15.30	13.00 - 14.90	9.50 - 13.00	6.10 - 9.50

LG 1910 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
398	37.00 - 38.00	37.50 - 31.90	23.30 - 31.90	15.00 - 23.30
372	34.50 - 35.50	29.80 - 35.00	21.80 - 29.80	14.00 - 21.80
330	30.50 - 31.50	26.40 - 31.00	19.30 - 26.40	12.40 - 19.30
298	27.50 - 28.50	23.90 - 27.50	17.50 - 23.90	11.20 - 17.50
266	24.50 - 25.50	21.30 - 25.00	15.60 - 21.30	10.00 - 15.60
236	21.50 - 22.50	18.90 - 22.20	13.80 - 18.90	8.90 - 13.80

LG 2680 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h

LG 2680 A				
330	50.00 - 52.00	44.20 - 51.80	32.30 - 44.20	20.70 - 32.30
298	45.00 - 46.00	39.90 - 46.80	29.20 - 39.90	18.70 - 29.20
266	40.00 - 43.00	35.60 - 41.80	26.10 - 35.60	16.70 - 26.10
236	36.00 - 38.00	31.60 - 37.10	23.10 - 31.60	14.80 - 23.10
210	32.00 - 34.00	28.10 - 33.00	20.60 - 28.10	13.20 - 20.60
197	30.00 - 32.00	26.30 - 28.30	19.00 - 26.30	12.00 - 19.00

LR 0700 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
490	19.00 - 20.00	15.50 - 16.50	13.00 - 14.00	6.50 - 7.50
472	17.50 - 18.50	14.00 - 15.00	11.50 - 12.50	5.50 - 6.50
420	15.50 - 16.50	12.50 - 13.50	10.00 - 11.00	5.00 - 6.00
372	13.50 - 14.50	11.00 - 12.00	9.00 - 10.00	4.50 - 5.50
330	12.00 - 13.00	9.50 - 10.50	8.00 - 9.00	4.00 - 5.00

LR 1190 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
472	22.10 - 22.60	19.20 - 22.10	14.10 - 19.20	9.00 - 14.10
420	19.60 - 20.10	17.10 - 19.60	12.50 - 17.10	7.90 - 12.50
372	17.10 - 17.80	15.20 - 17.10	11.10 - 15.20	7.10 - 11.70
330	15.40 - 15.80	13.40 - 15.40	9.90 - 13.40	5.90 - 9.90
298	13.80 - 14.20	12.10 - 13.80	8.90 - 12.10	5.70 - 8.90
266	12.40 - 12.80	10.90 - 12.40	7.90 - 10.90	5.10 - 7.90

LR 1560 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
398	30.80 - 31.70	26.60 - 30.80	19.40 - 26.60	12.50 - 19.40
372	28.70 - 29.60	24.90 - 28.70	18.10 - 24.90	11.70 - 18.10
330	25.40 - 26.30	22.00 - 25.40	16.00 - 22.00	10.30 - 16.00
298	22.90 - 23.70	19.90 - 22.50	14.00 - 19.90	9.40 - 17.50
266	20.40 - 21.20	17.70 - 21.20	13.00 - 17.70	8.30 - 13.00
236	17.90 - 18.70	15.80 - 17.90	11.50 - 15.80	7.40 - 11.50

LR 2200 A				
Speed r/min	< 200 mbar m³/h	200 - 400 mbar m³/h	400 - 600 mbar m³/h	> 600 mbar m³/h
330	41.20 - 42.80	36.40 - 42.70	26.60 - 36.40	17.10 - 26.60
298	37.10 - 37.90	37.10 - 38.50	24.10 - 32.90	15.40 - 24.10
266	33.00 - 35.40	29.30 - 34.00	21.50 - 29.30	13.70 - 21.50
236	29.70 - 31.30	26.00 - 30.60	19.10 - 26.00	12.20 - 19.10
210	26.40 - 28.00	23.20 - 27.20	17.00 - 23.20	10.90 - 17.00

Water pressure before flow regulating valve (once through operation only)	bar(g)	1
Max. allowable supply temperature	°C	80
Max. allowable kinematic viscosity	mm ² /s	20 <i>Consider the motor power for anything other than water - consult Busch.</i>
Max. allowable particle size	mm	0.4*

* For all operating systems make sure that no particles with a diameter larger than 0.4 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)
LG 0890 A & LR 0700 A	140
LG 1200 A & LR 1190 A	160
LG 1910 A & LR 1560 A	180
LG 2680 A & LR 2200 A	200

6 Electrical Connection



DANGER

Live wires.

Risk of electrical shock!

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

INSTALLATION(S) CURRENT PROTECTION:



DANGER

Missing current protection.

Risk of electrical shock!

- Provide current protection in accordance with EN 60204-1 on your installation(s).
- 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 electromagnetic disturbance from the mains. If necessary, contact your Busch representative for more information.
- 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* [→ 36] or *UK Declaration of Conformity* [→ 37]).

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 name plate of the motor.
- If the machine is equipped with a power connector, install a residual current protective device to protect persons in case of a defective insulation.
 - 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 a defective insulation.
 - 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 below are examples only. Refer to the connection instructions and diagrams of the variable speed drive.

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.

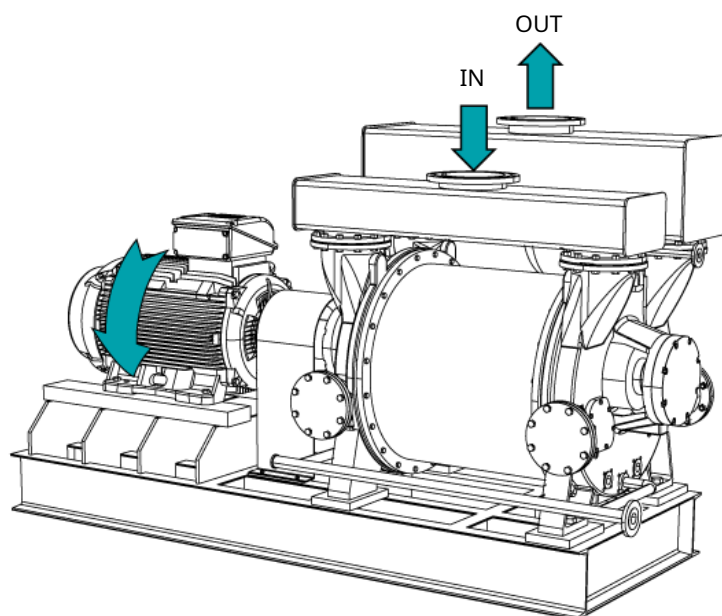
NOTICE

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

In operation, the surface of the machine may reach temperatures over 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 0.4 mm mesh size) during commissioning.

- Make sure that the *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 starting 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 purposes.
- 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.
- Start 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:

- Switch 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 used under normal operating conditions:

- Measure the motor current and record it as reference for future maintenance and troubleshooting 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 45 to 60 drips per minute.

7.1 Preventing Cavitation



NOTICE

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 inlet line!

The vapor pressure of the operating liquid and consequently the ultimate pressure can be reduced by lowering the temperature of the operating liquid. However in most cases, the low ultimate pressure is not required and cavitation shall be avoided by means of vacuum limitation rather than temperature reduction.

8 Maintenance



DANGER

Live wires.

Risk of electrical shock!

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



WARNING



The machine is 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!

- Before doing anything that requires touching the machine, let it cool down first.



CAUTION

Hot liquids.

Risk of burns!

- Before draining liquids, let the machine cool down first.

- Stop the machine and lock it to prevent accidental start-up.
- Switch off the operating liquid system.
- Vent the connected lines to atmospheric pressure.

If necessary:

- Drain the operating liquid
- 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 individually 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	• Check for abnormal noise, see <i>Troubleshooting</i> [→ 28]. • Check for excessive vibration, see problem “Vibration is high” in chapter <i>Troubleshooting</i> [→ 28]. • Check the operating liquid temperature, see Operating Liquid Connection. • Check the machine for liquid leaks - in case of leaks have the machine repaired (contact Busch). • If applicable, check gland packing leakage rate (45 to 60 drips per minute) and adjust as required.
Every 2500 operating hours	• Regrease the bearings. The amount of grease accounts for 2/3 of the free space of the bearing chamber. • Check the tension on the v-belt (if applicable).
Every year	• 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. • If applicable, gland packing has to be replaced annually or sooner if readjustment is no longer possible. If an inlet screen or filter is installed: • Check it and clean if necessary.
Every 5 years	• Have a major overhaul (contact the manufacturer).

9

Overhaul

**WARNING**

The machine is contaminated with hazardous material.

Risk of poisoning!

Risk of infection!

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.

**NOTICE**

Incorrect assembly.

Risk of premature failure!

Loss of efficiency!

- Any disassembly of the machine beyond that described in this manual must be carried out by technicians approved by Busch.

If the machine has conveyed gas contaminated with foreign materials which are hazardous to health:

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

The manufacturer will only accept machine accompanied by a signed, fully completed and legally binding "declaration of contamination", downloadable from the following link: buschvacuum.com/declaration-of-contamination.

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!

- Before doing anything that requires touching the machine, let it cool down first.



CAUTION

Hot liquids.

Risk of burns!

- Before draining liquids, let the machine cool down first.
- Stop the machine and lock it to prevent accidental start-up.
- Disconnect the power supply.
- Vent the connected lines to atmospheric pressure.
- Disconnect all connections.

If the machine is 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!

- Use only Busch genuine spare parts, consumables and supplies to ensure correct operation of the machine and to validate the warranty.

Spare parts kit	Description	Part no.
Service kit for: LG 0890 A LR 0700 A	Intended for standard applications 1 x V-150S V-ring 2 x V-160S V-rings 2 x 28mm ball valves 2 x flexible valve plates 2 x 205mm x 5.7mm O-rings	0993 700 534
Service kit for: LG 1200 A LR 1190 A	Intended for standard applications 1 x V-170S V-ring 2 x V-190S V-rings 2 x 28mm ball valves 2 x flexible valve plates 2 x 218mm x 5.3mm O-rings	0993 700 535
Service kit for: LG 1910 A LR 1560 A	Intended for standard applications 1 x V-190S V-ring 2 x V-220A V-rings 2 x 28mm ball valves 2 x flexible valve plates 2 x 255mm x 5.0mm O-rings	0993 700 536
Service kit for: LG 2680 A LR 2200 A	Intended for standard applications 1 x V-220A V-ring 2 x V-250A V-rings 2 x 28mm ball valves 2 x flexible valve plates 2 x 280mm x 5.0mm O-rings	0993 700 537

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.	Check the power supply.
	Corrosion between the rotor and the housing.	- Eliminate by use of anti-corrosion liquid. - Repair the machine (contact Busch).
	Solid foreign matter has entered the machine.	- Remove the solid foreign matter or repair the machine (contact Busch). - Install an inlet screen if necessary.
	Ice in the machine, the operating liquid has frozen.	- Carefully warm up the machine. - Defrost the operating liquid.
	The motor is defective.	Replace the motor.
	Water level too high inside when starting	Start with the water level specified.
	Packing gland too tight	Loosen the gland adequately.
	Belt too tight	Loosen the belt adequately.
	Wear developing in the pump	Turn the impeller with force and flush with water.
	Discharge pressure too high	Make sure the vent line is free of restrictions and is at least same size as pump connection.
Pump trip	If seized during commissioning, welding slag or other foreign matter may have been drawn in from new pipes with incoming gas.	Flush the machine and check rotation by hand. If trouble persists, contact Busch.
	Heavy lime deposit build-up	Flush the machine and check rotation by hand. If trouble persists, contact Busch.
	Discharge pressure too high	Make sure the vent line is free of restrictions.

Problem	Possible Cause	Remedy
The machine does not reach the usual pressure on the inlet connection.	Inlet or discharge lines too long or section diameter too small.	• Use larger diameter or shorter lines. • Seek advice from your local Busch representative.
	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 volume flow deteriorate)	• Reduce the temperature of the operating liquid or adjust the flow of operating liquid.
	The mechanical seal leaks.	• Repair the machine (contact Busch).
	Partial clogging in the inlet, discharge or pressure line.	• Remove the blockage.
	If an inlet screen is installed, it can be partially clogged.	• Clean the inlet screen.
	Internal parts are worn or damaged.	• Repair the machine (contact Busch).
	Excessive leakage from the gland packing.	• Tighten the packing gland
	Speed low due to slippage of the belt.	• Tighten the belt.
	Heavy lime deposits in the pump.	• Remove the lime deposit.
	Leakage occurring in the system.	• Check the joints are sealed sufficiently.
	Excessive clearance in the pump due to corrosion or corrosive substances in the medium.	• Clean the medium preventing solids from entering and replace the worn parts.
	Axial clearance not conforming with the requirements following a repair.	• Recalibrate the axial clearance.

Problem	Possible Cause	Remedy
The machine runs very noisily or rattles.	The operating liquid level is too high.	Adjust the regulating valves to drain the machine down to center line.
	Density or viscosity of the operating liquid too high.	- Check Operating Liquid Settings. - Provide a different operating liquid or a stronger drive motor.
	The machine runs in the wrong direction.	Check the direction of rotation, see <i>Wiring Diagram Three-Phase Motor</i> [→ 19].
	Defective bearings.	Repair the machine (contact Busch).
	The machine cavitates (periodic formation and collapsing of steam bubbles in the operating liquid).	- Consult the chapter <i>Preventing Cavitation</i> [→ 22]. - Adjust cooling liquid flow rate to reduce the temperature of the operation liquid.
	Worn coupling element.	Check the coupling and repair it if necessary.
	Belts loose.	Tighten the belts.
	Inlet and discharge piping is too thin.	Use thicker piping.
The machine runs too hot.	Insufficient air ventilation.	- Make sure that the cooling of the machine is not impeded by dust/dirt. - Clean the fan cowling, the fan, the ventilation grill and the cooling fins of the motor.
	Ambient temperature too high.	Observe the permitted ambient temperature, see <i>Technical Data</i> [→ 32].
	Temperature of the process gases at the inlet too high.	Observe the permitted gas inlet temperature, see <i>Technical Data</i> [→ 32].
	Insufficient gas transfer.	Introduce a suitable inert gas or air via the anti-cavitation connection.
	Partial blockage in the inlet, discharge or pressure line.	Remove the blockage.
Bearing temperature too high.	Belts are too tight.	Loosen the belts.
	Alignment fail.	Adjust alignment.
	Bearing lubricated insufficiently, the grease is dry or there is too much.	Ensure the bearings are lubricated sufficiently.
	The bearings have been installed incorrectly.	Reinstall the bearings.
	Bearing is damaged.	Replace the damaged bearing.

Problem	Possible Cause	Remedy
Vibration is high.	Loose contact between the baseplate and the foundation, or the anchor bolts are loose.	Fill the space with concrete, tighten the anchor bolts.
	Alignment fail.	Adjust alignment.

13 Technical Data

		LG 0890 A	LG 1200 A
Nominal pumping speed	m ³ /h	6000 / 8900	7650 / 12000
Ultimate pressure	hPa (mbar) abs.	160	
Max. overpressure	bar(g)	0.2 *	
Nominal motor rating	kW	132 / 160 / 185 / 200 / 220	160 / 185 / 220 / 250 / 280
Nominal rotational speed	min ⁻¹	330 / 372 / 420 / 472 / 490	266 / 298 / 330 / 372 / 420
Sound pressure level (ISO 3744), 1 m distance, at medium load	dB(A)	< 85	
Vibration velocity (rms)	mm/s (in/s)	≤ 4.5 (≤ 0.18)	
Maximum allowable gas inlet temperature	°C	Gas dry at 120	
		Gas saturated at 100	
Ambient temperature	°C	5 ... 40	
Relative humidity	at 30°C	90 %	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See <i>Operating Liquid Settings</i> [→ 14]	
Weight approx. without motor (bare shaft machine) – cast iron / full stainless steel	kg	3880 / 4150	5760 / 6165
Dimensions (L x W x H) – bare shaft machine	mm	2370 x 1330 x 1865	2500 x 1550 x 2160

* Consult Busch for pressures outside this range.

		LG 1910 A	LG 2680 A
Nominal pumping speed	m ³ /h	11550 / 19100	16160 / 26800
Ultimate pressure	hPa (mbar) abs.	160	
Max. overpressure	bar(g)	0.2 *	
Nominal motor rating	kW	220 / 280 / 315 / 355 / 450 / 500	315 / 355 / 400 / 500 / 560 / 650
Nominal rotational speed	min ⁻¹	236 / 266 / 298 / 330 / 372 / 398	197 / 210 / 236 / 266 / 298 / 330
Sound pressure level (ISO 3744), 1 m distance, at medium load	dB(A)	< 85	
Vibration velocity (rms)	mm/s (in/s)	≤ 4.5 (≤ 0.18)	
Maximum allowable gas inlet tem- perature	°C	Gas dry at 120	
		Gas saturated at 100	
Ambient temperature	°C	5 ... 40	
Relative humidity	at 30°C	90 %	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See <i>Operating Liquid Settings</i> [→ 14]	
Weight approx. without motor (bare shaft machine) – cast iron / full stainless steel	kg	8930 / 9560	12750 / 13650
Dimensions (L x W x H) – bare shaft machine	mm	2732 x 1785 x 2560	3191 x 2065 x 2965

* Consult Busch for pressures outside this range.

		LR 0700 A	LR 1190 A
Nominal pumping speed	m ³ /h	4920 / 7000	6700 / 11900
Ultimate pressure	hPa (mbar) abs.	33	
Max. overpressure	bar(g)	0.2 *	
Nominal motor rating	kW	110 / 132 / 160 / 185 / 200	160 / 160 / 185 / 220 / 280 / 355
Nominal rotational speed	min ⁻¹	330 / 372 / 420 / 472 / 490	266 / 298 / 330 / 372 / 420 / 472
Sound pressure level (ISO 3744), 1 m distance, at medium load	dB(A)	< 85	
Vibration velocity (rms)	mm/s (in/s)	≤ 4.5 (≤ 0.18)	
Maximum allowable gas inlet temperature	°C	Gas dry at 120	
		Gas saturated at 100	
Ambient temperature	°C	5 ... 40	
Relative humidity	at 30°C	90 %	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See <i>Operating Liquid Settings</i> [→ 14]	
Weight approx. without motor (bare shaft machine) – cast iron / full stainless steel	kg	3750 / 4050	5390 / 5770
Dimensions (L x W x H) – bare shaft machine	mm	2020 x 1350 x 1865	2258 x 1550 x 2160

* Consult Busch for pressures outside this range.

		LR 1560 A	LR 2200 A
Nominal pumping speed	m ³ /h	9500 / 15600	14100 / 22000
Ultimate pressure	hPa (mbar) abs.	33	
Max. overpressure	bar(g)	0.2 *	
Nominal motor rating	kW	220 / 250 / 280 / 315 / 400 / 450	315 / 355 / 400 / 500 / 600
Nominal rotational speed	min ⁻¹	236 / 266 / 298 / 330 / 372 / 398	210 / 236 / 266 / 298 / 330
Sound pressure level (ISO 3744), 1 m distance, at medium load	dB(A)	< 85	
Vibration velocity (rms)	mm/s (in/s)	≤ 4.5 (≤ 0.18)	
Maximum allowable gas inlet tem- perature	°C	Gas dry at 120	
		Gas saturated at 100	
Ambient temperature	°C	5 ... 40	
Relative humidity	at 30°C	90 %	
Ambient pressure		Atmospheric pressure	
Operating liquid requirements (once through operation only)		See <i>Operating Liquid Settings</i> [→ 14]	
Weight approx. without motor (bare shaft machine) – cast iron / full stainless steel	kg	8340 / 8940	12000 / 12840
Dimensions (L x W x H) – bare shaft machine	mm	2512 x 1785 x 2560	2891 x 2065 x 2965

* Consult Busch for pressures outside this range.

14 EU Declaration of Conformity

This Declaration of Conformity and the CE-markings affixed to the name plate 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: vacuum pump DOLPHIN LG 0890 A; DOLPHIN LG 1200 A; DOLPHIN LG 1910 A; DOLPHIN LG 2680 A; DOLPHIN LR 0700 A; DOLPHIN LR 1190 A; DOLPHIN LR 1560 A; DOLPHIN LR 2200 A

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

- 'Machinery Directive' 2006/42/EC, if the serial number is less than or equal to UKM126999999
- 'Machinery Regulation' (EU) 2023/1230, if the serial number is greater than or equal to UKM127000000
- 'Electromagnetic Compatibility' (EMC) 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)

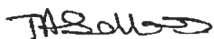
and comply(-ies) with the following harmonized standards that have been used to fulfill those provisions:

Standard	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN ISO 13857 : 2020	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN ISO 3744 : 2010	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
EN 61326-1 : 2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
EN 61010-1 : 2020	Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements
ISO 21940-1 : 2019	Mechanical vibration – Rotor balancing
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
EN IEC 61000-6-4 : 2020	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
EN 61000-3-3 : 2020	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
ISO 21360-1 : 2016	Vacuum technology - Standard methods for measuring vacuum-pump performance - Part 1: General description
ISO 21360-2 : 2020	Vacuum technology - Standard methods for measuring vacuum-pump performance - Part 2: Positive displacement vacuum pumps

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, 01.02.2024



Tracey Sellars, General Manager

Busch GVT Ltd.

15 UK Declaration of Conformity

This Declaration of Conformity and the UKCA-markings affixed to the name plate 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: vacuum pump DOLPHIN LG 0890 A; DOLPHIN LG 1200 A; DOLPHIN LG 1910 A; DOLPHIN LG 2680 A; DOLPHIN LR 0700 A; DOLPHIN LR 1190 A; DOLPHIN LR 1560 A; DOLPHIN LR 2200 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 2012

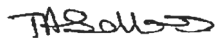
and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

Standard	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN ISO 13857 : 2020	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN ISO 3744 : 2010	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
EN 61326-1 : 2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
EN 61010-1 : 2020	Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements
ISO 21940-1 : 2019	Mechanical vibration – Rotor balancing
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
EN IEC 61000-6-4 : 2020	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
EN 61000-3-3 : 2020	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
ISO 21360-1 : 2016	Vacuum technology - Standard methods for measuring vacuum-pump performance - Part 1: General description
ISO 21360-2 : 2020	Vacuum technology - Standard methods for measuring vacuum-pump performance - Part 2: Positive displacement vacuum pumps

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, 01.02.2024



Tracey Sellars, General Manager

Busch GVT Ltd.

Notes

Grid of dots for notes.

BUSCH GROUP

The Busch Group is one of the world's largest manufacturers of vacuum pumps, vacuum systems, blowers, compressors and gas abatement systems. Under its umbrella, the group houses two well-known brands: Busch Vacuum Solutions and Pfeiffer Vacuum+Fab Solutions. Together, they offer solutions to a wide range of industries. A global network of highly competent local teams in 44 countries ensures that expert, tailor-made support is always available near you. Wherever you are. Whatever your business.



● Busch Group companies

▲ Busch Group production sites

● Busch Group service centers

■ Busch Group local representatives

www.buschvacuum.com

www.pfeiffer-vacuum.com